GREEN HILL
SOLAR FARM

Green Hill Solar Farm
EN010170

Environmental Statement
Appendix 21.1: High-Level Electromagnetic Field Assessment

Prepared by: Pager Power

Date: May 2025

Document Reference: APP/GH6.3.21.1

APFP Regulation 5(2)(a)

PAGERPOWER
Urban & Renewables

Electromagnetic Field Assessment

Green Hill Solar Farm

May 2025





ADMINISTRATION PAGE

Job Reference:	12512B
Author:	[redacted]
Telephone:	[redacted]
Email:	[redacted]pagerpower.com

Reviewed By:	[redacted]
Email:	[redacted]pagerpower.com

Issue	Date	Detail of Changes
1	March 2024	Initial issue
2	May 2024	Consideration of the updated electrical design
3	June 2024	Minor amendments
4	July 2024	Minor amendments
5	October 2024	Minor amendments
6	October 2024	Minor amendments
7	March 2025	Consideration of the finalised electrical design
8	April 2025	Minor updates
9 - 10	May 2025	Minor updates

Stour Valley Business Centre, Brundon Lane, Sudbury, CO10 7GB

T: +44 (0)1787 319001 E: info@pagerpower.com W:[redacted]

EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the potential electromagnetic fields generated by electrical equipment within a ground-mounted solar photovoltaic development with respect to safe levels for human exposure. The Scheme is located between Northampton and Wellingborough, Northamptonshire, England, and will include underground power cables, transformers, photovoltaic (PV) inverters, substations and a Battery Energy Storage System (BESS).

Emissions

All electrical equipment emits electric and magnetic radiation. Power cables produce both electric and magnetic fields which can potentially affect human health. Radiation from underground cables is generally less than radiation from overhead powerlines because emissions from adjacent conductors within a cable tend to cancel each other out. When assessing the impacts of overhead power lines, it is important to consider the impact of both electric and magnetic fields. Underground cables generally cause a negligible electric field above ground but can cause a significant magnetic field which is dependent on the current in the conductors.

Standards in the UK

The UK Policy on public exposure limits to Electromagnetic Fields (EMF) radiation is designed to comply with the 1998 ICNIRP (International Commission on the Non-Ionizing Radiation Protection) guidelines in terms of the 1999 EU Recommendation. In 2010 ICNIRP produced new guidelines but these have not yet been incorporated into UK Policy. The public exposure limits in UK policy define reference levels for electric and magnetic fields. Where field levels exceed these reference levels in significantly occupied spaces, further investigation is warranted. Further information can be found in section 3 of the report.

Overall Conclusion

Maximum electromagnetic radiation levels from the proposed underground cables are predicted to be below ICNIRP reference levels for single circuit configurations, but some cumulative trench configurations slightly exceed the limit. A 5m clearance distance is recommended, and all dwellings located over 17m away from the Order Limits, ensuring no significant impacts.

Radiation from the transformers and PV inverters will be even less significant due to protective enclosures and 'CE' marking (Conformité Européene, or European Conformity marking), and/or 'UKCA' marking (UK Conformity Assessed), ensuring compliance with electromagnetic disturbance standards.

Additionally, radiation from the substations and BESS will not be significant, as they will be located at least 170m from any surrounding dwellings. For users of Public Rights of Way (PRoWs), any radiation effects are expected to be minimal due to their transient exposure.

33kV to 400kV Underground Cables

The maximum magnetic field produced by the proposed underground cables (33kV to 400kV) in single circuit configurations is predicted to be 96.17 micro-Tesla, which is below the 100 micro-Tesla public exposure reference level. However, some cumulative trench configurations with multiple high-voltage cables slightly exceed the reference limit, reaching up to 102.18 micro-Tesla.

To mitigate this, a 5m clearance distance is recommended for these sections, as receptors beyond this distance will not experience magnetic fields exceeding the reference levels. The closest identified dwellings to the cable route centreline are located much further than this at over 17m away, which is a safe distance, given that electromagnetic field strength decreases exponentially with distance.

For users of PRoWs, any radiation effects are expected to be minimal due to their transient exposure as these are not continually occupied, rather they are moving receptors, as opposed to residential dwellings and workplaces.

Therefore, no significant impacts associated with the proposed underground cables are predicted.

Transformers, and PV Inverters

Notable sources of radiation other than the cables will be the conversion units (transformers/PV inverters) positioned across the Scheme.

The electrical equipment associated with the transformers and PV inverters will be ‘CE’ marked (Conformité Européene, or European Conformity marking), and/or ‘UKCA’ marked (UK Conformity Assessed). CE and UKCA markings indicate that a product has been assessed by the manufacturer and determined to meet the safety, health, and environmental protection requirements of the European Union and the United Kingdom, respectively. CE marking requirements were adopted and extended indefinitely in Great Britain until the UK left the EU in 2020. From 1 January 2021, the UKCA mark started to replace the CE mark for goods sold within Great Britain, and the CE mark has continued to be required for goods sold in Northern Ireland. The CE marking should ensure that electrical and electronic equipment does not generate, or is not unintentionally affected by, electromagnetic disturbance.

The transformers and PV inverters are also predicted to produce fields at a lower level than that of underground cables because the equipment is typically housed in protective enclosures. Therefore, no significant impacts associated with the proposed conversion units are predicted.

Substations and BESS

The Scheme will connect to Grendon Substation (an existing National Grid distribution substation). According to UK regulation, the substation conforms with the applicable exposure limitations for the general public, and the field from the equipment inside a substation does not extend far, if at all, outside the perimeter fence. Additionally, the Scheme will include connection to up to two 400kV substations located at Green Hill C and Green Hill BESS, along with up to five 132kV and a number of substations positioned throughout the Scheme. Electrical equipment associated with these substations will be 'CE' or ‘UKCA’ marked and housed in protective enclosures and thus predicted to produce fields at a lower level than that of underground cables. Additionally, the perimeters of Grendon Substation and the proposed 400kV substations are more than 170m from any identified dwelling and comply with public exposure limits, as electromagnetic fields from the equipment do not extend significantly beyond the perimeter fence.

The BESS contributes to the electromagnetic radiation produced by the Scheme. The preferred location for the BESS is at Green Hill BESS as shown in Figure 3.1, however BESS may also or alternatively be located on Green Hill C. The potential BESS locations at Green Hill BESS and Green Hill C are situated more than 170m from any identified dwelling. As electromagnetic radiation levels reduce with increased distance, all nearby dwellings and workplaces are expected to be situated at a safe distance from the BESS installations.

LIST OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 62 countries internationally.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems. Over the years, the company has expanded into numerous fields including:

- Renewable energy projects;
- Building developments;
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable, and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny and the company can provide support for a project at any stage.

1 INTRODUCTION

1.1 Purpose of the Study

Pager Power has been retained to assess the potential electromagnetic fields generated by electrical equipment within a fixed ground-mounted solar photovoltaic development, with respect to safe levels for human exposure. The Scheme is located between Northampton and Wellingborough, Northamptonshire, England, and will consist of underground power cables, transformers, photovoltaic (PV) inverters, substations and Battery Energy Storage System (BESS).

1.2 Scheme Site Areas

Figure 1 below shows the site areas (purple), the cable route corridor (pink), and potential alternative cable routing options (yellow) for the Scheme.

