Review of Environmental Factors

Installation of Underground High Voltage Cables Cudgen to Kings Forest

A component of the Kings Forest High Voltage Supply Project

February 2025

Project No. 793524

Essential Energy

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REVISION HISTORY

VERSION	NATURE OF REVISION
Draft01	Draft prepared for Essential Energy's Environmental Services peer review.
Draft02	Draft prepared for Essential Energy's Project Manager and Environmental Services Manager review
Final01	Final prepared for Essential Energy determination

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Acronyms and Abbreviations

ACRONYM/ABBREVIATION	DETAIL
ADSS	All-dielectric self-supporting. A type of fibre optic cable which is nonconductive, self-supporting and is capable of being erected under tension between supports.
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal Heritage Impact Permit
AEP	Annual Exceedance Probability
AOBV	Areas of Outstanding Biodiversity Value
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
ASS	Acid Sulfate Soils
AASS	Actual Acid Sulfate Soils
AEMO	Australian Energy Market Operator
BC Act	*Biodiversity Conservation Act 2016*
BDAR	Biodiversity Development Assessment Report
BoM	Bureau of Meteorology
BV	Biodiversity Values
BVM	Biodiversity Values Map
CEMP	Construction Environmental Management Plan
CO	Carbon monoxide
Consequence	The outcome of an event expressed qualitatively or quantitatively, being a loss, injury, disadvantage or gain.
dB(A)	Decibels (A) weighted
DCCEEW (Cth)	Department of Climate Change, Energy, the Environment and Water (Commonwealth)
DCCEEW (NSW)	Department of Climate Change, Energy, the Environment and Water (New South Wales)
DP	Deposited Plan
DPE	Department of Planning and Environment (Former NSW Government Department)
DPHI	Department of Planning, Housing and Infrastructure
DPI	Department of Primary Industries
EPA	Environment Protection Authority (NSW)
ELF	Extremely Low Frequency
EMF	Electric and Magnetic Fields

ACRONYM/ABBREVIATION	DETAIL
EMR	Electromagnetic Radiation
ENA	Energy Networks Association
Environmental Aspect	Any element of an organisation's activities, products or services that can interact with the environment.
Environmental Impact	Any change in the environment whether adverse or beneficial, wholly or partially resulting from organisation activities, products or services.
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Reg	*Environmental Planning and Assessment Regulation 2021*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPIs	Environmental Planning Instruments
ERP	Estimated Resident Population
ES Act	*Electricity Supply Act 1995*
ESD	Ecologically Sustainable Development
EWP	Elevated Work Platforms
FM Act	*Fisheries Management Act 1994*
FSC	Field Service Centre (Essential Energy)
FY	Financial Year
GDE	Groundwater Dependent Ecosystem
GHG	Greenhouse Gas
GSD	Ground Surface Disturbance
GSV	Ground Surface Visibility
Ha	Hectare
HDD	Horizontal Directional Drilling (commonly referred to as "underboring")
IARC	International Agency for Research on Cancer
IBRA	Interim Biogeographic Regionalisation of Australia
ICNIRP	International Commission on Non-Ionising Radiation Protection
IPC	Independent Planning Commission
KFH	Key Fish Habitat
KFHVSP	Kings Forest High Voltage Supply Project
km	Kilometre
KPoM	Koala Plan of Management
kV	Kilovolts

ACRONYM/ABBREVIATION	DETAIL
LALC	Local Aboriginal Land Council
Likelihood	A qualitative description of probability or frequency
LEP	Local Environmental Plan
LG Act	*Local Government Act 1993*
LGA	Local Government Area
m	Metre
mG	Milligauss
ML	Megalitres
mm	Millimetres
MVA	Mega Volt Amps
MNES	Matters of National Environmental Significance
NO_x	Oxides of Nitrogen
NPW Act	*National Parks and Wildlife Act 1974*
NSW	New South Wales
NVR	Native Vegetation Regulatory
NT Act	Native Title Act
PASS	Potential Acid Sulfate Soils
PCT	Plant Community Type
pHF	Field pH
pHFOX	Field pH peroxide test
POEO Act	*Protection of the Environment Operations Act 1997*
QLD	Queensland
REF	Review of Environmental Factors
Roads Act	*Roads Act 1993*
RMS	Roads and Maritime Service
SCADA	Supervisory control and data acquisition. A computer-based system for gathering and analysing real-time data to monitor and control equipment that deals with critical and time-sensitive materials or events.
SEE	Statement of Environmental Effects
SES	State Emergency Services
SEPP	State Environmental Planning Policy
SHI	State Heritage Inventory
SHR	State Heritage Register

ACRONYM/ABBREVIATION	DETAIL
SIS	Species Impact Statement
SO_2	Sulphur Oxide
STVM	State Vegetation Type Map
SWMP	Soil and Water Management Plan
TCECMP	Tweed Coast and Estuaries Coastal Management Program
TEC	Threatened Ecological Community
TfNSW	Transport for NSW
T&I SEPP	*State Environmental Planning Policy (Transport and Infrastructure) 2021*
TSC	Tweed Shire Council
UGOH	Underground-Overhead
WHO	World Health Organisation
WM Act	*Water Management Act 2000*
WM General Reg	*Water Management (General) Regulations 2018*
WSFMP	Wallum Sedge Frog Management Plan

REF Approval Form

PROJECT AND PROPONENT DETAIL

REF Name	Installation of Underground High Voltage Cables Cudgen to Kings Forest
Project Number	793524
REF prepared by	Nathan Hegerty
Title	Environmental Senior Specialist
Qualifications	Bachelor of Environmental Science Master of Environmental Law
Proponent Name	Essential Energy
Proponent Address	8 Buller Street, Port Macquarie NSW 2444

This Review of Environmental Factors (REF) assesses the potential impacts that may result from the proposed activities as outlined in "Description of the Proposal" section of this report.

Essential Energy is a state-owned corporation and is a determining authority as defined in the *Environmental Planning and Assessment Act 1979* (EP&A Act). The proposal satisfies the definition of an 'activity' under the EP&A Act, and as such Essential Energy must assess and consider the environmental impacts of the proposal before determining whether to proceed. This REF has been prepared in accordance with Section 5.5 of the EP&A Act and Clause 171 of the *Environmental Planning and Assessment Regulation 2021* (EP&A Reg). The EP&A Act requires Essential Energy to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity. The EP&A Reg sets out environmental factors to be considered in making that assessment. If the activity is considered likely to significantly affect the environment, additional assessment requirements under the EP&A Act would be required.

Section 5.7 of the EP&A Act states that a determining authority shall not carry out an activity, or grant an approval in relation to an activity, that is likely to significantly affect the environment (including critical habitat) or threatened species, populations or ecological communities, or their habitats, unless the determining authority has examined and considered an Environmental Impact Statement or Species Impact Statement in respect of the activity.

The REF has addressed the matters that are required to be considered by Part 5, Division 5.1 of the EP&A Act, with the conclusion that if the activity is carried out as described, it is not likely to have a significant effect on the environment (including critical habitat) or threatened species, populations, ecological communities or their habitats, and accordingly an Environmental Impact Statement is not required. The mitigation strategies forming part of the activity are fully considered and discussed in the REF.

The activity was also assessed against the requirements of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). As the proposed activity will not have, and is not likely to have a significant impact on matters of national environmental significance, a referral to the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) is not required.

The proposed activity is permissible under all relevant state and federal legislation, including the EPBC Act and the *Biodiversity Conservation Act 2016* (NSW).

Under *State Environmental Planning Policy (Transport and Infrastructure) 2021* (T&I SEPP) the activity is classified as development for the purpose of an electricity transmission or distribution network undertaken by or on behalf of a public authority, and is hence permitted on the land without the requirement for development consent.

Declaration

The Review of Environmental Factors for the proposed activity has been assessed by Essential Energy.

Considering the assessment of the impacts, including Sections 1.7 and 5.5 of the *Environmental Planning and Assessment Act 1979* and clause 171 of the *Environmental Planning and Assessment Regulations 2021*, it is concluded that:

- There is not likely to be a significant environmental effect as a result of the construction, operation and maintenance of the activity and an Environmental Impact Statement is not required; and
- A Species Impact Statement (SIS), or Biodiversity Development Assessment Report (BDAR) is not required.

AUTHOR DECLARATION

I certify that I have reviewed and endorsed the contents of this REF document and, to the best of my knowledge, it is in accordance with the EP&A Act, the EP&A Regulation and the Guidelines approved under clause 170 of the EP&A Regulation, and the information it contains is neither false nor misleading.

REF Addendum prepared by	Nathan Hegerty
Signature	Nathan Hegerty Digitally signed by Nathan Hegerty Date: 2025.02.21 11:34:17 +11'00'
Title	Environmental Senior Specialist
Date	

PEER REVIEW DECLARATION

I certify that I have reviewed and endorsed the contents of this REF document and, to the best of my knowledge, it is in accordance with the EP&A Act, the EP&A Regulation and the Guidelines approved under clause 170 of the EP&A Regulation, and the information it contains is neither false nor misleading

Peer Review by	Tim Haydon
Signature	Tim Haydon Digitally signed by Tim Haydon Date: 2025.02.21 11:44:15 +11'00'
Title	Environmental Senior Specialist
Date	

PROJECT MANAGER REVIEW DECLARATION

The assessment has been reviewed and it is recommended that the Activity may now proceed subject to the implementation of the recommendations and mitigation measures contained in the REF documentation.

Project Manager Review by	Glenn Potter
Signature	Glenn Potter Digitally signed by Glenn Potter Date: 2025.02.21 12:00:18 +11'00'
Title	Senior Program / Project Manager
Date	

DETERMINATION

1. Considering the assessment of the impacts, including sections 1.7 and 5.5 of the *Environmental Planning and Assessment Act 1979* and clause 171 of the *Environmental Planning and Assessment Regulation 2021*, it is determined that there is not likely to be a significant environmental effect as a result of the construction, operation and maintenance of the new underground high voltage cables between Cudgen Zone Substation and the previously installed underground high voltage cables at Kings Forest. Neither an Environmental Impact Statement (EIS), nor SIS, nor BDAR is required.
2. The Activity may now proceed subject to obtaining and complying with the relevant approvals as identified in the original REF and subject to the implementation of the recommendations and mitigation measures contained in the REF documentation.

Signature	Brett Hayward Digitally signed by Brett Hayward Date: 2025.02.21 12:18:05 +11'00'
Determining Authority	Brett Hayward
Title	Environmental Services Manager
Date	

Executive Summary

Background / Justification

Essential Energy is proposing to design, construct, operate and maintain a new section of high voltage electricity supply network, known as the Kings Forest High Voltage Supply Project (KFHVSP). The KFHVSP will deliver high voltage electricity supply to the new master planned Kings Forest community development (Kings Forest development), which when complete will comprise approximately 4,500 new dwellings, over an approximately 856 hectare (ha) site. The Tweed Local Government Area (LGA) is categorised as one of 25 LGAs in NSW which has a high need for affordable housing (JBA Planning, 2011). Tweed Shire Council (TSC) has adopted a number of strategic plans relating to housing and employment lands. The Kings Forest development features prominently in the plans, recognising the importance of the master planned development to TSC for providing affordable housing and employment opportunities. The Kings Forest development is also recognised in the NSW State Government's North Coast Regional Plan 2041 (NSW DPE, 2022) as an important urban release area on the north coast of NSW. The Kings Forest development is expected to be one of the largest projects for new housing and employment in the Tweed in the next 25 years (TSC, 2024).

An integral component of the KFHVSP will be the installation of approximately 4.4 kilometres (km) of new underground high voltage cables between Essential Energy's existing Cudgen Zone Substation (ZS) and the proposed new Kings Forest ZS. Together, the new underground high voltage cables and the new Kings Forest ZS form the KFHVSP.

Installation, operation and maintenance of approximately 4km of the 4.4km of new underground high voltage cables, and associated works, are subject to assessment in this REF report, prepared under Part 5 (Division 5.1) of the EP&A Act.

Installation of approximately 400m of 4.4km of new underground high voltage cables, located within the Kings Forest development site (southern extent of the KFHVSP) has already occurred, and was subject to assessment in a separate REF, previously prepared under Part 5 (Division 5.1) of the EP&A Act (Essential Energy, 2023). The separation was required to align with the construction schedules of early site preparatory activities and civil works associated with the broader Kings Forest development. That is, as the broader Kings Forest development commenced, significant land disturbance associated with civil works for new roads and other infrastructure were occurring, and this provided an optimal period to include installation of the underground high voltage cables in those areas, while refinement of the design for the remainder of the underground high voltage cable route was ongoing. Similarly, the REF for the ZS (Essential Energy, 2024) was prepared separately to enable construction to commence while significant disturbance work was occurring as part of the broader Kings Forest development, and also to allow for the longer construction schedule required for the ZS.

Construction and operation of the new Kings Forest underground high voltage cables, as an integral component of the KFHVSP, will ensure the local electricity infrastructure meets the current and future needs for the new Kings Forest development. It will thereby support the development of a critical new affordable housing release area, as identified by both TSC and the NSW State Government. The new ZS will also strengthen Essential Energy's existing electricity network in the broader area, as well as increase its capacity, which will help support future electricity connections.

The Proposal

The proposal comprises installation, operation and maintenance of approximately 4km of new underground high voltage cables, between Essential Energy's existing Cudgen ZS and the connection point with the previously installed sections of underground cables within the Kings Forest development. The proposal will also include the installation of new fibre optic communication cables and earthing cable alongside the high voltage electricity cables, installation of two new underground to overhead (UGOH) poles, and result in the removal of an approximately 460m section of existing overhead high voltage powerline.

Construction methodology will be primarily by a mixture of trenching and shallow underbores along the road reserves in the northern portion of the proposal, Three longer, deeper underbores will be required in the

southern portion of the proposal to avoid impacts to remnant vegetation, farms dams, and wetland environments. Several cable jointing pits and associated earth link boxes will be installed along the proposal route. These will be permanent structures installed below ground level with trafficable lids to allow access for inspection and maintenance from the surface when required.

Once the conduits are installed and cable pits constructed, the underground electricity, communication and earthing cables will be pulled through. It is proposed to use 66 kilovolt (kV) rated cable to enable future upgrade to the network. However, the electricity cables will initially be energised to 33kV upon commissioning.

Project Alternatives

One option would be to refrain from undertaking any further development of the network in the area. The consequences of Essential Energy doing nothing would be that, as years passed, supply interruptions would occur more frequently and affect more people, and there is insufficient capacity within the existing electricity supply network to meet the demand anticipated to be required by the Kings Forest development. The proposed new underground high voltage cables are an integral component of the KFHVSP, required to supply the Kings Forest development, and without the augmentation of high voltage supplies, additional electricity supplies at the distribution level are not possible. Due to Essential Energy's network licence obligations, the 'do nothing' option is not a viable alternative to the proposed new electricity supply to the Kings Forest development, of which the proposed new underground cables are a vital component.

Planning for the electricity supply to Kings Forest development commenced approximately 20 years ago. An Options Assessment (SKM, 2004) considered the location of a new 33/11kV ZS and associated connector powerlines to the existing Cudgen ZS to the north and existing Hastings Point high voltage overhead powerline to the south. A short list of five substation sites and five powerline routes were identified, taking into account the assessment of environmental constraints, cost, access and constructability. However, at the time of this assessment much of the study area and surrounding land was currently under investigation for future urban development, and the Concept Plan for the Kings Forest Master Planned Community was still under development. As such, the recommendations provided in the Options Assessment (SKM, 2004) were superseded once more was known about the scale and supply load forecasts for the Kings Forest development

Over several years, engagement with the developer (Leda) has been ongoing, with the aim of determining the most appropriate route for the high voltage powerline and location of the ZS. Several route options for the high voltage powerline to supply the development were canvassed and are discussed in Section 4 of this REF. Ultimately the preferred option, subject to assessment in this REF, was chosen, as it, meets the needs of the Kings Forest development; provides the highest line security and best network outcome; strengthens Essential Energy's existing electricity network in the broader area; and increases its capacity, while having the least societal and environmental impacts.

Statutory Planning and Legislation

Clause 2.44 of *State Environmental Planning Policy (Transport and Infrastructure) 2021* (T&I SEPP) applies to electricity transmission and distribution activities undertaken by an energy supply authority. Clause 2.44 states that development for the purpose of a transmission or distribution network may be carried out by or on behalf of an electricity supply authority or public authority without consent on any land with additional requirements for land reserved under the *National Parks and Wildlife Act 1974*. Exemptions to this broad (on any land) application include developments which require Part 4 approval under *State Environmental Planning Policy (Planning Systems) 2021* (Planning Systems SEPP) and activities triggering designated development under *State Environmental Planning Policy (Resilience and Hazards) 2021* (Resilience and Hazard SEPP) for development undertaken within mapped areas of coastal wetland or littoral rainforest.

The proposed activity is not located within land reserved under the NPW Act and does not meet the criteria to be considered State Significant Development (SSD), State Significant Infrastructure (SSI), Critical State Significant Infrastructure (CSI), or Regionally Significant Development (RSD) in accordance with the Planning Systems SEPP. An approximately 95 metre (m) section of the proposal intersects with a mapped coastal wetland. However Clause 2.44A of the T&I SEPP enables certain development for above or below ground electricity transmission or distribution lines to be carried out without development consent on land

identified as coastal wetlands or littoral rainforests, subject to certain requirements in clause 2.44A(2). The proposal satisfies these requirements and as such can be considered development permitted without consent.

As the activity does not require development consent, Essential Energy is the designated determining authority. Additionally, whilst Essential Energy does not require development consent to undertake the proposed activity, it has an obligation under Part 5, Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to consider the environmental impacts of the activity.

Specifically, Essential Energy has a statutory obligation to examine and take into account, to the fullest extent possible, all matters affecting or likely to affect the environment by reason of this activity. This REF has been prepared to facilitate the determination through consideration of the relevant factors specified in section 5.5 of the EP&A Act and clause 171 of the *Environmental Planning and Assessment Regulation 2021* (EP&A Reg).

Environmental Impact Assessment

A number of potential environmental impacts associated with the project have been avoided or reduced to acceptable levels during the design development and assessment stages. However, the project may still result in some impacts including air quality (dust), noise and vibration, soil, water, vegetation, traffic, waste generation, and visual amenity during construction and operation, as outlined in Section 6. Management and mitigation measures to alleviate these impacts have been developed as part of this REF and would be implemented during construction and operation of the proposal. Cumulative impacts associated with all components of the KFHVSP, and other nearby developments, have been considered. These impacts will be minimised to the greatest extent possible, and will not be significant.

Considering the assessment of the impacts detailed in this REF, it is concluded that the proposed activity is not likely to have a significant impact on the environment. On balance, the project is justified on the basis of supporting a critical new housing development on the Tweed (i.e., the Kings Forest development) and strengthening Essential Energy's electricity network in the broader area, whilst minimising potential environmental impacts.

1. Introduction

1.1 The Proposal

This Review of Environmental Factors (REF) assesses the potential environmental impacts associated with the construction, operation and maintenance of approximately 4km of proposed new underground high voltage cables at Kings Forest, New South Wales (NSW). The proposal forms part of the Kings Forest High Voltage Supply Project (KFHVSP). The significance of impact has been determined and appropriate mitigation measures recommended.

1.2 Context and Justification of the Proposal

Essential Energy has received a connection request from Kings Forest Estate Pty Ltd (known as "Leda") to service a new $5 billion, 4,500 dwelling, 856 hectare (ha) master planned community development at Kings Forest, located on the far north coast of NSW. The Kings Forest development received concept plan approval (MP 06_0318) and Stage 1 project approval (MP 08_0194) under the former Part 3A approval pathway of the *Environmental Planning and Assessment Act 1979* (EP&A Act). In 2018 the Stage 1 project approval (MP 08_0194) was transitioned from the former Part 3A approval pathway to State Significant Development (SSD) under Part 4 of the EP&A Act.

The Tweed Local Government Area (LGA) is categorised as one of 25 LGAs in NSW which has a high need for affordable housing (JBA Planning, 2011). Tweed Shire Council (TSC) has adopted a number of strategic plans relating to housing and employment lands, including but not limited to *Tweed Shire Council Local Strategic Planning Statement – 2020* (TSC, 2020), and the *Tweed Urban and Employment Land Release Strategy 2009* (TSC, 2009). The Kings Forest development features prominently in the plans, recognising the importance of the master planned development to council for providing affordable housing and employment opportunities. The Kings Forest development is also recognised in the NSW State *Government's North Coast Regional Plan 2041* (NSW DPE, 2022) as an important urban release area on the north coast of NSW. The Kings Forest development is expected to be one of the largest projects for new housing and employment in the Tweed in the next 25 years (TSC, 2024).

In order to facilitate the connection of the Kings Forest development and improve local electricity infrastructure, Essential Energy is proposing to design, construct, operate and maintain a new section of high voltage electricity supply network, known as the Kings Forest High Voltage Supply Project (KFHVSP). An integral component of the KFHVSP is the installation of approximately 4.4 kilometres (km) of new underground high voltage cables between Essential Energy's existing Cudgen Zone Substation (ZS) and the proposed new Kings Forest ZS. Together, the new underground high voltage cables and the new Kings Forest ZS form the KFHVSP (refer **Figures 1** and **2**).

Installation of approximately 400m of the 4.4km of new underground high voltage cables, located within the Kings Forest development site (southern extent of the KFHVSP), has already occurred, and was subject to assessment in a separate REF, prepared under Part 5 (Division 5.1) of the EP&A Act (Essential Energy, 2023). The separation was required to align with the construction schedules of early site preparatory activities and civil works associated with the broader Kings Forest development. That is, as the broader Kings Forest development commenced, significant land disturbance associated with civil works for new roads and other infrastructure were occurring, and this provided an optimal period to include installation of the underground high voltage cables in those areas, while refinement of the design for the remainder of the underground high voltage cable route was ongoing. Similarly, the REF for the ZS (Essential Energy, 2024) was prepared separately to align with disturbance work in Precinct 2 of the broader Kings Forest development and allow for the longer construction schedule required for the ZS.

Installation, operation and maintenance of the remaining approximately 4km section of the new underground high voltage cables, as well as the installation of two new underground-overhead (UGOH) poles and the decommissioning of approximately 460m of existing overhead high voltage powerline, are subject to assessment in this REF report, also prepared under Part 5 (Division 5.1) of the EP&A Act. Cumulative impacts associated with all components of the KFHVSP have been considered (refer **Section 6.16**).

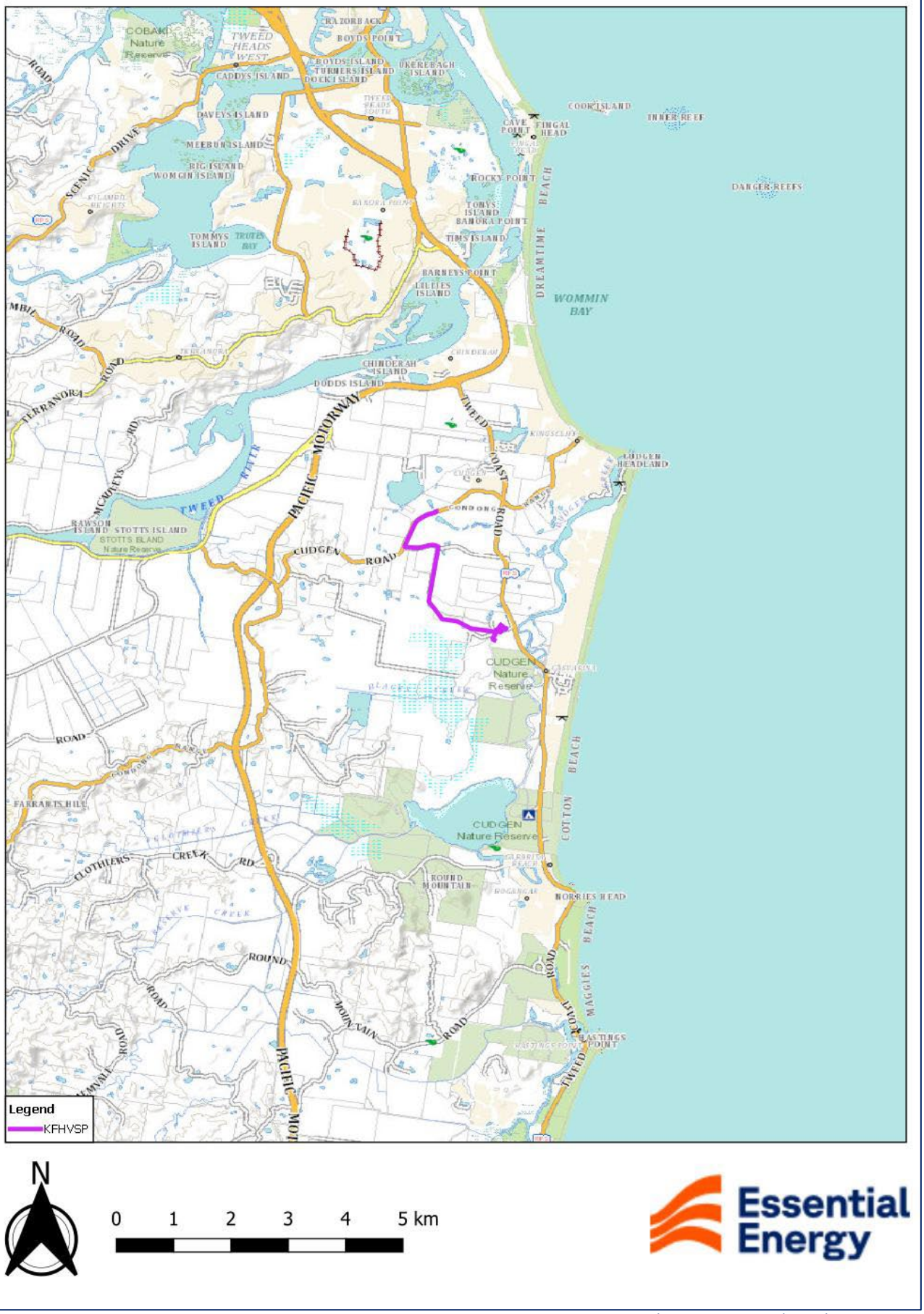


Figure 1: KFHVSP in regional context

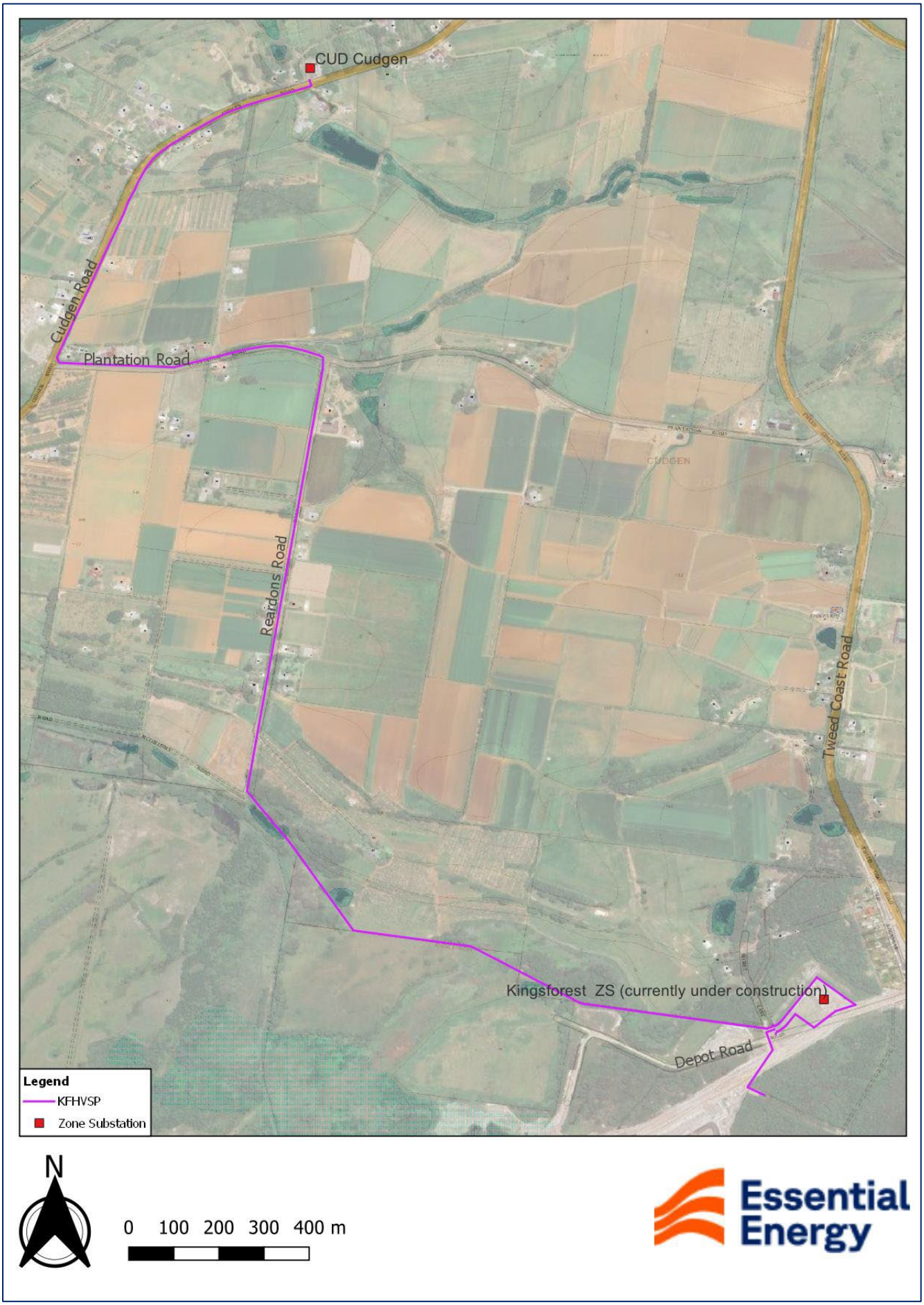


Figure 2: KFHVSP in local context

Figure 3 depicts the various components of KFHVSP, while **Figure 4** confirms the proposal site subject to assessment in this REF.

