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MARINUS LINK

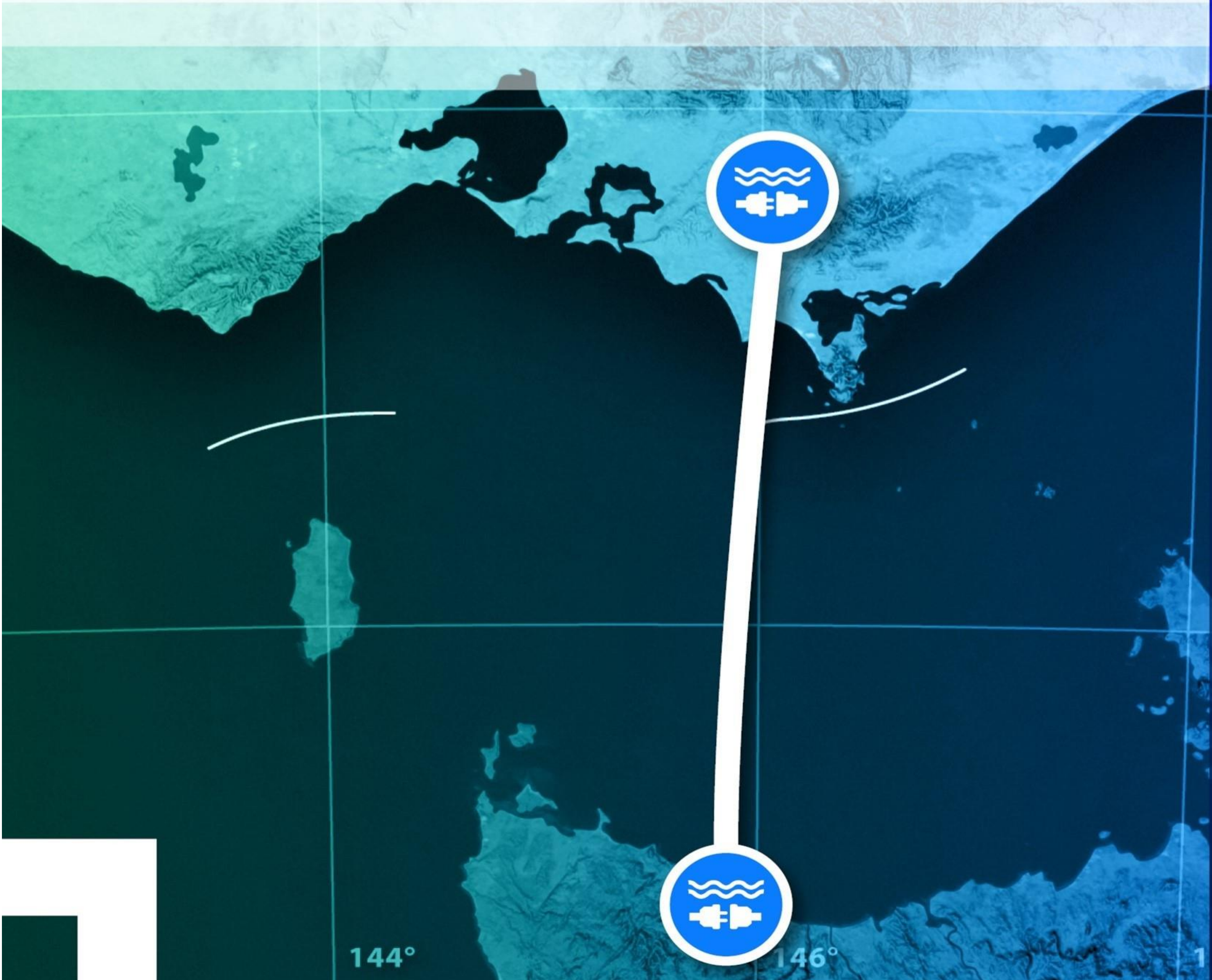
# Marinus Link

## Marinus Link EMF & EMI Impact Assessment – Supplementary Report

IS480100-SO114-EE-RPT-0001

June 2024

Marinus Link Pty Ltd



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Contents

# Executive Summary

The proposed Marinus Link (the project) comprises a high voltage direct current (HVDC) electricity interconnector between Tasmania and Victoria, to allow for the continued trading and distribution of electricity within the National Electricity Market (NEM).

The Electric and Magnetic Field (EMF) and Electromagnetic Interference (EMI) impact assessments in the EMF & EMI Impact Assessment Report (Technical Appendix A of the combined EIS/EES) allowed for the project to be delivered in two stages, each delivering one complete 750 MW HVDC circuit between Tasmania and Victoria, over an indicative 2025-2030 construction timeframe.

Marinus Link Pty Ltd (MLPL) recently published an information update regarding the potential delivery of Stages 1 and 2 in accordance with details set out in the update. The information update is titled Marinus Link Information Update #1 – timing of Stage 2. MLPL therefore requested the preparation of a supplementary report which identifies whether a change to the timing for delivery of Stages 1 and 2 in accordance with the Information Update would have any material implications for the assessment described in, or conclusions of, the EMF and EMI impact assessments presented in the EIS/EES.

MLPL is seeking approvals for both stages, but timing for the delivery of Stage 2 will be subject to market demand. It is anticipated that the Stage 1 circuit will be commissioned by 2030, followed by a potential gap in construction so that the Stage 2 circuit is commissioned by 2033.

The EMF and EMI impact assessments were prepared on the basis that the two stages would be completed by 2030 and considered the worst case cumulative effects of both circuits operating together.

The purpose of this supplementary assessment report is to identify if the proposed change to the timing for delivery of Stages 1 and 2 would have any material implications for the EMF and EMI impact assessments and if any changes are required to the proposed mitigation measures or Environmental Performance Requirements.

The analysis and results documented in the supplementary report confirm that there are no material impacts of the proposed timing of the project's Stage 1 and 2 delivery on the calculated EMF & EMI emissions and the cable heating along the HVDC cable sections and at the converter stations.

Accordingly, there are no significant changes to the impacts on sensitive receivers and no changes or additions to the proposed mitigation, monitoring and review measures or the Environmental Performance Requirements are deemed necessary.

# Glossary and Abbreviations

| Abbreviation | Definition |
|---|---|
| AC | Alternating Current |
| ACMA | Australian Communications and Media Authority |
| AIMD | Active Implantable Medical Device |
| AM | Amplitude Modulation |
| ARPANSA | Australian Radiation Protection and Nuclear Safety Agency |
| AS | Australian Standard |
| AS/NZS | Joint Australian New Zealand Standard |
| CDEGS | Current Distribution, Electromagnetic Fields. Grounding and Soil Structure Software |
| CYMCAP | Power Cable Installation Ampacity and Temperature Rise Calculation Software |
| DC | Direct Current |
| DGPS | Differential Global Positioning System |
| EES | Environmental Effects Statement |
| EIS | Environmental Impact Statement |
| ELF | Extremely Low Frequency |
| EMF | Electric and Magnetic Fields |
| EMI | Electromagnetic Interference |
| EN | European Normalised Standard |
| ENA | Energy Networks Australia |
| FM | Frequency Modulation |
| GPS | Global Positioning System |
| HDD | Horizontal Directional Drilling |
| HV | High Voltage |
| HVAC | High Voltage Alternating Current |
| HVDC | High Voltage Direct Current |
| IARC | International Agency for Research on Cancer |
| ICNIRP | International Commission on Non-Ionising Radiation Protection |
| ITU | International Telecommunication Union |
| MLPL | Marinus Link Pty Ltd |
| MNES | Matters of National Environmental Significance |
| MRI | Magnetic Resonance Imaging |
| NEM | National Electricity Market |

| Abbreviation | Definition |
|---|---|
| NHMRC | National Health and Medical Research Council |
| RFI | Radio Frequency Interference |
| RFID | Radio Frequency Identification |
| RHC | Radiation Health Committee |
| RHS | Radiation Health Series |
| RIV | Radio Influence Voltage |
| RMS | Root Mean Square |
| XLPE | Cross-linked Polyethylene |

# 1. Introduction

The proposed Marinus Link (the project) comprises a high voltage direct current (HVDC) electricity interconnector between Tasmania and Victoria, to allow for the continued trading and distribution of electricity within the National Electricity Market (NEM).

Details of the project are provided in the EMF & EMI Impact Assessment Report (Technical Appendix A of the combined EIS/EES). They have not been repeated in this report, which only provides supplementary information for the EMF and EMI impact assessments that pertain to a proposed change in the timing for delivery of the two stages of the project.

The EMF and EMI impact assessments allowed for the project to be delivered in two stages, each delivering one complete 750 MW HVDC circuit between Tasmania and Victoria, over an indicative 2025-2030 construction timeframe. The proposed scope of the works for the two stages is as follows:

- Stage 1 – earthworks, site preparation works, access tracks, construction laydown areas, Horizontal Directional Drilling (HDD) for the shore, road and river crossings and trenching works for the conduits and joint pits for both circuits and converter stations. Only the cables and converter station equipment for the first 750 MW HVDC circuit will be installed.
- Stage 2 – the cables and converter station equipment for the second 750 MW HVDC circuit will be installed.

Marinus Link Pty Ltd (MLPL) is seeking approvals for both stages, but timing for delivery of Stage 2 will be subject to market demand. It is anticipated that the Stage 1 circuit will be commissioned by 2030, followed by a potential gap in construction so that the Stage 2 circuit is laid and commissioned by 2033.

Subsequent to the completion of the EMF & EMI Impact Assessment Report, MLPL published an information update regarding the potential delivery of Stages 1 and 2. The information update is titled Marinus Link Information Update #1 – timing of Stage 2. MLPL therefore requested the preparation of a supplementary report which identifies whether a change to the timing for delivery of Stages 1 and 2 in accordance with the Information Update would have any material implications for the assessment described in, or conclusions of, the EMF and EMI impact assessments presented in the EIS/EES.

## 1.1 Purpose of this Report

The Electric and Magnetic Field (EMF) and Electromagnetic Interference (EMI) impact assessment was prepared on the basis that the two stages would be completed by 2030 and considered the worst case cumulative effects of both circuits operating together.

The purpose of this supplementary assessment report is to identify if the proposed change to the timing for delivery of Stages 1 and 2 would have any material implications for the EMF and EMI impact assessments and if any changes are required to the proposed mitigation measures or Environmental Performance Requirements.

## 1.2 Assessment Context

The proposed changes to the timing of the two project stages do not impact the context of the EMF & EMI assessments, which consider the potential effects on sensitive receivers, which include, but are not limited to: humans, marine life, fauna, wildlife, crops, vegetation, communications equipment, and very sensitive medical and scientific research equipment.

# 2. Assessment Guidelines

The EMF and EMI assessments for the project span all jurisdictions. The assessments consider impacts on/to sensitive receivers from the converter stations in Tasmania and Victoria, and the subsea and land HVDC cables in between the converter stations. Commonwealth, Tasmanian, and Victorian scoping requirements and guidelines therefore apply to the assessments.

The proposed changes to the timing of the two project stages do not impact the Commonwealth, Tasmanian, and Victorian scoping requirements and guidelines that apply to the assessments.

The EMF & EMI Impact Assessment Report was informed by, or informed, the technical studies identified in Table 2-1. Supplementary reports have similarly been prepared for these other reports.

*Table 2-1: Linkages to other reports*

| Technical Study | Relevance to this Assessment |
|---|---|
| Agriculture | • Description of the farms and animals present along the project alignment that are potentially exposed to EMF and EMI from the project |
| Marine ecology and resource use | • Identification of marine species and environment exposed to EMF and EMI from the subsea cables<br>• The potential effects of EMF exposure to Marine Flora and Fauna are addressed in the Marine Ecology and Resource Use (MERU) report (EIS/EES Appendix P). This report documents potential effects of EMF exposure, and applicable reference levels that relate to Marine Flora and Fauna including benthic species, epibenthic species, and those listed as threatened under the Threatened Species Protection Act 1995. References to the MERU report are made in this report where applicable. |
| Social impact assessment | • People will be exposed to EMF generated by the subsea cables, land cables, and converter stations. Moreover, the general environmental impacts of EMF and EMI will have social implications |

# 3. Legislation, Policy and Guidelines

The scope of works covered in the study comprises desktop assessments of the EMF and EMI associated with the proposed new Marinus HVDC Link. The key components of the HVDC link will be the ±320 kV subsea and land cable circuits, a 220 kV converter station at Heybridge (Tasmania) and a 500 kV converter station at Hazelwood (Victoria).

The proposed HVDC link will be arranged as a symmetric monopole with no earth return. The specifications for the indoor HVDC power equipment located within the converter station (e.g. rectifiers, filters, transformers, etc) will be confirmed during the subsequent stages of the project. The EMF and EMI from this equipment is therefore not modelled in the study but the appropriate requirements will be identified in this study and will inform the procurement of the equipment and requirement of the detailed design.

The EMF calculations documented in this supplementary report were carried out in the HIFREQ module of CDEGS, Ver. 19. The cable heating calculations documented in this supplementary report were carried out using CYMCAP Ver. 7.3.

The EMF and EMI assessments documented in this supplementary report have been carried out in accordance with the Australian and international standards and guidelines specified Table 3-1.