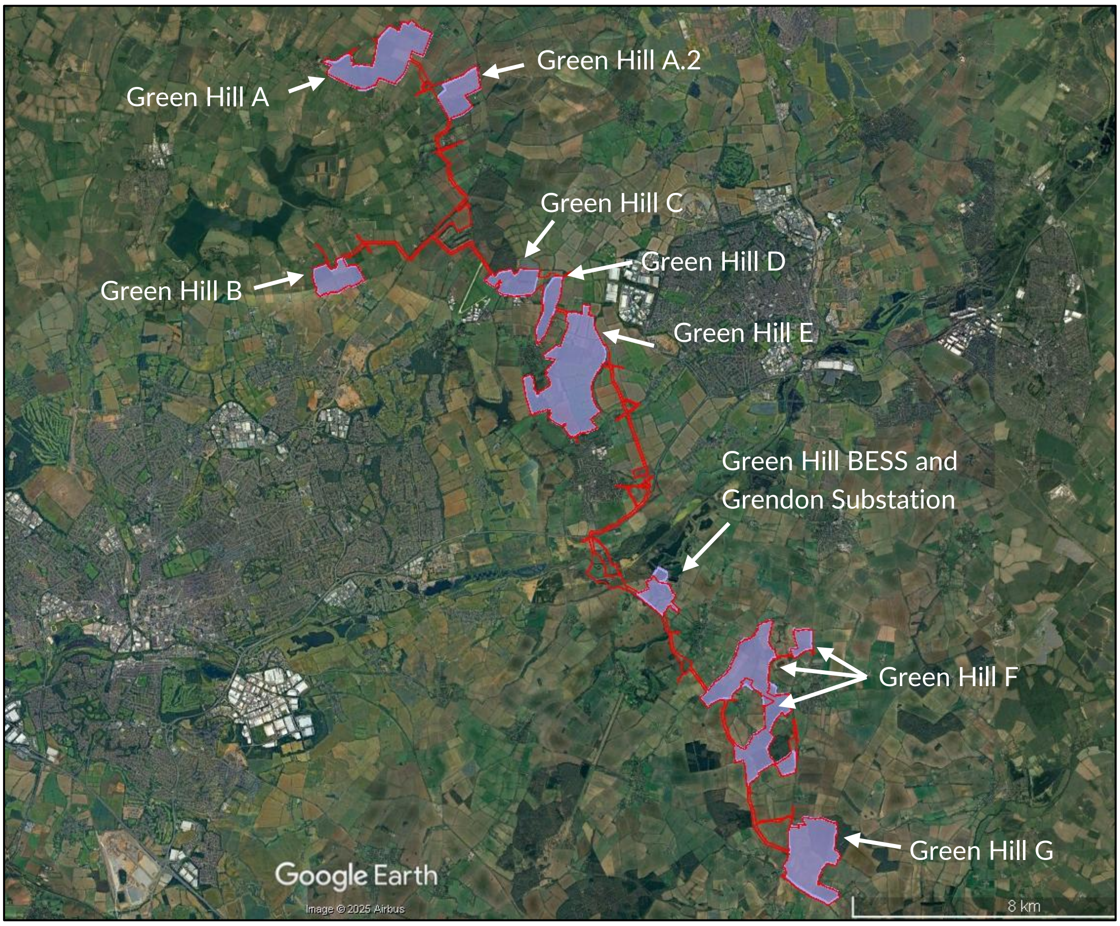

Figure 1 *Scheme site areas and cable route*

1.3 Assessed Infrastructure

The known locations of assessed infrastructure are shown in Figure 2 on the following page:

- Approximate proposed solar array footprint (dark blue polygons);
- All proposed underground cable route corridors (pink lines);
- Possible rerouting of the underground cable route (yellow lines);
- PV inverters/transformers (circular icons);
- Substations (green areas); and
- BESS (light blue areas).

Following this, Figures 3 to 6 present close-up views of specific areas for further clarity.

Assessment of the proposed underground cable routes are based on the cable route centreline, as this is most representative of the likely impacts. Where setback distances are recommended, it will be ensured that the final cable route is located outside of the relevant setbacks.