Construction and operation of the new Kings Forest underground high voltage cables, as an integral component of the KFHVSP, will ensure the local electricity infrastructure meets the current and future needs for the new Kings Forest development. It will thereby support the development of a critical new affordable housing release area, as identified by both TSC and the NSW State Government. The proposal will also strengthen Essential Energy's existing electricity network in the broader area, as well as increase its capacity, which will help support future electricity connections. The Kings Forest development will allow thousands of new customers to connect to Essential Energy's network and will also increase capacity and reliability for existing and future customers.

1.3 Network Investment Criteria

Network asset investment by Essential Energy is generally required to:

- Meet Essential Energy's duty of care
- Connect customers to the supply network
- Provide a satisfactory standard of supply to customers.

The overall performance of the network is driven by the reliability of individual network components and the redundancy provided by the network to enable maintenance of supply at times when critical parts of the network are out of service (due to maintenance or repair requirements). To maintain acceptable standards of customer service it is necessary to ensure:

- Infrastructure performance (reliability) is maintained at acceptable levels
- The network design provides adequate security (redundancy).

The reliability of equipment and infrastructure is managed through maintenance and replacement of that infrastructure and construction of new infrastructure. For Essential Energy, the decision to replace or construct new infrastructure is based on an assessment of equipment condition and consideration of the strategic needs of the network.

1.4 Proposal Objectives

The primary objective of the overall KFHVSP is to design, construct, operate and maintain new underground high voltage cables between Essential Energy's existing Cudgen ZS and the connection point with previously installed underground high voltage cables near the Kings Forest ZS. The upgrade will service the new master planned Kings Forest community development and strengthen Essential Energy's existing electricity network in the broader area. Secondary objectives associated with the project are to:

- Maximise social and economic benefits and
- Minimise the environmental and social impacts.



Figure 3: Components of the KFHVSP

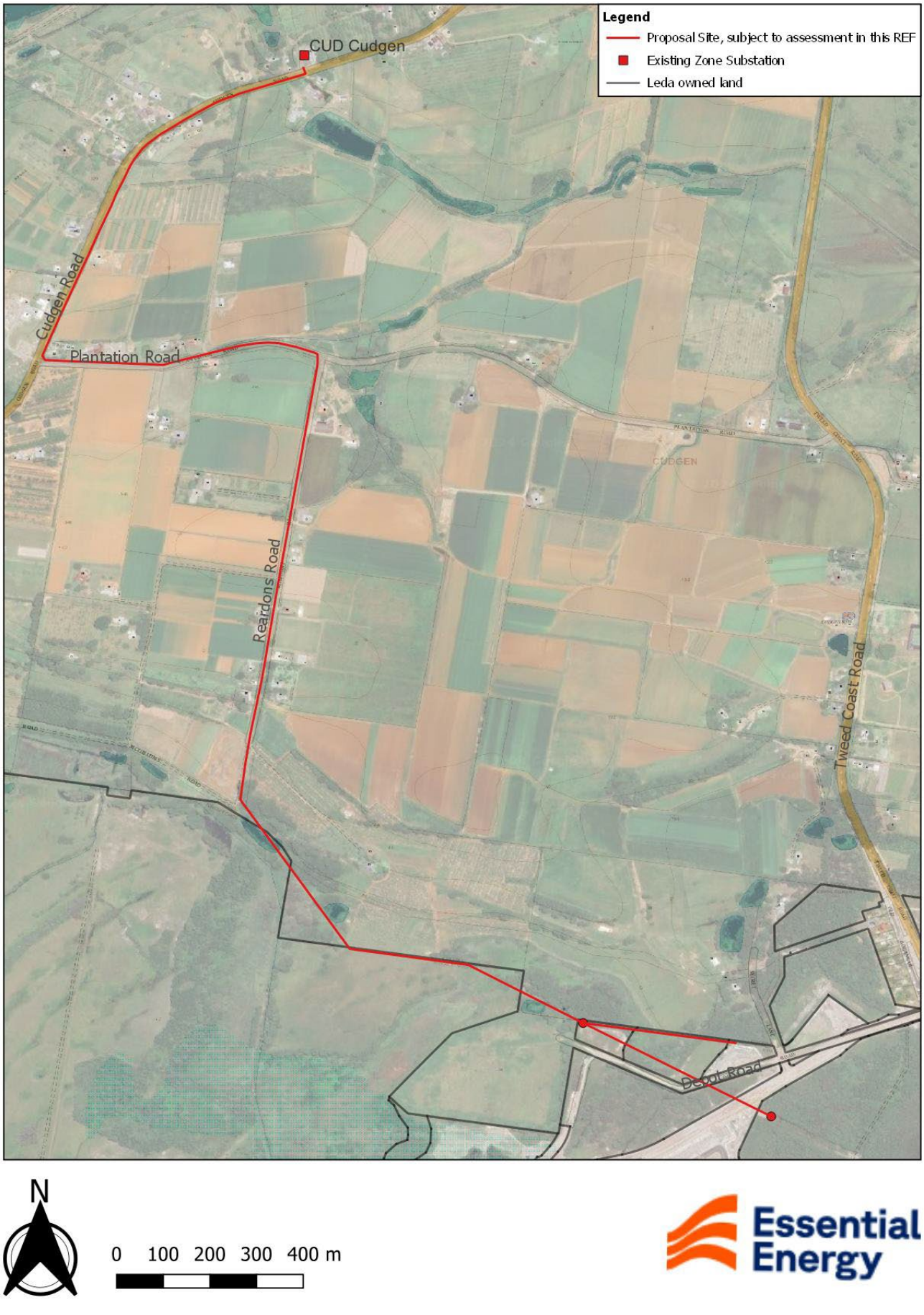


Figure 4: Proposal Site subject to assessment in this REF

1.5 Proposal Site

The activity being assessed in this REF, includes:

- Installation of approximately 4km of proposed new underground high voltage electricity, fibre optic and earthing cables between Essential Energy's existing Cudgen ZS, located at 571 Cudgen Road, Cudgen, and the termination of previously installed underground high voltage cables near the Kings Forest ZS
- Installation of two new underground-overhead (UGOH) poles within the existing overhead high voltage powerline corridor, on Leda owned land at the southern extent of the proposal site
- Decommissioning of approximately 460m of existing overhead high voltage powerline between the new UGOH poles referred to above.

Collectively the above forms the "proposal site". Refer **Figures 3** and **4**.

A description of the proposal site and supporting photographs are provided in **Table 1**.

The nearest population centres to the proposal site are Cudgen and Kingscliff, located approximately 760m and 2.2km northeast of the northern extent of the proposal site, respectively. South Kingscliff Beach and Casuarina, are located approximately 2.3km and 1.4km east of the eastern extent of the proposal site, respectively. Cabarita Beach / Bogangar is located approximately 4.5km to the south of the southern extent of the proposal site. The Queensland / NSW border is located approximately 10km north of the northern extent of the proposal site, at its closest point.

The proposal site is located within the TSC LGA. The majority of the land along the proposal site is zoned RU1 – Primary Production according to the *Tweed Local Environmental Plan 2014* (Tweed LEP). The southern portion of the proposal site, as it traverses Leda owned land is zoned:

- 7(a) - Environmental Protection (Wetlands and Littoral Rainforests) and
- 7(l) - Environmental Protection (Habitat) 2(c) - Urban Expansion according to *State Environmental Planning Policy (Precincts–Regional) 2021.*

The proposal site will be accessed primarily via the existing road network, including Cudgen Road, Plantation Road and Reardons Road. Some access to private property, including Lot 4 DP629229, and Lot 1 DP781633, the latter owned by Leda, will be required to facilitate cable installation from the end of Reardons Road through to the connection point with previously installed underground high voltage cable on Leda owned land (Lot 1 DP787633).

The proposal site is located on predominately heavily modified and disturbed land from historical and current uses, namely the construction and operation of the existing road and electricity networks, installation of other underground utilities, adjoining agricultural activities and recent construction work at the Kings Forest residential development site.

The proposal traverses two different NSW Landscapes (Mitchell Landscapes):

- Lamington Volcanic Slopes, comprising the northern portion of the proposal from Cudgen ZS to the southern end of Reardons Road
- Byron - Tweed Alluvial Plains, comprising the southern portion of the proposal, generally from the southern end of Reardons Road to the connection point with previously installed underground cables.

Further description of landscapes, geology and soils is provided in **Section 6.2**.

There are several ephemeral Strahler first order waterways located in agricultural land adjoining the northern portion of the proposal site, although the proposal site does not intersect with any of these. The southern portion of the proposal site intersects with, or is located in close proximity to, several farm dams and mapped coastal wetlands.

Further description of hydrology is provided in **Section 6.3**.

Review of the NSW State Vegetation Type Map (SVTM) (DPE, 2023) indicates that the majority of the proposal site is mapped as Plant Community Type (PCT) 0: not classified (refer Figure 6-5). Very little wooded vegetation occurs along the proposal site. Where remnant native PCT do exist, they are largely previously cleared and support groundcover species only, or with bracken fern and small shrub regrowth.

Three PCTs, excluding PCT 0 (not native vegetation) and small patches of planted garden vegetation, were determined to occur along the proposal site:

- PCT 3004 - Far North Bangalow Palm Swamp Forest – 0.03 hectares (ha)
- PCT 3988 - Far North Mesophyll Paperbark Swamp Forest – 0.03ha
- PCT 4004 - Northern Melaleuca quinquenervia Swamp Forest – 0.17ha

Planted vegetation occupies 0.03ha and non-native vegetation occupies 1.39ha. Further review and assessment of the vegetation types present at, and nearby the proposal site, as well as potential impacts on threatened species, communities and their habitats, is provided in **Section 6.5**.

The proposal also intersects with PCT 3961 – Coastal Freshwater Wetlands, as mapped by NSW SVTM, but will not be disturbed due to proposed underbore methodology being employed (refer **Section 2.1**).

The surrounding land uses, outside the road reserves and existing electricity corridors, are predominately agricultural in nature, consisting of cropping and grazing land. Isolated patches of remnant vegetation are present along and adjoining the southern portion of the proposal site. There are a number of rural and rural-residential residences located immediately adjacent to the northern portion of the proposal site along Cudgen, Plantation and Reardons Roads. Distance to sensitive receivers from the northern portion of the proposal site range from approximately 5m to 30m. The proposal site intersects with driveways of the majority of these residences. The closest sensitive receivers to the southern portion of the proposal site are rural residences, located between approximately 130m and 140m away.

1.6 Study Area

The broader study area includes the surrounding predominately cleared rural areas, used for cropping and other agricultural pursuits and existing road and powerline infrastructure in the general vicinity of the proposal site. Sensitive environmental areas within the broader region include waterways, wetlands, areas with biodiversity values, Aboriginal and non-Aboriginal heritage, and other environmental values, that form part of the immediate surrounding landscape.

1.7 Purpose of the REF

The purpose of this REF is to document the assessment of potential environmental impacts of the proposal and identify if there are likely to be any significant environmental impacts. It informs Essential Energy's determination of the proposal under Part 5, Division 5.1 of the EP&A Act.

Table 1: Description of proposed route of underground high voltage cables

FROM	TO	DESCRIPTION OF ROUTE	REPRESENTATIVE PHOTOS (RED LINE DENOTES APPROXIMATE UNDERGROUND CABLE ROUTE)
Cudgen ZS	Cudgen Road	From Cudgen ZS, the proposed underground cable route extends generally south-southeast across, and to the eastern side of Cudgen Road, remaining within the dedicated and disturbed road reserve.	 **Plate 1: Looking south-southeast from entry into Cudgen ZS across Cudgen Rd.**
Cudgen Road	Intersection with Plantation Road	After crossing Cudgen Road, the proposed underground cable route extends in a generally southerly direction within dedicated and disturbed road reserve of Cudgen Road, along the eastern side of the road. The proposed route generally follows the path of an existing overhead powerline. No woody vegetation removal is required. Ground cover disturbance only. At the main sweeping bend along Cudgen Road, the proposed route intersects with a small section of the corner of an adjacent lot (Lot B DP418423). An easement may be required over this lot, to avoid the	 **Plate 2: Looking southwest along Cudgen Rd after crossing Cudgen Rd**

FROM	TO	DESCRIPTION OF ROUTE	REPRESENTATIVE PHOTOS (RED LINE DENOTES APPROXIMATE UNDERGROUND CABLE ROUTE)
		cables being placed beneath the road.	 **Plate 3: Looking southwest along Cudgen Rd after crossing Cudgen Rd**  **Plate 4: Main bend along Cudgen Rd where corner of adjacent lot extends out to edge of road.**

FROM	TO	DESCRIPTION OF ROUTE	REPRESENTATIVE PHOTOS (RED LINE DENOTES APPROXIMATE UNDERGROUND CABLE ROUTE)
Intersection of Cudgen Road and Plantation Road	Intersection of Plantation Road and Reardons Road	From the intersection of Cudgen Road and Plantation Road the proposed route extends in generally easterly direction within the dedicated and disturbed road reserve on the northern side of Plantation Road. TSC have requested that work in potentially unstable fill material in the road verge at the eastern extent of this section, towards the intersection with Reardons Road, be avoided. As such the proposed route will extend from the road shoulder into an adjacent paddock. The paddock is currently being used by the adjacent landholder as a horse paddock and shed, but is located within the road reserve of Plantation Road. Consultation with this landholder will be undertaken regarding the proposed work.	 **Plate 5 Looking east at intersection of Cudgen Rd and Plantation Rd**  **Plate 6: Looking east along Planation Rd**

FROM	TO	DESCRIPTION OF ROUTE	REPRESENTATIVE PHOTOS (RED LINE DENOTES APPROXIMATE UNDERGROUND CABLE ROUTE)
			 Plate 7: Looking east along Planation Rd towards intersection with Reardons Rd
Intersection of Plantation Road and Reardons Road	End of Reardons Road	From the intersection of Plantation and Reardons Roads, the proposed route extends in generally a southerly direction within the dedicated disturbed road reserve on the western side of the Reardons Road.	 Plate 8: Looking south at intersection of Plantation Rd and Reardons Rd

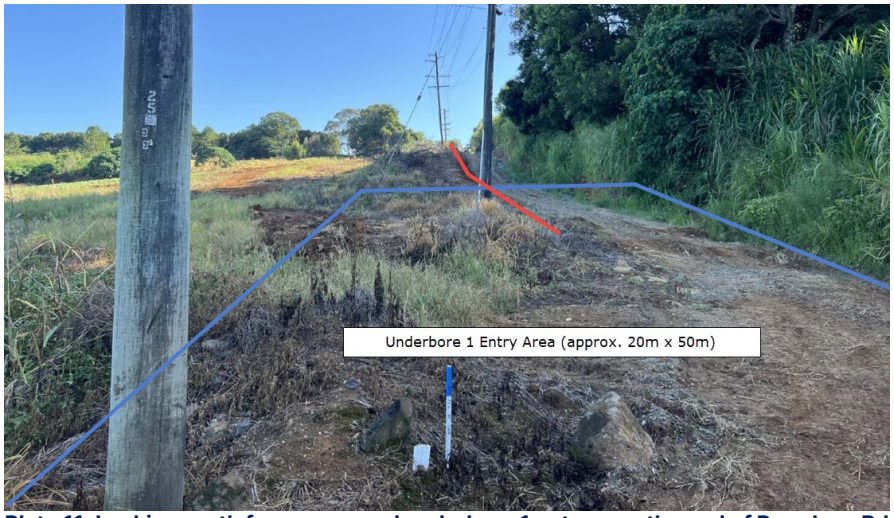
FROM	TO	DESCRIPTION OF ROUTE	REPRESENTATIVE PHOTOS (RED LINE DENOTES APPROXIMATE UNDERGROUND CABLE ROUTE)

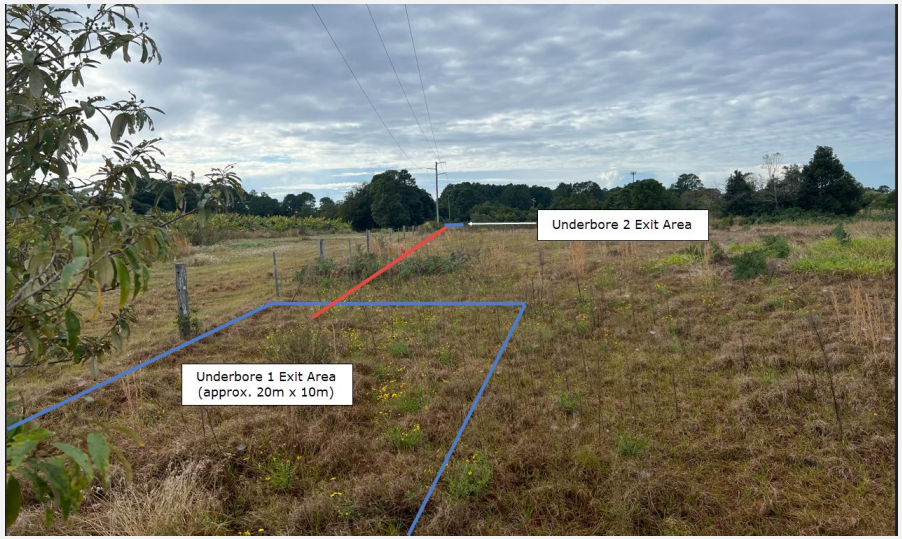
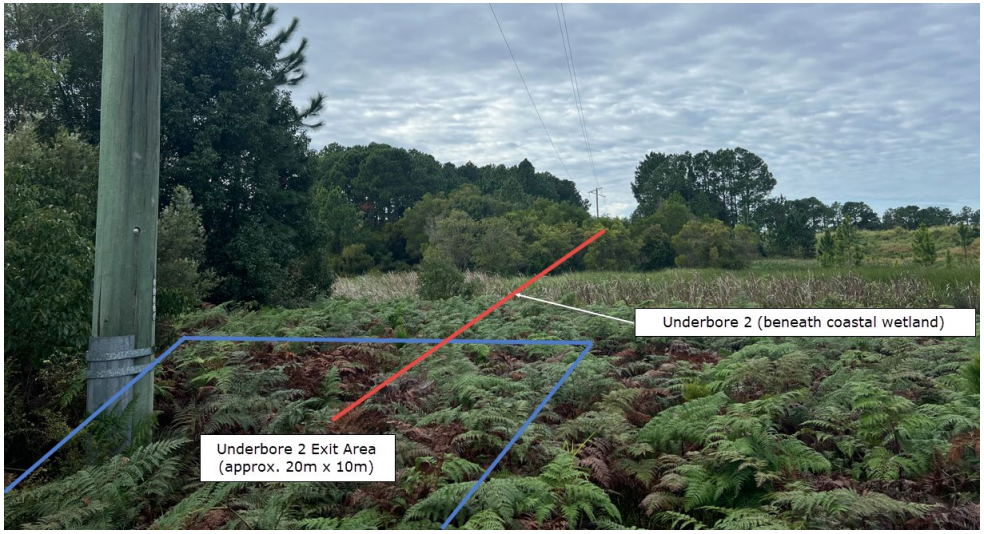


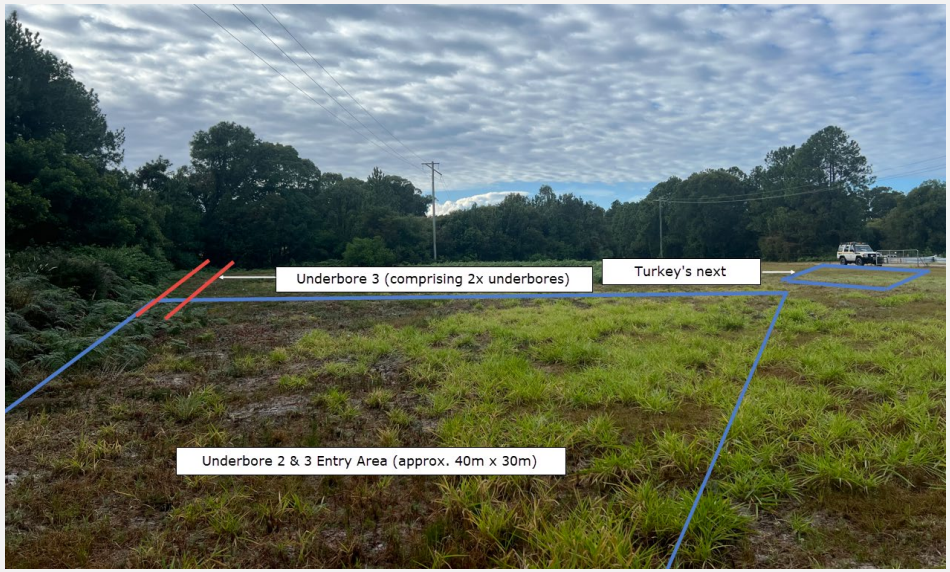
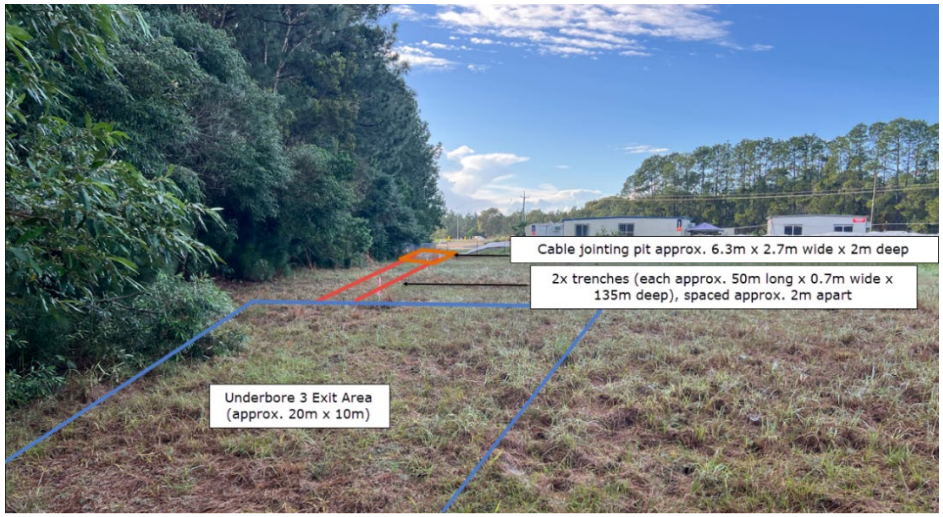
Plate 9: Looking south along Reardons Rd



Plate 10: Looking south towards the end of Reardons Rd

FROM	TO	DESCRIPTION OF ROUTE	REPRESENTATIVE PHOTOS (RED LINE DENOTES APPROXIMATE UNDERGROUND CABLE ROUTE)
End of Reardons Road – underbore 1 entry area	Underbore 1 exit area on Leda owned land	From the end of Reardons Road the proposed route extends in generally southeasterly direction following an existing overhead high voltage powerline corridor, skirting the edge of several farm dams and adjoining vegetation. This section will be underbored to avoid impacts to more sensitive ecological values associated with the farm dams, and patches of remnant native vegetation.	 **Plate 11: Looking north from proposed underbore 1 entry area the end of Reardons Rd**  **Plate 12: Looking southeast from the end of Reardons Road showing approximate route of underbore 1.**

FROM	TO	DESCRIPTION OF ROUTE	REPRESENTATIVE PHOTOS (RED LINE DENOTES APPROXIMATE UNDERGROUND CABLE ROUTE)
Underbore 1 exit area on Leda owned land	Underbore 2 exit area on Leda owned land	From underbore 1 exit area the proposed route extends in east-southeasterly direction along a flat and cleared section of Leda owned land to underbore 2 exit area.. This area will also be utilised for conduit laydown and welding area for underbores 1 and 2.	 **Plate 13: Looking east-southeast across Leda owned land from underbore 1 exit area towards underbore 2 exit area.**
Underbore 2 exit area on Leda owned land	Underbore 2 and 3 entry area	From underbore 2 exit area the proposed route extends in a southeasterly direction to underbore 2 and 3 entry area. This section will be underbored to avoid impacts to a small section of mapped coastal wetland and patches of remnant native vegetation.	 **Plate 14: Looking southeast from proposed underbore 2 exit area across mapped coastal wetland**

FROM	TO	DESCRIPTION OF ROUTE	REPRESENTATIVE PHOTOS (RED LINE DENOTES APPROXIMATE UNDERGROUND CABLE ROUTE)
Underbore 2 and 3 entry area	Underbore 3 exit area	From underbore 2 and 3 entry area, the proposed route extends in an east-southeasterly direction, to underbore 3 exit area The majority of this section will be underbored to avoid impact to vegetation, and an adjoining ephemeral drainage line.	 **Plate 15: Looking east-southeast from proposed underbore 2 and 3 entry area across Leda owned land towards vegetation to be underbored**
Underbore 3 exit area	Connection point with previously installed underground high voltage on Leda owned land.	The final section from underbore 3 exit area will continue in an east-southeasterly direction to the connection point with previously installed underground high voltage cables on Leda owned land behind the construction site office established for the Kings Forest residential development. This section will include the construction of a cable pulling/jointing pit at the connection point with previously installed cable	 **Plate 16: Looking east-southeast from underbore 3 exit area towards the connection point with the previously installed underground high voltage cables**

2. Description of the Proposal

2.1 Scope of Works

The scope of work being assessed as part of this REF includes approximately 4km of underground high voltage cable. The proposal will also include the installation of new fibre optic communication cables and earthing cable alongside the high voltage electricity cables, installation of two new UGOH poles, and result in the removal of an approximately 460m section of existing overhead high voltage powerline. The scope for each component is outlined below.