*Table 3-1: Standards and guidelines referenced in the EMF and EMI study*

| Number | Revision | Title |
|---|---|---|
| ICNIRP | 2010 | International Commission on Non-Ionising Radiation Protection – Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz-100 kHz) |
| ICNIRP | 2014 | International Commission on Non-Ionising Radiation Protection – Guidelines for limiting exposure to electric fields induced by movement of the human body in a static magnetic field and by time-varying magnetic fields below 1 Hz |
| EN 45502-2-1 | 2003 | Active implantable medical devices – Particular requirements for active implantable medical devices intended to treat bradyarrhythmia (cardiac pacemakers) |
| EN 45502-2 | 2008 | Active implantable medical devices – Particular requirements for active implantable medical devices intended to treat tachyarrhythmia (includes implantable defibrillators) |
| EN 50527-1 | 2016 | Procedure for the assessment of the exposure to electromagnetic fields of workers bearing active implantable medical devices |
| AS/NZS 61000.6.1 | 2006 | Electromagnetic compatibility (EMC) - Generic standards - Immunity for residential, commercial and light-industrial environments |
| AS 2344 | 2016 | Limits of electromagnetic interference from overhead a.c. powerlines and high voltage equipment installation in the frequency range 0.15 MHz to 3000 MHz |
| ENA | 2016 | EMF Management Handbook |

# 4. Project Description

A description of the project is provided in the EMF & EMI Impact Assessment Report (Technical Appendix A of the combined EIS/EES) and only the parts that relate to the change addressed in this supplementary report has been included in this section.

The project will be delivered in two stages, each delivering one complete 750 MW HVDC circuit between Tasmania and Victoria. The Information Update (Marinus Link Information Update #1 – timing of Stage 2) describes and details the infrastructure and sequence applicable to Stage 1 with respect to Stage 2. Therefore, the Information Update has been used as the source of the assumptions of what equipment will be applicable to Stage 1 and Stage 2. A high-level description of the scope of the works for the two stages is as follows:

- Stage 1 – earthworks, site preparation works, access tracks, construction laydown areas, Horizontal Directional Drilling (HDD) for the shore, road and river crossings and trenching works for the conduits and joint pits for both circuits and converter stations. Only the cables and converter station equipment for the first 750 MW HVDC circuit will be installed.
- Stage 2 – the cables and converter station equipment for the second 750 MW HVDC circuit will be installed.

Marinus Link Pty Ltd (MLPL) is seeking approvals for both stages, but timing for delivery of Stage 2 will be subject to market demand. It is anticipated that the Stage 1 circuit will be commissioned by 2030, followed by a potential gap in construction so that the Stage 2 circuit is laid and commissioned by 2033.

## 4.1 Construction, Operation, and Decommissioning

The EMF and EMI assessment of the project is focussed on the operational phase of the project, as this phase will generate the only significant levels. EMF and EMI generated by construction, commissioning and decommissioning activities are discussed but will not be significant.

# 5. Assessment Methodology

An integrated approach was used to assess the potential EMF and EMI impacts that could occur as a result of the project. This involved the following steps:

- A desktop survey of the study area was first conducted to identify sensitive receivers that could be impacted by the EMF and EMI associated with the proposed power infrastructure. The survey comprised an audit of online aerial imagery of the study area, followed by an online search for public information regarding the likely residential, commercial or industrial use of identified buildings and installations, and electrical and electronic equipment that may be installed at those locations.
- The basic mechanisms by which EMF and EMI can impact sensitive receivers were then introduced and cause-effect relationships established for the various receivers identified within the study area.
- Limits and reference levels were then confirmed for the identified impacts, based on state, national and international standards, guidelines and published research.
- The power infrastructure was then modelled in an appropriate software package and typical and worst-case EMF and EMI levels are calculated at the sensitive receiver locations for comparison with the impact assessment criteria.
- Finally, mitigations and management methods were assessed, and the residual risk established for the identified impacts.

Given that the project's Stage 1 HVDC equipment may operate for some time without the Stage 2 equipment, the EMF and EMI impacts have been reassessed for only the emissions produced by the Stage 1 equipment. No changes were made to the study area, the modelling methods for the converter stations, subsea cables and land cables, and the applied exposure and immunity limits and reference levels that are described in detail in the EMF & EMI Impact Assessment Report (Technical Appendix A of the combined EIS/EES).

The EIS guidelines and EES scoping requirements both include requirements for the assessment of cumulative impacts. Cumulative impacts result from incremental impacts caused by multiple projects occurring at similar times and within proximity to each other.

All possible projects that could result in cumulative impacts on the project were identified in the EMF & EMI Impact Assessment Report. The proposed delay in the project's Stage 2 works does not alter the cumulative impacts considerations in the EMF and EMI impact assessment and no additional projects have been considered in this supplementary report.

## 5.1 Assumptions and Limitations

The screened HVDC cables and indoor HVDC power equipment will not produce significant electric fields in the surrounding environment.

The subsea and land cable arrangements will only be confirmed during the detailed design process. Conservative assumptions have been described in the EMF & EMI Impact Assessment Report and were again adopted for the supplementary assessments. These will result in worst-case EMF and EMI levels.

The modelling and results presented in this supplementary report consider the nominal rating of each circuit (i.e. 750 MW). However, the impact of the overload rating for the proposed cables has also been considered in the supplementary impact assessment.

The overload rating is a temporary scenario and it has been assumed, for the purposes of this assessment, to apply to both Stage 1 and Stage 2 cables simultaneously. The overload scenario and emergency current rating is assumed to be 150 MW per stage (i.e. Stage One overload rating is 900 MW and Stage Two overload rating is also 900 MW).

# 6. Impact Assessment

## 6.1 Construction Impact Assessment

### 6.1.1 Key Issues

Potential impacts for electric and magnetic fields and electromagnetic interference in relation to the construction activities of the project are summarised in Table 6-1. An overview of the significance of construction impacts is described in the following section.

*Table 6-1: Radio and television interference limits as defined in Australian Standard 2344*

| Project component | Project activity | Potential for impact to electric and magnetic fields and electromagnetic interference and associated consequence | Standard controls |
|---|---|---|---|
| Project-wide | All activities related to construction of the HVDC cables and converter stations. | Radiocommunication equipment used for construction activities (e.g., mobile telephones and Citizens Band radios) will generate radio frequency emissions during construction. There is therefore a potential to create radio frequency interference to nearby sensitive receivers. | The radiocommunication equipment used during construction must have appropriate Regulatory Compliance Mark labelling. |

### 6.1.2 Significance of impacts

Construction of the project infrastructure involves commercial plant and electrical equipment that will have appropriate EMC certification. This provides assurance that EMF and EMI from the construction site will be below the limits specified in applicable Australian Communications and Media Authority (ACMA) and product safety standards for a construction environment. When discussing the significance of impacts, this therefore implies post-mitigation or residual impacts.

Construction workers may need to work at closer distances to live transmission line conductors than the general public are permitted. They will therefore be exposed to higher EMF levels. Public access to work sites will be restricted with appropriate fencing and occupational exposure to EMF and EMI will be managed as part of safe work method planning in accordance with occupational health and safety requirements (e.g. access controls and/or appropriate warning signages).

The proposed change to the timing for delivery of Stages 1 and 2 would have no material implications for the construction EMF and EMI impacts and no changes are required to the proposed mitigation measures or Environmental Performance Requirements to accommodate the proposed change.

## 6.2 Operation Impact Assessment

### 6.2.1 Heybridge Converter Station

The HIFREQ model of the AC Air Insulated Switchgear (AIS) equipment and associated structural components at Heybridge converter station, including the landing span, is shown below in Figure 6-1 for the Stage 1 installation only. The modelling and calculations for the Stage 1 and 2 installations both operational are documented in the EMF & EMI Impact Assessment Report.

The electric and magnetic fields around the fence line are plotted in Figure 6-2 and Figure 6-3. The results are summarized in Table 6-2 and Table 6-3.

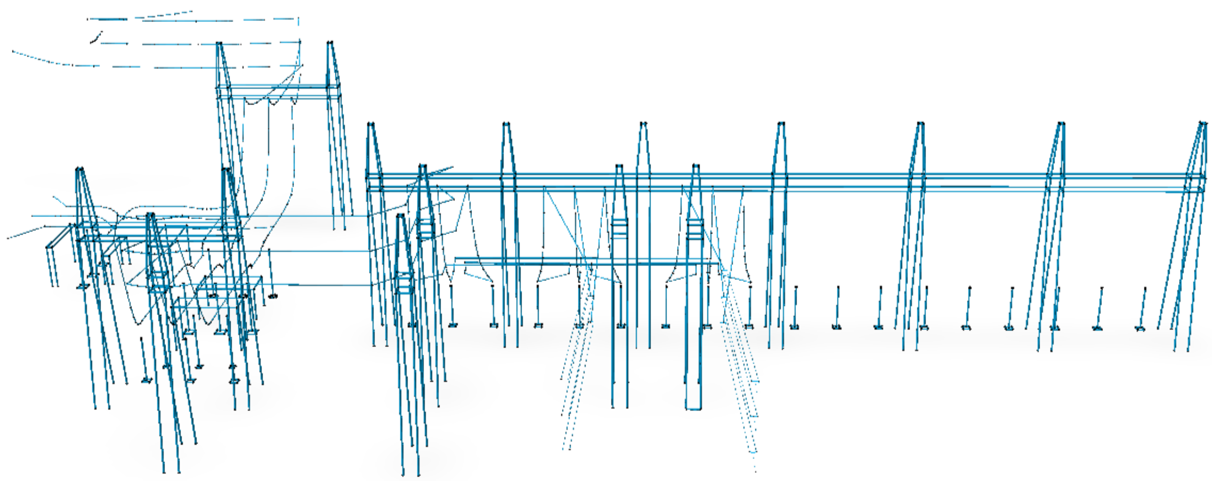

*Figure 6-1: HIFREQ model - AC equipment and supporting structures at the Heybridge Converter Station (Stage 1 only)*

*Table 6-2: Human health impact assessment for the Heybridge converter station (Stage 1)*

| EMF | General Public Reference Level | Maximum Calculated Value |
|---|---|---|
| Electric Field Strength (kV/m) | 5 | 3.5 |
| Magnetic Flux Density (μT) | 200 | 14.3 |

*Table 6-3: Farming and wildlife impact assessment for the Heybridge converter station (Stage 1 only)*

| Exposure Scenario | Electric Field Strength (kV/m) | | Magnetic Field Strength (μT) | |
|---|---|---|---|---|
| | Reference Level | Maximum Calculated Value | Reference Level | Maximum Calculated Value |
| Livestock | 5* | 3.5 | 200* | 14.3 |
| Apiaries | 4.1 | 3.5 | 100 | 14.3 |
| Wildlife | 5* | 3.5 | 200* | 14.3 |

* Conservative assumed value

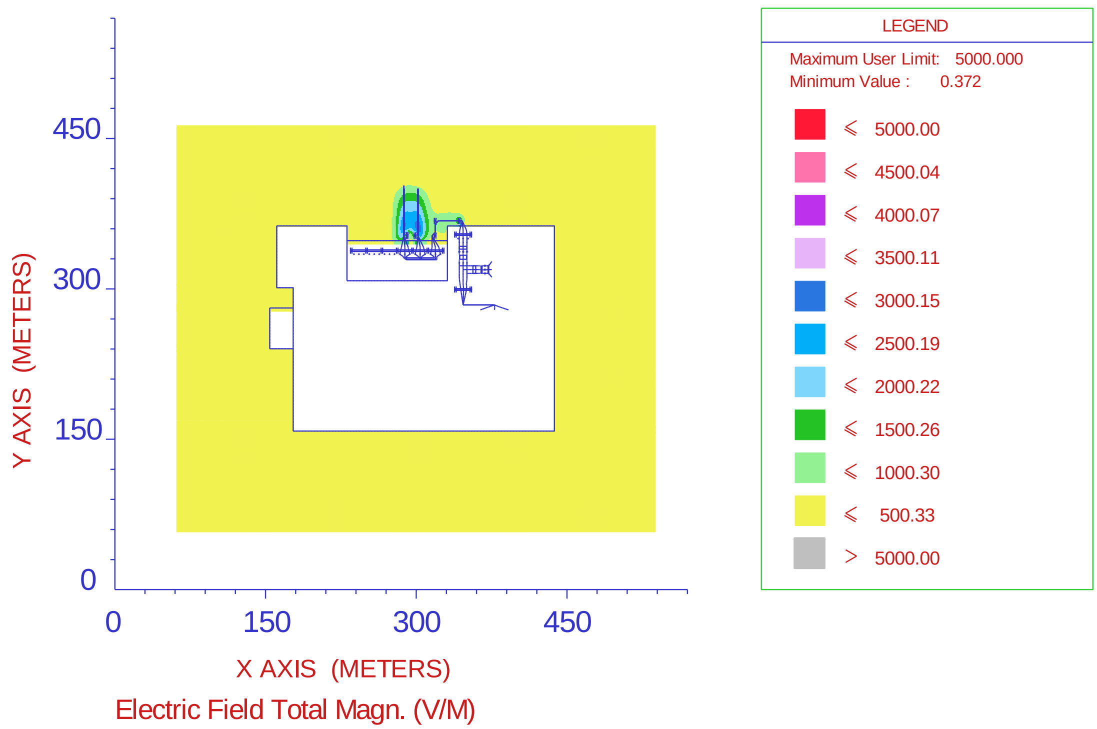


*Figure 6-2: Calculated electric field strength around the fence line of Heybridge Converter Station (Stage 1 only)*