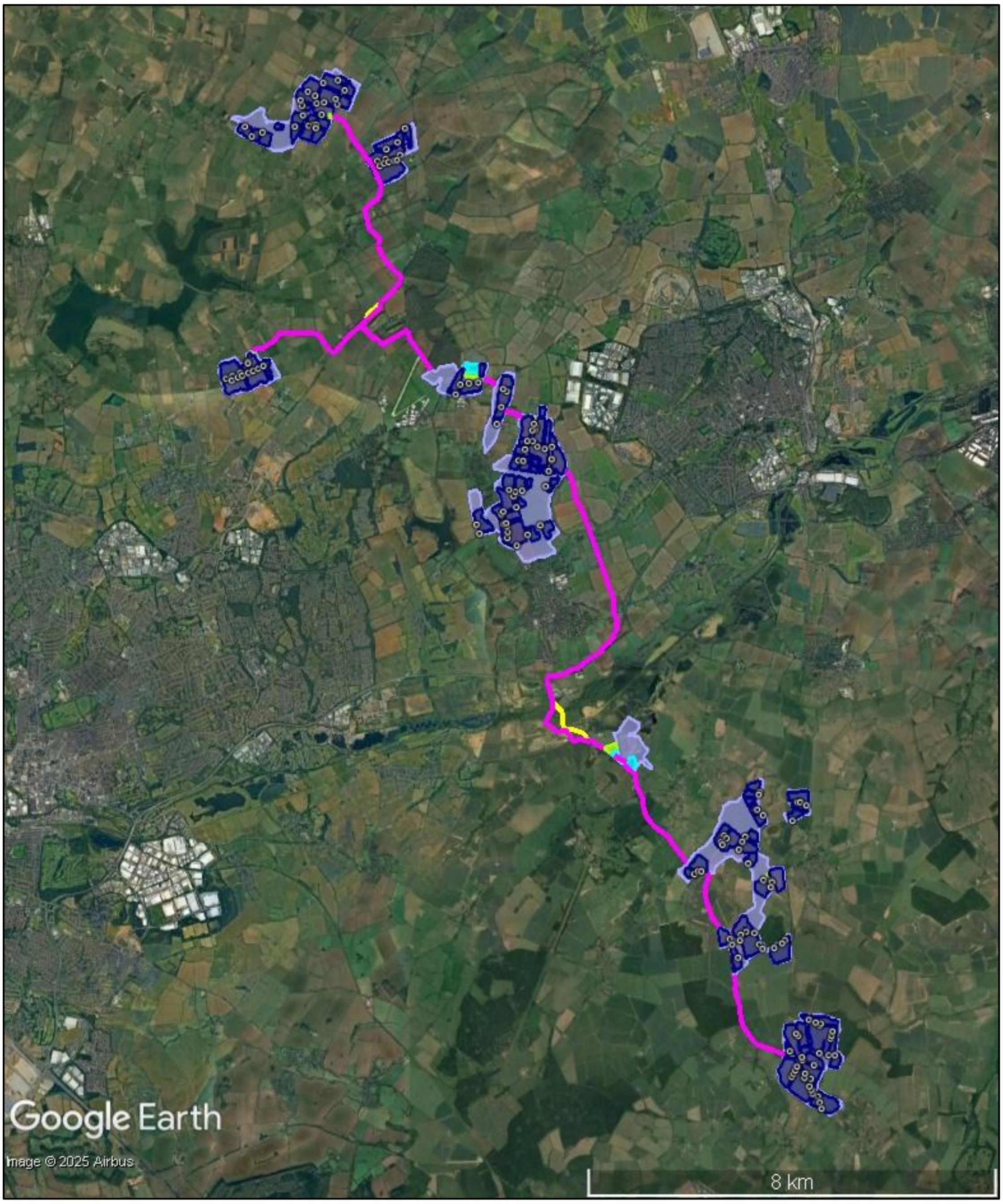

Figure 2 *Assessed infrastructure locations*

Figure 3 *Assessed infrastructure locations – Green Hill A and A.2*

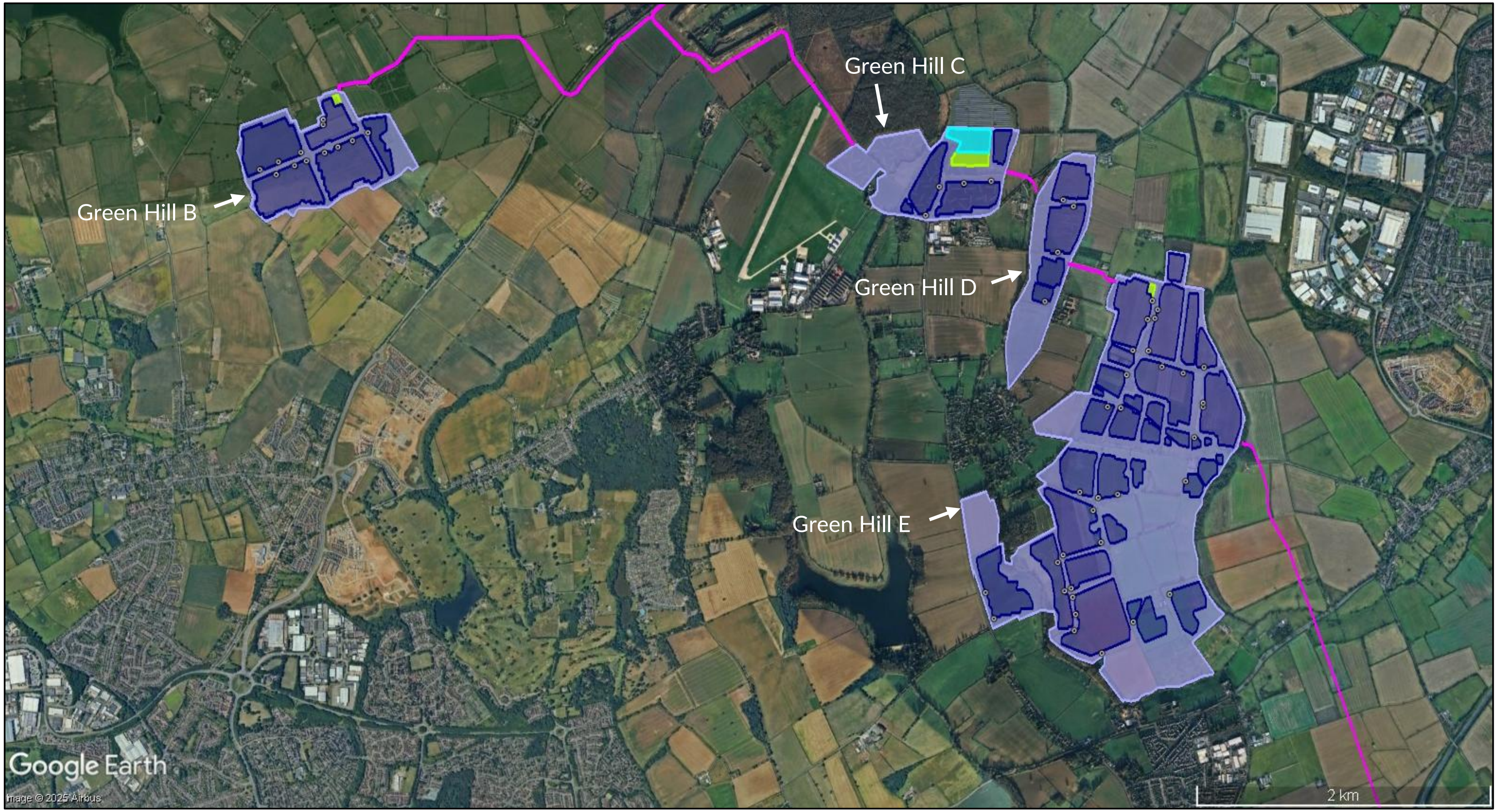

Figure 4 *Assessed infrastructure locations – Green Hill B, C, D and E*

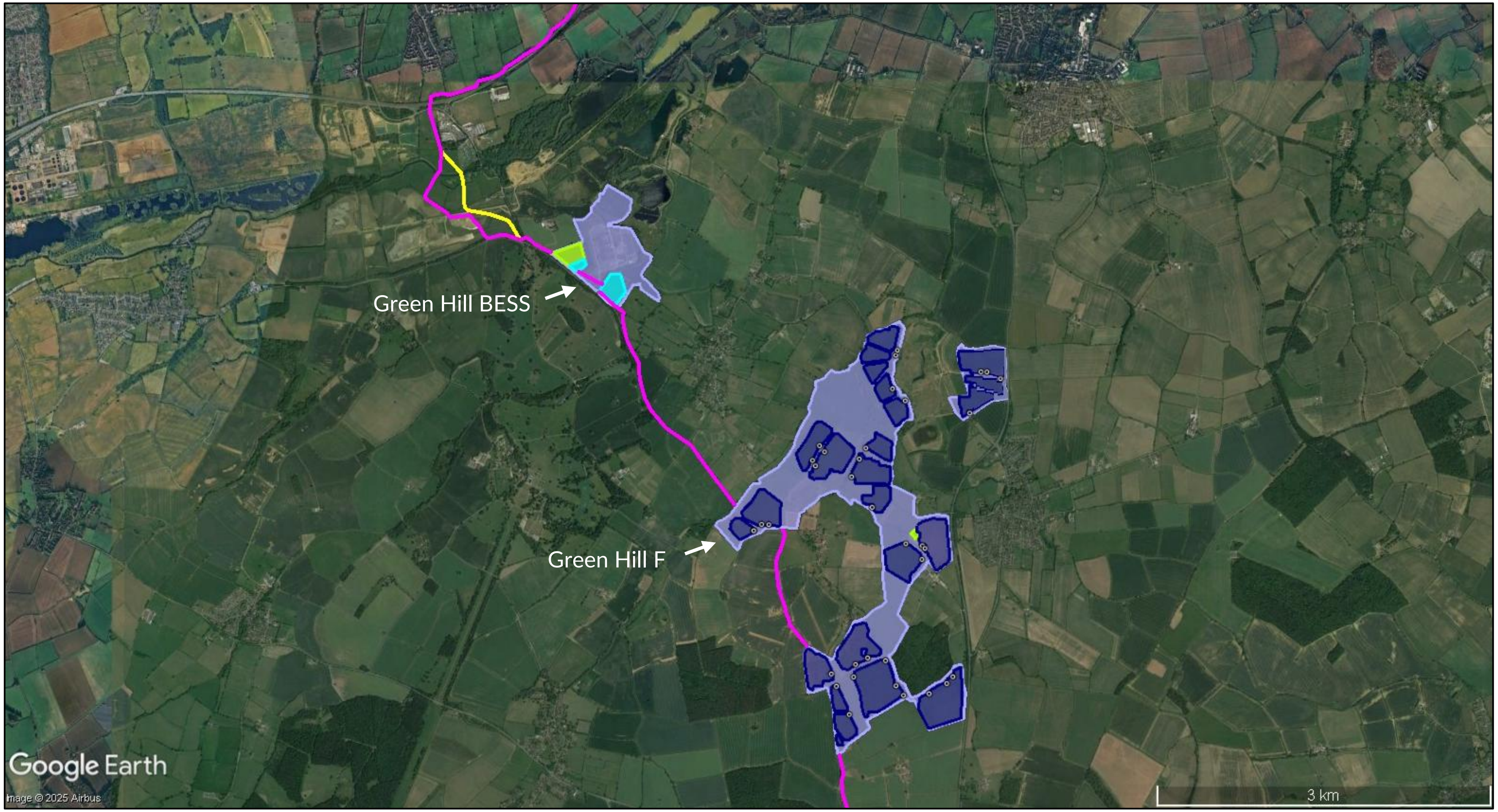

Figure 5 *Assessed infrastructure locations – Green Hill BESS and F*

Figure 6 *Assessed infrastructure locations – Green Hill F and G*

1.4 Assessed Infrastructure Technical Information

The technical information considered in this assessment is presented in Table 1 below. Table 2, on the following page, outlines the cable route information. Information in italics is to be confirmed and are subject to change as design progresses, but the worst case has been assumed for the purpose of this assessment.