2.1.1 INSTALLATION OF UNDERGROUND HIGH VOLTAGE CABLES

- Installation of approximately 4km of new underground high voltage cables within the road reserves of Cudgen Road, Plantation Road and Reardons Road, and across low lying land from the end of Reardons Road to the connection point with previously installed underground high voltage cables (refer **Figure 3**)
- Construction methodology in the northern portion of the proposal will be via a mixture of open trenching and shallow (i.e., approximately one to three metres deep) underbores along the road reserves. Underbore methodology will likely be used in preference to trenching along much of the northern portion of the proposal route to avoid and minimise impacts to roads, driveways and planted ornamental vegetation,, though a worse case disturbance footprint of trenching has been assessed along the northern portion of the proposal site in this REF.
- Where required, trench dimensions will be approximately 1m wide by 1.5m deep (refer **Appendix A**). Trenches will likely be excavated using a small to medium sized excavator (i.e. eight to 16 tonne), subject to availability and final construction methodology
- Several cable jointing pits and associated earth link boxes will be installed along the proposal route. These will be permanent structures installed below ground level with trafficable lids to allow access for inspection and maintenance from the surface when required. The approximate dimensions of the joining pits are 6.3m long by 2.7m wide by 2.0m deep. The earth link boxes will be approximately 1.6m long by 0.9m wide by 0.75m deep (refer Appendix A)
- Construction methodology in the southern portion of the proposal will be dominated by three longer, deeper underbores to avoid and minimise impacts to remnant vegetation, farms dams, and wetland environments:
  - Underbore 1: entry from approximately the end of Reardons Road, progressing in a southeasterly direction through Lot 1 DP12737 and Lot 4 DP629229, to an exit point in a cleared paddock on Leda owned land (Lot 1 DP781633), a total of approximately 426m.
  - Underbore 2: entry from Leda owned land (Lot 1 DP781633), off Depot Road and on the eastern side of the mapped coastal wetland, progressing in a northwesterly direction across the corner of Lot 2 DP597802 and back to Leda owned land (Lot 1 DP781633) on the western side of the mapped coastal wetland, with the exit point near the proximity of an existing power pole 38946, a total of approximately 271m

Underbore 3: entry will be from approximately the same entry point as underbore 2 (i.e., the eastern extent of underbore 2), progressing in an easterly direction to the connection point with the previously installed underground high voltage cables all on Leda owned land (Lot 1 DP781633), a total of approximately 280m. Underbore 3 will require two separate bores spaced approximately two metres apart. Two separate bores are required at underbore 3 to facilitate a second set of cables installed to a new UGOH pole Refer **Figure 5.**

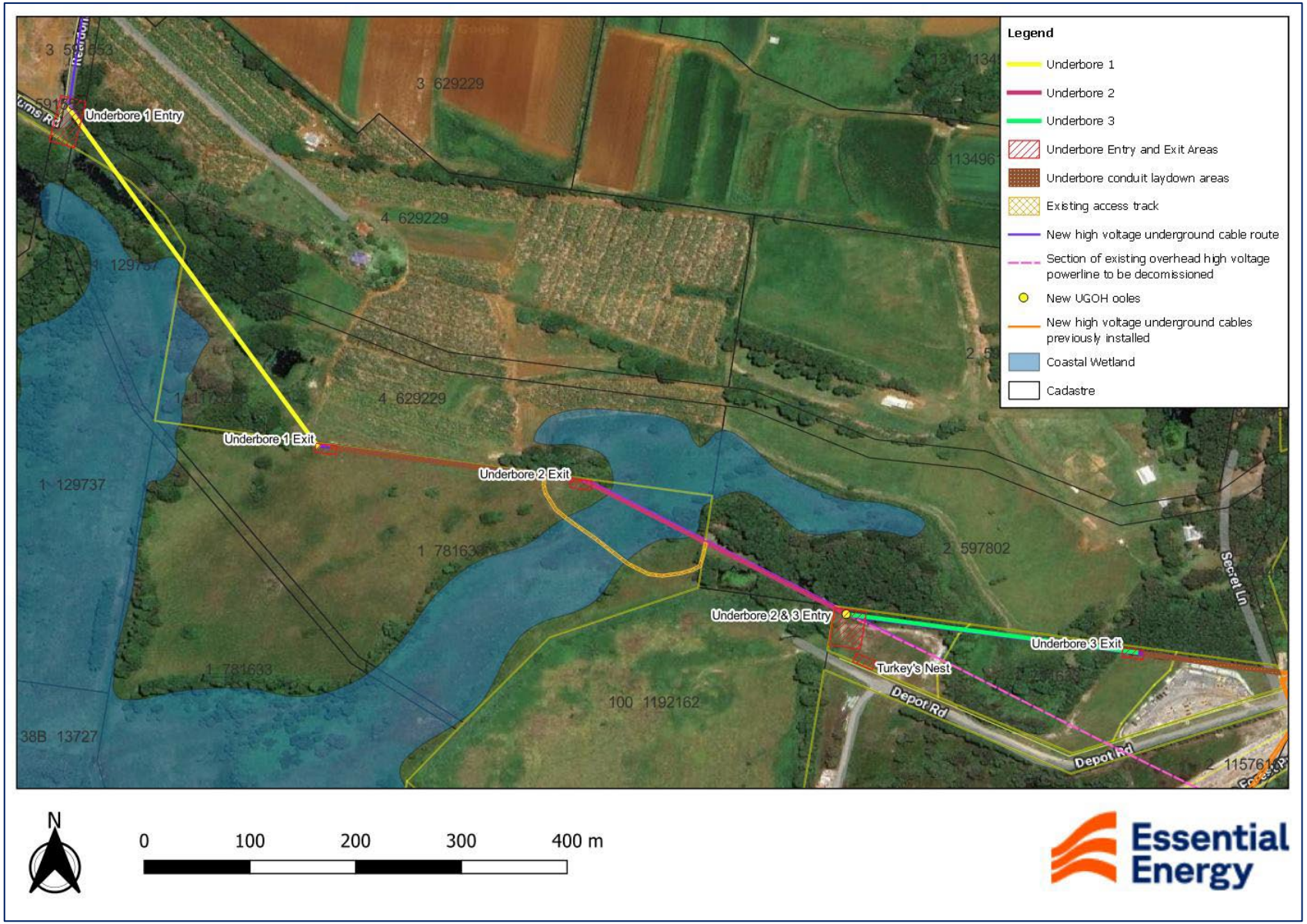


Figure 5: Location of longer, deeper underbores in southern portion of proposal site

- Underboring (or HDD) is a process whereby an initial pilot hole is drilled beneath the ground surface, mostly horizontally, along a designated path to a target location (refer **Figure 6**). The hole is subsequently enlarged by varying diameter back reamers, until the hole in large enough for the designed pipe or utility to be installed (refer **Figure 7**). Injection of drilling fluid is an essential part of the underbore process, which is responsible for suspending the cuttings and removing them from the bore hole. Water is the main component of the drilling fluid, however, it is also usually necessary to add bentonite, a naturally occurring clay, which acts as a viscosifier and bore sealant. The drilling fluids form part of an overall system, which may consist of mixing systems, holding tanks, cleaning and recycling systems. At the end of the installation process a drilling slurry remains, which requires management and/or disposal. The drilling slurry is comprised of the injected drilling fluid and drill cuttings, the latter of which have been extracted during the underbore process (Willoughby, 2005; Yan et al, 2018; Hegerty, 2021)
- Underbore size and depth will vary. A bore diameter of 350mm and depth between one and three metres will be sufficient for road and driveway crossings, and to avoid planted garden ornamental plantings for the shallower underbores, where required, along the road reserves of Cudgen, Plantation and Reardons Road in the northern portion of the proposal. A bore diameter of up to 550mm will be required for longer bores used to avoid impacts to remanent vegetation, farm dams and mapped coastal wetlands in the southern portion of the proposal site. Underbore depths in these areas may be up to 11m below ground, to minimise the potential risk of frac-outs. Horizontal Directional Drilling (HDD) Bore Plans have been prepared by Underbore Solutions (2024) (refer **Appendix B**)
- Surface disturbance areas for underbores will be limited to the areas around the entry and exit points for each underbore. For the shallow underbores where required along the northern portion of the proposal, i.e., in road reserves of Cudgen, Plantation and Reardons Roads, entry and exist pits will be approximately 1.5m wide by 1.5m long by 1.0m deep. This will be sufficient for fluid return with vacuum truck to support.
- Additional surface disturbance will be required at the entry and exit points for each of the three longer, deeper underbores in the southern portion of the proposal site. At these locations there will need to be sufficient area to operate a larger drill rig, excavate entry / exit pits, as well as accommodate associated machinery, equipment and support vehicles. Larger areas will be required at the underbore entry points. The approximate disturbance areas for each underbore entry and exit are provided in **Table 2** and Illustrated on **Figures 5**, **9** and **10**. The areas are approximate, based on advice provided by a specialist underbore consultant (Underbore Solutions, 2023). The exact orientation and layout of each may change slightly, but would be designed to minimise, and where possible, avoid impacts to any fringing vegetation and remain within the assessed footprint. The entry and exit area of underbore 2 will be located outside the extent of the mapped coastal wetland and associated native PCT.
- A turkey's nest may be required adjacent to underbore 2 and 3 entry area (refer **Figure 10**) to temporarily manage additional drilling slurry liquid, though most of, if not all the liquid, will be managed through the recycling unit and associated holding tanks.
- Stringing and installing the conduits requires a laydown area, ideally linear in nature, on which the conduits can be laid out in a continuous fashion to be welding together. Excavators, trucks and light vehicles will require access along this line of the conduit. The ideal conduit stringing area for underbores 1 and 2 would be in the cleared paddock along the same alignment as the section of underground cable between underbore 1 and 2 exit points (refer **Figure 5** and **8**). The conduit stringing laydown area for underbore 3 would be from the exit point in an easterly direction, in already cleared and disturbed area associated with the Kings Forest development (refer **Figure 8**). Once the conduits are welded together, and the underbores complete, the conduit string would be installed (i,e, pulled though) in approximately one day.
- Once the conduits are installed and cable pits constructed, the underground electricity, communication and earthing cables will be pulled through. It is proposed to use 66 kilovolt (kV) rated cable to enable future upgrade to the network. However, the electricity cables will only be energised to 33kV upon commissioning.

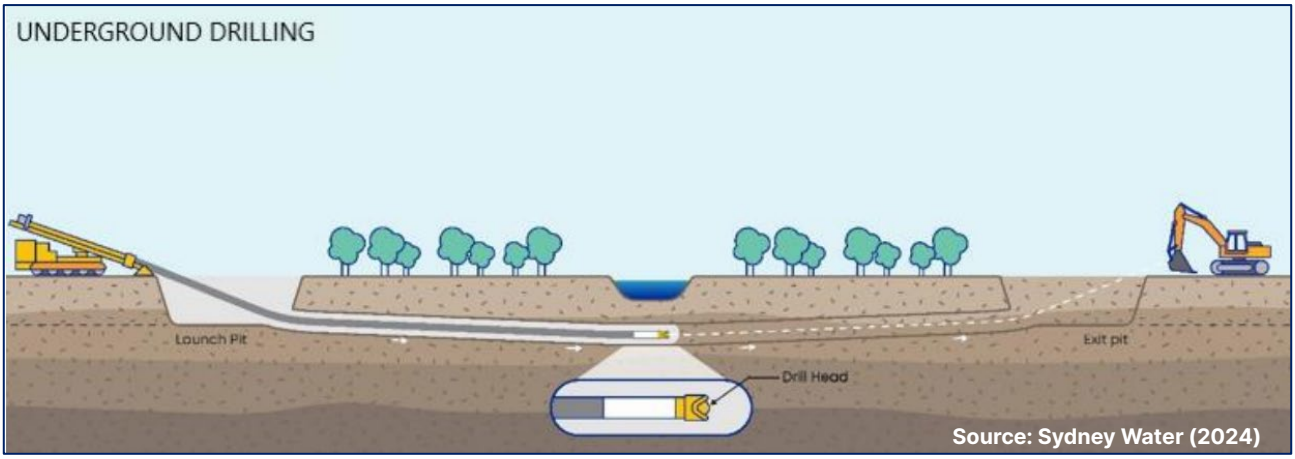


Figure 6: Illustration of typical underbore

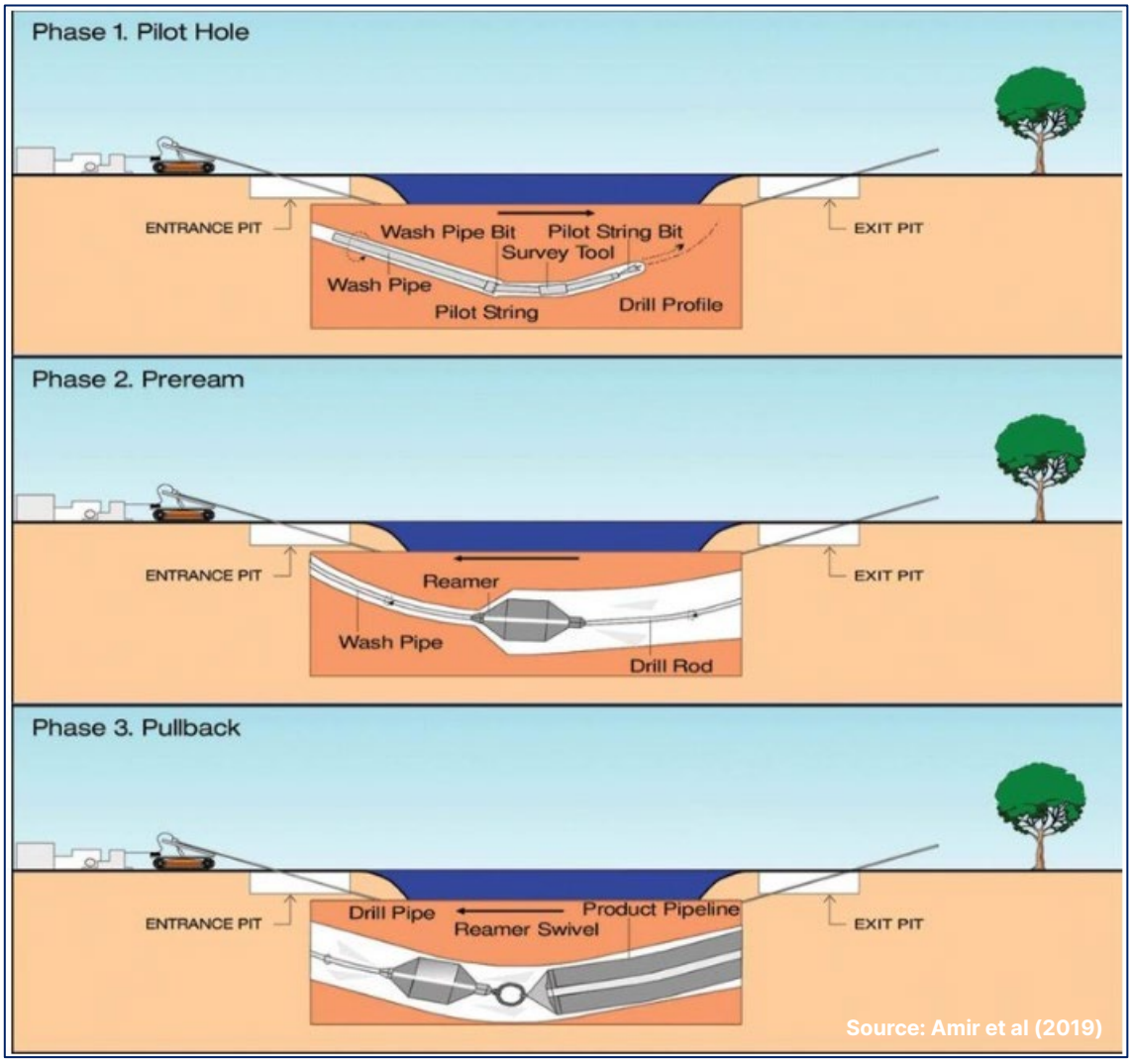


Figure 7: Steps involved the underbore process

Table 2: Approximate surface disturbance areas for three larger underbores in the southern portion of the proposal

UNDERBORE SURFACE DISTURBANCE AREAS	DISTURBANCE TYPE	APPROXIMATE TOTAL DISTURBANCE AREA
Underbore 1 Entry	Requires access for excavator, vacuum trucks, light vehicles and room for semi-trailers to enter and exit. Parking of equipment and machinery. May require hardstand (i.e., imported rock) if ground soft at time of drilling. Excavation of entry pit (approximately 2.0m long by x 1.5m wide by 1.0m deep).	1250m^2 (25m x 50m)
Underbore 1 Exit	Requires access for excavator, vacuum trucks, and light vehicles. Excavation of exit pit (approximately 2.0m long by x 1.5m wide by 1.0m deep).	200m^2 (20m 10m)
Underbore 2 and 3 Entry (combined)	Requires access for excavator, vacuum trucks, and room for semi-trailers to enter and exit. Parking of equipment and machinery. Site shed, facilities and tools/spares May require hardstand (i.e., imported rock) if ground soft at time of drilling. Excavation of entry pit (approximately 2.0m long by x 1.5m wide by 1.0m deep).	1200m^2 (40m x 30m)
Underbore 2 Exit	Requires access for excavator, vacuum trucks, and light vehicles. Excavation of exit pit (approximately 2.0m long by x 1.5m wide by 1.0m deep).	200m^2 (20m x 10m)
Underbore 3 Exit	Requires access for excavator, vacuum trucks, and light vehicles. Excavation of exit pit (approximately 2.0m long by x 1.5m wide by 1.0m deep).	200m^2 (20m x 10m)
Turkeys Nest (if required at Underbore 2 and 3)	Approximately 20m x 10m with 0.5m high bund, lined with geofabric or similar. Requires access for excavator, vacuum trucks and light vehicles	200m^2 (20m x 10m)
Conduit Stringing Laydown Area for Underbore 1 and 2	Requires access for excavator and light vehicles. No excavation required	1200m^2 (240m x 5m)
Conduit Stringing Area for Underbore 3	Requires access for excavator and light vehicles. No excavation required.	500m^2 (130m x 5m)

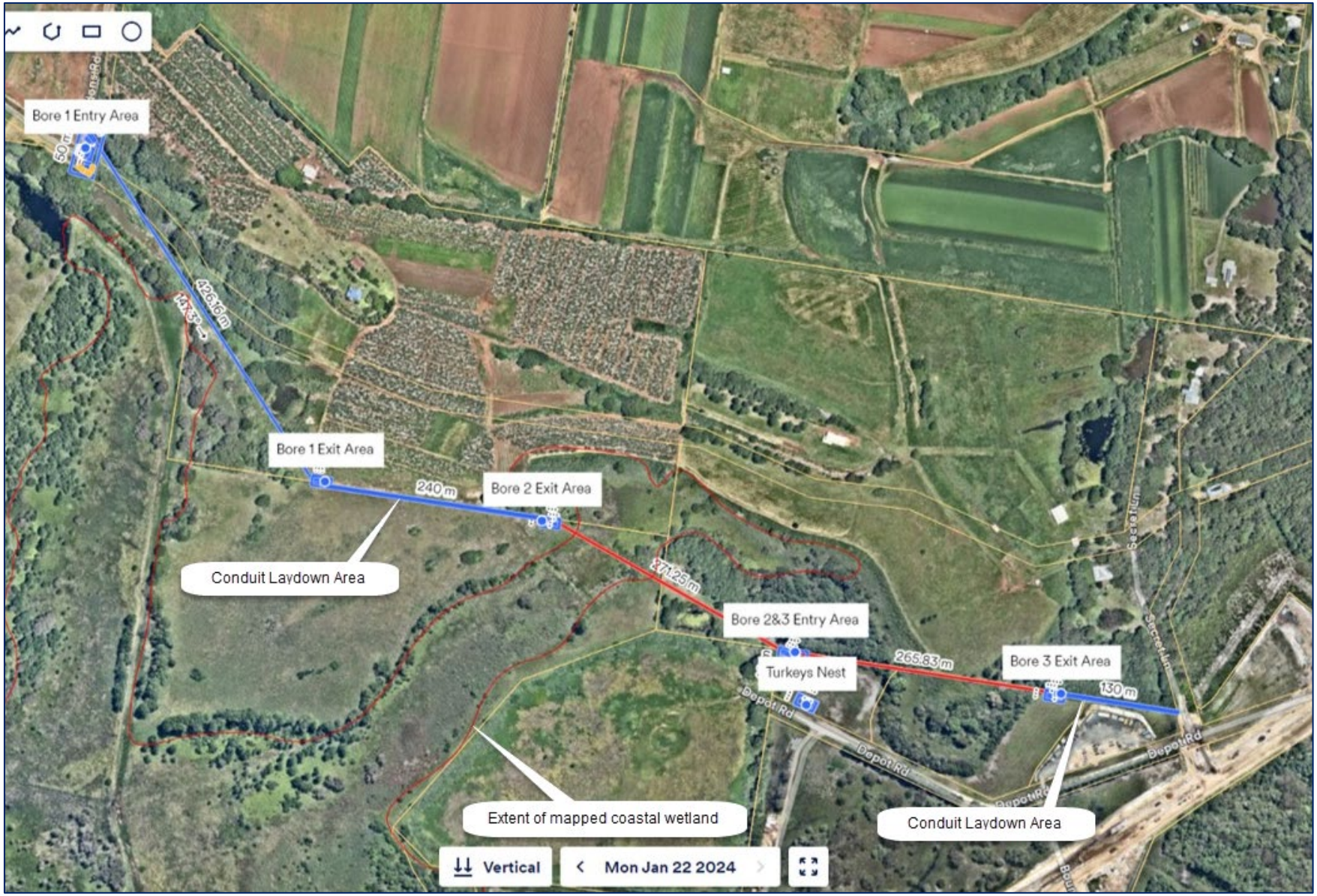


Figure 8: Underbore entry and exit area locations and laydown areas



Figure 9: Underbore 1 indicative entry and exit areas

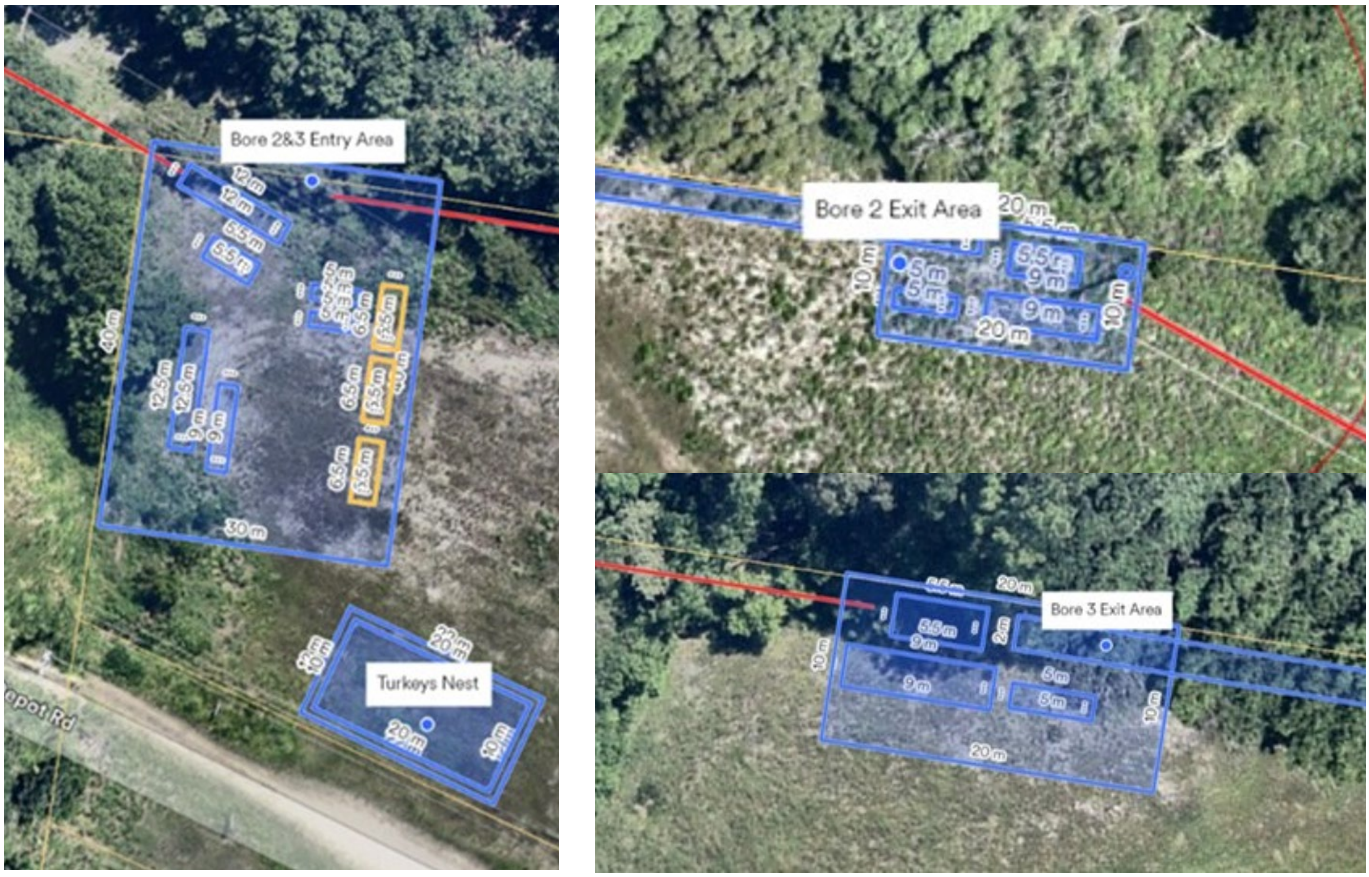


Figure 10: Underbores 2 and 3 indicative entry and exit areas

2.1.2 INSTALLATION OF UNDERGROUND HIGH VOLTAGE CABLES

- New fibre optic communication cables will be installed within the same alignment as the underground electricity cables (refer above).