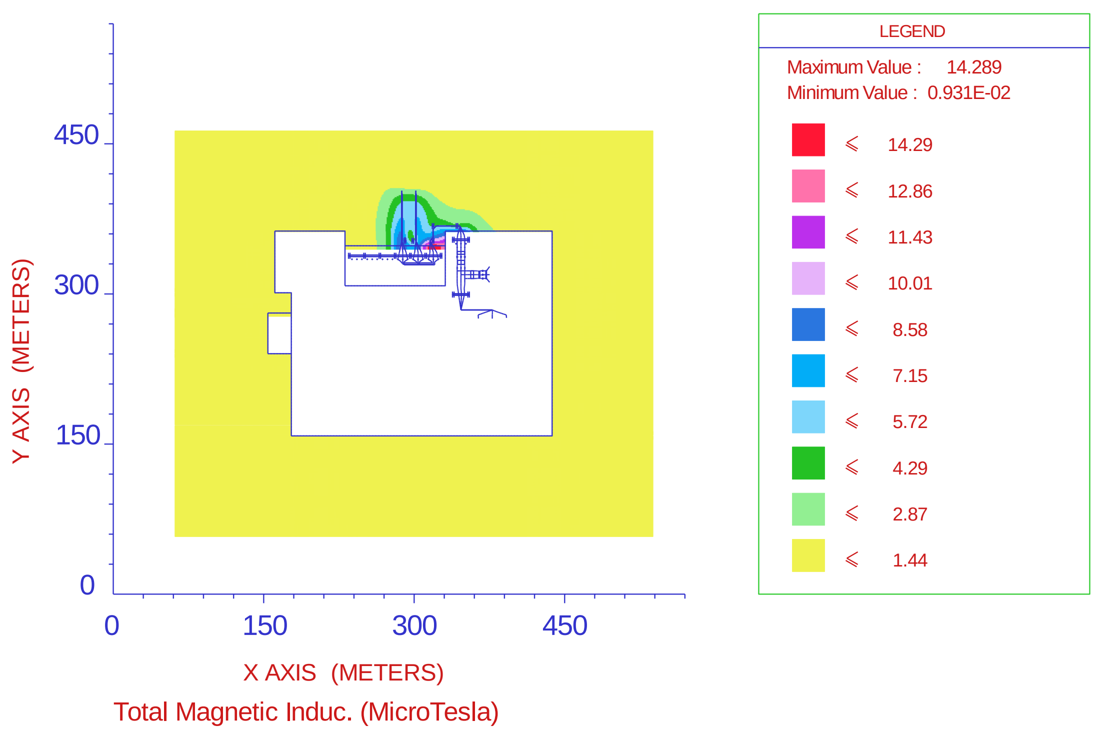


*Figure 6-3: Calculated magnetic flux density around the fence line of Heybridge Converter Station (Stage 1 only)*

The surface voltage gradient on the flexible connections within the Heybridge converter station were calculated using the HIFREQ model for the Stage 1 installation only and are plotted in Figure 6-4. The modelling and calculations for the Stage 1 and 2 installations both operational are documented in the EMF & EMI Impact Assessment Report.

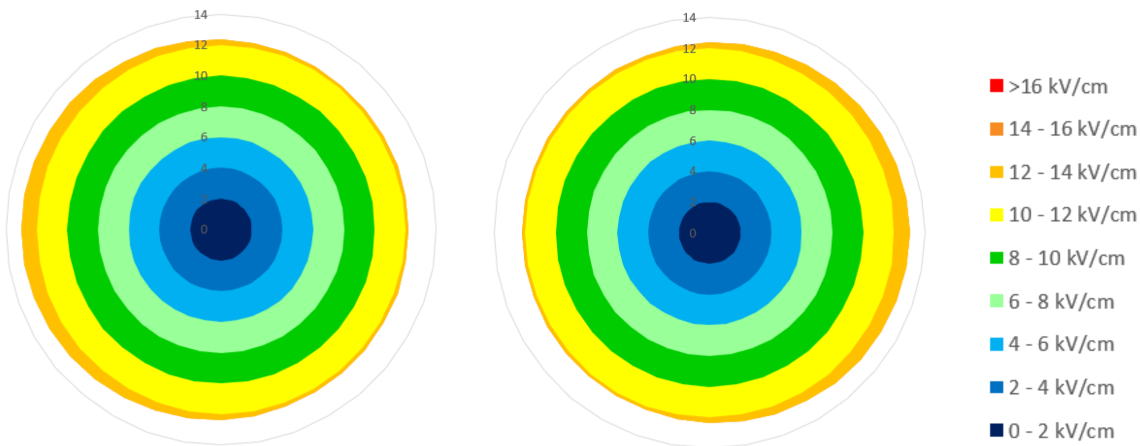


*Figure 6-4: Calculated surface voltage gradient on flexible connections at the Heybridge Converter station*

It is noted that there are no material impacts of the proposed timing of the project's Stage 1 and 2 delivery on the calculated EMF and EMI emission levels at the Heybridge converter station. Accordingly, there are no significant impacts on sensitive receivers and additional mitigation measures or changes to the Environmental Performance Requirements are not required.

### 6.2.2 Hazelwood Converter Station

The HIFREQ model of the AC Air Insulated Switchgear (AIS) equipment and associated structural components at Hazelwood converter station, including the landing spans for both the incoming and outgoing circuits, is shown below in Figure 6-5 for the Stage 1 installation only. The modelling and calculations for the Stage 1 and 2 installations both operational are documented in the EMF & EMI Impact Assessment Report.

The calculated electric and magnetic fields around the fence line are plotted in Figure 6-6 and Figure 6-7. The results are summarized in Table 6-4 and Table 6-5.

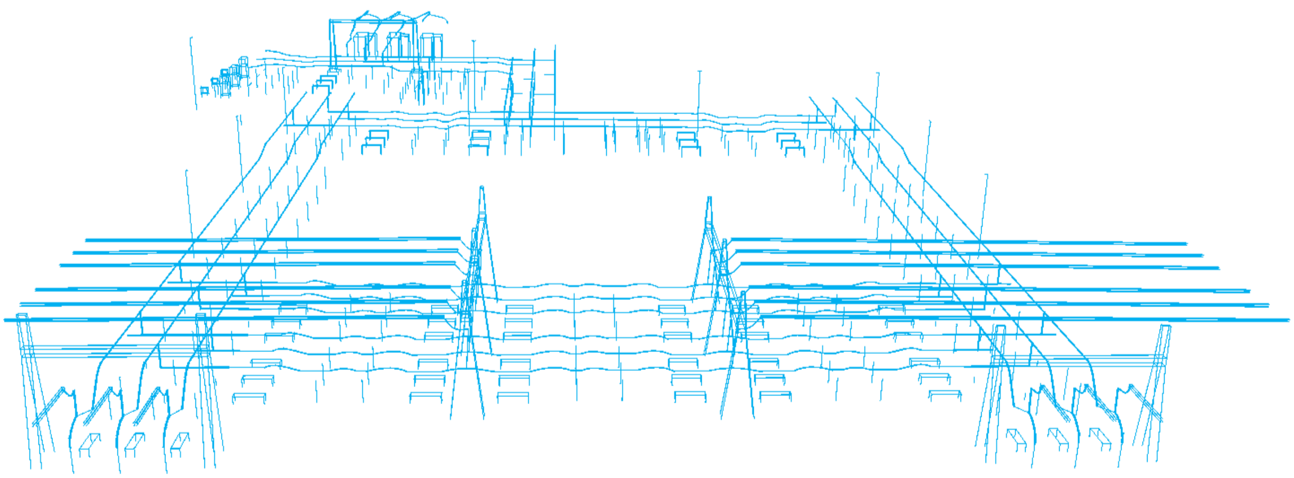

*Figure 6-5: HIFREQ model - AC equipment and supporting structures at the Hazelwood Converter Station (Stage 1 only)*

*Table 6-4: Human health impact assessment for the Hazelwood converter station (Stage 1 only)*

| EMF | General Public Reference Level | Maximum Calculated Value |
|---|---|---|
| Electric Field Strength (kV/m) | 5 | 3.2 |
| Magnetic Flux Density (μT) | 200 | 2.2 |

*Table 6-5: Farming and wildlife impact assessment for the Hazelwood converter station (Stage 1 only)*

| Exposure Scenario | Electric Field Strength (kV/m) | | Magnetic Field Strength (μT) | |
|---|---|---|---|---|
| | Reference Level | Maximum Calculated Value | Reference Level | Maximum Calculated Value |
| Livestock | 5* | 3.2 | 200* | 2.2 |
| Apiaries | 4.1 | 3.2 | 100 | 2.2 |
| Wildlife | 5* | 3.2 | 200* | 2.2 |

* Conservative assumed value

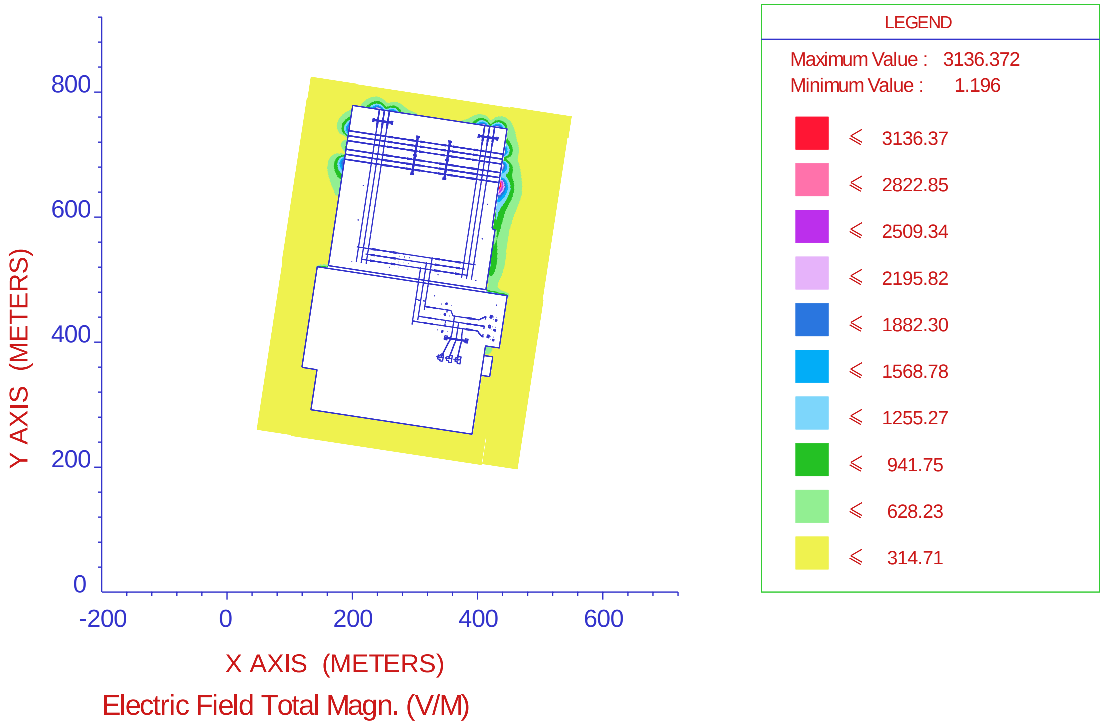


*Figure 6-6: Calculated electric field strength around the fence line of the Hazelwood Converter Station (Stage 1 only)*

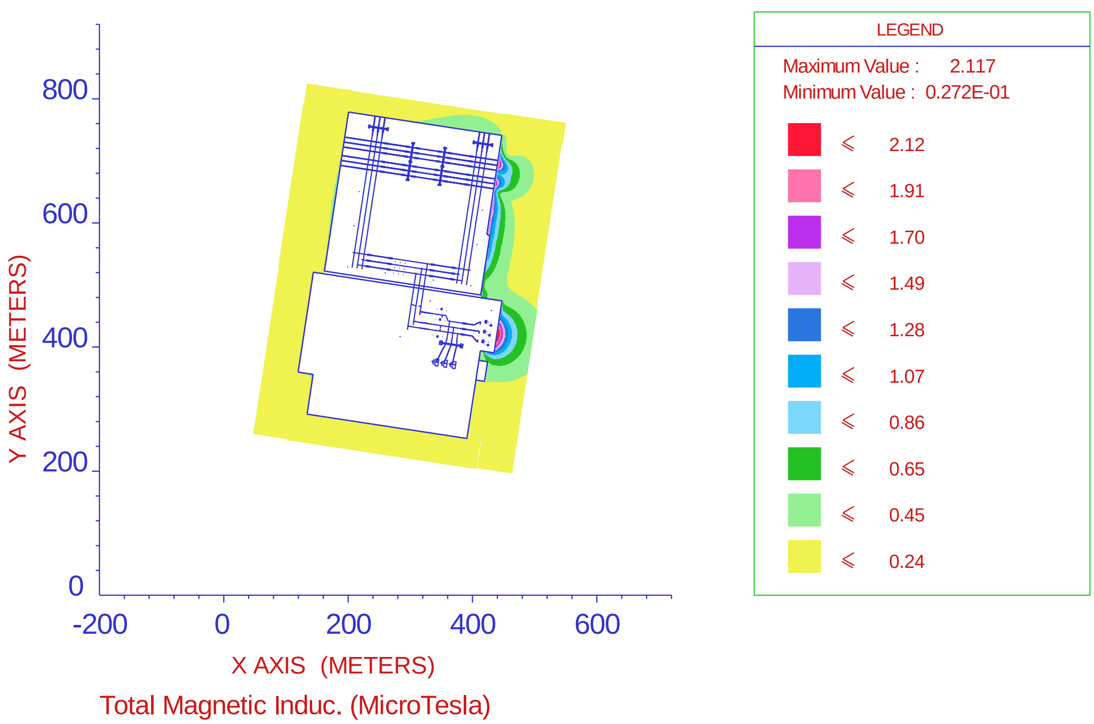


*Figure 6-7: Calculated magnetic flux density around the fence line of the Hazelwood Converter Station (Stage 1 only)*

The surface voltage gradient on the flexible connections and rigid bus sections within the Hazelwood converter station were also calculated using the HIFREQ model for the Stage 1 installation only and are plotted in in Figure 6-8 and Figure 6-9. The modelling and calculations for the Stage 1 and 2 installations both operational are documented in the EMF & EMI Impact Assessment Report.