Assessed Infrastructure Technical Information		
Underground cables	Voltages	33kV to 400kV cables
	Locations	Highlighted in Figures 1 to 6
	Minimum Depth	0.9m - subject to design and ground conditions
Substations	Voltages	Up to two 400kV substations, *up to five 132kV substations and 33kV substations*
	Proposed locations	Green Hill A: 132kV *Green Hill A.2: 33kV* Green Hill B: 132kV Green Hill C: 400kV *Green Hill D: 33kV* *Green Hill E: 132kV or 33kV substations* Green Hill F: 132kV Green Hill G: 132kV Green Hill BESS: 400kV
BESS	Proposed locations	Green Hill BESS site *and Green Hill C (optional)*
Conversion Units (Transformers and PV inverters)	Proposed locations	*Positioned across the Scheme*

Table 1 *Assessed infrastructure technical information*

<table>
<tr><th colspan="2">Cable Route Technical Information</th></tr>
<tr><th>Cable route locations</th><th>Trench configurations</th></tr>
<tr><td rowspan="2">Green Hill A to A.2</td><td>132kV 1 circuit</td></tr>
<tr><td>33kV 1 circuit</td></tr>
<tr><td>Green Hill A.2 to C</td><td>132kV 1 circuit</td></tr>
<tr><td>Green Hill B to C</td><td>132kV 1 circuit</td></tr>
<tr><td>Green Hill F to G</td><td>132kV 1 circuit</td></tr>
<tr><td>Green Hill C to A and B</td><td>132kV 2 circuits</td></tr>
<tr><td>Green Hill BESS to F and G</td><td>132kV 2 circuits</td></tr>
<tr><td>Green Hill BESS1 to F</td><td>132kV 2 circuits</td></tr>
<tr><td>Green Hill BESS1 to BESS2</td><td>33kV 10 circuits</td></tr>
<tr><td>Green Hill BESS to E</td><td>400kV 1 circuit</td></tr>
<tr><th colspan="2">Three 33kV substations at Green Hill E option</th></tr>
<tr><td rowspan="2">Green Hill C to D</td><td>400kV 1 circuit</td></tr>
<tr><td>33kV 5 circuits</td></tr>
<tr><td rowspan="2">Green Hill D to E</td><td>400kV 1 circuit</td></tr>
<tr><td>33kV 4 circuits</td></tr>
<tr><th colspan="2">132kV substation at Green Hill E option</th></tr>
<tr><td rowspan="3">Green Hill C to D</td><td>400kV 1 circuit</td></tr>
<tr><td>132kV 1 circuit</td></tr>
<tr><td>33kV 1 circuit</td></tr>
<tr><td rowspan="2">Green Hill D to E</td><td>400kV 1 circuit</td></tr>
<tr><td>132kV 1 circuit</td></tr>
</table>

Table 2 *Cable route technical information*

2 TECHNICAL BACKGROUND

2.1 Emissions

All electrical equipment emits electric and magnetic radiation. Power cables produce both electric and magnetic fields which can potentially affect human health. Radiation from underground cables is generally less than radiation from overhead lines because emissions from adjacent conductors within a cable tend to cancel each other out. When assessing the impacts of overhead powerlines, it is important to consider the impact of both electric and magnetic fields.

Underground cables generally cause a negligible electric field above ground but can cause a significant magnetic field which is dependent on the current in the conductors.

2.2 Electromagnetism

The movement of electric charge causes electric and magnetic fields to be produced in the space surrounding the charge. Human exposure to such fields can cause health problems if persistent and/or they are of high strength. The magnitude of the effects is dependent on both the field strength and the exposure time.

2.3 Health Concerns – Potential Effects

The potential effects on human health caused by time-varying magnetic fields, such as those generated by AC[1] cables, are due to induced current on functions of the central nervous system. There are various international bodies which provide maximum safe exposure levels to time varying electromagnetic fields.

Various sources of information relating to safe exposure levels have been reviewed as part of this study.

The UK Policy on public exposure limits to EMF radiation is designed to comply with the 1998 ICNIRP (International Commission on the Non-Ionizing Radiation Protection) guidelines in terms of the 1999 EU Recommendation. In 2010 ICNIRP produced new guidelines but these have not yet been incorporated into UK Policy. The public exposure limits in UK policy define reference levels for electric and magnetic fields. Where field levels exceed these reference levels in significantly occupied spaces, further investigation is warranted.

Another relevant resource consulted is the EMFs.info webpage[2], where the UK electricity industry have collected the relevant studies pertaining to safe limits on exposure in the UK and elsewhere in the world. The relevant sections are analysed in the next chapter.

---

[1] Alternating Current.

[2] Accessed 28th March 2024.

2.4 Radiation from Home Electrical Equipment

The World Health Organization (WHO) publishes data regarding electromagnetic fields including the following typical levels for home electrical equipment, shown in Table 3 below.

Appliance	Electric field strength (Volts per metre)	Magnetic field strength (micro-Tesla) (at 1 metre)
Hair Dryer	80	0.01 – 7
Iron	120	0.12 – 0.3
Vacuum Cleaner	50	2 – 20
Refrigerator	120	0.01 – 0.25
Television	60	0.04 - 2

Table 3 *Typical emissions from home electrical equipment*

2.5 Radiation Reduction with Distance

Radiation levels reduce with distance which means, for example, the typical magnetic field from a vacuum cleaner reduces from 800 micro-Tesla to 2 micro-Tesla when the separation distance increases from 3 centimetres to 100 centimetres.

This means radiation levels from the cables, transformers, PV inverters, substations and BESS will tend to reduce with distance in any direction – including towards a receptor.

3 OVERVIEW OF ELECTROMAGNETIC FIELDS

3.1 Overview

The Electricity Networks Association[3] provides a comprehensive overview of electromagnetic fields (EMFs) and the issues associated with these on their webpage[4]. Regarding health issues caused by EMFs they state the following:

However, there are suggestions that magnetic fields may cause other diseases, principally childhood leukaemia, at levels below these limits. The evidence for this comes from epidemiology studies, which have found a statistical association - an apparent two-fold increase in leukaemia incidence, from about 1 in 24,000 per year up to 1 in 12,000 per year, for the children with the top half percent of exposures. The evidence is strong enough for magnetic fields to be classified by the World Health Organization as "possibly carcinogenic". But because these studies only show statistical associations and do not demonstrate causation, and because the evidence from the laboratory is against, the risk is not established, it remains only a possibility.

3.2 Exposure limits in the UK

As set out in the previous section, the limits in the UK come from the 1998 ICNIRP guidelines. The original guidance in 1999 specified:

i) Basic Restrictions

   These are the levels at which radiation is potentially harmful to humans. This is a current density[5] given in mA m^{-2} (milliamps per metre squared).

ii) Reference Level (Investigation Level)

   Provided for practical exposure assessment purposes to determine whether the basic restrictions are likely to be exceeded. Compliance with the reference level will ensure compliance with the relevant basic restriction.

iii) Field Actually Required

   This is the field strength at which the basic restriction is likely to be exceeded.