2.1.3 INSTALLATION OF UGOH POLES

- Installation of two new UGOH poles within the existing overhead high voltage powerline corridor, and Leda owned land at the southern extent of the proposal site. One will be installed in the vicinity of and replace existing pole 38948 and the other in the vicinity of and replace existing pole 38951 (refer **Figure 3**). Pole holes will be augured using an approximately 1.2m diameter to approximately 3.5m depth.

2.1.4 REMOVAL OF EXISTING OVERHEAD HIGH VOLTAGE POWERLINE

- Once the new underground electricity, communications and earthing cables are installed and commissioned, an approximately 460m section (three spans, two poles) of existing overhead high voltage powerline will be removed (refer **Figure 3**).

2.1.5 STAGING AREAS

Construction equipment and machinery required for the activity will move as work progresses along the proposed route and be positioned with the previously described underbore entry and exit pits and conduit laydown areas for underbore activities. All civil work will be completed by a suitably qualified contractor, with underbore experience.

2.2 Design Criteria

The proposed new underground high voltage cables will be primarily constructed to form a component of the KFHVSP required to facilitate power supply to the new Kings Forest development, and strengthen Essential Energy's existing electricity network in the broader area.

Minimising impacts on the broader community was a key consideration in the design of the underground cables. The design also avoids other sensitive and critical infrastructure within the immediate vicinity through consultation with important stakeholders, including Leda and TSC.

The design has been developed to meet the following criteria:

- Meet the design life requirements
- Be cost effective when assessed on a life cycle cost basis
- Be capable of being constructed cost-efficiently and within time constraints
- Provide durability and reliability of the intended function
- Minimise potential environmental impacts.

2.3 Construction Activities

2.3.1 TIMING AND WORK HOURS

Construction work is expected to commence in latter half of Financial Year (FY) 25 and take approximately six to 12 months to complete, weather dependant.

In considering the short term and transient nature of the work as it progresses along the proposed underground cable route, construction work that has the potential to create audible noise at the nearest sensitive receiver, will be between 7am and 6pm Monday to Saturday. On occasions works outside these hours may be undertaken where the following requirements are met:

- Neighbours (and other sensitive receivers) adjacent to the works or the local council or the Environment Protection Authority (EPA) have been notified; and

- The works are justified on the basis that they are emergency works, required due to construction requirements or, because of supply security network outages or construction limitations, it is deemed that the works can only be achieved outside these hours.

2.3.2 RESOURCES AND EQUIPMENT

The following equipment is likely to be used on site to complete the work:

- Excavator
- Backhoe
- Trencher
- Underbore rigs
- Trucks
- Concrete trucks
- Water truck
- Vacuum Trucks
- Crane
- Tanker trucks
- Cable trucks
- Light vehicles
- Elevated work platforms (EWP)
- Cable winches
- Large cable drum stands
- Scaffolding on UGOH poles.

Security guards may be employed to monitor unenergised copper cables if they are required to be left on-site overnight.

2.3.3 IMPACT MITIGATION

The mitigation measures as detailed in **Section 6** form part of the proposed activity and will be implemented, as required, as part of the construction and operational phases.

2.4 Operation and Maintenance Requirements

Once the project is constructed, periodic maintenance will be required. Regular inspections of the infrastructure will be undertaken to help identify defects and hazards such as damaged components and vandalism. The site will not accommodate staff or contractors on a permanent basis. Periodic collection of waste may be required.

Likely maintenance activities include:

- Regular inspection of cable pits and maintenance of electrical equipment.

3. Consultation

3.1 Overview

Community consultation defines the processes we use to seek views or provide information about projects. The term consultation can describe processes ranging from simply delivering information to residents, community information displays, or holding meetings with community representatives designed to actively seek feedback from local communities into a particular project.

The population as a whole is more aware than ever of their social, environmental and economic needs. They want to know about what is planned for their area and how it would impact on them.

Incorporating community consultation as a key business practice is both a necessary and a desirable path for Essential Energy to take. It must be undertaken in good faith and be transparent in all activities.

Essential Energy has in place a policy for community consultation on all major projects. The policy ensures that the community is informed about proposed development, and that concerns and issues are taken into consideration.

3.2 Engaging the Community

Landholder consultation regarding the overall KFHVSP, in particular with the residents located along the proposed underground cable route, has commenced and is continuing. Ongoing engagement and project progression has also been created via the Essential Energy Engagement website:

Kings Forest High Voltage Supply Project | Essential Engagement

3.3 Consultation Requirements under the T&I SEPP

Under the EP&A Act, Essential Energy is the determining authority for certain developments defined under the T&I SEPP as being permissible without consent. While the nature of work being undertaken does not require council consent, Division 1 of the T&I SEPP does provide consultation requirements with the local council where works are anticipated to impact upon council infrastructure, local heritage items, flood liable land and certain land within the coastal zone. In addition, consultation may be required with the State Emergency Service (flood liable land) and other specified public authorities in certain circumstances.

The proposed construction and operation of the new underground cables will occur predominately within TSC managed road reserves. While some disruption to local roads may occur during the delivery of large plant and equipment, the works are considered to be minor and inconsequential and will not involve significant disruption of pedestrian or vehicle traffic. The proposal will not have a substantial impact on the stormwater management system, or involve a connection to the local sewer or water reticulation system. Consultation with the local council is therefore not triggered under clause 2.10 of the T&I SEPP.

The proposal site is not located within a mapped area of local heritage, according to Tweed Shire LEP. Consultation with the local council is therefore not triggered under clause 2.11 of the T&I SEPP.

The proposal site is not located on flood liable land (i.e., within 1% Annual Exceedance Probability (AEP)) according to the TSC's online Flood Mapping Tool (TSC, 2024). Consultation with TSC or State Emergency Services (SES) is therefore not triggered under clauses 2.12 and 2.13, respectively.

The proposal site is located within the coastal zone (coastal environment area), however, coastal vulnerability area mapping is currently not available and the Tweed Coast and Estuaries Coastal Management Program (TCECMP) is currently under development. Notwithstanding, the proposal is not inconsistent with the management objectives set out in the Tweed Coast Estuaries Coastal Zone Management Plan 2013, which will be superseded by the TCECMP once developed. Consultation with TSC is therefore not triggered under clause 2.14.

The southeastern extent of the proposal where the section of existing overhead high voltage powerline is to be removed and installation of new UGOH pole will occur is located on land adjacent to Cudgen Nature Reserve – land reserved under the *National Parks and Wildlife Act 1974*. Notification to the Environment and Heritage division of the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) is therefore required in accordance with clause 2.15 of the T&I SEPP. Essential Energy must take into consideration any response to the notice that is received from that authority within 21 days after the notice is given.

The proposal is not located on any other land, or adjacent to land, that would trigger consultation with other specified public authorities under clause 2.15 of the T&I SEPP.

In addition to consultation requirements, additional notification and approval requirements are outlined in **Table 5**.

4. Project Alternatives

4.1 Do Nothing (Maintain Current Supply Infrastructure)

One option would be to refrain from undertaking any further development of the network in the area. The consequences of Essential Energy doing nothing would be that, as years passed, supply interruptions would occur more frequently and affect more people, and there is insufficient capacity within the existing electricity supply network to meet the demand anticipated to be required by the Kings Forest development.

The proposed new underground high voltage cables are an integral component of the KFHVSP, required to supply the Kings Forest development, and without the augmentation of high voltage supplies, additional electricity supplies at the distribution level are not possible.

Due to Essential Energy's network licence obligations, the 'do nothing' option is not a viable alternative to the proposed new electricity supply to the Kings Forest development, of which the proposed new underground cables are a vital component.

4.2 Project Planning Options

Planning for the electricity supply to Kings Forest development commenced approximately 20 years ago. An Options Assessment (SKM, 2004) considered the location of a new 33/11kV ZS and associated connector powerlines to the existing Cudgen ZS to the north and existing Hastings Point high voltage overhead powerline to the south. A short list of five substation sites and five powerline routes was identified, taking into account the assessment of environmental constraints, cost, access and constructability. However, at the time of this assessment much of the study area and surrounding land was currently under investigation for future urban development, and the Concept Plan for the Kings Forest Master Planned Community was not yet finalised. As such, the recommendations provided in the Options Assessment (SKM, 2004) were superseded once more was known about the scale and supply load forecasts for the Kings Forest development.

Over several years now, engagement with the developer (Leda) has been ongoing, with the aim of determining the most appropriate route for the high voltage powerline and location of the ZS. Several route options for the high voltage powerline to supply the development were canvassed, as discussed below. Ultimately, the preferred location for the ZS was selected for ease of connection to the new underground cables, it's location in an employment lands precinct, minimising land use conflicts, and minimising environmental impacts. Further information on the ZS site selection process is documented in the REF prepared for the Kings Forest ZS (Essential Energy, 2024). The route options considered for the high voltage powerline are discussed below.

4.3 High Voltage Supply Route Options

4.3.1 OPTION 1: UTILISING PROPOSED AND EXISTING EASEMENTS

Option 1 involved building a new high voltage supply via proposed and existing easements, with both underground and overhead components along Cudgen Road and on private property (refer **Figure 11**). The advantages of route option 1 was that it made use of some existing easements, and had a reasonably even balance of overhead and underground works. However, several disadvantages were identified for this option, including the route:

- Was reliant on additional easements on proponent and non-proponent land;
- Required purchase of Crown lands, with associated long delivery timeframe;
- Intersected with sensitive environmental areas, include two areas of mapped coastal wetlands.

4.3.2 OPTION 2: PLANTATION ROAD AND TWEED COAST ROAD

Option 2 involved building a new high voltage supply via Plantation and Tweed Coast Road, utilising existing easements and road reserves, with a mix of overhead and underground components (refer **Figure 12**). The advantages of route option 2 included usage of existing easements and road reserves, and low visual impact. Disadvantages includes complex construction due to space constraints in road corridor of Tweed Coast Road (already contains several underground and overhead utilities in limited road shoulder), high cost of construction, and network constraints.

4.3.3 OPTION 3: EAST OF CUDGEN ZS VIA TWEED COAST ROAD

Option 3 involved building a new high voltage supply east of Cudgen ZS via Tweed Coast Road (refer **Figure 13**), primarily overhead, with some sections of underground at the Kings Forest ZS end. Advantages of route option 3 included use of existing alignments, and being the cheapest route to build. Disadvantages included, access issues east of Cudgen ZS through low lying, swampy lands; new easement required on all land other than road reserve, and the exit from Cudgen ZS to overhead line would be complex.

4.3.4 OPTION 4: SOUTH OF CUDGEN ZS VIA PLANTATION AND REARDONS ROADS

Option 4 involved building a new high voltage supply south of Cudgen ZS via Plantation and Reardons Road, entirely underground (refer **Figure 14**). Advantages of route option 4 included highest line security and best network outcome, low visual impact and utilisation of road reserves for the majority of the route. Disadvantages included easements across private property at the southern end of the route, high cost of construction, and intersection with one small section (approximately 95m) of mapped coastal wetlands.

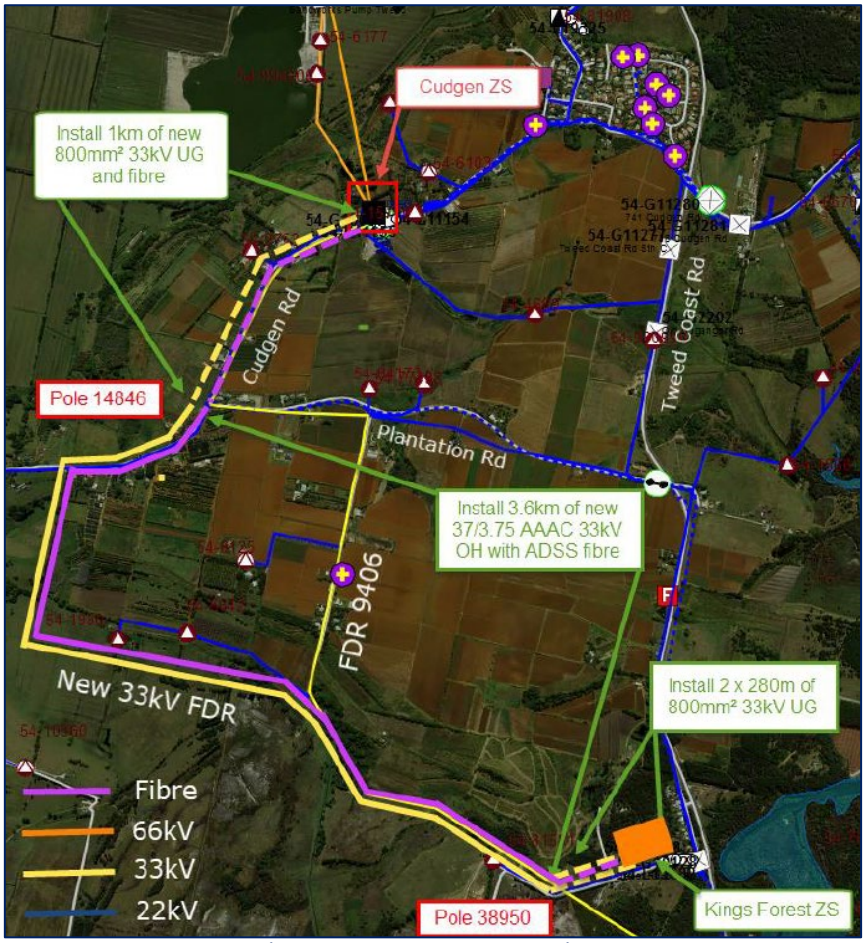


Figure 11: Proposed route Option 1

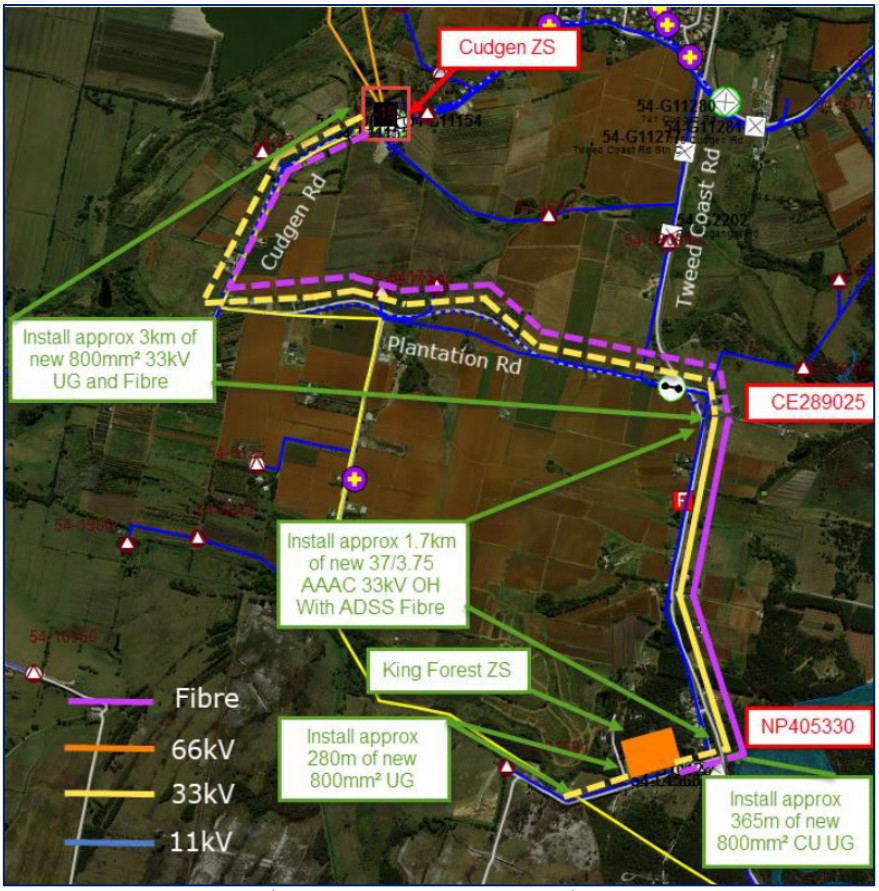


Figure 12: Proposed route Option 2

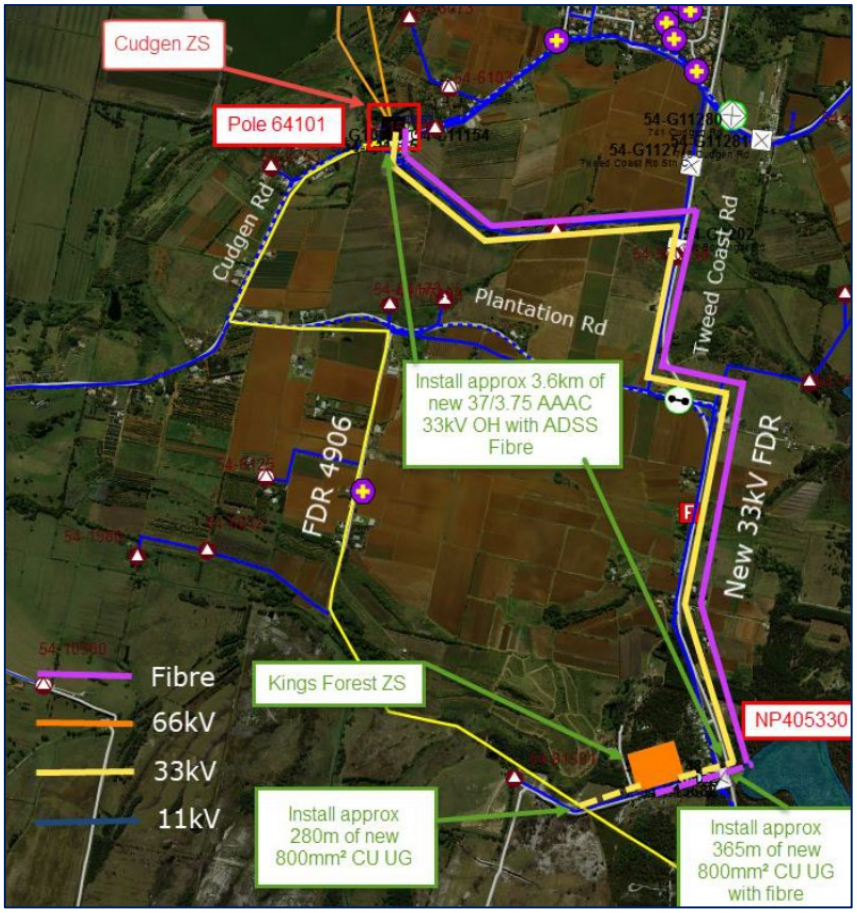


Figure 13: Proposed route Option 3

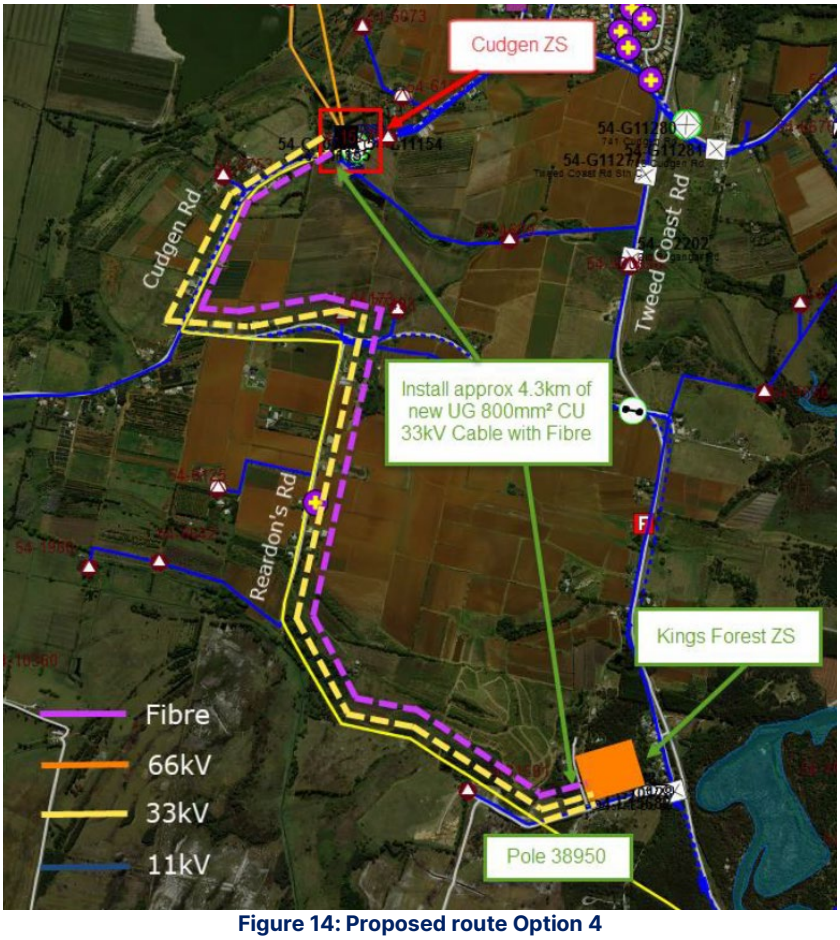


Figure 14: Proposed route Option 4

4.4 Preferred Route Option

Ultimately option 4 was considered to be the most preferred option and is the subject of the assessment in this REF. Option 4 was chosen as it:

- Can be readily accommodated into the new Kings Forest development area
- Provides the highest line security and best network outcome
- Strengthens Essential Energy's existing electricity network in the broader area; and increases its capacity, which will help support future electricity connections
- Contains the least societal and environmental impacts.

5. Environmental Legislation

The following section addresses the regulatory and statutory context of the proposed activity including its definition, land use permissibility, and compliance with the relevant environmental planning instruments (EPIs).

5.1 Environmental Planning and Assessment Act, 1979 (EP&A Act)

The EP&A Act is the primary piece of legislation regulating land use planning in NSW. It provides the framework for the development of state and local planning instruments which, through their hierarchy, determine the statutory process for environmental impact assessment. Under the EP&A Act there are two distinct processes, which are:

- Part 4 - 'development' proposals which require consent, including state significant development; and
- Part 5, which regulates 'activities' and requires an approval by a determining authority (e.g. Essential Energy). Part 5 also includes an assessment pathway for state significant infrastructure.

The proposal can therefore proceed under Part 5, Division 5.1 of the EP&A Act, given the proposal:

- May be carried out without development consent
- Is not exempt development
- Would be carried out by a determining authority or requires the approval of a determining authority.

A determining authority, for the purposes of this activity, is defined in Part 5 of the EP&A Act to include, but not be limited to, a state-owned corporation within the meaning of the *State Owned Corporations Act 1989*. Essential Energy is listed as a state-owned corporation, and would therefore be the determining authority for the activity covered by this REF.

In accordance with state and local EPIs (described below), this REF has been prepared under Part 5, Division 5.1 of the EP&A Act to assess the possible environmental outcomes of the proposed activity. In determining the proposal and degree of impact, Essential Energy is required to consider Section 5.5 of the EP&A Act and clause 171 of the EP&A Reg which are summarised in **Section 9**.

In accordance with clause 171(4) of the EP&A Reg, Essential Energy is required to publish this REF on the NSW planning portal, as the capital value of the proposal will exceed $5 million, prior to the activity commencing.

5.2 Environmental Planning Instruments

EPIs regulate the permissibility to undertake an activity and the type of assessment process that is required. EPI's comprise state environmental planning policies, and local environmental plans (LEPs). EPIs that apply to this development are outlined below.

5.2.1 STATE ENVIRONMENTAL PLANNING POLICIES

5.2.1.1 State Environmental Planning Policy (Transport and Infrastructure) 2021

State Environmental Planning Policy (Transport and Infrastructure) 2021 (T&I SEPP) enables the efficient delivery of new infrastructure. Subject to certain exemptions, the T&I SEPP allows development for the purpose of an electricity transmission or distribution network to be carried out by or on behalf of an electricity supply authority or public authority without consent on any land.

Exemptions to this broad (on any land) application include developments which require Part 4 approval under *State Environmental Planning Policy (Planning Systems) 2021* (Planning Systems

SEPP) or activities triggering designated development under *State Environmental Planning Policy (Resilience and Hazards) 2021* (Resilience and Hazard SEPP) (refer below).