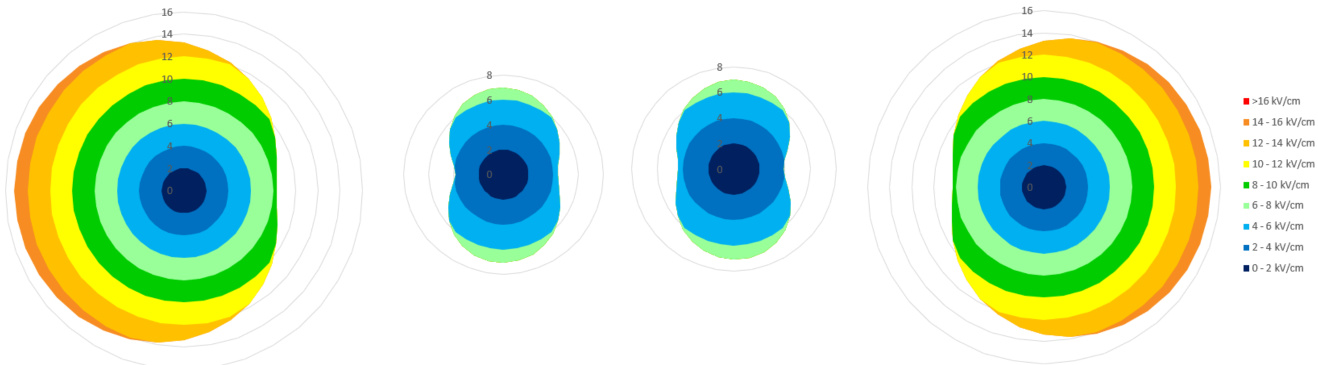


*Figure 6-8: Calculated surface voltage gradient on the flat-arranged flexible connections at the Hazelwood Converter station (Stage 1 only)*

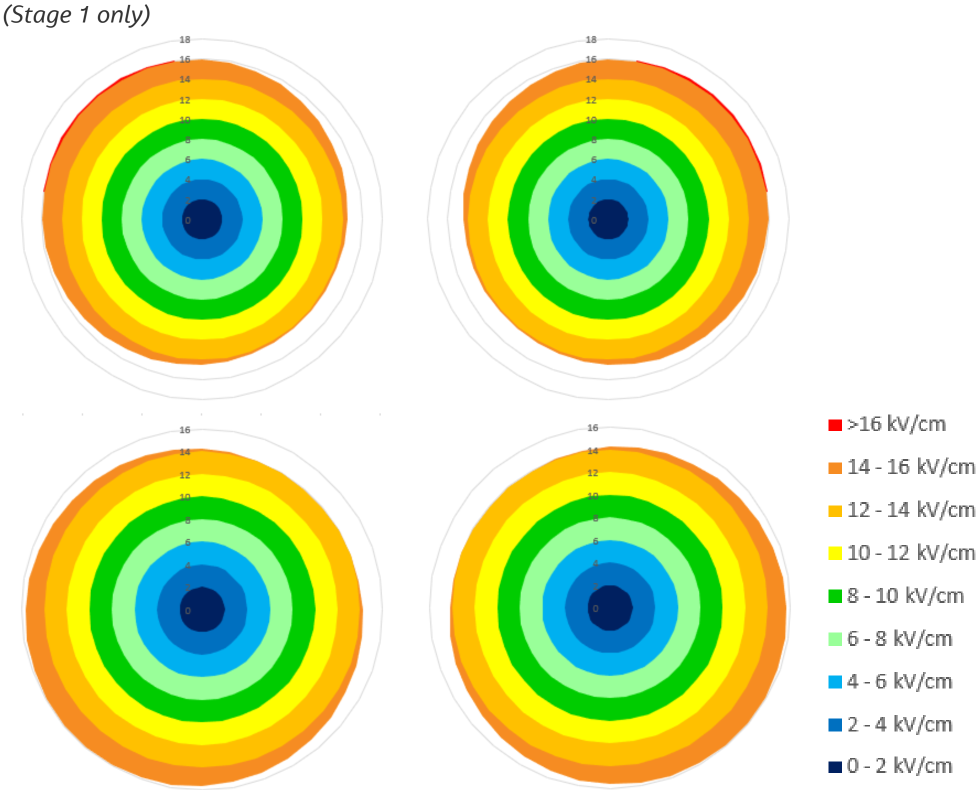


*Figure 6-9: Calculated surface voltage gradient on the square -type flexible connections at the Hazelwood Converter station (Stage 1 only)*

It is noted that there are no material impacts of the proposed timing of the project's Stage 1 and 2 delivery on the calculated EMF and EMI emission levels at the Hazelwood converter station. Accordingly, there are no significant impacts on sensitive receivers and additional mitigation measures or changes to the Environmental Performance Requirements are not required.

### 6.2.3 Subsea HVDC Cables

The magnetic field levels were calculated in different areas along the Stage 1 subsea HVDC cables to verify the worst-case impact on the marine environment. The results are plotted in Figure 6-10 to Figure 6-17.

Fluctuations in sea water conductivity were considered in the modelling but were found to have negligible impact on the intensity of the static fields. The static electric field produced by the cable in the conductive water is negligible for all reasonable water salinities and ocean current velocities.

The largest generated magnetic field strength is 193 μT at the shore crossings (Figure 6-10 to Figure 6-14). The magnetic field strength drops to below 5 μT at a distance of 50 m from the closest cable along the shore crossings.

At locations where the cable cannot be buried at the modelled depth, the magnetic flux density at the seabed level will change. At the 1 m minimum end of the proposed burial depth range, the maximum magnetic flux density at seabed level will increase by up to 150% from the plotted values.

During the worst case possible overload scenario (i.e. where the Stage 1 circuit is overloaded at 900 MW) the maximum magnetic flux density at seabed level will increase by up to 12.5%.

Both a horizontal and vertical separation between positive and negative cables for the Stage 1 circuit was considered along the Bass Straight subsea cable section. The EMF produced by vertically separated cables are plotted in Figure 6-16. The EMF produced by horizontally separated cables are plotted in Figure 6-17. The largest magnetic field strength is 24 μT for the horizontally arranged cables. This reduces to 21 μT for the vertically arranged cables. The calculated magnetic field strength reduces to less than 5 μT at a distance of 3 m from the centre of each cable trench.

The worst case calculated magnetic field strengths are compared to the derived reference levels for human health impacts in Table 6-6.

*Table 6-6: Human health impact assessment along the HVDC subsea project alignment (Stage 1 cables only)*

| Exposure Scenario | Cable Area | Magnetic Field Strength (μT) | |
|---|---|---|---|
| | | Reference Level | Calculated Level |
| People – All areas | Heybridge shore crossing | 400,000 | 193 |
| | Bass Strait – Vertical | 400,000 | 21 |
| | Bass Strait – Horizontal | 400,000 | 24 |
| | Waratah Bay shore crossing | 400,000 | 193 |
| Active implantable medical devices | Heybridge shore crossing | 500 | 193 |
| | Bass Strait – Vertical | 500 | 21 |
| | Bass Strait – Horizontal | 500 | 24 |
| | Waratah Bay shore crossing | 500 | 193 |

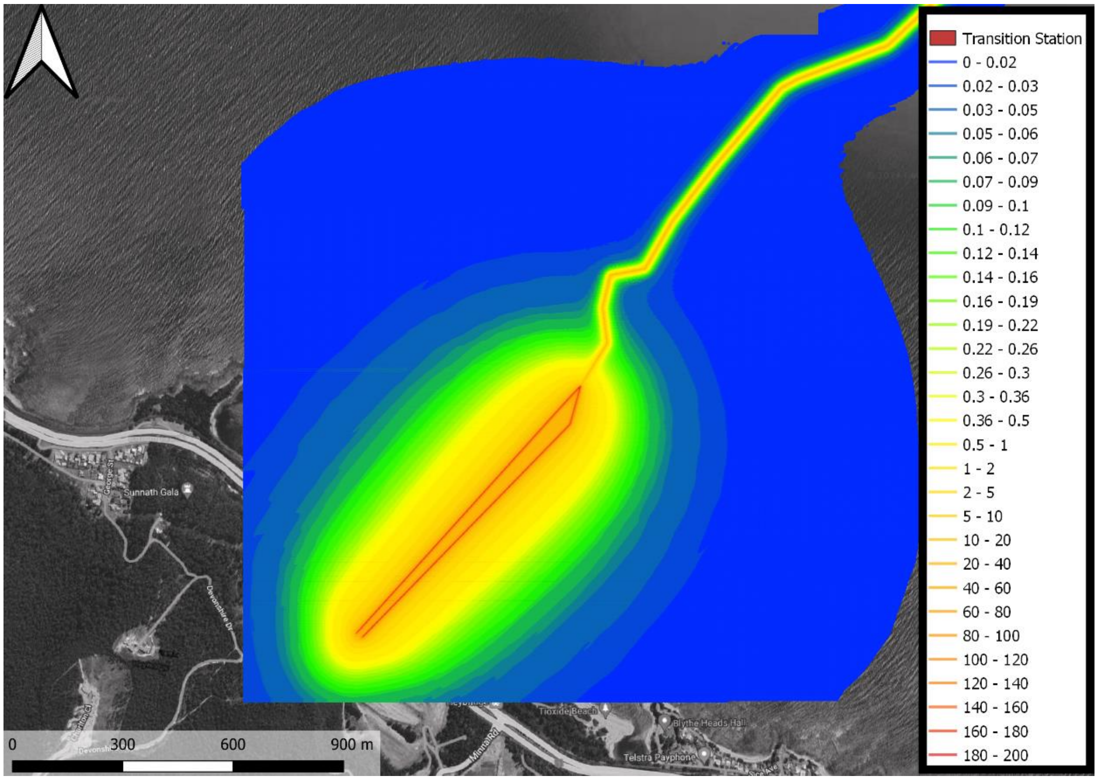


*Figure 6-10: Calculated magnetic field distribution on the seabed at the Heybridge shore crossing (µT) (Stage 1 cables only)*

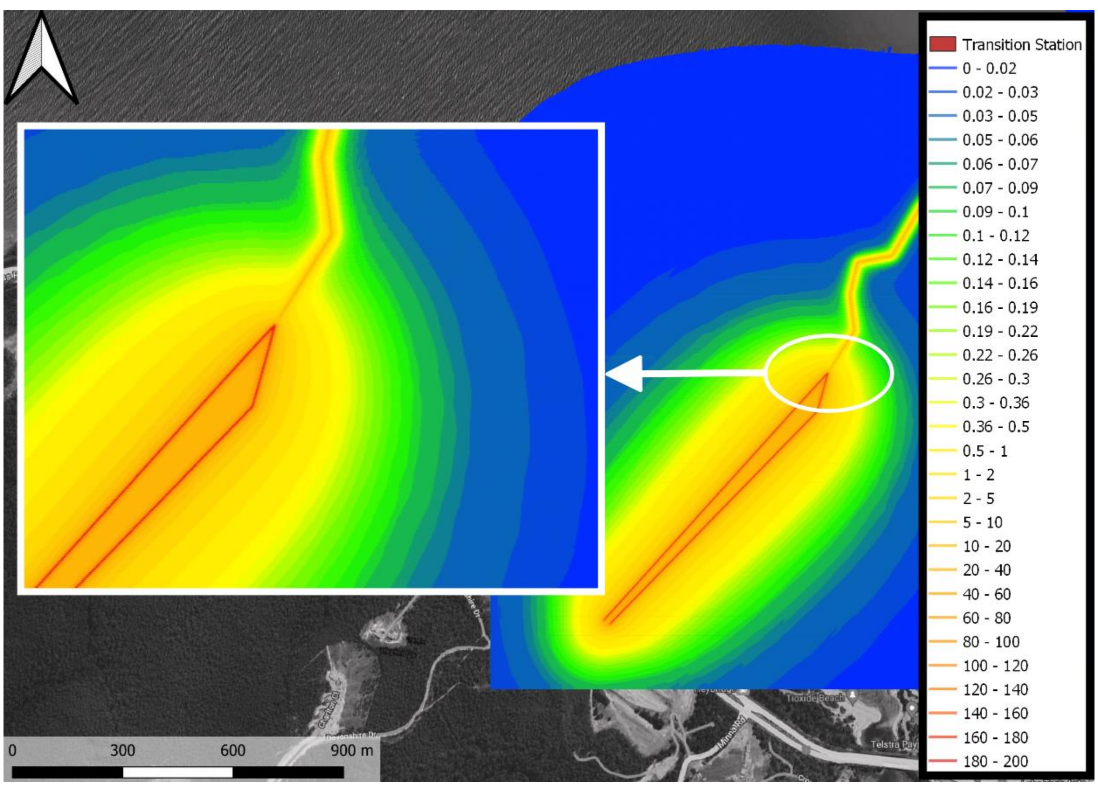


*Figure 6-11: Calculated magnetic field distribution on the seabed at the Heybridge shore crossing (µT) (Stage 1 cables only)*