The values for the above stated in the ICNIRP 1998 paper are shown in Table 4 on the following page. These are the public exposure values, not the occupational exposure values – the former is more conservative than the latter by a factor of five.

---

[3] This is an industry body for the companies which run the UK and Ireland's energy networks. The group comprises 14 members including National Grid.

[4] [redacted] [Accessed 28th March 2024].

[5] Current density is the amount of electric current flowing through a unit area.

ICNIRP 1998 – Public Exposure Limits				
Basic Restriction ($mA\ m^{-2}$)	Magnetic Fields Reference Level (µT)	Electric Fields Reference Level ($kV\ m^{-1}$)	Magnetic Field Actually Required to Exceed Basic Restriction (µT)	Electric Field Actually Required to Exceed Basic Restriction ($kV\ m^{-1}$)
2	100	5	360	9

Table 4 *ICNIRP Exposure Limits 1998*

The public exposure limits in Table 4 will be considered within this analysis.

3.3 Height Above Ground Used for Testing Compliance

EMFs.info specifically states the following with regard to the height to be used to test compliance:

The standard height for measuring fields, especially from power lines, is 1 m above ground level ... This isn't just because it's a convenient round number, it's because roughly half way up the height of a standing person is actually the height that gives the best approximation to the induced current in the body.

3.4 Safe Levels – Summary

The values of interest are those shown in Table 4 above. Effectively, this means that in locations of significant exposure time, such as residences, levels should be below:

- 100µT (magnetic fields).
- 5kV m^{-1} (electric fields).

Values exceeding the limits above, at one metre above ground level, would suggest that further investigation is required.

4 TECHNICAL ASSESSMENT

4.1 Field Levels – 400kV Underground Cables

Field level data from various cable configurations have been sourced from EMFS.info. The data below and on the following page shows the magnetic fields for 400kV cables, which represent the maximum assumed voltage for underground cables in the Scheme, considering a worst-case scenario. Typical values for magnetic fields are approximately a quarter of these maximum values[6]. The assessment accounts for varying cable voltages in the Scheme, with the analysis based on the maximum voltage and shallowest depths to adopt a conservative approach. Maximum field data has been used where possible to provide a more conservative assessment. It's important to note that there are no electric fields above ground associated with underground cables. The relevant chart is shown in Figure 7 below. Table 5 on the following page provides the associated indicative numerical values at set distances[7].

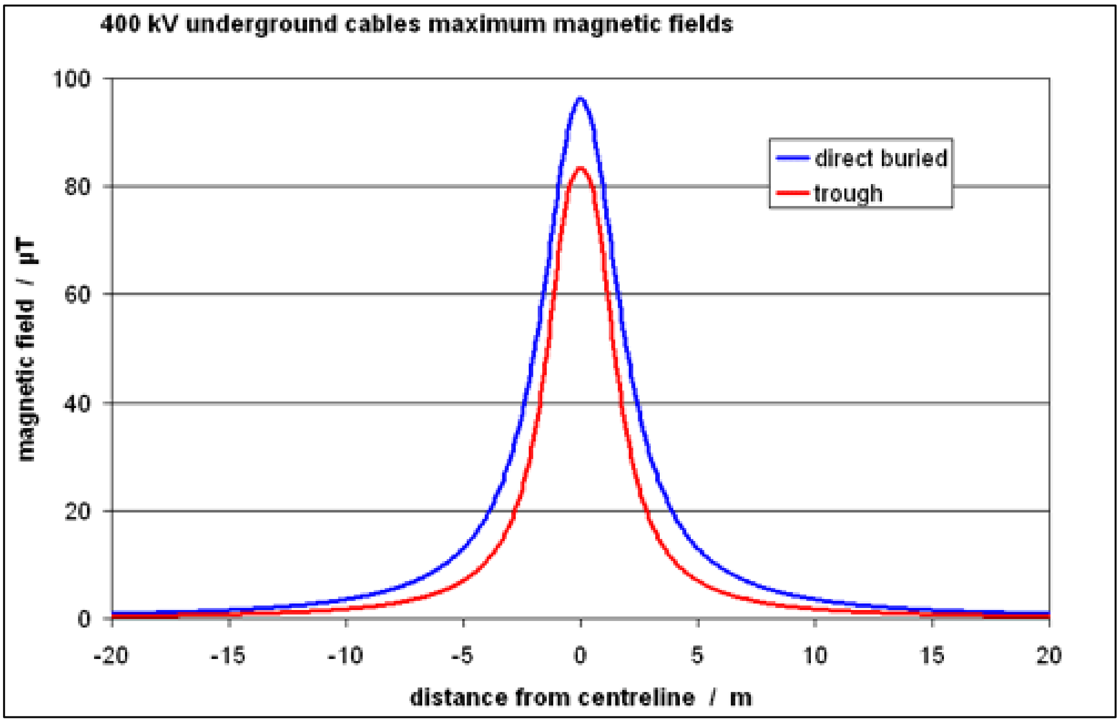

Figure 7 *Maximum magnetic fields associated with 400kV underground cables*

[6] Source: [redacted] [Accessed 28th March 2024].
[redacted] [Accessed 28th March 2024].

Distance from Centreline (m)	Magnetic Field (trough double circuit cable with 0.13m spacing and 0.3m depth)	Magnetic Field (direct buried single cable with 0.5m spacing and 0.9m depth)[8]
0	83.30 micro Teslas	96.17 micro Teslas
5	7.01 micro Teslas	13.05 micro Teslas
10	1.82 micro Teslas	3.58 micro Teslas
20	0.46 micro Teslas	0.92 micro Teslas

Table 5 *Maximum magnetic field levels for an underground 400kV cable*

4.2 Field Levels – 132kV Underground Cables

The data below and on the following page shows the magnetic fields for 132kV cables. Maximum field data has been used where possible to provide a more conservative assessment. The relevant chart for the magnetic fields associated with 132kV underground cables is shown in Figure 8 below. Table 6 on the following page provides the associated indicative numerical values at set distances.