Consultation requirements under the Infrastructure SEPP are addressed in **Section 3.3**, whilst notification provisions are detailed in **Table 5**.

5.2.1.2 State Environmental Planning Policy (Planning Systems) 2021

State Environmental Planning Policy (Planning Systems) 2021 (Planning Systems SEPP) identifies state or regionally significant development, state-significant infrastructure, and critical state-significant infrastructure. It also provides for consideration of development delivery plans by local Aboriginal land councils in planning assessment, and allows the planning secretary to elect to be the concurrence authority for certain development that requires concurrence under nominated state environmental planning policies.

Chapter 2 of the Planning Systems SEPP identifies land which is State Significant Development (SSD), State Significant Infrastructure (SSI), Critical State Significant Infrastructure (CSSI), and Regionally Significant Development (RSD). Clause 2.6(1) of the Plannings Systems SEPP declares development to be SSD, pursuant to section 4.36 of the EP&A Act, if:

(a) the development on the land concerned is, by the operation of an environmental planning instrument, not permissible without development consent under Part 4 of the Act, and

(b) the development is specified in Schedule 1 or 2.

The proposal does not meet the development specified in Schedule 1 or 2, and is permissible without consent pursuit to the T&I SEPP, as discussed in **Section 5.2.1.1**. The proposal therefore does not meet the requirements to be declared SSD.

Clause 2.13(1) of the Planning Systems SEPP declares development to be SSI, pursuant to section 5.12(2) of the EP&A Act, if:

(a) the development on the land concerned is, by the operation of a State environmental planning policy, permissible without development consent under Part 4 of the Act, and

(b) the development is specified in Schedule 3.

Clause 2.14 also declares development to be SSI, pursuant to section 5.12(4) of the EP&A Act, if the development is specified in Schedule 4 of the Plannings Systems SEPP.

The proposal is permissible without consent under Part 5 (Division 5.1) of the EP&A Act and does not satisfy the criteria for SSI under Schedule 3 or 4 of the Planning Systems SEPP. The proposal therefore does not meet the requirements to be declared SSI.

Clause 2.15 of the Planning Systems SEPP declares development to be CSSI if the development is specified in Schedule 5 of the Planning Systems SEPP —

(a) may be carried out without development consent under Part 4 of the Act, and

(b) is declared to be State significant infrastructure for the purposes of the Act if it is not otherwise so declared, and

(c) declared to be critical State significant infrastructure for the purposes of the Act

The proposal does not meet the requirements to be declared CSSI.

Clause 2.19 declares development to be RSD, pursuant to section 4.5(b) of the EP&A Act, if the development is specified in Schedule 6, generally above a certain value and requiring development consent. The proposal does not require consent and therefore there is no basis to be declared to be RSD.

5.2.1.3 State Environmental Planning Policy (Resilience and Hazards) 2021

State Environmental Planning Policy (Resilience and Hazards) 2021 (Resilience and Hazards SEPP) provides provisions for land use planning within the coastal zone, and to manage hazardous and

offensive development. It also provides a state-wide planning framework for the remediation of contaminated land and to minimise the risk of harm.

Clause 2.7(1) of the Resilience and Hazards SEPP requires:

(1) The following may be carried out on land identified as "coastal wetlands" or "littoral rainforest" on the Coastal Wetlands and Littoral Rainforests Area Map only with development consent—

(a) the clearing of native vegetation within the meaning of Part 5A of the Local Land Services Act 2013,

(b) the harm of marine vegetation within the meaning of Division 4 of Part 7 of the Fisheries Management Act 1994,

(c) the carrying out of any of the following—

(i) earthworks (including the depositing of material on land),

(ii) constructing a levee,

(iii) draining the land,

(iv) environmental protection works,

(v) any other development.

Clause 2.7(2) states that development for which consent is required by subsection (1), other than development for the purpose of environmental protection works, is declared to be designated development for the purposes of the Act.

An approximately 95m section of the proposed underground cable route traverses through mapped coastal wetlands, according to the Coastal Wetlands and Littoral Rainforests Area Map.

For the section of the proposal route that intersects with mapped coastal wetlands, the proposal would be considered to be the carrying out of *earthworks* or *any other development*,. However, clause 2.44A of the T&I SEPP enables certain development for above or below ground electricity transmission or distribution lines and/or telecommunication facilities that are related to the functioning of an electricity transmission or distribution network, to be carried out without development consent on land identified as coastal wetlands or littoral rainforest areas, subject to certain requirements in clause 2.44A(2). As demonstrated in **Table 3** below, the proposal meets the requirements in clause 2.44A(2) to be considered development permitted without consent for the section of the proposal that intersects with the mapped coastal wetland:

Table 3: T&I SEPP Clause 2.44A requirements for development permitted without consent in coastal wetlands and littoral rainforest

T&I SEPP CLAUSE 2.44A REQUIREMENTS	COMMENT
(a) the development does not involve the clearing of native vegetation from coastal wetlands or littoral rainforest, and	No clearing of native vegetation is proposed within the section of the proposal that is located on land mapped as coastal wetland.
(b) the electricity supply authority or public authority is satisfied the development—	
(i) includes adequate measures to minimise adverse impacts on coastal wetlands or littoral rainforest, and	The proposal's design and construction methodology (i.e., underboring) has significantly minimised potential impacts to the section of mapped coastal wetland which it intersects. Notwithstanding, a range of environmental mitigation measures are proposed in **Chapter 6** to further minimise any residual adverse potential impacts. For example, standard project specific safeguards would be employed during construction to

T&I SEPP CLAUSE 2.44A REQUIREMENTS	COMMENT
	ensure inadvertent impact to water quality, water bodies and hydrological processes does not occur, and any incidents such as frac-outs are managed effectively and swiftly.
(ii) is not likely to significantly impact the biophysical, hydrological or ecological integrity of coastal wetlands or littoral rainforest, and	Impact to areas with aquatic habitat values from surface disturbance activities would be avoided by underboring. The cross-sectional impact of the underbore will be minimal in the context of the mapped coastal wetland, and located at a depth, unlikely to significantly impact the biophysical, hydrological or ecological integrity of coastal wetlands. The proposal would not directly impact any mapped areas of terrestrial or aquatic GDEs. The proposal would not result in changes to groundwater systems. Given the temporary, low impact nature and small area of disturbance, it is unlikely the proposal will disturb function of groundwater dependent ecosystems.
(iii) is not likely to significantly impact the quantity and quality of surface and ground water flows to and from coastal wetlands, and	Cross sectional impact of the underbore and subsequent installation of the cable occurs in a closed system, meaning interactions between inert drilling materials and the surface water or groundwater systems is considered unlikely. It is also unlikely that the proposal would obstruct any surface or groundwater movement or alter hydrological processes by stopping or slowing the movement of water, or biological process associated with that water.
(c) the development does not involve earthworks other than earthworks that are ancillary to the following development—	
(i) geotechnical testing and sampling that involves a drill hole with a diameter of no more than 120mm	None proposed.
(ii) surveying and the placement of survey marks,	Survey marks may be required when marking out the proposed route within the mapped coastal wetland.
(iii) boring or directional drilling that does not disturb the surface of coastal wetlands or littoral rainforest and that involves a drill hole with a diameter of no more than 1,800mm,	An approximate 550mm diameter underbore will be required beneath the section of the proposal that intersects with the mapped coastal wetland.
(iv) replacing an electricity pole with a new pole with a diameter of no more than 1,200mm,	No pole replacements within the mapped coastal wetland are proposed.
(v) installing supporting posts for a gate on an existing fence	None proposed.

T&I SEPP CLAUSE 2.44A REQUIREMENTS	COMMENT
(vi) creating a trench to lay an electricity line to connect 2 connection points that are no more than 100m apart.	No trenches within the mapped coastal wetland are proposed.

In addition, as the proposal is not seeking development consent the provisions relating to hazardous and offensive development and contaminated land do not apply. Notwithstanding, the risk of potential contamination is assessed in **Section 6.8.**

5.2.1.4 State Environmental Planning Policy (Biodiversity and Conservation) 2021

State Environmental Planning Policy (Biodiversity and Conservation) 2021 (Biodiversity and Conservation SEPP), among other things, provides planning rules and controls for the clearing of native vegetation in NSW and the land use planning and assessment framework for koala habitat.

Vegetation disturbance is limited to predominately groundcover species, and while the provisions relating to koala habitat do not apply to Part 5 assessments under the EP&A Act, potential impacts to koalas has been considered in Section 6.5.

5.2.2 LOCAL ENVIRONMENTAL PLANS (LEPS)

LEPs are developed by councils (they become law only after Ministerial approval) and guide planning decisions for local government areas. According to the Department of Planning and Environment (DPE), LEPs, through zoning and development controls, allow councils to regulate the ways in which land is used. Council LEPs also list heritage items that are of local heritage significance.

The application of the T&I SEPP overrides the need to consider zoning controls, as developments covered by the T&I SEPP are permissible on any land without consent. However, the T&I SEPP provides consultation and notification provisions where activities are likely to substantially impact upon council-related infrastructure, or items of local heritage significance.

5.3 Key Legislation

5.3.1 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999 (COMMONWEALTH) (EPBC ACT)

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) requires the approval of the Commonwealth Minister for the Environment for actions that may have a significant impact on matters of national environmental significance (MNES). Approval from the Commonwealth is in addition to any approvals under NSW legislation.

The EPBC Act lists nine MNES which must be addressed when assessing the impacts of a project. An assessment of how the project may impact on MNES is provided in **Table 4**.

Table 4: Matters of National Environmental Significance

MATTER OF NATIONAL ENVIRONMENTAL SIGNIFICANCE	IMPACT
World heritage properties	There are no world heritage properties proximate to the proposed development, or that would potentially be affected by the proposal
National heritage places	There are no national heritage places proximate to the proposed development, or that would potentially be affected by the proposal

MATTER OF NATIONAL ENVIRONMENTAL SIGNIFICANCE	IMPACT
Wetlands of international importance	There are no Ramsar wetlands proximate to the proposed development, and the proposal is not likely to have a significant impact on the ecological character of a Ramsar wetland.
Commonwealth listed threatened species and ecological communities	The proposal is not expected to have any significant impact on threatened species, populations or ecological communities listed within Commonwealth (or State) legislation (refer **Section 6.5**)
Great Barrier Reef Marine Park	The proposal would not result in any impacts to the Great Barrier Reef Marine Park
Commonwealth listed migratory species	The proposal is not expected to have an impact on listed migratory species (refer **Section 6.5**)
Nuclear action	The proposal would not result in any nuclear action, nor would the activity require any nuclear action to be undertaken
Commonwealth marine areas	There are no Commonwealth marine areas proximate to the proposed development, or that would potentially be affected by the proposal
Impacts on water resources resulting from large coal mining and coal seam gas developments	The proposal is not related to any large coal mining or coal seam gas developments. The project would not impact on water resources

Given that the project would not significantly impact on matters of NES and would not be carried out on Commonwealth land, the EPBC Act is not triggered and approval from the Commonwealth Minister for the Environment is not required.

5.3.2 NATIVE TITLE ACT 1993 (COMMONWEALTH) (NT ACT)

The *Native Title Act 1993* (Cth) (NT Act) as validated by the *Native Title (New South Wales) Act 1994* was part of the Commonwealth Government's response to the High Court's decision in Mabo v Queensland, which found that Australian common law can recognise the rights and interests over land and water possessed by Indigenous people in Australia under traditional laws and customs – 'native title'. The High Court rejected the doctrine that Australia was terra nullius (land belonging to no-one) at the time of European settlement and said that native title can continue to exist:

- Where Aboriginal and Torres Strait Islander people have maintained their connection with the land through the years of European settlement; and
- Where their title has not been extinguished by valid acts of Imperial, Colonial, State, Territory or Commonwealth Governments.

The decision does not give native title primacy over valid interests in land granted by governments. A validly granted freehold title would extinguish native title.

In relation to development on land subject to a successful native title claim or Indigenous Land Use Agreement, certain future acts are valid to the extent that they are ".....acts involving facilities for services to the public (section 24KA)....."

The native title holders and any registered native title claimants or parties to an Indigenous Land Use Agreement (ILUA), in relation to land concerned, have a procedural right for their interests to be considered. Therefore, where land is subject to native title or an Indigenous Land Use Agreement, they are required to be notified of the proposed "future act" and are entitled to have matters considered including their native title rights and interests in the land.

The proposal site is located within the boundary of a large Native Title claim application covering northeastern NSW, overlapping the southeastern Queensland border and west to the Border Ranges National Park in NSW. The claim was lodged on behalf of the Tweed River Bundjalung People (Tribunal ID NCD202020/002), on 4 August 2020. The claim was not accepted for registration (date of Decision

16 September 2020) and there has been no determination of the claim. In addition, the proposal traverses local council road reserves and privately owned land, which would not normally been included as claimable land under the NT Act. Notification under s 24KA is therefore not required.

5.3.3 BIODIVERSITY CONSERVATION ACT 2016

The *Biodiversity Conservation Act 2016* (BC Act) provides the process for listing threatened species, threatened ecological communities, and areas of outstanding biodiversity value, and details the process for assessing impacts on those matters.

Section 1.7 of the EP&A Act requires that assessment of an activity must consider its impact on threatened species, threatened populations, and threatened ecological communities or their habitats in accordance with Part 7 of the BC Act. The assessment for determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats is referred to in section 7.3 of the BC Act. The purpose of the assessment is to determine whether the proposed works are likely to have a significant impact. If a significant impact is determined, a species impact statement (SIS) is required, or if the proponent so elects, a Biodiversity Development Assessment Report (BDAR) can be prepared.

The proposal site is not located within a declared area of outstanding biodiversity value. The proposed activity will be carried out on predominately highly disturbed land associated with the construction of previous road and electricity networks and adjoining farming practices. A significant impact on threatened species, populations, ecological communities, or their habitats as a result of the proposal is considered unlikely (refer to **Section 6.5** and **Appendix E**).

5.3.4 BIOSECURITY ACT 2015

The *Biosecurity Act 2015* (Biosecurity Act) provides for the prevention, elimination, minimisation and management of biosecurity risks posed by biosecurity matter, dealing with biosecurity matter, carriers and potential carriers, and other activities that involve biosecurity matter, carriers or potential carriers. Section 22 of the Biosecurity Act requires that any person who deals with biosecurity matter, or a carrier, and who knows, or ought reasonably to know, the biosecurity risk posed or likely to be posed by the biosecurity matter, carrier or dealing, has a biosecurity duty to ensure that, so far as is reasonably practicable, the biosecurity risk is prevented, eliminated or minimised. This obligation is referred to elsewhere within the Biosecurity Act as the “general biosecurity duty”.

Given the excavation and disturbance of surface and sub soils associated with the proposed activity, Essential Energy has a general biosecurity duty to ensure the biosecurity risks posed by the potential for the introduction of weed species are prevented, eliminated or minimised.

In addition, the proposal site is located on the far north coast of NSW, where there have been several red imported fire ant infested areas declared. At the time of writing, the proposal site is located with the NSW protection zone (i.e., all of NSW), but not within a declared fire ant infested area or movement control area. Notwithstanding Essential Energy has an obligation to comply with the relevant biosecurity orders, as they relate to movement of material into and out of infested and movement control areas, where applicable.

5.3.5 CROWN LAND MANAGEMENT ACT 2016

The *Crown Land Management Act 2016,* (Crown Land Management Act) consolidates several pieces of legislation, including the repeal of the *Crown Lands Act 1989, the Crown Lands (Continued Tenures) Act 1989, the Western Lands Act 1901* and certain other legislation. Existing leases, licences or permits issued under previous legislation will continue for their agreed term. From 1 July 2018, all new leases, licences and permits will be issued under the new legislation.

The vast majority of the proposal route are within the existing road reserves of Cudgen Road, Plantation Road and Reardons Road. The remainder of the proposed route is located on private property. No areas of Crown land are intersected by the proposal.

5.3.6 ELECTRICITY SUPPLY ACT 1995

The *Electricity Supply Act 1995* (ES Act) establishes a comprehensive wholesale and retail market in electricity and regulates the network operations, wholesale trading, and electricity supply in the retail market. The ES Act confers special powers on Essential Energy in respect of development and maintenance of electricity infrastructure and sets out the licencing regime. In particular, it allows Essential Energy to trim and remove trees, carry out works on public roads, and acquire land.

The ES Act also requires that no works (other than routine repairs or maintenance works) may be carried out unless 40 days' notice has been given to the local council to make a submission in relation to the proposal. Any submission must be considered by Essential Energy.

5.3.7 FISHERIES MANAGEMENT ACT 1994

The objects of the *Fisheries Management Act 1994* (FM Act) are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. Amongst other things, the Act provides for the listing of threatened aquatic species, populations and ecological communities, and key threatening processes and their management through recovery plans and threat abatement plans. Section 111(4) of the EP&A Act requires that assessment of an activity must consider its impact on threatened species, populations, ecological communities or their habitats. A significant impact on threatened species, populations, ecological communities, or their habitats as a result of the proposal is considered unlikely (refer to **Section 6.5** and **Appendix E**).

Under Section 199 of the FM Act, a public authority (other than local authority), such as Essential Energy proposing to undertake dredging or reclamation work, must submit written notification to the Minister of the proposal and consider any matters concerning the proposed work that are made by the Minister within 28 days after giving the notice. NSW DPI have advised that as the proposal will avoid areas of Key Fish Habitat (KFH) through design and construction methodology (underboring) notification to the Minister for any dredging and reclamation work, or a permit, is not required.

5.3.8 HERITAGE ACT 1977

The *Heritage Act 1977* (Heritage Act) provides for the protection of heritage items of local and state significance. Such items may include places, buildings, works, relics, moveable objects, or precincts with historical, scientific, cultural or aesthetic value to the state. Where works are likely to impact upon an item listed on the State Heritage Inventory (SHI), approval may be required under two sections of the Heritage Act:

- Section 60 approval relating to impacts on items listed on the SHI; and
- Section 140 approval requiring an excavation permit for activities with potential to excavate or disturb a relic.

As described in **Section 6.7.2** there is no foreseeable likelihood that an item listed on the SHI would be impacted by the proposal, therefore further assessment and a permit from the Department is not required. Further discussion of potential impacts and measures to minimise impacts to items of local heritage significance is provided in **Section 6.7.**

5.3.9 LOCAL LAND SERVICES ACT 2013

The *Local Land Services Act 2013* (LLS Act), established Local Land Services, a government agency with the responsibility for providing advice on biosecurity, natural resources and agricultural advisory services in NSW. The LLS Act includes provisions for the regulation of native vegetation including the approval of certain activities.

Under the LLS Act, approval is required from the Minister for the Environment or delegate to clear native vegetation (exemptions apply). Exemptions include, but are not limited to, urban areas, electricity line maintenance and Part 5 activities under the EP&A Act.

The LLS Act is administered by the various local land services under delegated authority by the Minister for the Environment.

Given that the proposal will be assessed under Part 5, Division 5.1 of the EP&A Act, the provisions relating to the LLS Act are not applicable.

5.3.10 NATIONAL PARK AND WILDLIFE ACT 1974

The *National Parks and Wildlife Act 1974* (NPW Act) provides for the management of all national parks, historic sites, nature reserves, reserves, Aboriginal areas and state game reserves. It also provides for the protection and care of native flora and fauna, and Aboriginal places and objects throughout NSW. Under the NPW Act it is an offence, without authorisation, to:

- Harm an Aboriginal object or place without consent;
- Pick or harm any plant or animal that is protected or is a threatened species, population or ecological community; or
- Damage any critical habitat, or habitat of a threatened species, an endangered population or an endangered ecological community or reserved land.

When an activity is likely to harm an Aboriginal object or place, approval under section 90 is required.

The NPW Act also serves to direct the management and protection of reserved land. In relation to utility installations, the Minister for the Environment may grant easements or rights of way through reserved land for the conveyance or transmission of electricity.

The proposal site is not located on reserved land. Approval under the NPW Act is not required in respect of the proposed activity.

As described in **Section 6.6**, based on the design, and mitigation measures, the proposal is not likely to impact upon Aboriginal objects or places.

5.3.11 PROTECTION OF ENVIRONMENT OPERATIONS ACT 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) provides a framework for the licencing of activities that have potential to result in pollution of the environment. The POEO Act is administered by OEH. An environment protection licence is not required for the proposed activities as they do not fall within Schedule 1 of the POEO Act; however, the following restrictions apply:

- The proposal must not pollute waters;
- Waste from the works must not be wilfully or negligently disposed of in a manner that harms or is likely to harm the environment;
- Waste must not be transported to a place that cannot lawfully be used as a waste facility for that waste;
- There must be no litter in or on a public place or an open private place caused by workers; and
- Any environmental incident that involves actual or potential harm to the health or safety of human beings or to ecosystems must be reported to the Environment Protection Authority (EPA).

During construction, there is the potential for discharge to surface waters from excavation, and trenching activities. A number of management strategies are available to Essential Energy for the discharge to surface waters, including discharging water over grassed or well vegetated areas away from waterways, or the use of filter bags in urban environments.

5.3.12 ROADS ACT 1993

The *Roads Act 1993* (Roads Act) provides for the ownership and management of public roads, and also requires the consent of the appropriate roads authority for various works in respect of certain public roads.

Section 138 of the Roads Act requires the consent of the appropriate roads authority for various works in respect of public roads and classified roads. Under Schedule 2 (5) (1) of the Roads Act Essential Energy is exempt from obtaining approval for works on or over an unclassified road other

than a Crown road. However, works that require a connection to or crossing of a classified road must be approved by Transport for NSW (TfNSW).

The proposed activity will be limited to private property and the road reserves of several local roads. No work within, on, or over a classified road is required, therefore there is no requirement for a Section 138 approval from TfNSW.

5.3.13 WATER ACT 1912

Under the *Water Act 1912* (Water Act), for any temporary or permanent works not defined in a gazetted water sharing plan under the Water Management Act 2000 (WM Act), a licence or permit is required to:

- Extract water from a stream, river or water course via a pump or other work; or
- Extract groundwater via any type of bore, well, spear point or groundwater interception scheme (including dewatering).

The proposal site is located on land to which Water Sharing Plan for the Tweed River Area Unregulated and Alluvial Water Sources 2023 and potentially the Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources 2016 apply and are in force. A licence or permit under the Water Act is therefore not required. Assessment of applicable licences, work or use approvals under the WM Act is provided in the following section.

5.3.14 WATER MANAGEMENT ACT 2000

The *Water Management Act 2000* (WM Act) governs the issue of new water licences and the trade of water licences and allocations for those water sources (rivers, lakes and groundwater) in NSW where water sharing plans have commenced. Under the WM Act, should water need to be extracted from a surface water or groundwater source, defined in gazetted water sharing plan, then four licence/approvals may apply, including:

- An access licence to obtain access to a share of the water source
- A water use approval to obtain permission for how the water would be used
- A water management works approval to obtain permission to install and use the works for water supply, drainage or flood mitigation work
- An activity approval, namely a controlled activity approval and/or aquifer interference approval.

The proposed activity would not trigger the need to obtain a water use approval or a water management works approval.

The proposal does not involve the taking of water from a surface water or groundwater source, however, a water licence is required whether water is taken for consumptive use or whether it is taken incidentally by the aquifer interference activity. For example, dewatering of groundwater during building construction activity requires a water licence (unless an exemption applies) even where that water is not being used consumptively as part of the activity's operation.

The WM Act defines an aquifer interference activity as involving any of the following:

> *(a) the penetration of an aquifer,*
>
> *(b) the interference with water in an aquifer,*
>
> *(c) the obstruction of the flow of water in an aquifer,*
>
> *(d) the taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations,*
>
> *(e) the disposal of water taken from an aquifer as referred to in paragraph (d).*

An aquifer is defined as, *a geological structure or formation, or an artificial landfill, that is permeated with water or is capable of being permeated with water*.

A geotechnical investigation undertaken by Regional Geotechnical Solutions (RGS), 2023 (refer **Appendix C**), for the boarder KVHVSP, indicated groundwater along the northern portion of the proposal site (i.e., within the road reserves of Cudgen, Plantation and Reardons Road) was not encountered down to depths of approximately 3m. It is therefore unlikely that any shallow excavation and trenching works (to a maximum depth of approximately 1.35m) and shallow underbores (to a maximum of 3m depth) within the road reserves along the northern portion of the proposal site will result in an aquifer interference activity. For the southern portion of the proposal site, between approximately the southern end of Reardons Road and the connection point with the previously installed high voltage cables, RGS (2023) found that groundwater level, or water inflow, ranged between approximately 0.9m and 1.5m, or was not encountered. Based on these findings, and the landscape in which the southern portion of the proposal is located, it is likely that penetration of an aquifer will occur, and as such meet the definition of an aquifer interference activity during the underbore activities. Although less likely, excavation and trenching works required in the southern portion of the proposal site may also penetrate groundwater, depending on prevailing weather conditions, and where the groundwater level is shallow (i.e., less than approximately one metre depth).

However, Clause 7 in Schedule 4 of the *Water Management (General) Regulation 2018* (WM General Regulation) provides an exemption for the taking of up to 3 megalitres (ML) of groundwater from a groundwater source by one or more of those activities in a water year, if the taking of that groundwater is not for the purpose of its consumption or supply and the activity is in connection with an authorised project. The taking of groundwater as it relates to the proposal is incidental by the aquifer interference activity, and not for the purposes of consumption or supply. An authorised project includes an activity to which Division 5.1 of the EP&A Act applies. It is highly unlikely that dewatering in that excess of 3ML will be required. A water access licence exemption would therefore apply for an aquifer interference activity.

A controlled activity approval confers a right on its holder to carry out a specified controlled activity at a specified location in, on or under waterfront land. Under the WM Act, a controlled activity means:

a) the erection of a building or the carrying out of a work (within the meaning of the Environmental Planning and Assessment Act 1979), or

b) the removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise, or

c) the deposition of material (whether or not extractive material) on land, whether by way of landfill operations or otherwise, or

d) the carrying out of any other activity that affects the quantity or flow of water in a water source.