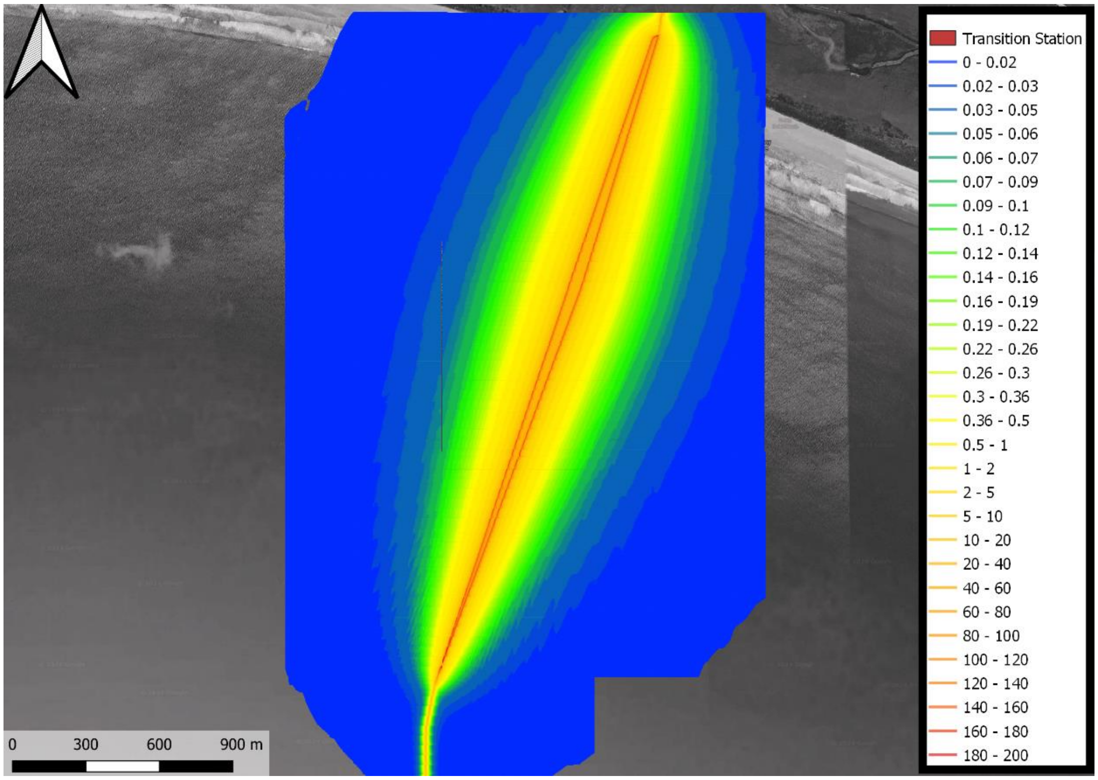


*Figure 6-12: Calculated magnetic field distribution on the seabed at the Waratah Bay shore crossing (μT) (Stage 1 cables only)*

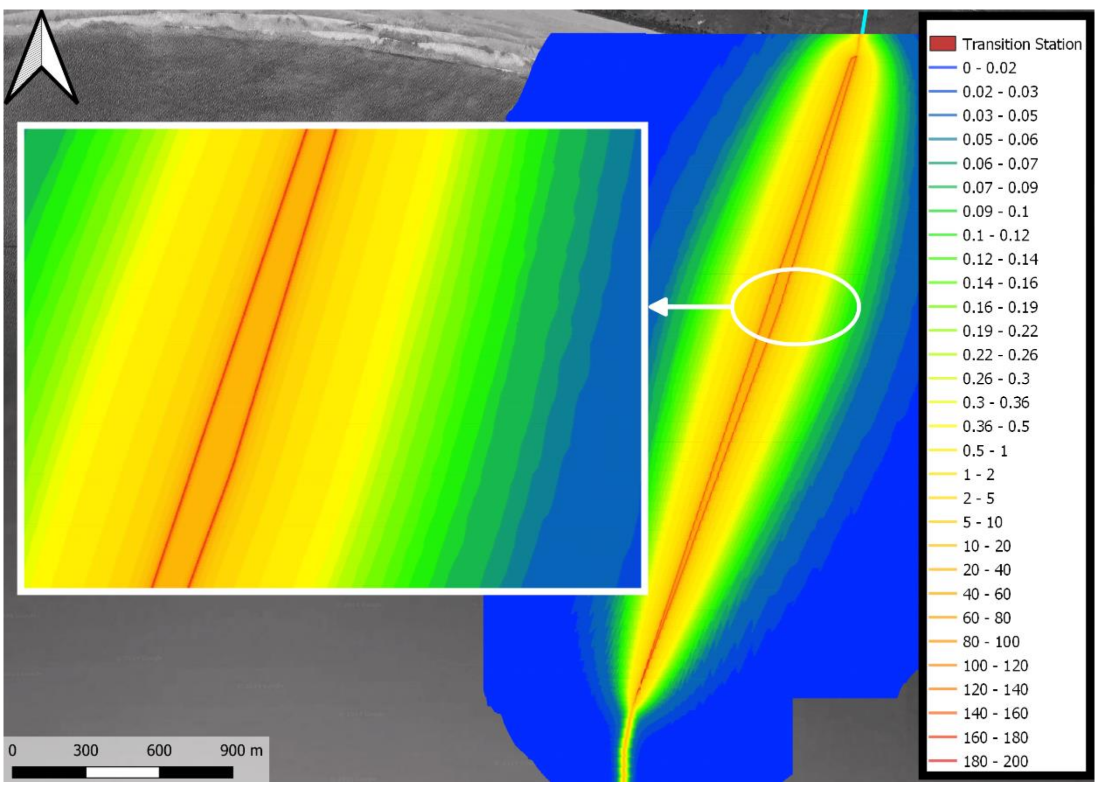


*Figure 6-13: Calculated magnetic field distribution on the seabed at the Waratah Bay shore crossing (μT) (Stage 1 cables only)*

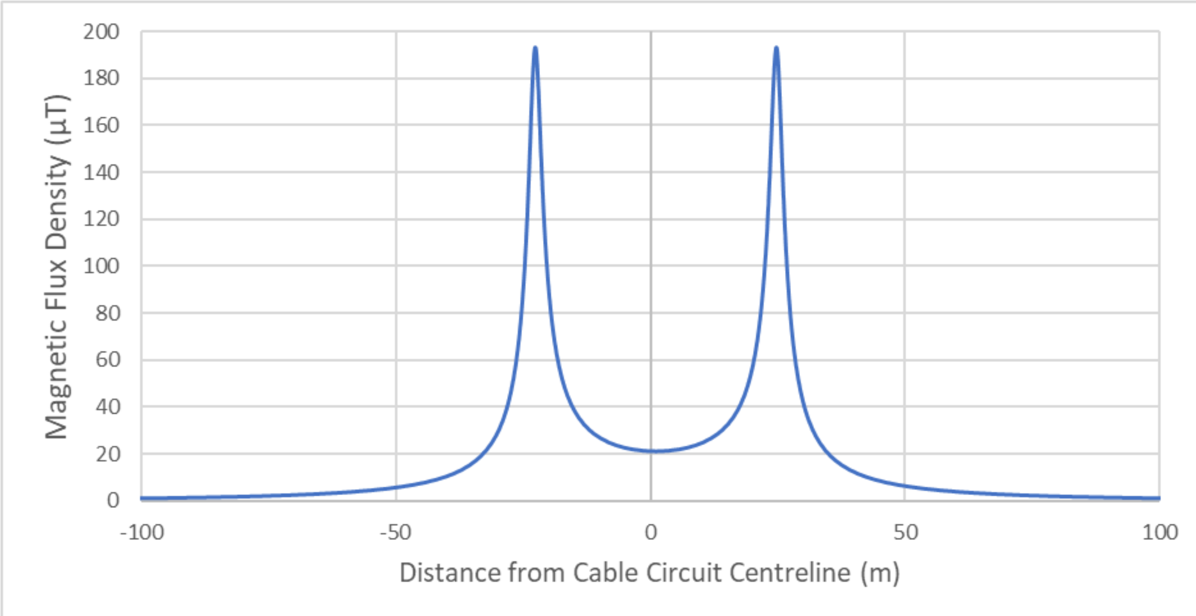


*Figure 6-14: Calculated magnetic field profile across the Waratah Bay shore crossing cable ducts (Stage 1 cables only)*

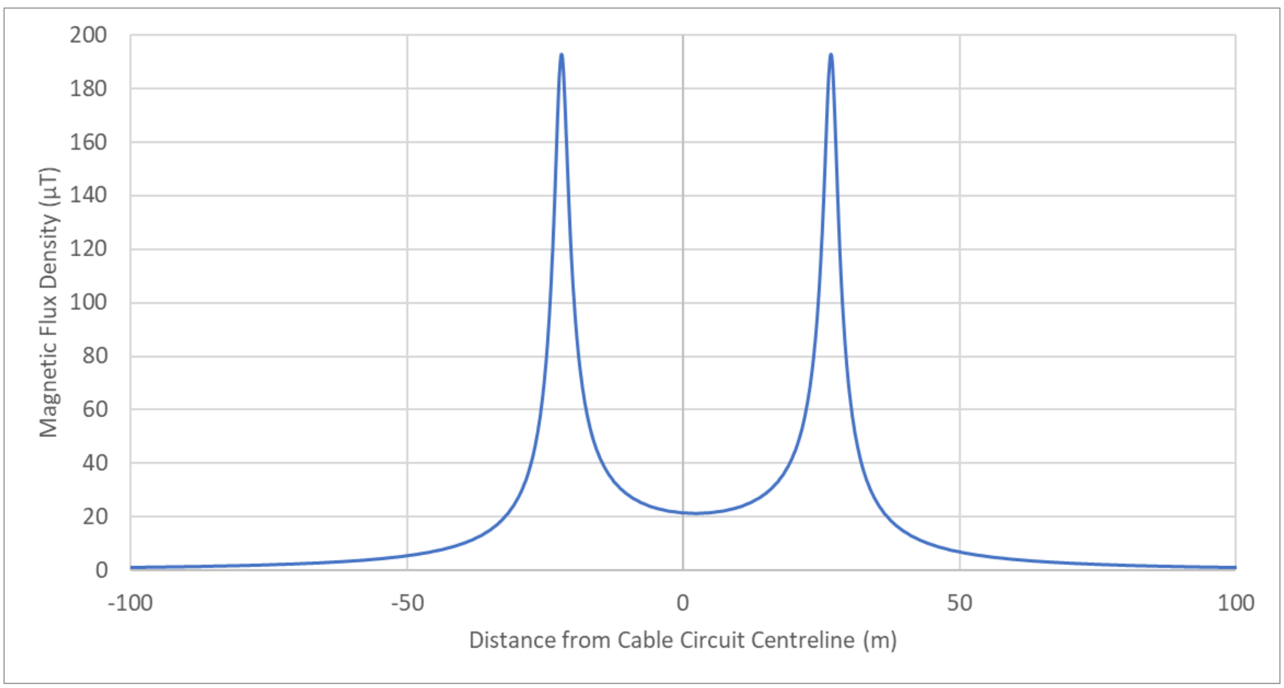


*Figure 6-15: Calculated magnetic field profile across the Heybridge shore crossing cable ducts (Stage 1 cables only)*