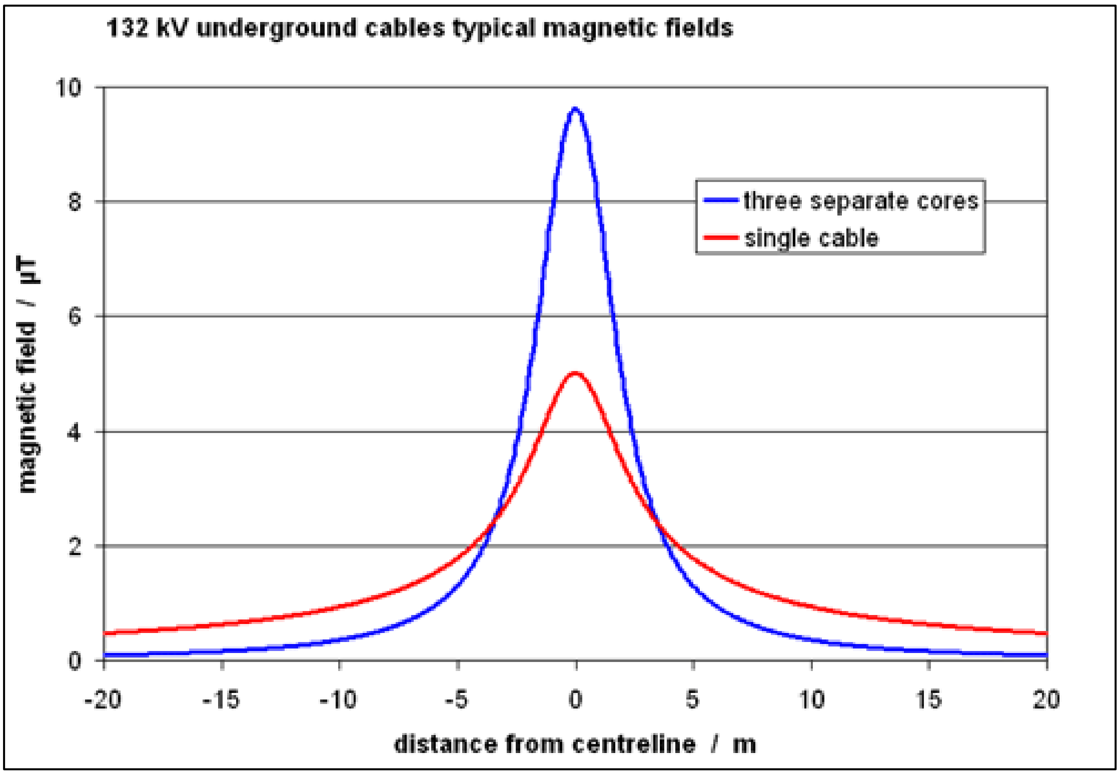

Figure 8 *Typical magnetic fields associated with 132kV underground cable*

[8] This cable was used for the assessment in the following sections.

Distance from Centreline (m)	Magnetic Field (single 132 kV cable at 1m depth)
0	5.01 micro-Tesla
5	1.78 micro-Tesla
10	0.94 micro-Tesla
20	0.47 micro-Tesla

Table 6 *Typical magnetic field levels for an underground 132kV cable*

4.3 Field Levels – 33kV Underground Cables

The data below shows the magnetic fields for 33 kV cables. The relevant chart for the magnetic fields associated with 33kV underground cables is shown in Figure 9 below. Table 7 below provides the associated indicative numerical values at set distances.

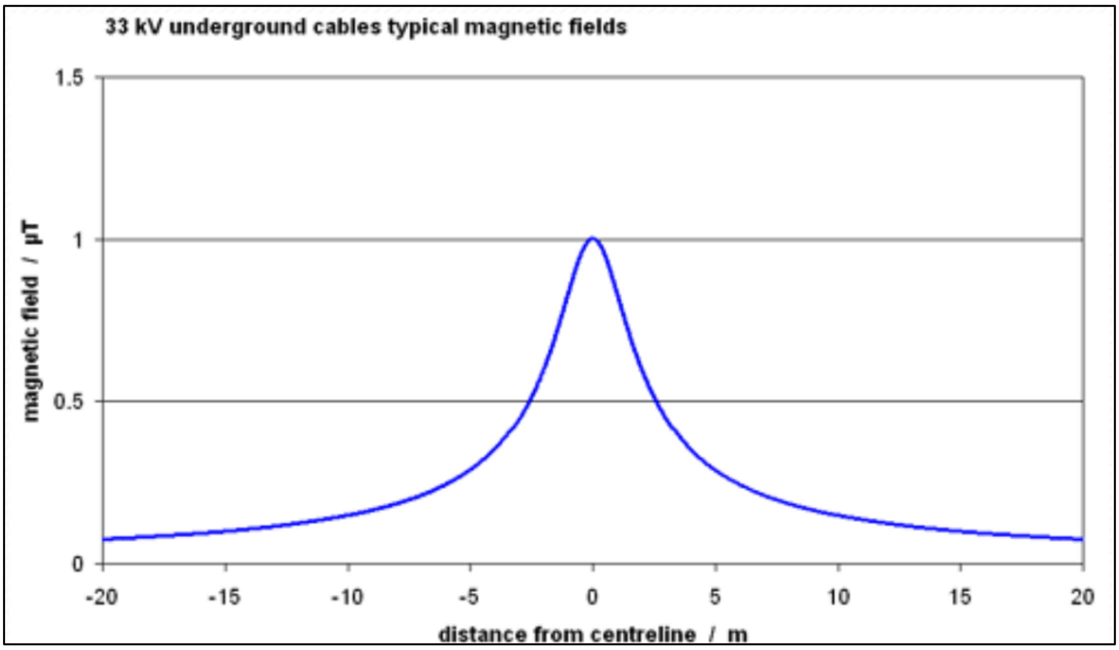

Figure 9 *Typical magnetic fields associated with 33 kV underground cable*

Distance from Centreline (m)	Magnetic Field (single 33 kV cable at 0.5m depth)
0	1.00 micro Teslas
5	0.29 micro Teslas
10	0.15 micro Teslas
20	0.07 micro Teslas

Table 7 *Typical magnetic field levels for an underground 33 kV cable*

4.4 Recommended Minimum Clearance Distances

The recommended minimum clearance distances for underground cables based on the public exposure limits previously referenced in this report for magnetic and electric fields are presented in Table 8 below.

The dataset provided maximum values and typical values for single circuit configurations of the cables that have been evaluated – in all cases the 'maximum' option has been chosen where possible in order to remain conservative.

Type of Line	Estimated Maximum Magnetic Field (micro-Tesla)	Recommended minimum Clearance Distance (m)	Estimated Maximum Electric Field (kV/m)
400kV underground cable	96.17 (below 100 limit)	None	-
132kV underground cable	5.01 (below 100 limit)	None	-
33 kV underground cable	1.00 (below 100 limit)	None	-

Table 8 *Recommended clearance distances for single circuit underground cables*

Table 8 confirms that clearance distances are not required for any proposed single-circuit underground cables. The table demonstrates that the maximum magnetic fields generated by these cables remain below the acceptable exposure limit, and no significant effects on human health are anticipated.

For the trench configurations outlined in Table 2 in Section 1.4 the worst case is based upon the addition of source a and source b; however, it is important to note that this is only true for magnetic fields that are exactly in line. When the electromagnetic fields are not in line, the sum of these is less than 'a+b'. The estimated maximum magnetic fields and associated recommended minimum clearance distances are outlined in Table 9 below and on the following page.

Cable route locations	Trench configurations	Estimated Maximum Magnetic Field (micro-Tesla)	Recommended minimum Clearance Distance (m)
Green Hill A to A.2	132kV 1 circuit 33kV 1 circuit	6.01 (below 100 limit)	None
Green Hill A.2 to C	132kV 1 circuit	5.01 (below 100 limit)	None

Cable route locations	Trench configurations	Estimated Maximum Magnetic Field (micro-Tesla)	Recommended minimum Clearance Distance (m)
Green Hill B to C	132kV 1 circuit	5.01 (below 100 limit)	None
Green Hill F to G	132kV 1 circuit	5.01 (below 100 limit)	None
Green Hill C to A and B	132kV 2 circuits	10.02 (below 100 limit)	None
Green Hill BESS1 to F and G	132kV 2 circuits	10.02 (below 100 limit)	None
Green Hill BESS1 to BESS2	33kV 10 circuits[9]	10.00 (below 100 limit)	None
Green Hill BESS to E	400kV 1 circuit	96.17 (below 100 limit)	None
Three 33kV substations at Green Hill E option			
Green Hill C to D	400kV 1 circuit 33kV 4 circuits	100.17 (above 100 limit)	5m
Green Hill D to E	400kV 1 circuit 33kV 3 circuits	99.17 (below 100 limit)	None
132kV substation at Green Hill E option			
Green Hill C to D	400kV 1 circuit 132kV 1 circuit 33kV 1 circuit	102.18 (above 100 limit)	5m
Green Hill D to E	400kV 1 circuit 132kV 1 circuit	101.18 (above 100 limit)	5m
Green Hill A to A.2	132kV 1 circuit 33kV 1 circuit	6.01 (below 100 limit)	None

Table 9 *Recommended clearance distances for assessed trench configurations*

[9] 12 cables may be needed, however these would be far below the threshold.