Waterfront land means—

(a) the bed of any river, together with any land lying between the bed of the river and a line drawn parallel to, and the prescribed distance inland of, the highest bank of the river, or

(a1) the bed of any lake, together with any land lying between the bed of the lake and a line drawn parallel to, and the prescribed distance inland of, the shore of the lake, or

(a2) the bed of any estuary, together with any land lying between the bed of the estuary and a line drawn parallel to, and the prescribed distance inland of, the mean high water mark of the estuary, or

(b) if the regulations so provide, the bed of the coastal waters of the State, and any land lying between the shoreline of the coastal waters and a line drawn parallel to, and the prescribed distance inland of, the mean high water mark of the coastal waters,

where the prescribed distance is 40 metres or (if the regulations prescribe a lesser distance, either generally or in relation to a particular location or class of locations) that lesser distance. Land that

falls into 2 or more of the categories referred to in paragraphs (a), (a1) and (a2) may be waterfront land by virtue of any of the paragraphs relevant to that land.

While some portions of the proposal site are within 40m of waterfront land, in accordance with Section 41 of the Water Management (General) Regulation 2018, Essential Energy, a public authority, is exempt from section 91E (1) of the WM Act in relation to all controlled activities that it carries out in, on, or under waterfront land. A controlled activity approval is therefore not required.

5.4 Summary of Licences, Permits, Approvals and Notifications

Specific approvals required for the construction, maintenance and operation of the proposal are outlined in **Table 5**.

Table 5: Summary of licences, Permits, Approvals and Notifications

LEGISLATION	AUTHORITY	REQUIREMENT
Electricity Supply Act 1995	Tweed Shire Council	40 days notice of the proposed works must be given. Essential Energy's Design Services will be responsible for this notification. This notification has been sent.
T&I SEPP	Environment and Heritage division of the NSW DCCEEW	21 days notification for works on land adjacent to Cudgen Nature Reserve.

6. Environmental Assessment

6.1 Air Quality and Greenhouse Gases

6.1.1 EXISTING ENVIRONMENT

The northern portion of the proposal site, from Cudgen ZS to the southern end of Reardons Road is situated on cleared and disturbed land associated with the road reserves of several local roads. The surrounding land is also predominately cleared and used for agricultural purposes. The southern portion proposal site, from the southern end of Reardons Road to the connection point with previously installed underground high voltage cables, intersects with a mixture of vegetated and cleared rural land, as well as passing adjacent to, and intersecting with a small section of mapped coastal wetlands. The main air quality influences on the existing environment would therefore be agricultural, and transport exhaust emissions, and dust from vehicles on unsealed rural roads.

There are a number of rural and rural-residential residences located immediately adjacent to the northern portion of the proposal site along Cudgen, Plantation and Reardons Roads. Distances to sensitive receivers from the northern portion of the proposal site range from approximately 5 to 30m. The closest sensitive receivers to the southern portion of the proposal site are rural residences, located between approximately 130m and 140m from the proposal site (refer **Figure 4**).

6.1.2 ASSESSMENT OF IMPACT

6.1.2.1 Air quality during construction

It is expected that during civil excavation works required for construction of trenches,cable joining pits, and entry and exit disturbance areas for the underbores, there would be minor amounts of dust generated from the disturbance of soil, and wind erosion of any exposed stockpiles. Dust generation during underbore operations are considered negligible due to being an underground, closed system.

There will be minimal exhaust emissions from vehicles. Exhaust emissions from construction equipment are likely to include nitrogen oxides (NOx), carbon monoxide (CO), sulphur oxide (SO_2), hydrocarbons, and total suspended particulates. All vehicles will be fitted with approved exhaust systems to maintain vehicle exhaust emissions within accepted standards.

Works will be limited to the proposal site itself. Impacts to air quality will be small in intensity, over twelve months, and will be small in scope. It is unlikely that there will be an odour impact. Any impacts on air quality will be short-term and localised.

6.1.2.2 Air quality during operation

Once operational, the underground cables will have negligible impacts on air quality. All Essential Energy's assets are subject to regular maintenance and monitoring to ensure all equipment is operating effectively.

6.1.3 ENVIRONMENTAL MITIGATION MEASURES

The following minimisation measures will be implemented to prevent air quality impacts:

- Any potential dust-borne materials transported to and from the activity site will be covered at all times during transportation
- All vehicles and machinery will be maintained according to manufacturer requirements to ensure emissions are kept within acceptable limits.

6.1.4 CONCLUSION

The proposal is not anticipated to result in substantial or uncontrollable dust or exhaust emissions in the area during construction or operation. Any air quality impacts would be short-term and minor

during construction or future maintenance. Given the mitigation measures outlined in this assessment the overall environmental risk is considered to be low.

6.2 Geology and Soil

6.2.1 EXISTING ENVIRONMENT

A geotechnical investigation for the proposed route of the high voltage cables was undertaken by RGS (2023) (refer **Appendix C**). The investigation indicated the proposal site can be separated into two distinct terrain types comprising undulating residual hills over the northern portion from Cudgen ZS to approximately the southern end of Reardons Road, and low-lying undulating aeolian and alluvial profiles over the southern portion from approximately the southern end of Reardons Road to the connection point with previously installed underground high voltage cables. The boundary between the two terrain types is clearly defined by the plunging south facing slopes that terminate at the coastal wetlands associated with the aeolian and alluvial profiles (refer **Figure 15**).

The northern portion of the proposal site comprises undulating residual slopes of basaltic origins. Surface slopes are typically in the order of 2 to 5 degrees with localised steeper slopes. Surface exposures indicate a profile comprising residual clay soils with basalt cobbles and boulders. An exposure at the southern end of Reardons Road exhibits a matrix of stiff to hard residual clays with extremely weathered to fresh basalt core stones, cobbles and boulders. The western end of underbore 1 will be within the residual terrain and traverse the contact or convergence of the residual and alluvial terrain. The southern portion of the proposal site consists of a low-lying wetland area comprising alluvial and aeolian sand deposits. The surface is flat to undulating. An ephemeral creek meanders from west to east through a series of billabongs and man-made dams. Underbores 2 and 3 will be within the alluvial terrain.

Reference to the Tweed Heads 1:100 000 Coastal Quaternary Geology Map indicates the northern portion of the proposal site in the elevated residual areas of the are underlain by tertiary volcanic rocks, including basalt, rhyolite, trachyte, gabbro and syenite (Tv). The southern low lying alluvial areas are underlain by Holocene estuarine paleochannel fill: organic mud, peat, clay, silt, marine sand (Qhea) and Pleistocene bedrock-mantling dune: marine sand, indurated sand. An extract of the geology mapping relative to the proposal site is provided as **Figure 16**.

Review of the NSW Mitchell Landscapes Mapping V3.1, which can be viewed on the NSW Government's SEED website, indicates that the majority of the proposal site is located on the Lamington Volcanic Slopes comprising very extensive hills and ridges forming a broadly circular pattern 50km in diameter with radial drainage centred on Mt Warning. The Tertiary Lamington volcanics complex of multiple layers of flows of basalt, rhyolite and trachyte and pyroclastics including; tuff and agglomerate. General elevation 50 to 1120m. Local relief varies considerably and is greatest in the higher landscape where it is up to 500m. Soils are mostly red and brown gradational structured loams with high organic content and high fertility. On lower slopes adjacent to valleys, red, brown and grey-brown texture-contrast soils occur.

The southern portion of the proposal site from approximately the end of Reardons Road is located on the Byron - Tweed Alluvial Plains soil landscape comprising channels, floodplain, terraces and estuary of the Tweed River and other coastal streams on Quaternary alluvium. General elevation is between 0 to 50m, with local relief of 15m. Soils are typically characterised by uniform brown earths and structured brown clays on floodplains. Brown texture-contrast soil with high organic content on terrace remnants (NSW DECC, 2002). **Figure 17** shows the mapped Mitchell Landscapes relative to the proposal site, respectively.

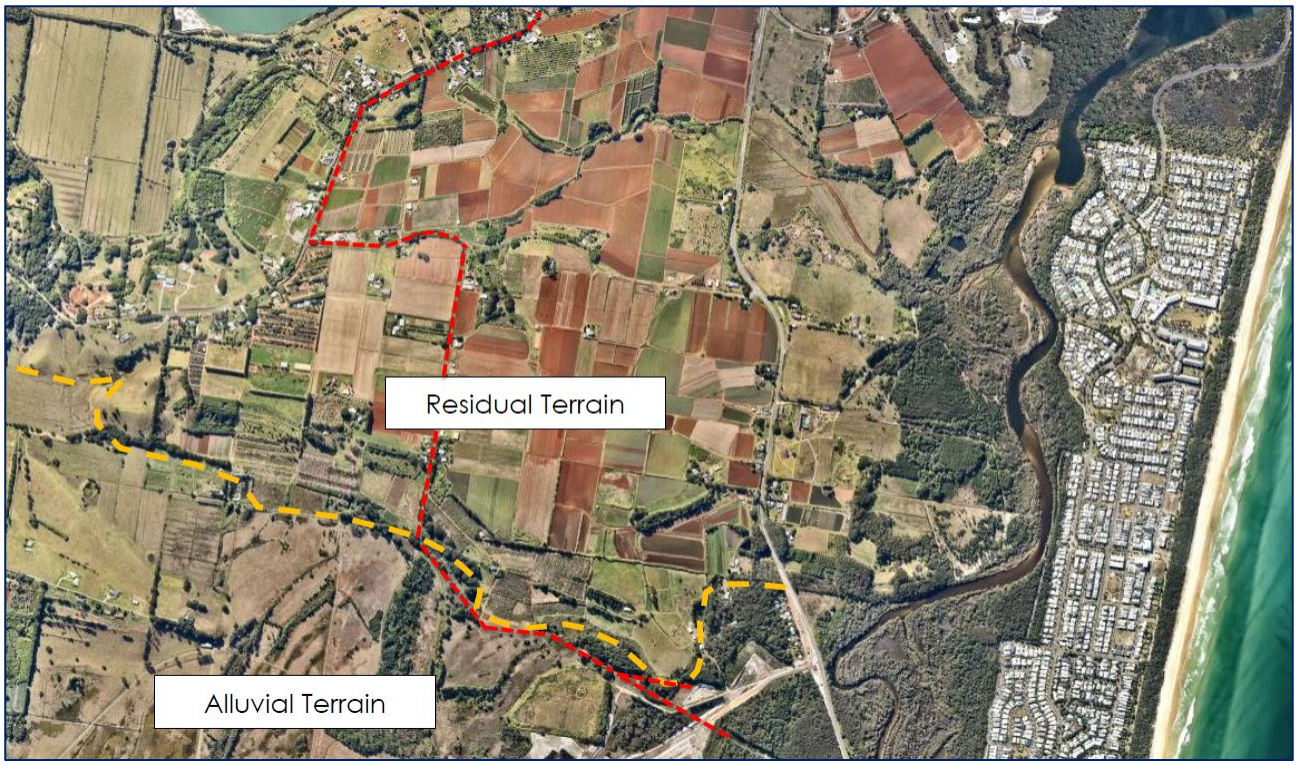


Figure 15: Terrain types relative to the proposal site

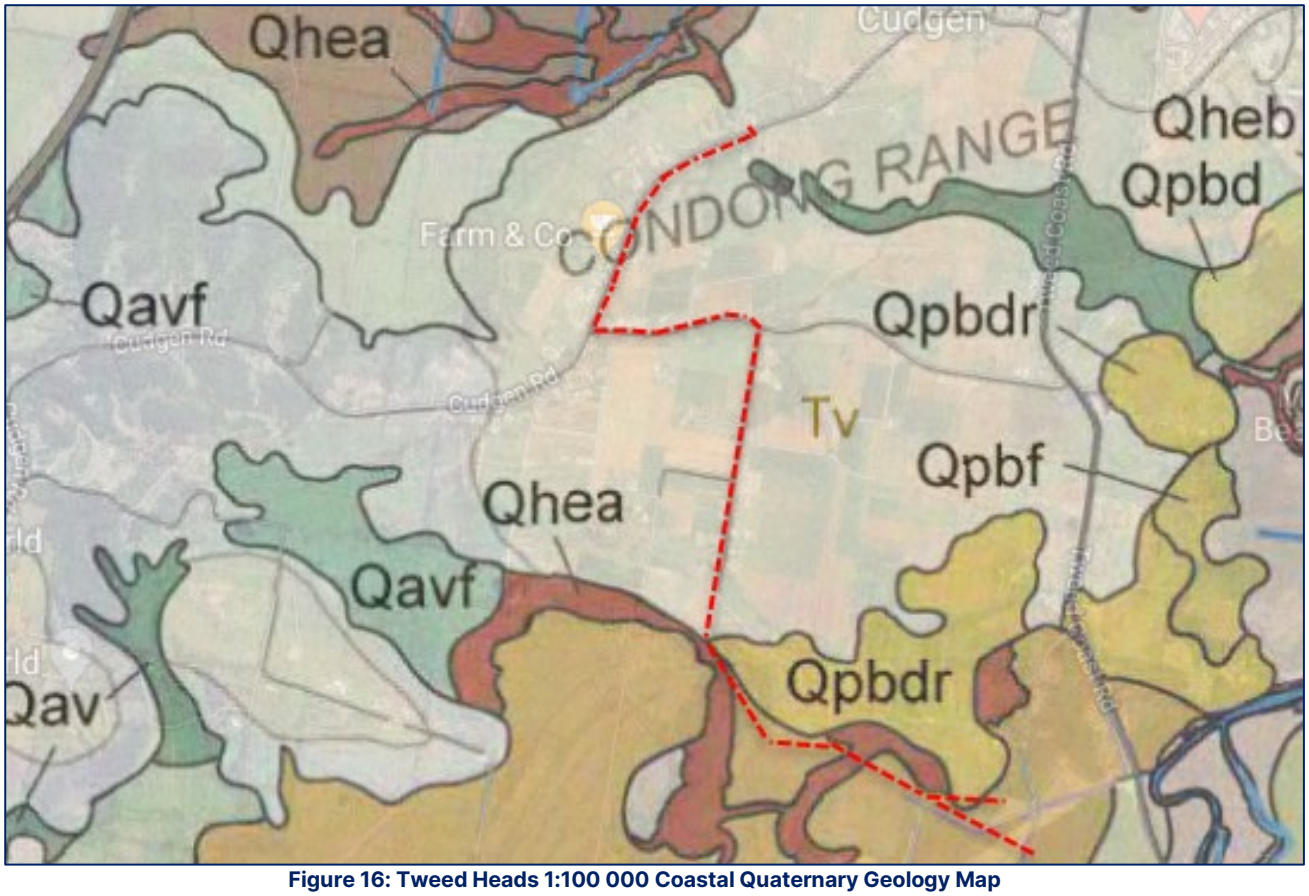


Figure 16: Tweed Heads 1:100 000 Coastal Quaternary Geology Map

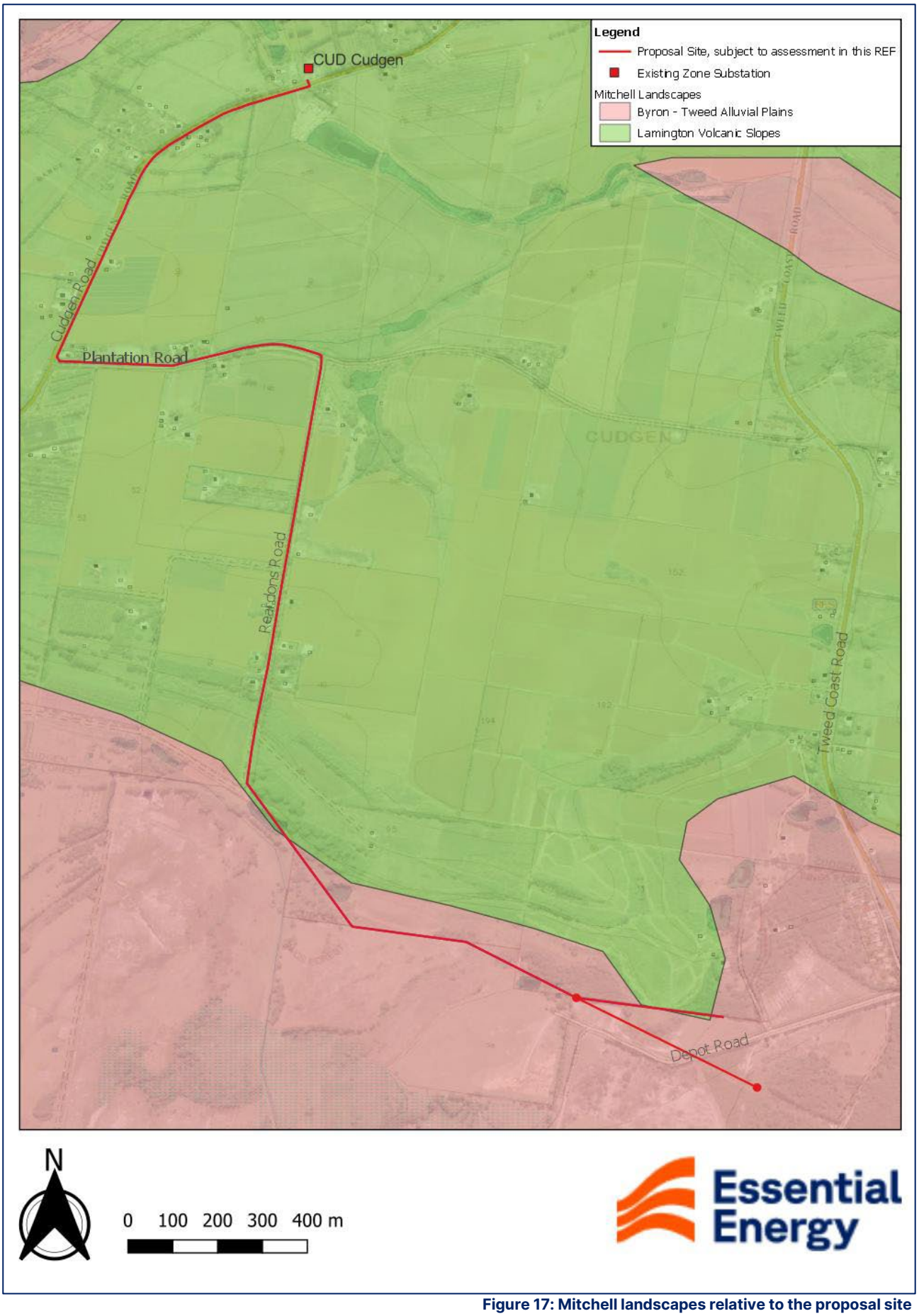


Figure 17: Mitchell landscapes relative to the proposal site

6.2.1.1 Geotechnical Investigation

RGS (2023) undertook a geotechnical investigation of the proposal site. The scope included:

- Drilling of twelve boreholes (BH1 to BH12) between the Cudgen zone substation and the southern end of Reardons Road. The boreholes were drilled to depth of up to 3m with a ute mounted drill rig and auger drilling methods.
- Drilling of three boreholes (BH13 to BH15) to depths of up to 9m with a ute mounted drill rig and auger drilling methods.
- Drilling of five boreholes (BH-U1, BH-U3, BH-U5, BH-U6 and BH-U8) in the southern portion of the proposalwith a Geoprobe drill rig to depths of up to about 15m.

The location of the boreholes relative to the proposal site are presented in **Figures 18** and **19**.

Subsurface soil profiles are summarised as below. Further details, including bore logs are provided in **Appendix C**.

Cudgen ZS to End of Reardons Road (BH1 to BH12)

Fill: Sandy gravel pavement material, dense. Typically, between 0.3 to 0.5m deep.

Topsoil: Silty clay, low to medium plasticity, with gravel and rootlets to typically 0.2m

Residual: Silty clay, medium to high plasticity, very stiff to hard and friable extending up to 3m. The residual clay contains varying amounts of basalt gravel, cobbles and small boulders. The boulders are typically rounded and high strength.

Extremely Weathered Basalt: Recovered as gravelly clay, medium plasticity, hard and friable was encountered in some of the boreholes, typically over the southern portion of the residual terrain. The weathered basalt is variable within the profile as evidenced in the cutting exposure adjacent to Reardons Road. The exposure indicates the basalt has weathered to residual soil with the more resistant material remaining as high strength rounded basalt cobbles and boulders or core stones within the residual clay soil matrix.

Potential Open Trenching Section Between Underbore locations in Southern Portion of the Proposal Site (BH13, BH14 and BH15)

Fill: Sandy gravel pavement material, dense. To 0.15m at BH13. Gravelly clay and sand to 1.2m at BH 15.

Aeolian / Alluvial: sand, loose to medium dense to depths up to 9.0m. The alluvial soils contained layers / lenses of sandy silt and peat.

Underbore Sections in Southern Portion of Proposal Site (BH-U1, BH-U3, BH-U5, BH-U6 and BH-U8)

BH – U8 and BH-U5 were drilled within the residual terrain while BH-U1, BH-U3, BH-U6 and BH15 were drilled within the alluvial terrain. The residual terrain comprises silty clay soils overlying weathered rock. Core stones of medium to high strength rock were encountered within the residual and upper weathered rock profile that extended to depths up to 15.15m in BH-U8. In BH-U5 bands of high strength rock were encountered from 12.35 to 15.0m. The rock is variable and includes Jasper and Trachyte overlying sandstone from 13.35m.

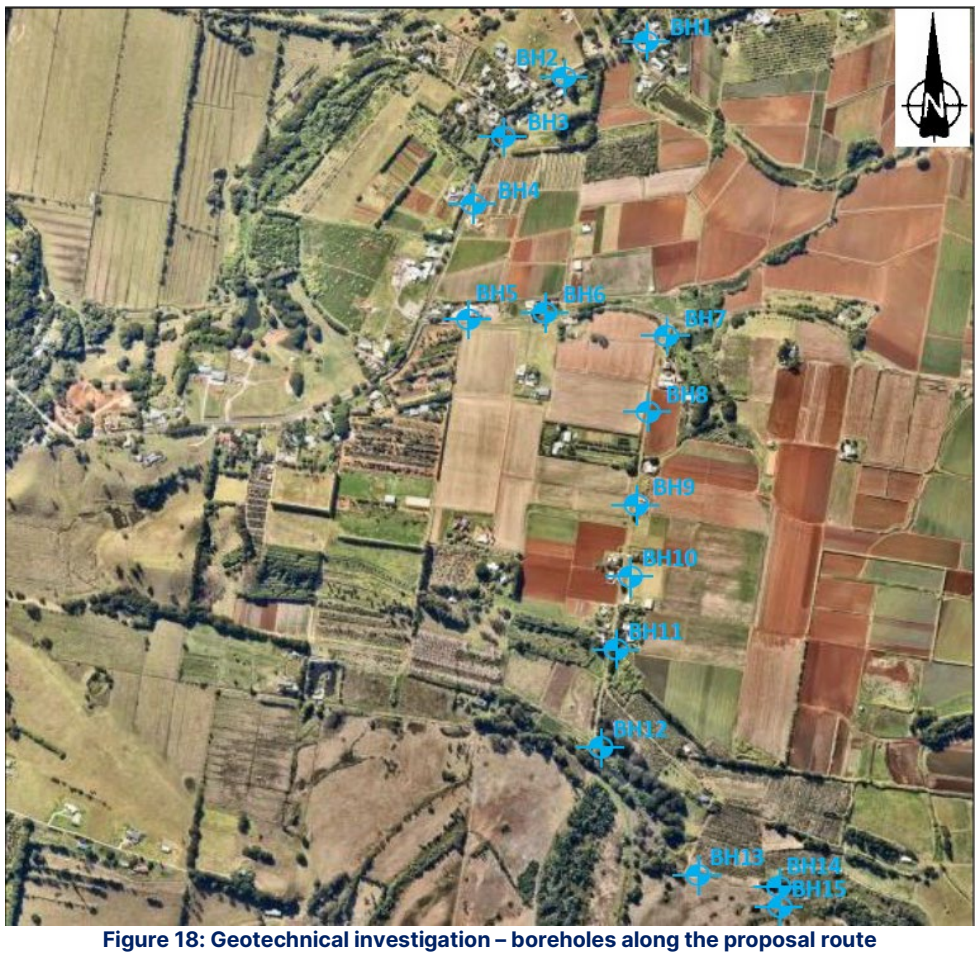


Figure 18: Geotechnical investigation – boreholes along the proposal route

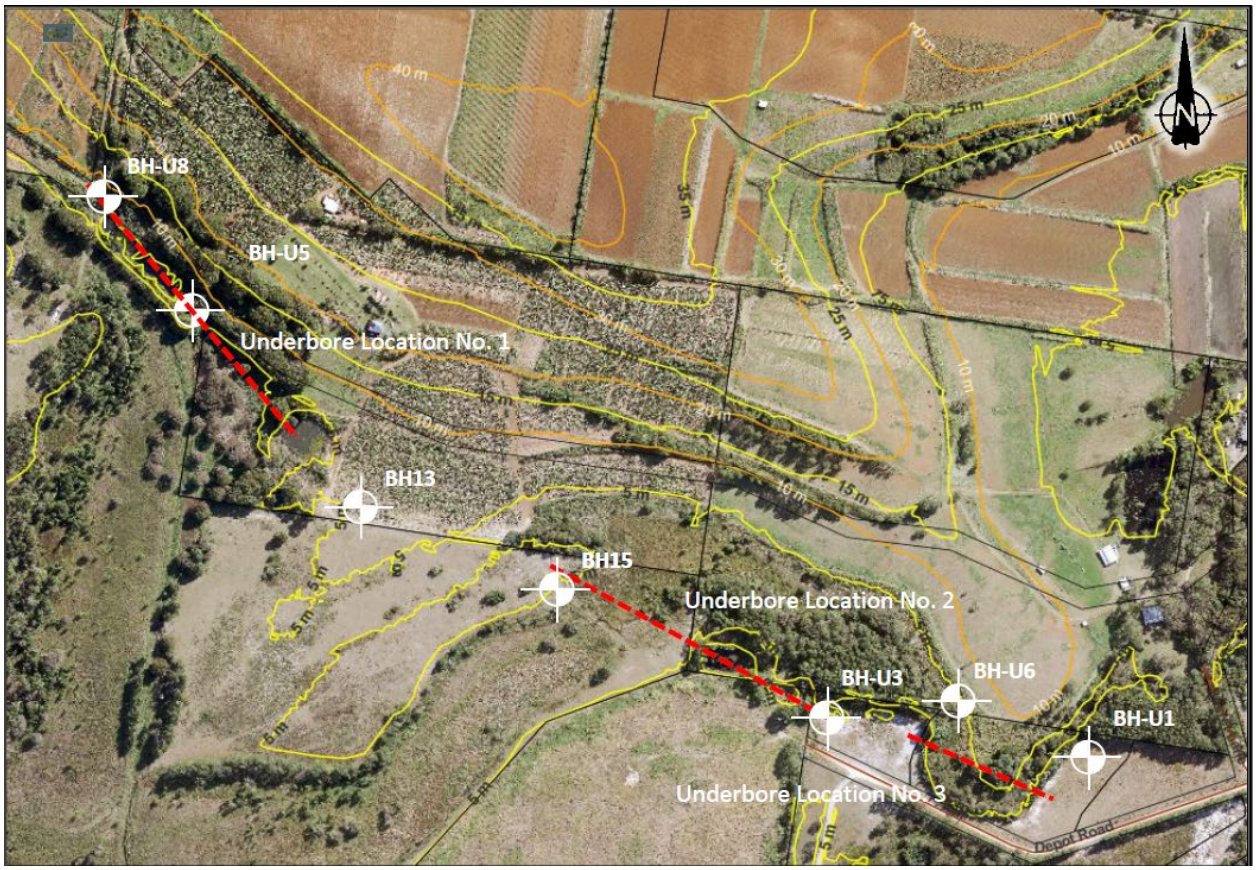


Figure 19: Geotechnical investigation - boreholes in vicinity of deeper underbore locations in southern portion of the proposal site

6.2.1.2 Potential Acid Sulfate Soil (PASS)

According to the Tweed LEP, the majority of the proposal site is located on land mapped as Class 5 PASS. Class 5 relates to works within 500m of adjacent Class 1, 2, 3 or 4 land that is below 5m Australian Height Datum (AHD) and by which the water table is likely to be lowered below one metre AHD on adjacent Class 1, 2, 3 or 4 land

The southern portion of the proposal site as it extends through vegetated land and mapped coastal wetlands is located on Class 2 and 3 PASS. Class 2 Pass relates to works below the natural ground surface, or works by which the water table is likely to be lowered. Class 3 PASS relates to works one metre below the natural ground surface, and by which the water table is likely to be lowered more than one metre below the natural ground surface.