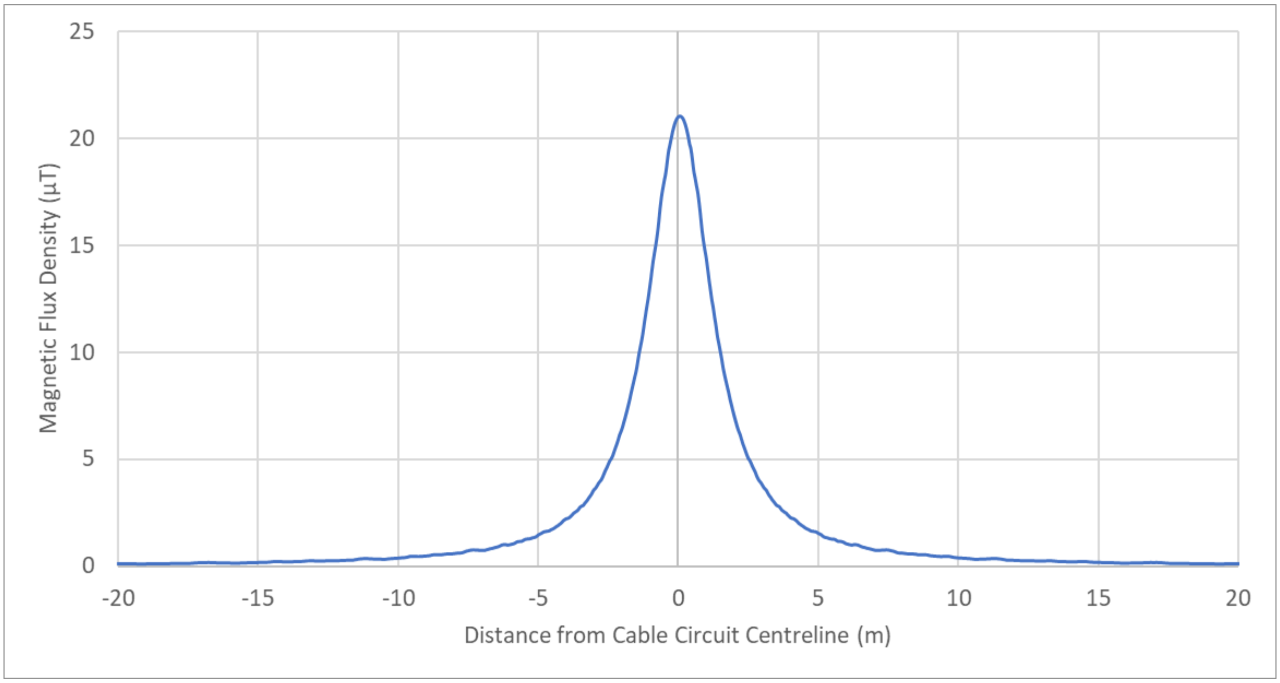


*Figure 6-16: Calculated magnetic field profile across the Bass Strait cables at sea floor level (Stage 1 cables only) - Vertical*

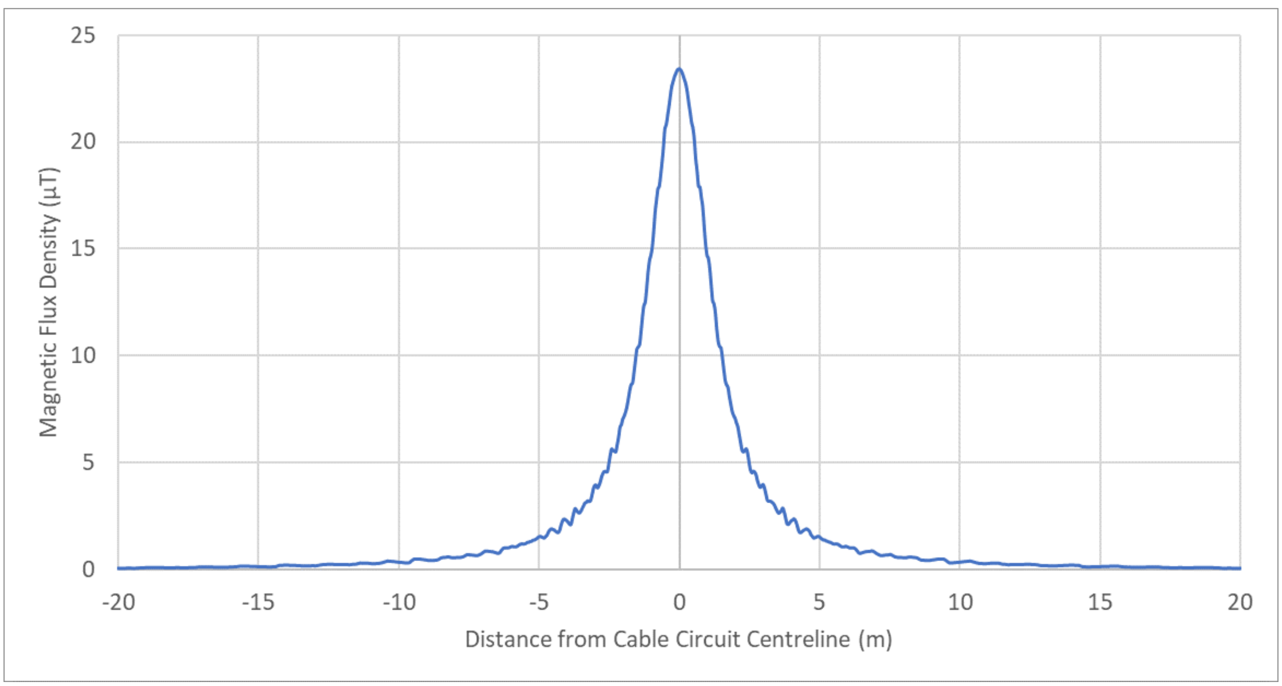


*Figure 6-17: Calculated magnetic field profile across the Bass Strait cables at sea floor level (Stage 1 cables only) - Horizontal*

It is noted that there are no material impacts of the proposed timing of the project's Stage 1 and 2 delivery on the calculated EMF and EMI emission levels along the subsea HVDC cables. Accordingly, there are no significant impacts on sensitive receivers and additional mitigation measures or changes to the Environmental Performance Requirements are not required.

### 6.2.4 Land HVDC Cables

The magnetic field distribution was calculated along the Stage 1 HVDC land project alignment. The nominal horizontal spacing between the trenched positive and negative cables in the Stage 1 circuit will be 0.5 m, but could increase to 4 m for HDD installations at road and river crossings.

The calculated magnetic field distributions and profiles along the Stage 1 HVDC land cable sections are plotted in Figure 6-18 to Figure 6-25 for different cable spacings between 0.5 m and 4 m. The calculated magnetic field profiles above the Stage 1 HVDC land cables with different cable spacings are compared to each other in Figure 6-26.

The worst case calculated magnetic field strengths are compared to the derived reference levels for human health, sensitive electrical and electronic equipment, fauna and flora impacts in Table 6-7 and Table 6-8 respectively.

*Table 6-7: Human health impact assessment along the HVDC land project alignment (Stage 1 cables only)*

| Exposure Scenario | Inter-cable Spacing (m) | Magnetic Field Strength (μT) | |
|---|---|---|---|
| | | Reference Level | Calculated Level |
| People | 0.5 | 400,000 | 24 |
| | 1 | 400,000 | 45 |
| | 2 | 400,000 | 80 |
| | 4 | 400,000 | 108 |
| Active implantable medical devices | 0.5 | 500 | 24 |
| | 1 | 500 | 45 |
| | 2 | 500 | 80 |
| | 4 | 500 | 108 |

*Table 6-8: Sensitive receiver impact assessment along the HVDC land project alignment (Stage 1 cables only)*

| Exposure Scenario | Inter-cable Spacing (m) | Magnetic Field Strength (μT) | |
|---|---|---|---|
| | | Reference Level | Calculated Level |
| RFID tags | 0.5 | 3,000,000 | 24 |
| | 1 | 3,000,000 | 45 |
| | 2 | 3,000,000 | 80 |
| | 4 | 3,000,000 | 108 |
| Livestock | 0.5 | 400,000* | 24 |
| | 1 | 400,000* | 45 |
| | 2 | 400,000* | 80 |
| | 4 | 400,000* | 108 |

| Exposure Scenario | Inter-cable Spacing (m) | Magnetic Field Strength (μT) | |
|---|---|---|---|
| | | Reference Level | Calculated Level |
| Apiaries | 0.5 | 2 | 24 |
| | 1 | 2 | 45 |
| | 2 | 2 | 80 |
| | 4 | 2 | 108 |
| Wildlife | 0.5 | 400,000* | 24 |
| | 1 | 400,000* | 45 |
| | 2 | 400,000* | 80 |
| | 4 | 400,000* | 108 |

* Conservative assumed value

During the worst case possible overload scenario (i.e. where the Stage 1 circuit is overloaded at 900 MW) the maximum magnetic flux density above the land cables will increase by up to 12.5%.

The HVDC land cables could have some impact on the behaviour of honeybees within 5 m of the cable trench. This is because directly above the buried cables, and within 5 m of the cable trench, the calculated field levels are above 2 μT. It is recommended that any apiaries located within 5 m of the trench be relocated outside the cable easement during the construction of the HVDC land cable. Publicly available information indicates that there are currently no existing apiaries within 5 m of the proposed land project alignment.

The findings and recommendations relating to honeybees in the paragraph above are consistent with the findings of the EMF and EMI impact assessment presented in the EIS/EES. Therefore, the EMF and EMI Environmental Performance Requirements presented in the EIS/EES address and cover the potential impacts to apiaries (i.e., there are no changes or additions to the proposed Environmental Performance Requirements).

It is noted that there are no material impacts of the proposed timing of the project's Stage 1 and 2 delivery on the calculated EMF and EMI emission levels along the land HVDC cables. Accordingly, there are no significant impacts on sensitive receivers and additional mitigation measures or changes to the Environmental Performance Requirements are not required.

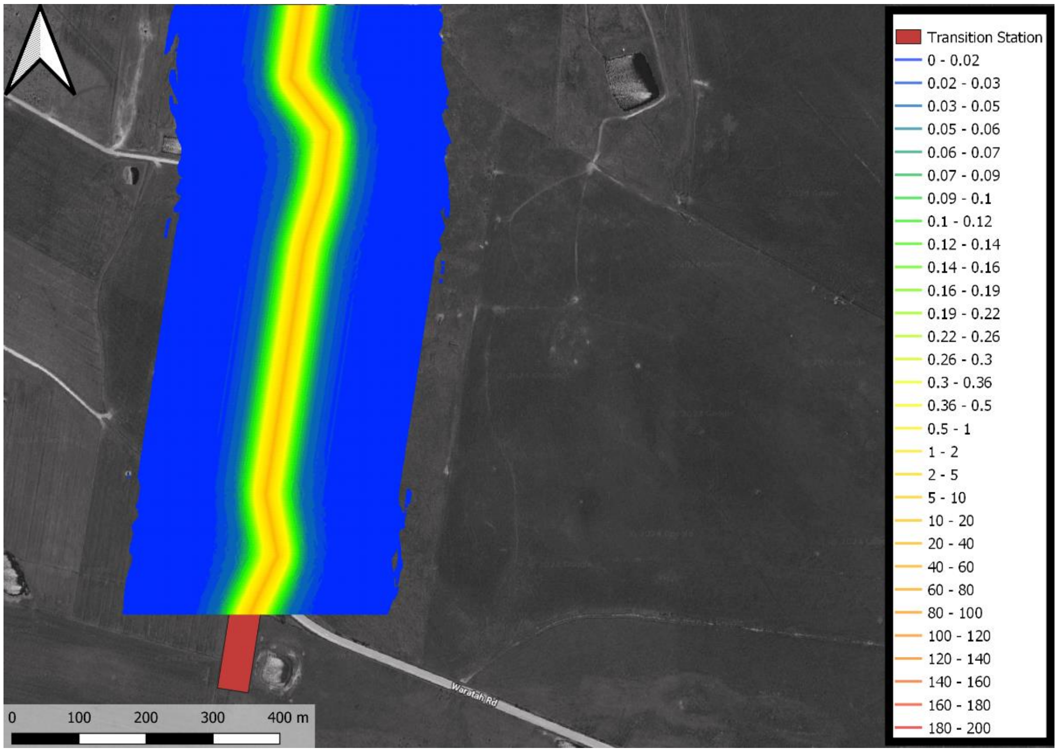


*Figure 6-18: Calculated magnetic field distribution in the vicinity of the HVDC land cable – 0.5 m inter-cable spacing (Stage 1 cables only)*