Three of the assessed trench configurations, of which a maximum of two are expected to proceed, exceed the ICNIRP 1998 public exposure reference limit for magnetic fields (100 µT). However, this remains well below the threshold of 360 µT required to exceed basic restrictions. A worst-case conservative assessment indicates that these exceedances are marginal and occur only for receptors with prolonged exposure directly above the cable route centreline.

A 5m clearance distance is recommended for these sections, as receptors beyond this distance are unlikely to experience magnetic fields exceeding the reference limits. A review of aerial imagery, as shown in Figure 10 below, confirms that the nearest dwelling is 17m from the cable route order limits. Given this separation, no significant impacts are predicted.

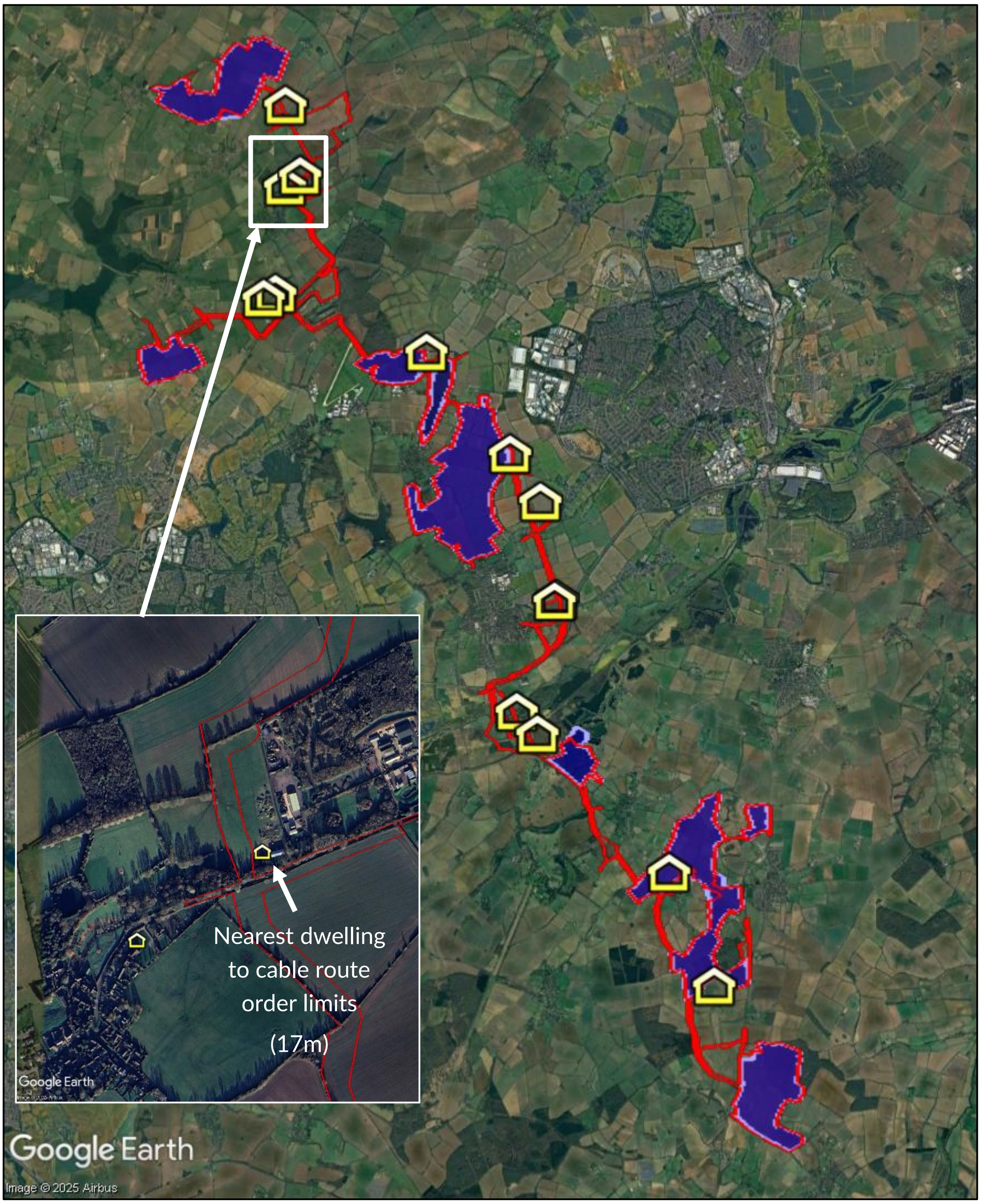

Figure 10 *Nearest dwellings to the assessed cable route*

4.5 Radiation from Other Components of the Scheme

4.5.1 Transformers and PV Inverters

Notable sources of radiation, other than the underground cables, will include the transformers and PV inverters positioned across the Scheme. As of the time of this report, the specific locations for these have not been finalised.

The transformers and PV inverters should be CE marked (Conformité Européene, or European Conformity marking), and/or 'UKCA' marked (UK Conformity Assessed). CE and UKCA marking indicates that a product has been assessed by the manufacturer and deemed to meet the safety, health and environmental protection requirements of the European Union[10] and the United Kingdom[11], respectively. CE marking requirements have been adopted and extended indefinitely in Great Britain until the UK left the EU in 2020. From 1 January 2021, the UKCA mark started to replace the CE mark for goods sold within Great Britain, and the CE mark has continued to be required for goods sold in Northern Ireland. This will be confirmed prior to installation.

The relevant EU Directive for CE marking is[12] Electromagnetic Compatibility Directive 2014/30/EU, and the relevant UK Statutory guidance for UKCA marking is the Electromagnetic Compatibility Regulations 2016[13]. This legislation should ensure that electrical and electronic equipment should not generate, or be affected by, electromagnetic disturbance.

Additionally, the transformers and PV inverters are also predicted to produce fields at a lower level than that of underground cables as the equipment will be housed in a protective enclosures.

4.5.2 Substations and BESS

Other notable sources of radiation associated with the Scheme include the substations and BESS. The favoured site for the BESS is Green Hill BESS Site surrounding Grendon Substation. Another potential site under consideration for a BESS is Green Hill C.

Furthermore, as detailed in Table 1 within Section 1.4, the Scheme will include connection to Grendon Substation and up to two 400kV substations (Green Hill BESS and Green Hill C) and up to five 132kV substations and up to five 33kV substations throughout the Scheme. The proposed locations of which are detailed in Section 1.

A detailed overview of the potential BESS locations (light blue) and proposed 400kV substations (green) Figures 11 and 12 on the following pages.

---

[10] Source: [redacted]

[11] Source: https://www.gov.uk/guidance/using-the-ukca-marking.

[12] Source: [redacted]

[13] Source: https://www.gov.uk/government/publications/electromagnetic-compatibility-regulations-2016/electromagnetic-compatibility-regulations-2016-great-britain.

Figure 11 *Minimum distance between BESS (Green Hill BESS parcel) and the nearest dwellings*

Figure 12 *Minimum distance between BESS (Green Hill C parcel) and the nearest dwellings*

The minimum horizontal distance between the proposed BESS in the Green Hill BESS parcel and any dwelling is approximately 170m, and 344m between the proposed BESS in Green Hill C and any dwelling.