Figure 20 shows mapped PASS, relative to the proposal site.

Historic acid sulfate soil testing, reviewed and summarised in Gilbert and Sutherland (2011a) for Stage 1 of the broader Kings Forest development site (encompassing the southern end of the proposal site), indicated the material with the highest acid sulfate soil potential occurred within the wetland/relict stream channel areas and was generally encountered throughout the sampling depth (i.e., from 0 to 6m below ground level). Whereas those samples not exhibiting any acid sulfate potential during screening were generally found outside the wetland/relict stream channel, and were associated with older Pleistocene sands, often indurated, underlying the more recently deposited Holocene peats and sediments.

Acid sulfate soil analysis undertaken by RGS (2023) within the alluvial terrain at 0.8-1.0m depth (BH13) and 1.2-1.5m depth (BH15), where excavation, trenching and soil disturbance through underbore activities will occur, indicated the following:

- pHF values between 5.04 and 5.93 in distilled water
- pHFOX values between 1.94 and 4.08 in hydrogen peroxide

To provide a more comprehensive assessment, four samples were submitted for Chromium Reducible Sulfur (SCr) and net acidity analysis. The results indicated:

- A Titratable Actual Acidity (TAA) concentration of 63 mol H/*t was recorded for BH15, therefore the soils are acidic
- Chromium reducible sulphur (SCr) of 49 mol H/*t, indicating potential sulfidic acidity. The net acidy is 117 mol H/*t, which exceeds the adopted action criteria of 62 mol H/*t.

The acid sulfate soil analysis within the alluvial terrain in the southern portion of the proposal site indicate the soils are naturally acidic and are actual acid sulfate soils (AASS) and/or PASS (RGS, 2023).

6.2.2 ASSESSMENT OF IMPACT

The proposed works will involve site disturbance through excavation, trenching, underboring and pole hole auguring. The trenches for the installation of the majority of the proposed underground high voltage cables along the road reserves of Cudgen, Plantation and Reardons Roads will be approximately 1m wide by approximately 1.5m deep, with an approximately 4m wide disturbance corridor. It is noted that this is a conservative assumption based on open trench construction methodology, based on a worst case construction footprint for assessment in the REF. It is likely that an alternative construction approach utilising underboring may be adopted, which will reduce the length of trenching required.

Pole hole auguring will be limited to two holes required for the installation of two new UGOH poles. This will be achieved using an augur of approximately 1.2m diameter to a depth of 3.5m.

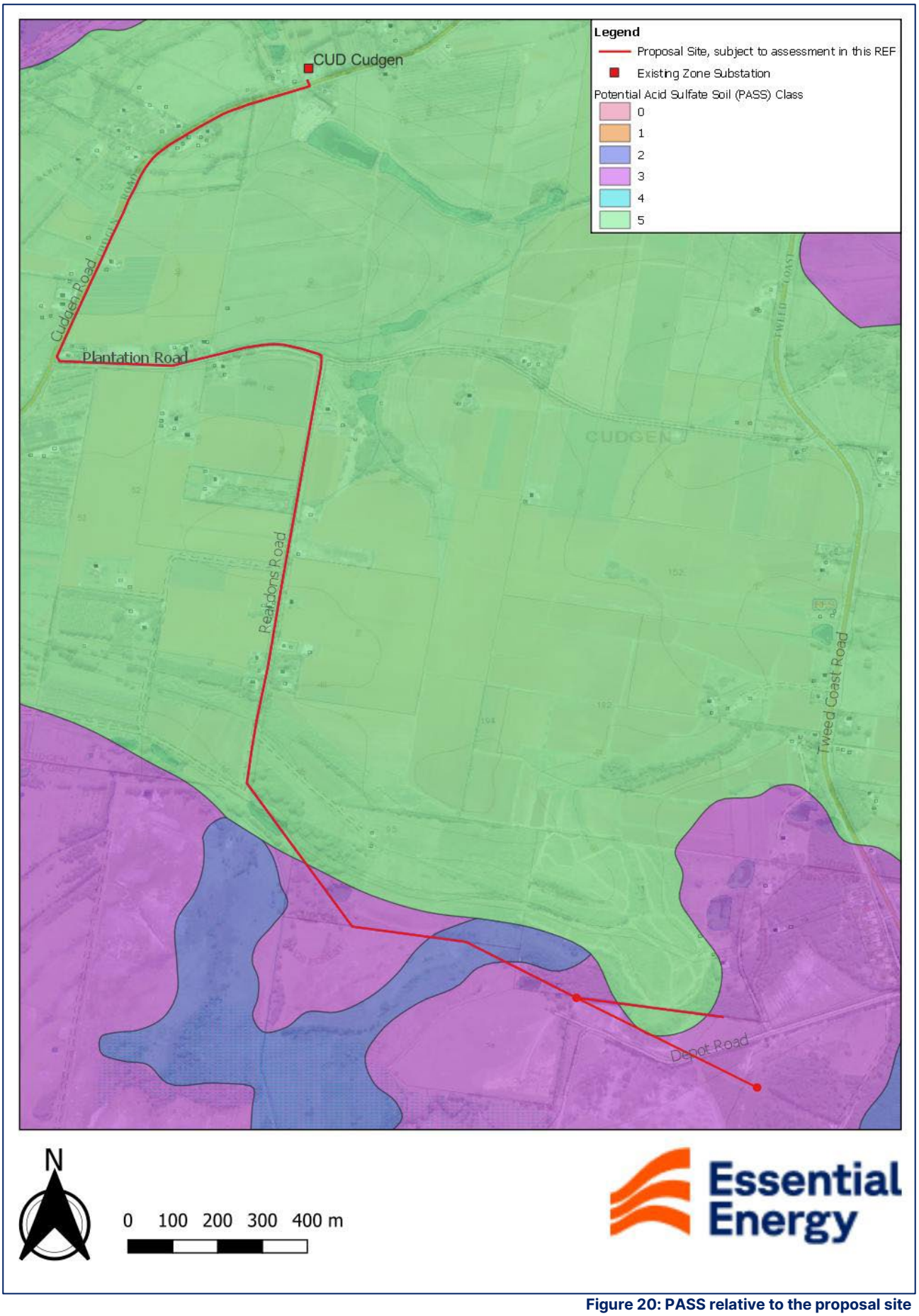


Figure 20: PASS relative to the proposal site

Excavation will also be required for underbore entry and exit pits. These excavations will range in size, but expected to be approximately 2.0m long by x 1.5m wide by 1.0m deep for the deeper underbores in the southern portion of the proposal. Excavations for entry and exits pits for shallower underbores utilised along the northern portion of the proposal will likely be smaller than this. Broader surface disturbance at the entry and exist areas for the deeper underbores will be required to accommodate access, including import of rock (i.e. hardstand) if ground is soft at time of drilling, underbore equipment, machinery, trucks and support vehicles. Inclusive of the entry pits, site disturbances of up to an area of approximately 25m by 50m for the entry area for underbore 1 and approximately 40m by 30m for underbore 2 and 3 combined. Surface disturbance at underbore exit areas are expected to be smaller, approximately 20m by 10m.

These activities have the potential to impact on soil stability and erosion potential within the proposal site. However, the extent of these impacts is likely to be minimal as works will be restricted to active work areas only, which will be stabilised as soon as practicable as work progresses along the route. The proposed activity is expected to have a low impact on soils and geology in the area.

Underbore methodology, which will likely be utilised for small sections within the road reserves, and the three longer sections within the southern portion of the proposal, will generate a liquid slurry which will need to be managed appropriately on-site and/or taken for offsite disposal. Further discussion of its impact and management is provided in **Section 6.3.**

Given the depth of trenching and underbore works, PASS is likely to be encountered within the alluvial terrain in the southern portion of the proposal site. An acid sulfate soil management plan will be required for the southern portion of the proposal site, consistent with that presented in **Appendix D**.

Mitigation measures proposed to manage erosion and sedimentation are outlined in **Section 6.2.3**. Water quality impacts are discussed in **Section 6.3.2**, air quality impacts are discussed in **Section 6.1.2**, and contamination impacts are discussed in **Section 6.8.2.**

6.2.3 ENVIRONMENTAL MITIGATION MEASURES

The following mitigation measures will be employed to manage erosion and sedimentation:

- Risks associated with sediment and erosion will be managed in accordance with The Blue Book – Managing Urban Stormwater: Soils and Construction (Landcom 2004). In particular, controls including, but not limited to the following, will be implemented:
  - Diversion of upslope runoff around the proposal site in a way that minimises erosion
  - Sediment control fences or other measures shall be installed at the downslope perimeter of disturbed areas, including any temporary stockpiles.
  - Maintenance of all erosion control measures at operational capacity until land is stabilised.
- Disturbed areas will be progressively stabilised as soon as practicable following construction activities
- A site specific erosion and sediment control plan will be included as part of the Construction Environmental Management Plan (CEMP).
- Essential Energy's CEOP8064 Management of Excavated Material; Guideline for Construction Sites will be consulted to determine the most appropriate beneficial reuse or disposal method for any surplus excavated materials
- A site specific acid sulfate soil management plan should be included as part of the CEMP for the southern portion of the proposal site (i.e., south of southern end of Reardons Road), consistent with that presented in **Appendix D**.

6.2.4 CONCLUSION

The proposal is not anticipated to have any adverse impacts on the soils and geology of the environment. Given the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low. Further potential impacts to water quality are discussed in the following section.

6.3 Water quality and Hydrology

6.3.1 EXISTING ENVIRONMENT

There are several ephemeral Strahler first order waterways located in agricultural land adjoining the northern portion of the proposal site, although the proposal site does not intersect with any of these. The southern portion of the proposal site intersects with, or is located in close proximity to, several farm dams and mapped coastal wetlands. An ephemeral Strahler first order drainage line, not marked on maps appears to meander from west to east through a series of billabongs, man-made dams and the mapped coastal wetland, towards Cudgen Creek, which is located approximately 820m east of the southern extent of the proposal. The Pacific Ocean is located approximately 2.15km to the east of the proposal site.

Waterways relevant to the proposal site are illustrated on **Figure 21**.

Current drainage at the proposal site would be expected to infiltrate the ground surface or follow overland flow to roadside stormwater drains, and/or to natural and constructed drainage lines. Being installed below ground, once constructed, the new underground cables are unlikely to significantly impact stormwater flows or infiltration.

The geotechnical investigation undertaken by RGS (2023) indicated that groundwater along much of the northern portion of the proposal site (i.e., within the residual terrain, encompassing the road reserves of Cudgen, Plantation and Reardons Roads) was not encountered to depths of approximately 3m below ground level. It is therefore unlikely that the shallow trenching and other excavation work (to a depth of approximately 1.5m) within the road reserves will encounter groundwater. For the southern portion of the proposal site, within the alluvial terrain between approximately the end of Reardons Road and the connection point with the previously installed high voltage cables, RGS (2023) found that groundwater level, or water inflow, ranged from between approximately 0.9m and 1.5m below ground level, or was not encountered. Based on these findings, and the alluvial terrain in which the southern portion of the proposal is located, it is likely that groundwater will be encountered during underbore activities. It is also possible that groundwater will be encountered during excavation and trenching works where the groundwater level is shallow (i.e., less than approximately one metre depth).

According to TSC flood mapping, with the exception of a small section of underbore 1, the majority of the proposal site is not affected by flooding for the design flood or climate change events (refer **Figures 22** and **23**, respectively). The design flood event is based on the 1% Annual AEP. The climate change flood event level in the projected 2100 design flood event considering expected sea level rise and increased rainfall intensity. Following 2007 guidance from the NSW State Government, this event is based on 0.91m rise in sea levels and a 10% increase in rainfall intensity (TSC, 2024).

6.3.2 ASSESSMENT OF IMPACT

The following activities have the potential to impact on water quality during the construction and operation of the project:

- Excavation and trenching
- Underboring
- Fuel or oil leaks from construction and maintenance equipment

These activities have the potential to affect the water quality in the area. Construction erosion and sediment controls and stabilisation following the works would be required for activities to prevent any impacts off-site, including sedimentation of drainage lines, waterways and wetlands. Control measures would also be implemented to minimise the risk of leaks and accidental spills of fuels and oils.

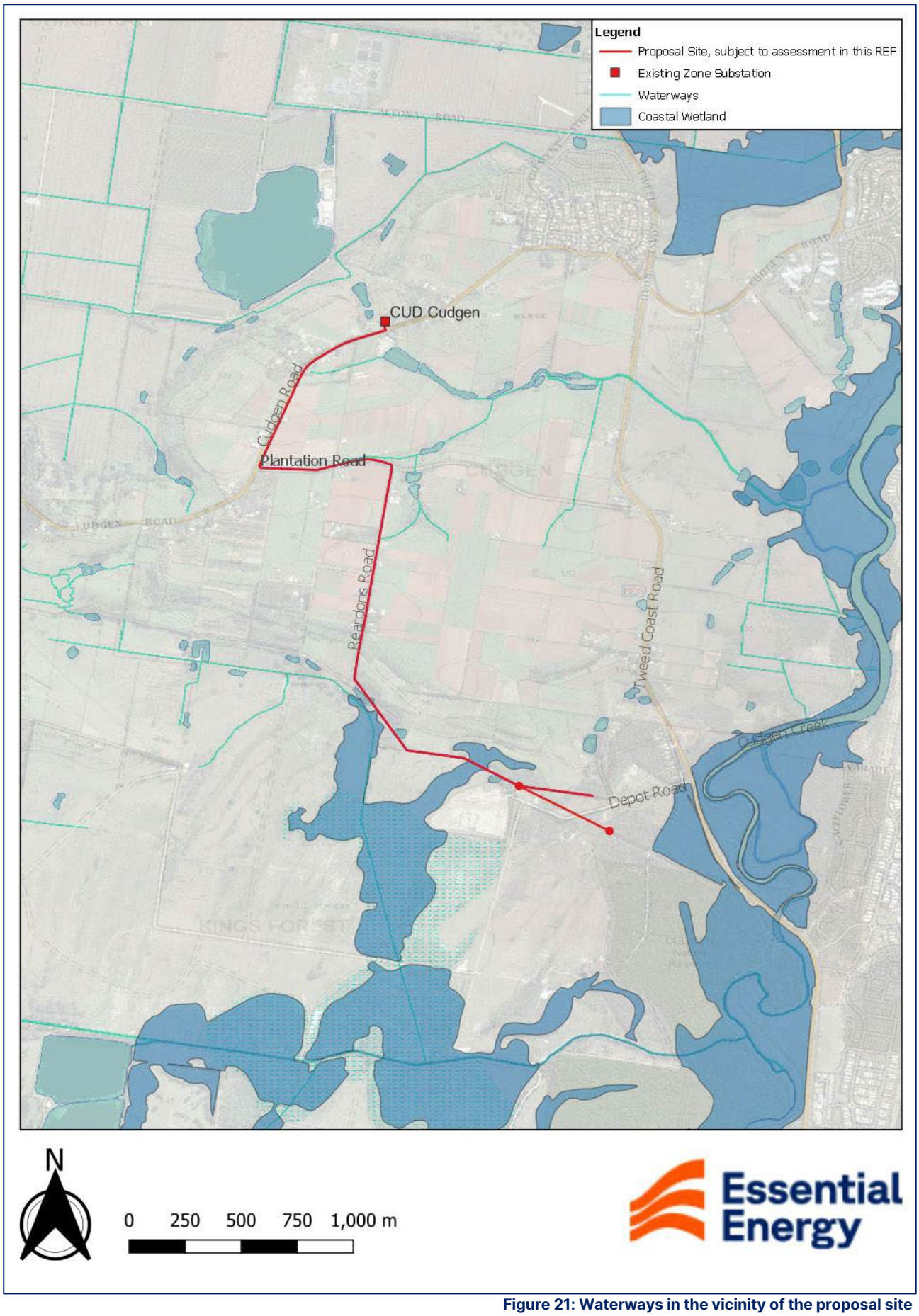


Figure 21: Waterways in the vicinity of the proposal site

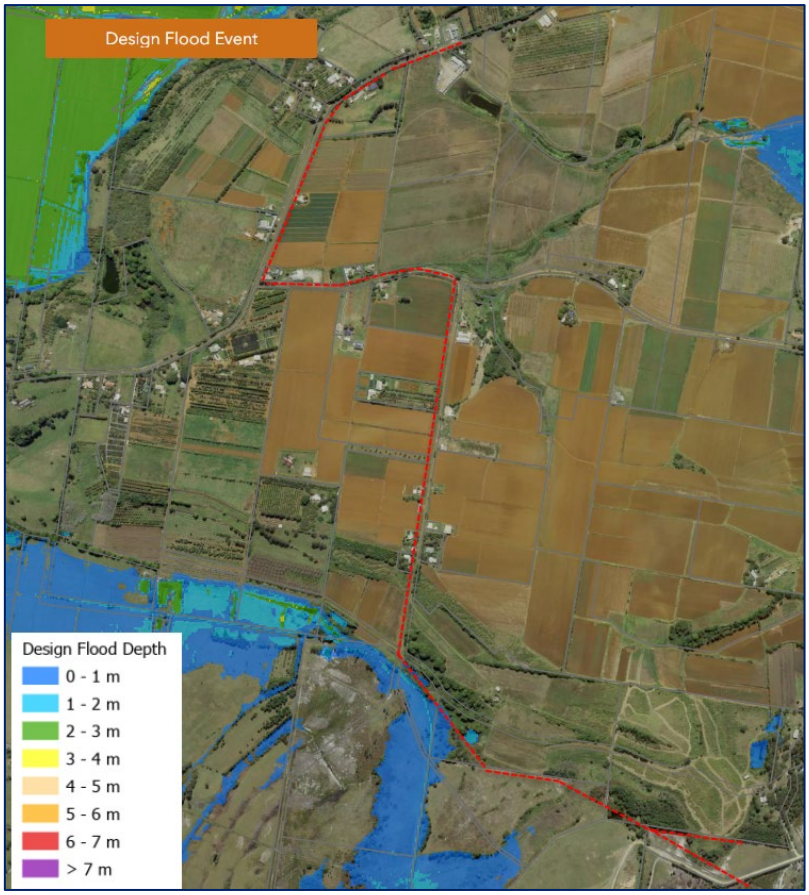


Figure 22: 1% AEP flood depths relative to the proposal site

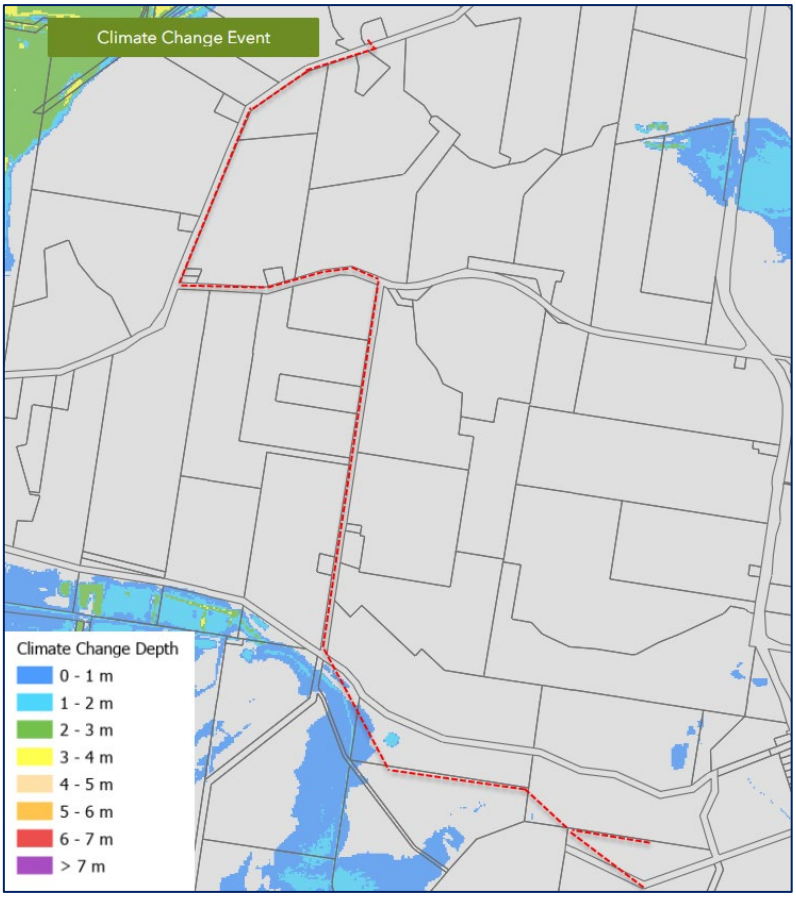


Figure 23: Climate change flood depths relative to the proposal site

6.3.2.1 Horizontal Directional Drilling (HDD)

The proposal involves HDD (underboring). Bentonite, used to transport the cuttings, cool the drill bit and to seal and support the drilled hole is likely to be used which, when mixed with water would generate a liquid slurry. Bentonite is a naturally occurring clay which is self-sealing and therefore used as a lining material to seal any cracks which may result from the drilling process. The use of drilling fluid could potentially result in sediment laden water entering a waterway if it is not appropriately contained and managed onsite. Drilling fluid would be recirculated and therefore any loss of fluid would adversely affect drilling operations and would be immediately apparent to the drilling rig operators via a loss in pressure and fluid ceasing to be pumped to the drill-head. Appropriate management measures would be implemented to ensure the drilling slurry is appropriately recycled and contained onsite such as through the use of holding tanks, or collected via vacuum trucks for offsite disposal as liquid waste. If required, excess drilling slurry could be managed through an appropriately constructed, lined and bunded turkey's nest. The liquid slurry could then be dried out onsite and be used for beneficial reuse on site, subject to appropriate treatment. Alternatively, the material can be classified in accordance with the Waste Classification Guidelines (EPA, 2014), and disposed of off-site. Any acid sulfate soils cannot be reused and must be disposed of after appropriate treatment with lime (refer **Section 6.3.2.2**).

The proposed HDD has been designed such that the entry and exit points of the drilling would be beyond the extents of mapped coastal wetlands, waterbodies, or generally located within highly disturbed areas, such as road reserve or cleared paddocks. Therefore, disturbance to wetlands, waterbodies and areas of remnant vegetation is not anticipated during the construction works. Drilling, if correctly applied, should have no impact on wetland vegetation, water quality or drainage patterns. The HDD bore plans (refer **Appendix B**), which were informed by the geotechnical investigation (RGS, 2023) and ground elevation survey, have been prepared by a specialist underbore consultant (Underbore Solutions, 2024). The risk of frac-outs has been considered, and will be minimised to the greatest extent possible, through design of the underbores and management measures employed during construction.

6.3.2.2 Acid Sulfate Soils

Both AASS and PASS may be encountered within the alluvial terrain in the southern portion of the proposal site during both excavation/trenching and HDD (underboring). When excavating/trenching, excavated material will be examined for properties that indicate the likely presence of potential or actual acid sulfate soil (e.g. saturation, blue-grey colouring, odour of hydrogen sulfide gas [strong smell of rotten eggs]). Any acid sulfate soil encountered will be managed in accordance with a site-specific acid sulfate soil management plan.

The HDD drilling contractor will be required to prepare a site-specific acid sulfate soil management plan for woks in the southern portion of the proposal, consistent with that presented in **Appendix D**.

6.3.2.3 Groundwater

It is likely that groundwater will be encountered during underboring and possibly trenching and excavation activities within the alluvial terrain in the southern portion of the proposal site. Depending on groundwater depth at the time of construction, dewatering may potentially be required during construction works, particularly if the construction is preceded by, or carried out during, periods of prolonged wet weather.

Where groundwater is encountered during the construction works, it would need to be managed so that it does not result in pollution, including sedimentation, of any local waterways. Groundwater devoid of sediment or contaminants would be disposed of in a way that does not cause erosion. If groundwater is encountered during the works, dewatering may be required, in which case water would be discharged over grassed or well vegetated areas away from waterways.

It is highly unlikely that dewatering in that excess of 3ML will be required. A water access licence exemption would therefore apply for an aquifer interference activity.

Underboring in the southern portion of the proposal has the potential to intercept groundwater. However, the nature of underbore construction methodology, which includes the use of bentonite, acting as a seal around borehole, and the drilling fluid pressure and recycling system involved, it is considered unlikely any significant interaction with, and dewatering of the local groundwater, will occur.. It is not expected that

subsequent installation of the cable would obstruct any surface or groundwater movement or alter hydrological processes by stopping or slowing the movement of groundwater. The proposal is not anticipated to contribute to a cumulative adverse impact on groundwater.

6.3.2.4 Flooding

With the exception of a small portion of the proposal route at the end of Reardons Road, in the vicinity of underbore 1, the proposal route is not affected by flooding. Given the proposed high voltage cables will be installed below ground no impact on flooding or local hydrological conditions are expected, as a result of the proposal.