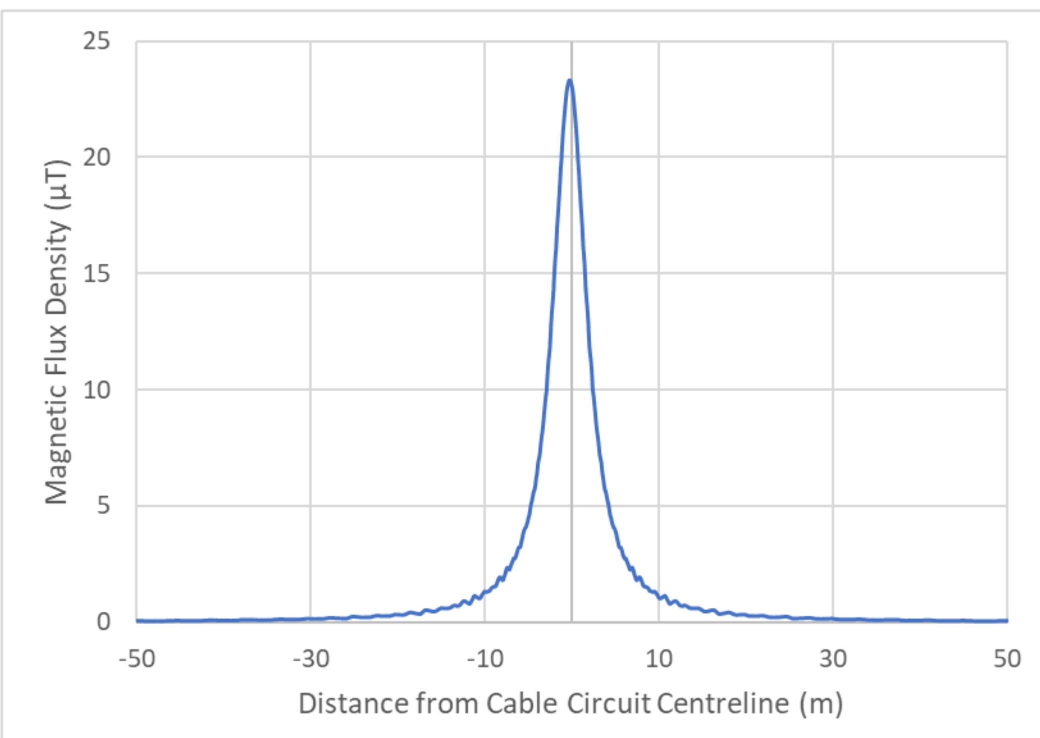


*Figure 6-19: Calculated magnetic field profile above the HVDC land cable – 0.5 m inter-cable spacing (Stage 1 cables only)*

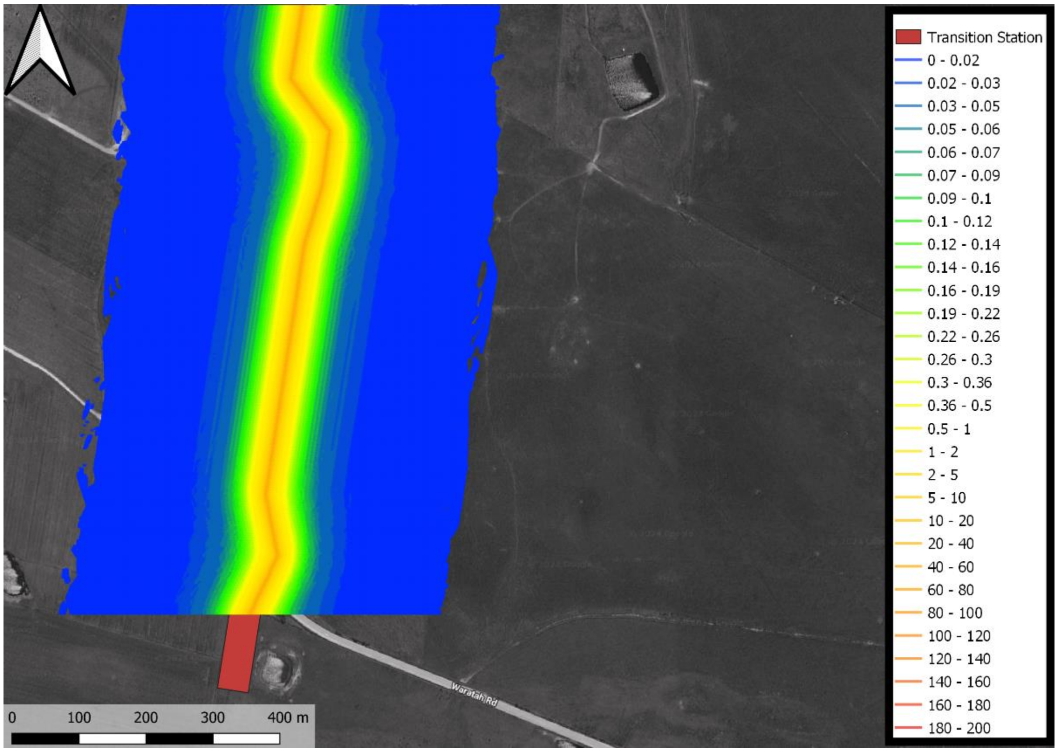


*Figure 6-20: Calculated magnetic field distribution in the vicinity of the HVDC land cable – 1 m inter-cable spacing (Stage 1 cables only)*

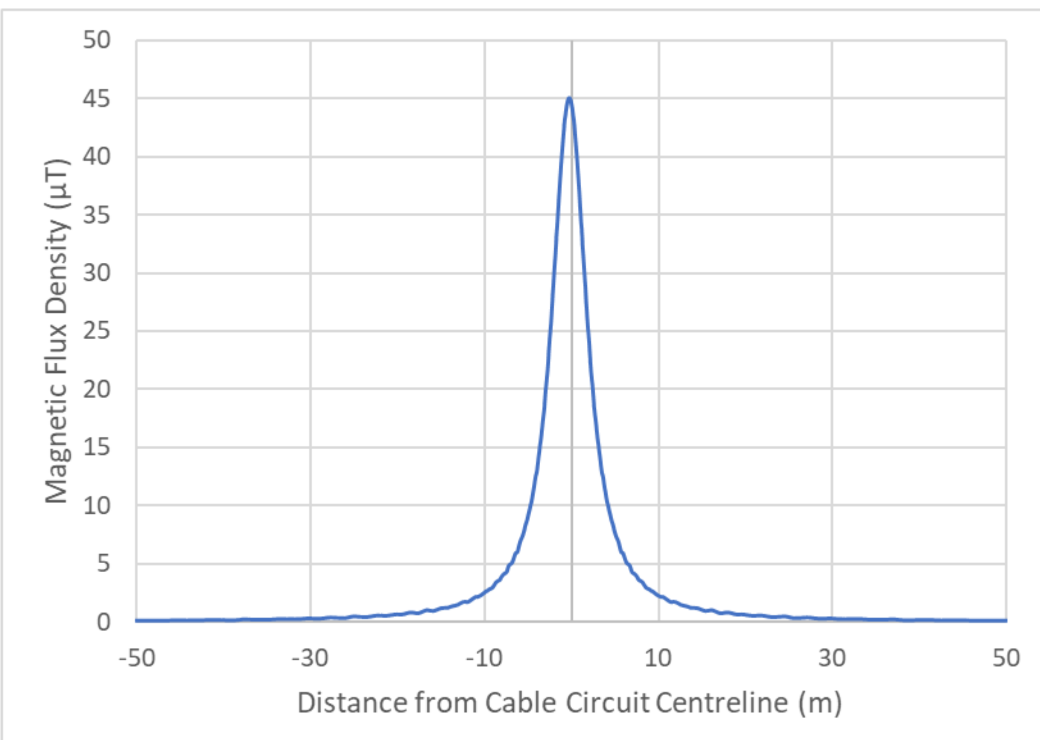


*Figure 6-21: Calculated magnetic field profile above the HVDC land cable – 1 m inter-cable spacing (Stage 1 cables only)*

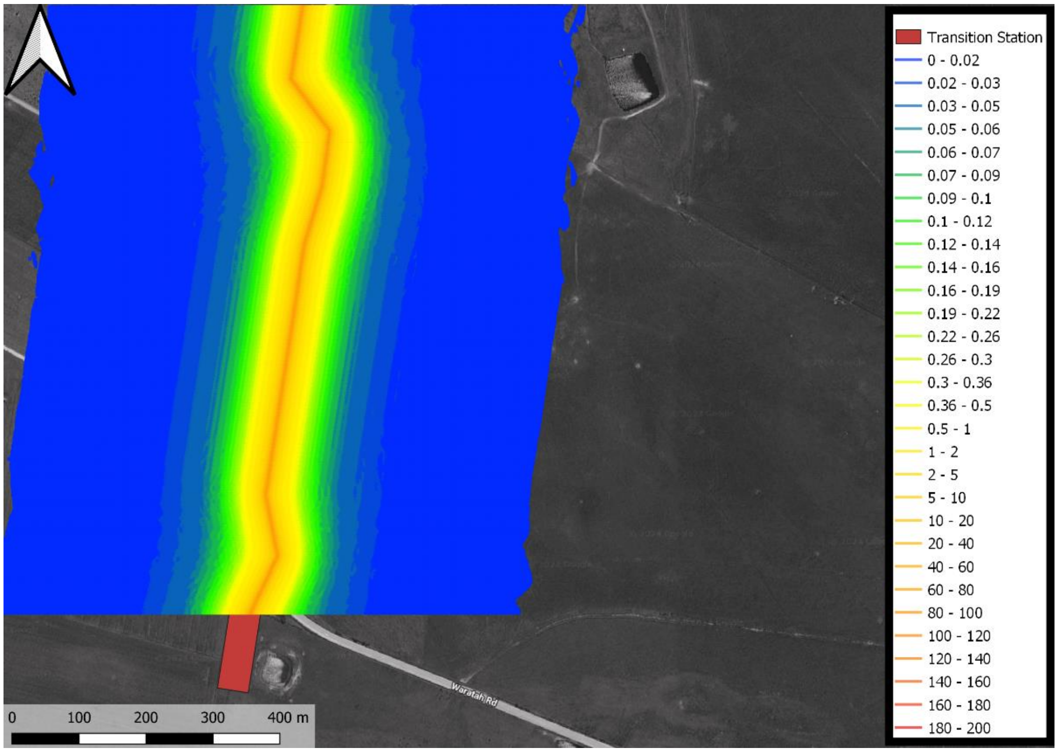


*Figure 6-22: Calculated magnetic field distribution in the vicinity of the HVDC land cable – 2 m inter-cable spacing (Stage 1 cables only)*

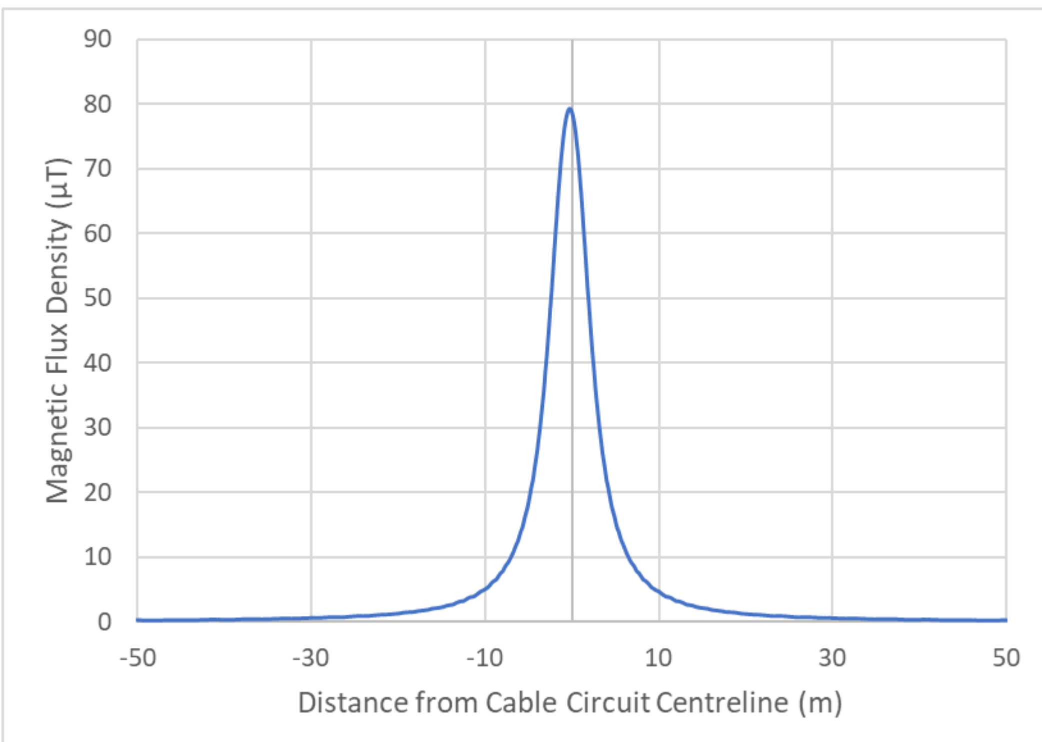


*Figure 6-23: Calculated magnetic field profile above the HVDC land cable – 2 m inter-cable spacing (Stage 1 cables only)*