Based on a desk-based review of imagery, there are overhead powerlines surrounding the Green Hill BESS parcel connecting to Grendon Substation. These are likely to be 400kV pylons. 400kV overhead powerlines would produce more significant electric and magnetic fields than any type of electrical infrastructure proposed as a part of this development. Therefore, the most significant source of radiation for these dwellings is the existing overhead powerlines[14] connecting to Grendon Substation. These dwellings are already considerably close to the existing substation and are in even closer proximity to the existing overhead power cables, which are a much more significant source of radiation. Additionally, the magnetic fields from the proposed underground cable routes have been assessed accordingly within this report for the nearest dwelling locations.

Similarly to the transformers and PV inverters, the additional and alternative proposed substations, ranging from 33kV to 400kV, are expected to be comprised of equipment that is 'CE' and/or 'UKCA' marked. CE and 'UKCA' marking should ensure that electrical and electronic equipment does not generate, or is not unintentionally affected by, electromagnetic disturbance. The substations are also predicted to produce fields at a lower level than that of underground cables because the equipment is expected to be housed in protective enclosures.

Significant radiation is not predicted from the existing substation, proposed substations and BESS because:

- The perimeters of Grendon Substation and the proposed 400kV substations are more than 185 metres from any dwelling and would be required to comply with the relevant exposure limits for the general public, and the electromagnetic fields from the equipment inside a substation do not extend far if at all outside the perimeter fence.
- The potential BESS locations in Green Hill BESS and Green Hill C are all more than 340 metres from any dwelling, meaning that all dwellings are at a safe distance as electromagnetic radiation levels reduce as the separation distance increases.
- For users of Public Rights of Way (PRoWs), any radiation effects would likely be minimal as these are not continually occupied, rather they are moving receptors, as opposed to residential dwellings and workplaces.

4.6 Comparative Assessment

The maximum magnetic field produced by household appliances like vacuum cleaners can reach up to 50 micro-Tesla[15]. It would follow that appliances with higher voltages would generate stronger magnetic fields. For instance, the proposed underground cables are projected to

[14] Understood to be 400kV.

[15] Source: [redacted]

produce a maximum magnetic field of 96.17 micro-Tesla. While this value is notably higher than that of household appliances, it remains within acceptable exposure limits. Notably, the magnetic field strength is expected to drop to approximately 13 micro-Tesla just 5 meters from the source for 400kV cables less than 1 meter deep; a value even less than that of a vacuum cleaner. With the confirmed depth of the high voltage 400kV underground cables being a minimum of 0.9 metres for the Scheme, a likely reduction in the strength of the magnetic field is predicted.

Moreover, the transformers and PV inverters will produce magnetic fields at levels lower than the underground cables.

4.7 Cumulative Effects

When assessing the cumulative effects of electromagnetic fields, the worst case is based upon the addition of source a and source b; however, it is important to note that this is only true for magnetic fields that are exactly in line. When the electromagnetic fields are not in line, the sum of these is less than 'a+b'.

For the purpose of this assessment the worst case has been calculated i.e. based upon 'a+b'. As there are no proposed overhead powerlines to consider for the Scheme, there are no cumulative effects to assess of this regard.

There are existing overhead lines in the baseline environment, particularly in the vicinity of Grendon Substation. Existing electrical infrastructure will comply with the ICNIRP reference levels and respect any required setback distances. Significant cumulative impacts are not predicted based on the relative locations of existing and proposed electrical infrastructure relative to the receptors.

As discussed in Section 4.5, the transformers, PV inverters, substations and BESS produce smaller magnetic fields than that of the underground cables, thus, considering all sources of radiation and their relative locations, it is predicted that the cumulative magnetic and electric fields are likely to be below the acceptable exposure limits.

The cumulative effects are not significantly impacted by the use of household items. Electrical household appliances will add to the overall exposure of electromagnetic fields; however, these levels will still remain below the recommended exposure limit, due to the lower voltages of the appliances, and are not used constantly, providing only a temporary addition to the resultant electromagnetic field levels.

It is not expected that there will be any significant cumulative effects with other known solar schemes. This is because of the substantial distances between the developments and the absence of any known possibility for high-voltage cables to overlap.

The electrical design is considering multiple high-voltage cables within a single trench along certain sections of the cable route. The cumulative resultant fields and associated set back distances have been assessed in Table 9 in Section 4.4.

5 CONCLUSIONS

5.1 33kV to 400kV Underground Cables

The maximum magnetic field produced by the proposed underground cables (33kV to 400kV) in single circuit configurations is predicted to be 96.17 micro-Tesla, which is below the 100 micro-Tesla public exposure reference level. However, some cumulative trench configurations with multiple high-voltage cables slightly exceed the reference limit, reaching up to 102.18 micro-Tesla.

To mitigate this, a 5m clearance distance is recommended for these sections, as receptors beyond this distance will not experience magnetic fields exceeding the reference levels. The closest identified dwellings to the cable route centreline are located much further than this at over 17m away, which is a safe distance, given that electromagnetic field strength decreases exponentially with distance.

For users of PRoWs, any radiation effects are expected to be minimal due to their transient exposure as these are not continually occupied, rather they are moving receptors, as opposed to residential dwellings and workplaces.

Therefore, no significant impacts associated with the proposed underground cables are predicted.

5.2 Transformers, and PV Inverters

Notable sources of radiation other than the cables will be the conversion units (transformers/PV inverters) positioned across the Scheme.

The electrical equipment associated with the transformers and PV inverters will be 'CE' marked (Conformité Européene, or European Conformity marking), and/or 'UKCA' marked (UK Conformity Assessed). CE and UKCA markings indicate that a product has been assessed by the manufacturer and determined to meet the safety, health, and environmental protection requirements of the European Union and the United Kingdom, respectively. CE marking requirements were adopted and extended indefinitely in Great Britain until the UK left the EU in 2020. From 1 January 2021, the UKCA mark started to replace the CE mark for goods sold within Great Britain, and the CE mark has continued to be required for goods sold in Northern Ireland. The CE marking should ensure that electrical and electronic equipment does not generate, or is not unintentionally affected by, electromagnetic disturbance.

The transformers and PV inverters are also predicted to produce fields at a lower level than that of underground cables because the equipment is typically housed in protective enclosures. Therefore, no significant impacts associated with the proposed conversion units are predicted.

5.3 Substations and BESS

The Scheme will connect to Grendon Substation (an existing National Grid distribution substation). According to UK regulation, the substation conforms with the applicable exposure limitations for the general public, and the field from the equipment inside a substation does not extend far, if at all, outside the perimeter fence. Additionally, the Scheme will include connection to up to two 400kV substations located at Green Hill C and Green Hill BESS, along with up to five 132kV and up to five 33kV substations positioned throughout the Scheme. Electrical equipment associated with these substations will be 'CE' or 'UKCA' marked and housed in protective enclosures and thus predicted to produce fields at a lower level than that of underground cables. Additionally, the perimeters of Grendon Substation and the proposed 400kV substations are more than 170m from any identified dwelling and comply with public exposure limits, as electromagnetic fields from the equipment do not extend significantly beyond the perimeter fence.

The BESS contributes to the electromagnetic radiation produced by the Scheme. The preferred location for the BESS is at Green Hill BESS as shown in Figure 3.1, however BESS may also or alternatively be located on Green Hill C. The potential BESS locations at Green Hill BESS and Green Hill C are situated more than 170m from any identified dwelling. As electromagnetic radiation levels reduce with increased distance, all nearby dwellings and workplaces are expected to be situated at a safe distance from the BESS installations.

PAGERPOWER
Urban & Renewables

Pager Power Limited
Stour Valley Business Centre
Sudbury
Suffolk
CO10 7GB

Tel: +44 1787 319001 **Email:** info@pagerpower.com **Web:** www.pagerpower.com