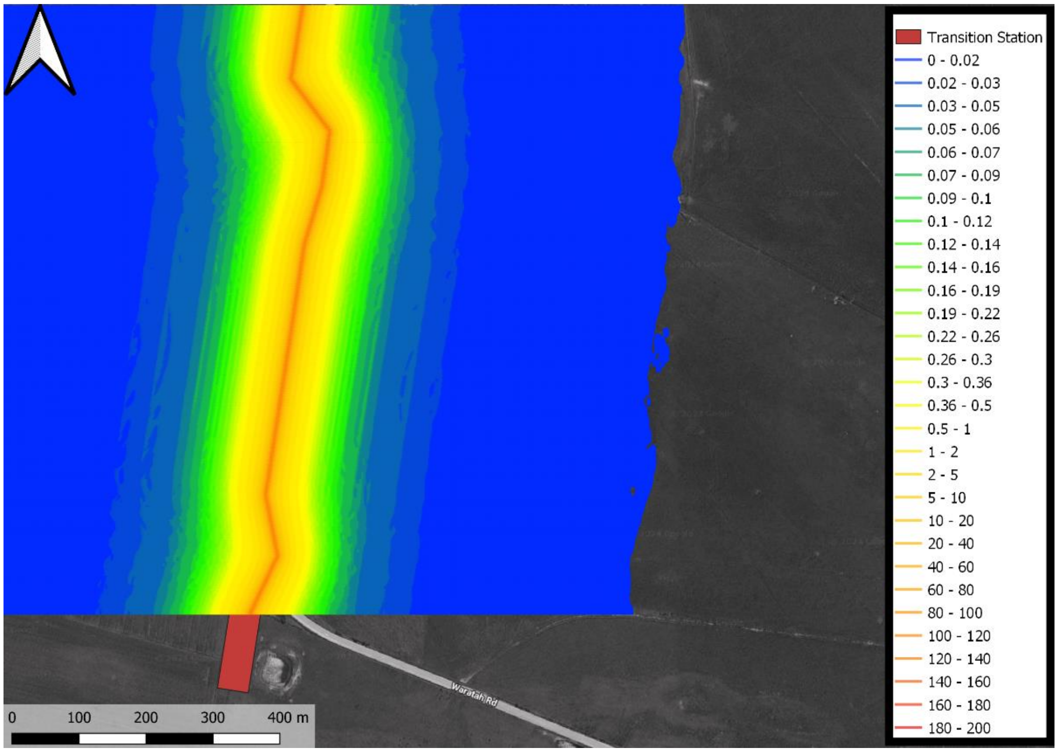


*Figure 6-24: Calculated magnetic field distribution in the vicinity of the HVDC land cable – 4 m inter-cable spacing (Stage 1 cables only)*

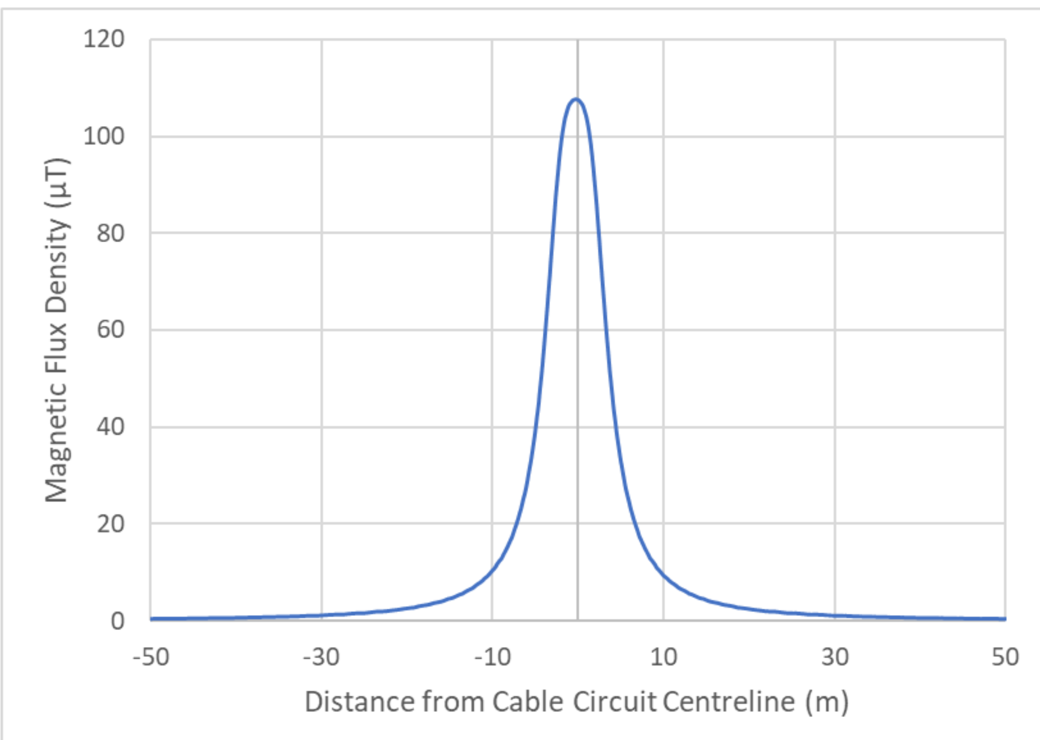


*Figure 6-25: Calculated magnetic field profile above the HVDC land cable – 4 m inter-cable spacing (Stage 1 cables only)*

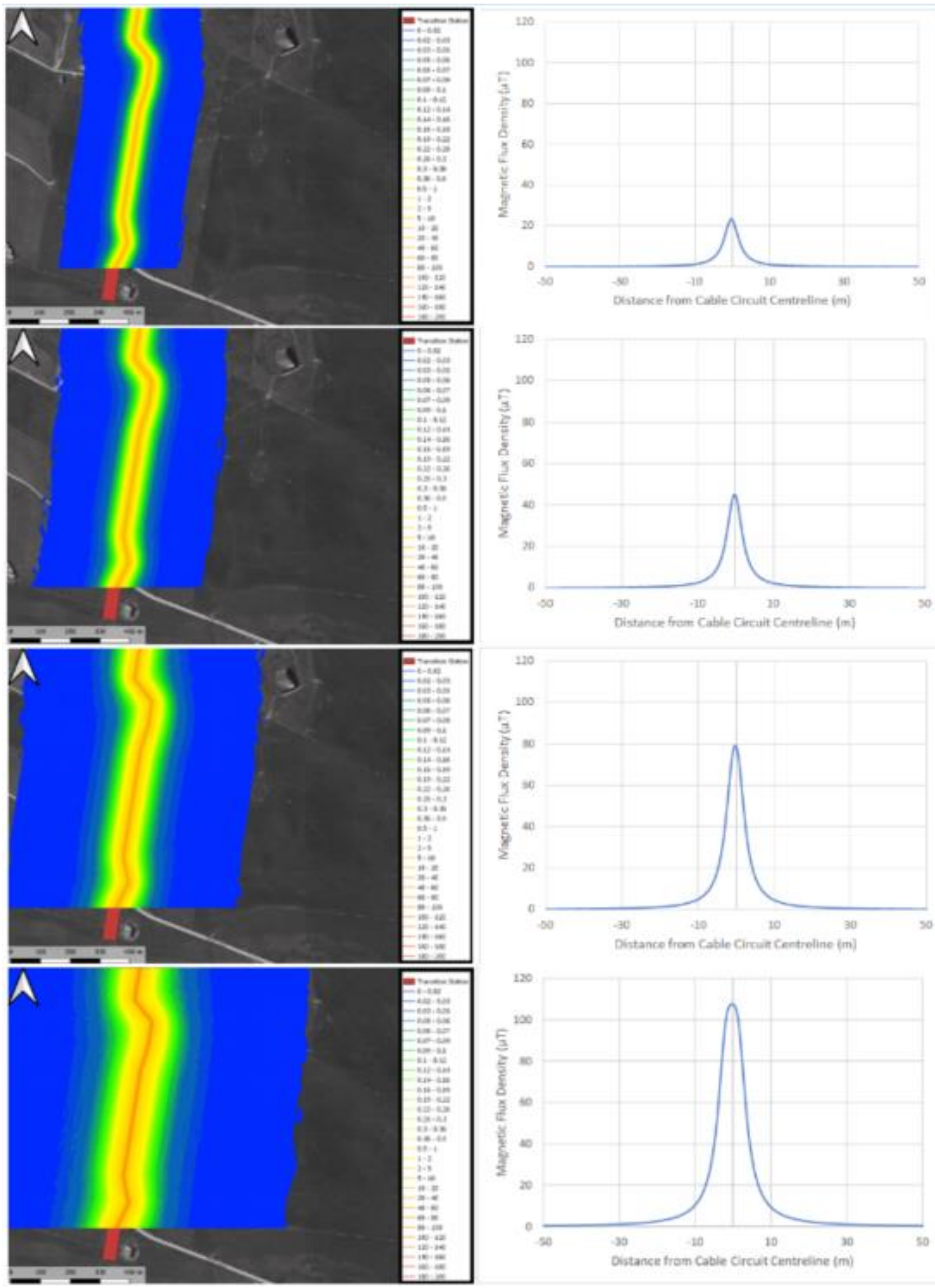


*Figure 6-26: Comparison of calculated magnetic fields for different HVDC land cable separations (0.5 m, 1 m, 2 m, and 4 m) (Stage 1 cables only)*

### 6.2.5 Cable Heating Assessment

Soil temperature rise contours have been calculated for various operating scenarios for the Stage 1 subsea and land HVDC cables in different areas along the proposed project alignment as part of the impact assessment.

Several CYMCAP models were created to analyse the different Stage 1 cable sections of the project alignment. The land HVDC cables have been modelled in PVC ducts, whilst the subsea cables have been modelled as direct buried. It is assumed that the land HVDC cables will be buried in Thermally Stable Backfilling Material (TSBM) with nominal cross-sectional dimensions of 1 m wide by 0.4 m deep. Cable and soil heating calculations were performed for the following three operating scenarios:

1. The Stage 1 cables operating at the proposed steady-state current
2. The Stage 1 cables operating at a temperature of 70°C
3. The Stage 1 cables operating at a temperature of 90°C

The scenarios where the Stage 1 cables are operating at 70°C and 90°C correspond to the maximum operating temperatures for typical cables. The results of the cable and soil heating calculations are summarised in Table 6-9 at depths of 0.1 m, 0.5 m and 1 m below the surface of the ground/seabed.

*Table 6-9: Cable heating assessment results with thermal backfill mitigation applied, where required (Stage 1 cables only)*

| Operating Condition | Increase in Soil Temperature above Ambient for various cable sections | | | | | |
|---|---|---|---|---|---|---|
| | Heybridge Converter Station | Submarine Section | Waratah Bay - Smallmans Rd | Smallmans Rd - Darlimurla Rd[1] | Darlimurla Rd - Strzelecki Hwy | Strzelecki Hwy - Hazelwood |
| **Steady state current 1.0 m depth** | +8°C | +7°C | +8°C | +20°C | +8°C | +14°C |
| **Conductor temp 70°C 1.0 m depth** | +11°C | +22°C | +11°C | +25°C | +11°C | +17°C |
| **Conductor temp 90°C 1.0 m depth** | +15°C | +30°C | +15°C | +35°C | +15°C | +25°C |
| **Steady state current 0.5 m depth** | +3°C | +2°C | +3°C | +9°C | +3°C | +6°C |
| **Conductor temp 70°C 0.5 m depth** | +5°C | +9°C | +5°C | +12°C | +5°C | +8°C |
| **Conductor temp 90°C 0.5 m depth** | +6.5°C | +12°C | +6.5°C | +16°C | +6.5°C | +11°C |
| **Steady state current 0.1 m depth** | +0°C | +0°C | +0°C | +1°C | +0°C | +1°C |
| **Conductor temp 70°C 0.1 m depth** | +1°C | +0°C | +1°C | +2°C | +1°C | +1.5°C |
| **Conductor temp 90°C 0.1 m depth** | +1.5°C | +1°C | +1.5°C | <3°C | +1.5°C | +2°C |

[1] Modelled with additional thermal backfill to encapsulate the 50°C contour

It is noted that there are no material impacts of the proposed timing of the project's Stage 1 and 2 delivery on the calculated cable heating along the subsea and land HVDC cables. Accordingly, there are no significant impacts on sensitive receivers and additional mitigation measures or changes to the Environmental Performance Requirements are not required.

## 6.3 Cumulative Impacts

All possible projects that could result in cumulative impacts on the project were identified in the EMF & EMI Impact Assessment Report. The proposed delay in the project's Stage 2 works does not alter the cumulative impacts considerations in the EMF and EMI impact assessment and no additional projects have been considered in this supplementary report.

## 6.4 Mitigation

It has been noted throughout the supplementary report that there are no material impacts of the proposed timing of the project's Stage 1 and 2 delivery on the calculated EMF & EMI emissions and the cable heating along the HVDC cable sections and at the converter stations. Accordingly, there are no significant changes to the impacts on sensitive receivers and additional mitigation measures are not required.

## 6.5 Monitoring and Review

It has been noted throughout the supplementary report that there are no material impacts of the proposed timing of the project's Stage 1 and 2 delivery on the calculated EMF & EMI emissions and the cable heating along the HVDC cable sections and at the converter stations. Accordingly, there are no significant changes to the impacts on sensitive receivers and additional monitoring and review measures are not required.

## 6.6 Environmental Performance Requirements

It has been noted throughout the supplementary report that there are no material impacts of the proposed timing of the project's Stage 1 and 2 delivery on the calculated EMF & EMI emissions and the cable heating along the HVDC cable sections and at the converter stations. Accordingly, there are no significant changes to the impacts on sensitive receivers and no changes or additions to the proposed Environmental Performance Requirements are deemed necessary.

# 7. Conclusions & Recommendations

There are no material impacts of the proposed timing of the project's Stage 1 and 2 delivery on the calculated EMF & EMI emissions and the cable heating along the HVDC cable sections and at the converter stations.

Accordingly, there are no significant changes to the impacts on sensitive receivers and no changes or additions to the proposed mitigation, monitoring and review measures or the Environmental Performance Requirements are deemed necessary.