6.3.3 ENVIRONMENTAL MITIGATION MEASURES

The following mitigation measures will be applied:

- Control measures will be implemented to manage risks associated with the handling of fuel through using spill trays when undertaking in field re-fuelling
- Disturbed areas will be managed in accordance with the requirements of the Blue Book to minimise potential impacts to waterways. Sediment fencing will be erected, where required, downslope of disturbed areas, and impacts would be minimised where practicable. The use of filter bags may be required to discharge collected sediment-laden water where there are insufficient grassed areas available
- All areas where ground disturbance has occurred would be progressively stabilised following completion of works.
- Any water collected in excavations and trenches during rainfall and surface water ingress should be pumped to a grassed area on-site (where a suitable area is available) to allow for infiltration, reused for dust suppression, or pumped to stormwater using a sediment sock. All options should be conducted in a manner that does not result in turbid water entering the stormwater system or nearby waterway.
- Weather conditions and forecasts will be monitored to minimise work undertaken during heavy rainfall and to allow demobilisation of plant and equipment from flood prone areas in which overland flooding is forecast
- A site specific erosion and sediment control plan and acid sulfate soil management plan will be included as part of the Construction Environmental Management Plan (CEMP).
- A drilling management plan / procedures would be developed as part of the CEMP that details measures to minimise risk of frac-outs, and management of drilling slurry. This would include, but not be limited to, the following:
  - HDD construction, including angles of entry and exit, depth and horizontal alignment to be undertaken consistent with the HDD bore plan (refer **Appendix B**), unless updated information or advice is provided by a competent underbore specialist to indicate otherwise.
  - The drilling process, pressures and return rates should be continually monitored, and a dedicated spotter deployed to inspect ground surface along the underbore route, to enable early identification of potential frac-outs
  - If a turkey's nest is required to manage drilling slurry on site, this is to be appropriately constructed, and lined to ensure no offsite discharge of sediment laden water
  - Any liquid waste generated will be disposed of at a facility capable of lawfully receiving liquid waste, or appropriately dried out and reused on site or assessed in accordance with a relevant waste order and exemption (does not apply to areas of known or potential ASS)
  - Underbore entry and exit areas will be restored to as close as possible to their original condition following completion of work.
- It is anticipated that 3ML or less of groundwater will be taken via an aquifer interference activity. As such a water access licence exemption applies.

6.3.4 CONCLUSION

The proposal is not anticipated to have any impact upon the water quality or hydrological conditions in the area. While disturbance to surface and subsoils will occur, potential impact to water quality can be adequately managed through the implementation of appropriate mitigation measures and therefore the overall impact is assessed to be low. Any impacts that might occur would be short-term and minor, and would occur during construction and maintenance. Given the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low.

6.4 Noise and Vibration

6.4.1 EXISTING ENVIRONMENT

The proposal site is located in a predominately rural environment. There are a number of rural and rural-residential residences located immediately adjacent to the northern portion of the proposal site along Cudgen, Plantation and Reardons Roads. Distance from the proposal site to receivers range from approximately 5 to 30m. There are fewer sensitive receivers located in close proximity to the proposal in the southern portion of the proposal site. Here distances to receivers are between approximately 130m and 140m away (refer **Figure 4**).

The main noise influences on the existing environment would be from agricultural activities and road traffic noise emanating from Cudgen, Plantation and Reardons Roads.

With the exception of intermittent noise from agricultural machinery and vehicles passing on nearby roads, the immediate surrounding landscape would be characterised as a low noise environment, with background noise levels expected to be between approximately 30 db(A) (night time) and 35 dB(A) (day time).

6.4.2 ASSESSMENT OF IMPACT

6.4.2.1 Noise during construction

The main sources of noise during the construction phase will be equipment needed for site works and the transportation and installation of electrical equipment. The following activities are likely to be the main sources of construction noise impacts:

- Site preparation
- Excavation and trenching
- Underboring
- Cable pulling and joining
- Set up and movement of construction vehicles and equipment
- Vehicles and trucks transporting construction materials to and from the site
- Alteration of traffic movements on surrounding roads.

Construction vehicles will use the local road network to access the proposal site.

Construction is expected to take between approximately six to 12 months to complete, dependent on weather. Noise levels would vary depending on the nature of the activities being undertaken. The use of several items of construction equipment simultaneously is only expected to occur intermittently, if at all. Works would progress along the northern portion of the proposal site and therefore noise would be transient along the alignment and not concentrated at the same location for an extended period of time. Although construction works would have a longer duration within the southern portion of the proposal site, any impacts are not anticipated to be significant due to the limited sensitive receivers in the immediate vicinity of proposed work.

Given the duration of the works, surrounding land use, the open landscape, the nature of existing traffic movements and relatively low intensity construction methods, it is anticipated that construction activities will not substantially affect the ambient noise in the area.

6.4.2.2 Vibration during construction

Construction equipment also has the potential to cause some vibration impacts, mainly along the northern portion of the proposal site where sensitive receivers are located within 5-30m. The vibration generated from construction works would vary depending on the level and type of activity carried out at each site during each activity. Potential vibration generated to receivers for the works would be dependent on separation distances, the intervening soil and rock strata and dominant frequencies of vibration.

Dominant vibration generating plant include:

- Underbore machines
- Excavator
- Compactor
- Truck movements along unsealed roads

In northern portion of the proposal site, there is the potential for the nearest sensitive receivers to be affected by the above listed construction plant. It is recommended that plant location takes into consideration distance from structures, where possible noting the highly constrained alignment. Residents should be informed of the construction schedule and the construction contractor should provide their details to respond to any enquiries during works.

6.4.2.3 Noise and vibration during operation

Once construction is complete, and the cables are energised, there is not expected to be any increase in operational noise or vibration from the perspective of any residential receiver.

6.4.3 ENVIRONMENTAL MITIGATION MEASURES

In considering the short term and transient nature of the work as it progresses along the proposed underground cable route, construction work that has the potential to create audible noise at the nearest sensitive receiver, will be between 7am and 6pm Monday to Saturday. On occasions works outside these hours may be undertaken where the following requirements are met:

- Neighbours (and other sensitive receivers) adjacent to the works or the local council or the NSW Environment Protection Authority (EPA) have been notified
- The works are justified on the basis that they are emergency works, or, because of supply security network outages or construction limitations, it is deemed that the works can only be achieved outside these hours, or, affected landowners have provided consent for the works to occur in exchange for a shorter construction timeframe.

All plant and equipment will be operated and maintained in accordance with the manufacturer's specifications. Any noise complaint will be investigated with additional control measures put in place if required.

6.4.4 CONCLUSION

The proposal will have acoustic and vibration impacts during construction. The acoustic and vibration impacts during the construction phase will be short term and moderate, whilst operational noise generated by the proposal will be negligible and unlikely to impact on the closest sensitive receivers.

Given the mitigation measures outlined in this assessment, the impacts can be effectively managed, and the overall environmental risk is considered to be low to moderate.

6.5 Flora and Fauna

AREA Environmental and Heritage Consultants (AREA) (2024) were engaged to undertake an ecological impact assessment for the proposal. The key findings of this assessment are presented below, with the full ecological impact assessment attached to this REF as **Appendix E**.

6.5.1 EXISTING ENVIRONMENT

6.5.1.1 Desktop Assessment

Landscape Context

The landscape lies amongst predominately rural development, large lot hobby farms and small patches of highly disturbed and modified coastal forest/vegetation types.

Cleared areas are dominated by exotic plant species of tree, shrub and grass.

Other environmental values include areas mapped as Vegetation Class - Coastal Freshwater Lagoons.

Cudgen Nature Reserve lies within 500m of the proposal site, and would not be directly, or indirectly impacted by this proposal.

IBRA Bioregion and Subregion

The Interim Biogeographic Regionalisation of Australia (IBRA), and IBRA subregion inform the identification of PCTs and habitat suitability for threatened species. The proposal site is located within the Burringbar-Conondale Ranges IBRA subregion of the South Eastern Queensland bioregion.

NSW Landscapes (Mitchell Landscapes)

NSW (Mitchell) Landscapes were developed for conservation planning and reserve establishment purposes to provide consistent state-wide ecological units finer than the existing bioregions and sub-regions. These landscapes have relatively homogeneous geomorphology, soils and broad vegetation types, and help to provide site context for the assessment area.

The proposal traverses two different Michell Landscapes:

- Lamington Volcanic Slopes, comprising the northern portion of the proposal
- Byron - Tweed Alluvial Plains, comprising the south portion of the proposal, generally from the end of Reardons Road to the connection point with previously installed underground cables.

The landscape descriptions and soil types of these two landscapes are provided in **Section 6.2.1**. **Table 6** provides a description of the typical vegetation encountered in each landscape, along with the estimated percentage cleared.

Table 6: Vegetation descriptions from NSW Mitchell Landscapes relative to the proposal site

NAME	DESCRIPTION	PERCENT CLEARED
Lamington Volcanic Slopes	Typical subtropical species include; white booyong (*Argyrodendron trifoliolatum*), red carabeen (*Geissois benthamii*), rose marara (*Pseudoweinmannia lanchnocarpa*), pigeonberry ash (*Cryptocarya erythroxylon*), myrtle ebony (*Diospyros pentamera*), incense cedar (*Anthocarapa sp.)* and emergent Moreton Bay fig (Ficus macrophylla), strangling fig (*Ficus watkinsiana*), giant stinging tree (*Dendrocnide excelsa*) and yellow carabeen (*Sloanea woollsii*). Drier sites and less fertile soils support forests of; Sydney blue gum (*Eucalyptus saligna*), brush box (*Lophostemon confertus*), broad-leaved apple (*Angophora subvelutina*), flooded gum (*Eucalyptus grandis*), turpentine (*Syncarpia glomulifera*), blackbutt (*Eucalyptus pilularis*) and coachwood (*Ceratopetalum apetalum*). On lower slopes; tallow wood (*Eucalyptys microcorys*) grey gum (*Eucalyptus punctata*), white mahogany (*Eucalyptus acmenoides*), manna gum (*Eucalyptus viminalis*) and forest oak (Allocasuarina torulosa).	57

NAME	DESCRIPTION	PERCENT CLEARED
Byron - Tweed Alluvial Plains	Most of the valley is cleared but contained subtropical closed forest with; white booyong (*Argyrodendron trifoliolatum*), red cedar (*Toona australis*), and retains many rare species such as; heart-leaved bosistoa (*Bosistoa selwynii*), velvet laurel (*Endiandra hayesii*), red-fruited ebony (*Diospyros mabacea*) and southern fontainea (*Fontainea australis*). Dry coastal hardwood forest on the terraces and slopes including; cabbage gum *(Eucalyptus amplifolia*), forest red gum *(Eucalyptus tereticornis*), broad-leaved apple (*Angophora subvelutina*), river oak (*Casuarina cunninghamiana*), silky oak (*Grevillea robusta*), rough-barked apple (*Angophora floribunda*), native teak (*Flindersia australis*), coastal grey box *(Eucalyptus bosistoana*), pink bloodwood (*Corymbia intermedia*), spotted gum *(Corymbia maculata*), grey ironbark *(Eucalyptus paniculata*), broad-leaved paperbark (*Melaleuca quinquenervia*), blackwood (*Acacia melanoxylon*) and black she-oak (*Casuarina litoralis*).	81

Waterways

Landscape features such as distance to water and land-use can greatly influence the ecology of an area and consequently the likelihood that protected matters are present.

No waterways in the assessment area were mapped in the Directory of Important Wetlands or as part of a Ramsar site.

With the exception of two farm dams, and a small section of mapped coastal wetland, the proposal does not cross any mapped waterways, however several unnamed waterways and Cudgen Creek occur within 500m (refer **Figure 21**).

The farm dams and mapped coastal wetland will be underbored.

Land use

The NSW Landuse 2017 map captures how land in the state is utilised across various sectors such as residential, commercial, agricultural, industrial, and conservation. The NSW State Land use maps several different land uses classes intersected by the proposal, including but not limited to grazing modified pastures, cropping plantation forests, residential and farm infrastructure, transport and communication and nature conservation. Refer **Section 6.14** for a full list of land uses intersected by the proposal.

Climate

The climate of the far north coast region of NSW is relatively mild, changing slightly with the seasons. **Table 7** presents the long-term climate statistics for Coolangatta, collected from Bureau of Meteorology (BoM).

Table 7: Climate statistics for Coolangatta

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
Mean Max (°C)	28.5	28.4	27.4	25.6	23.2	21.1	20.7	21.7	23.4	24.7	26.1	27.5	24.9
Mean Min (°C)	21.0	20.9	19.9	17.0	13.9	11.3	10.1	10.6	13.4	16.0	18.0	19.8	16.0
Mean Rain (mm)	161.6	195.0	199.4	155.4	130.8	125.8	73.7	56.1	42.6	93.0	115.3	155.9	1503.1
Mean Rain Days	10.8	12.3	13.3	11.2	10.2	7.8	6.0	5.0	4.8	7.5	8.8	10.2	107.9

Recent rainfall data collected at Kingscliff (Woram Place) in the months and days prior to the ecological field assessment shows average rainfall during April and May with 237.0 millimetres (mm) and 248.2mm, respectively. June received below average rainfall with only 19.1mm recorded. In the nine days prior to the field assessment, 144.6mm of rain fell. Areas which hold water and therefore would provide frog breeding habitat during times of rainfall would have been inundated at the time of the assessment. However no such areas were noted to occur along the southern section of the proposal site that would be subject to surface disturbance.

Ecological Context

Predicted species

A review of the Burringbar-Conondale subregion found a total of 93 listed species predicted to occur. A combined list of IBRA and EPBC listed threatened species is found in Appendix C of the ecological impact assessment (attached to this REF as **Appendix E**).

BioNet species records

BioNet is a biodiversity database and mapping system used in NSW. It serves as a comprehensive repository of biodiversity information, including data on species occurrence, habitats, ecosystems, and conservation status.

Seventeen threatened species have previously been recorded within 500m of the proposal site (**Table 8, Figure 24**) More substantial populations of Mitchell's Rainforest Snail and Wallum Froglet occur within 1,500m and beyond (**Figure 25**).

Table 8: NSW Bionet threatened species recorded within a 500m buffer of the proposal

CLASS	SCIENTIFIC NAME	COMMON NAME	BC ACT STATUS	EPBC ACT STATUS	RECORDS WITHIN 500m
Amphibia	*Crinia tinnula*	Wallum Froglet	Vulnerable	Not listed	11
Aves	*Ardenna tenuirostris*	Short-tailed Shearwater	Not listed	C, J, R*	2
Aves	*Burhinus grallarius*	Bush Stone-curlew	Endangered	Not listed	7
Aves	*Calyptorhynchus lathami lathami*	South-eastern Glossy Black-Cockatoo	Vulnerable	Vulnerable	6
Aves	*Circus assimilis*	Spotted Harrier	Vulnerable	Not listed	1
Aves	*Hirundapus caudacutus*	White-throated Needletail	Vulnerable	Vulnerable C, J, R	1
Aves	*Hydroprogne caspia*	Caspian Tern	Not listed	JAMBA	1
Aves	*Pandion cristatus*	Eastern Osprey	Vulnerable	Not listed	1
Aves	*Tyto longimembris*	Eastern Grass Owl	Vulnerable	Not listed	2
Flora	*Desmodium acanthocladum*	Thorny Pea	Vulnerable	Vulnerable	9
Flora	*Lindsaea fraseri*	Fraser's Screw Fern	Endangered	Not listed	1
Mammalia	*Cercartetus nanus*	Eastern Pygmy-possum	Vulnerable	Not listed	9
Mammalia	*Miniopterus australis*	Little Bent-winged Bat	Vulnerable	Not listed	2
Mammalia	*Petaurus norfolcensis*	Squirrel Glider	Vulnerable	Not listed	6
Mammalia	*Phascolarctos cinereus*	Koala	Endangered	Endangered	6
Mammalia	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	Vulnerable	Not listed	1
Mammalia	*Scoteanax rueppellii*	Greater Broad-nosed Bat	Vulnerable	Not listed	3
				Total	**137**

Notes:

C – China-Australia Migratory Bird Agreement (CAMBA) (EPBC Act)
J – Japan-Australia Migratory Bird Agreement (JAMBA) (EPBC Act)
K – Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) (EPBC Act)

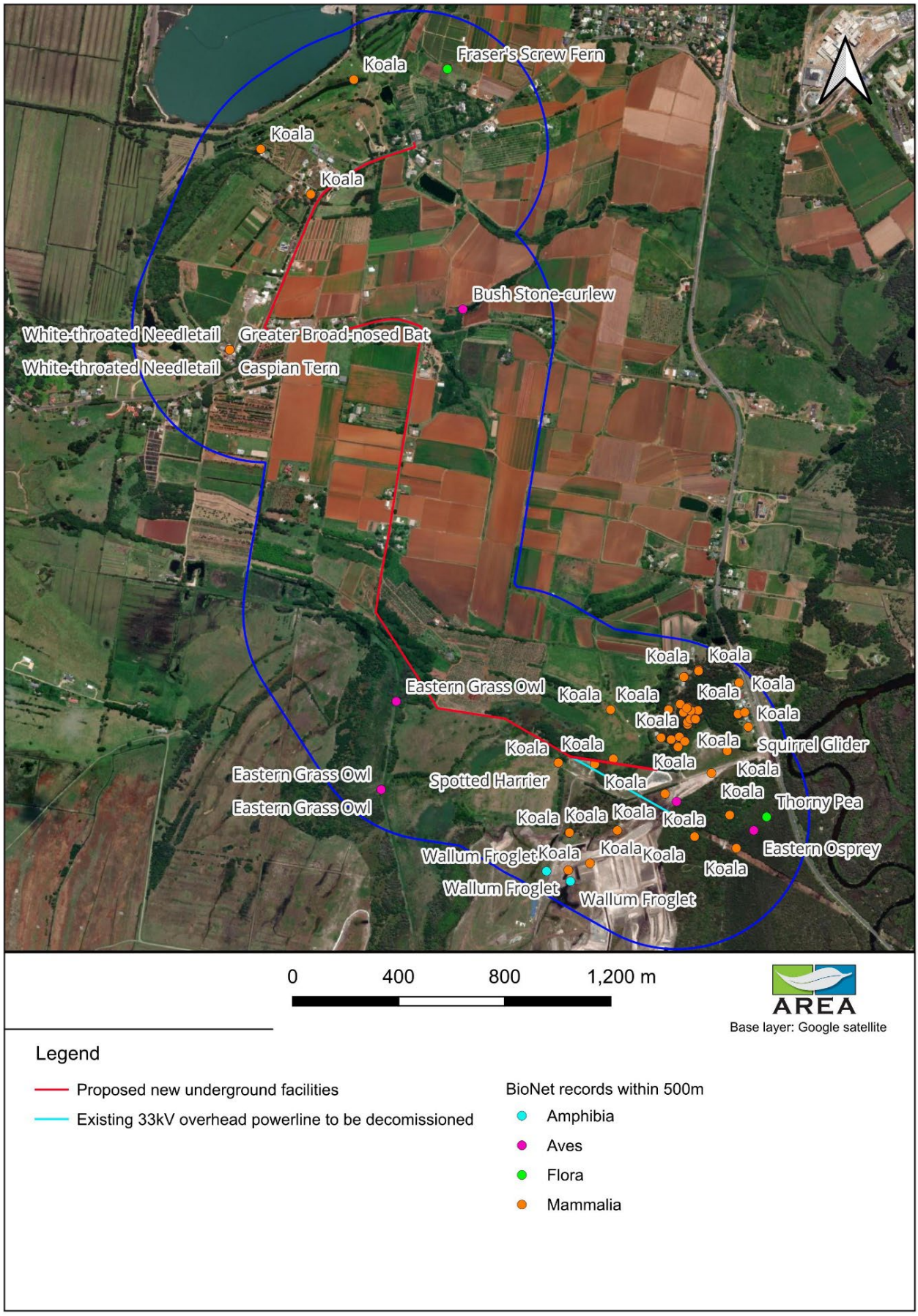


Figure 24: BioNet records within 500m of the proposal

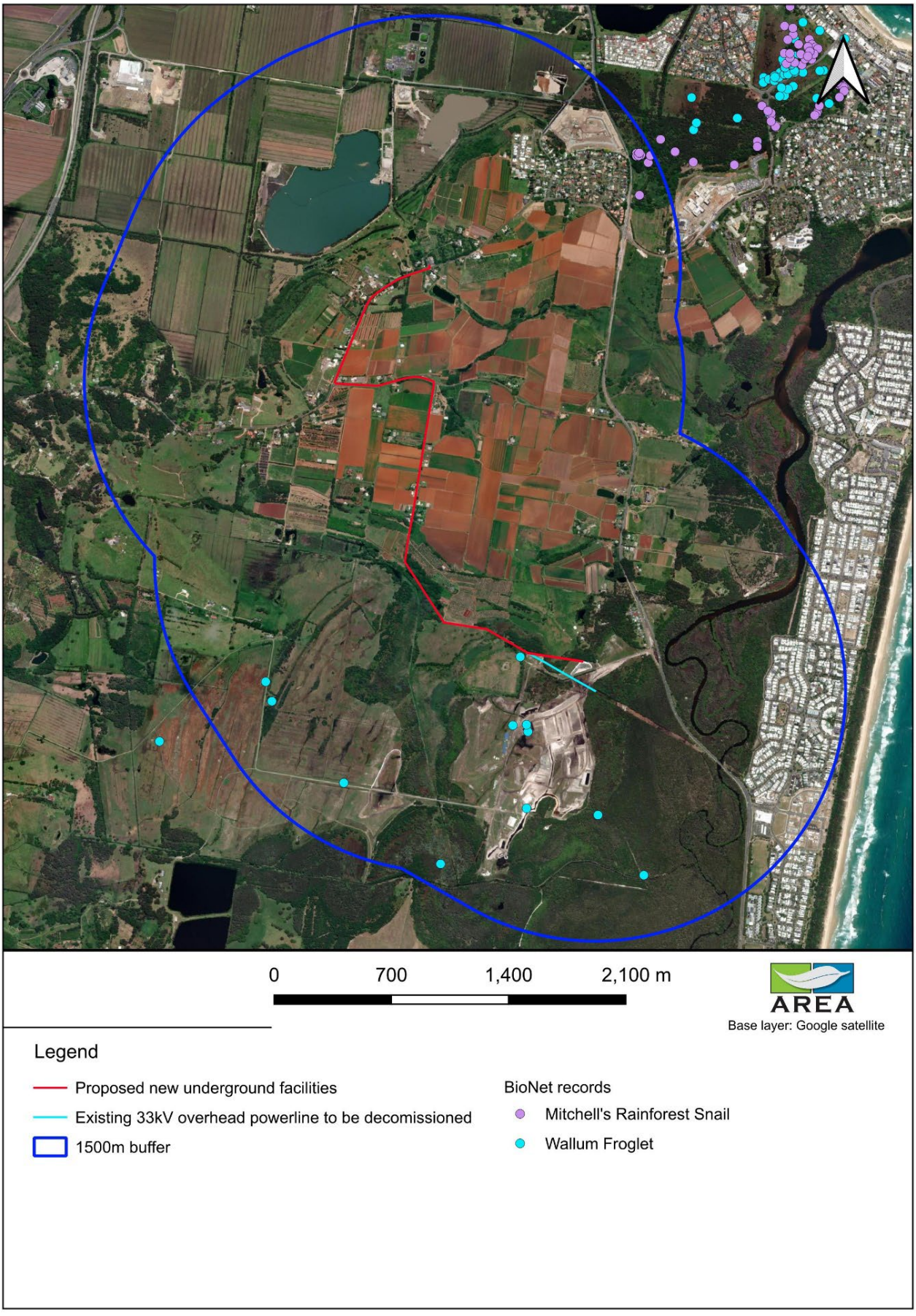


Figure 25: BioNet records Mitchell's Rainforest Snail and Wallum Froglet records in broader study area

Plant Community Types

Plant Community Types taken from the NSW State Vegetation Type Map (STVM) with a 500-metre buffer applied, were used during the desktop assessment to understand the range of PCTs with potential to occur within the proposal site. Seventeen PCTs, excluding not native vegetation (identified as 'Not classified'), are mapped within 500m of the proposal (refer **Table 9** and **Figure 26**).

Table 9: PCTS within 500m of the proposal on the STVM

PCT ID	PCT NAME	VEGETATION FORM	VEGETATION CLASS
0	Not classified	Not classified	Not classified
3004	Far North Bangalow Palm Swamp Forest	Rainforests	Subtropical Rainforests
3011	Far North Lowland Subtropical Rainforest	Rainforests	Subtropical Rainforests
3147	Far North Brush Box-Bloodwood Wet Forest	Wet Sclerophyll Forests (Shrubby sub-formation)	North Coast Wet Sclerophyll Forests
3148	Far North Brush Box-Walnut Wet Forest	Wet Sclerophyll Forests (Shrubby sub-formation)	North Coast Wet Sclerophyll Forests
3232	Far North Coastal Hills Blackbutt-Ironbark Forest	Wet Sclerophyll Forests (Grassy sub-formation)	Northern Hinterland Wet Sclerophyll Forests
3548	Far North Sands Scribbly Gum Heathy Forest	Dry Sclerophyll Forests (Shrubby sub-formation)	Coastal Dune Dry Sclerophyll Forests
3788	Coastal Foredune Wattle Scrub	Heathlands	Coastal Headland Heaths
3801	Far North Sandplain Wallum Heath	Heathlands	Wallum Sand Heaths
3913	Northern Sandplain Wet Heath	Freshwater Wetlands	Coastal Heath Swamps
3961	Coast Sands Lepironia Sedgeland	Freshwater Wetlands	Coastal Freshwater Lagoons
3989	Far North Paperbark Fern Swamp Forest	Forested Wetlands	Coastal Swamp Forests
3990	Far North Paperbark Gahnia Swamp Forest	Forested Wetlands	Coastal Swamp Forests
3991	Far North Sands Swamp Turpentine-Paperbark Forest	Forested Wetlands	Coastal Swamp Forests
4004	Northern Melaleuca quinquenervia Swamp Forest	Forested Wetlands	Coastal Swamp Forests
4008	Northern Sands Swamp Mahogany Shrubby Rush Forest	Forested Wetlands	Coastal Swamp Forests
4026	Estuarine Sea Rush Swamp Oak Forest	Forested Wetlands	Coastal Floodplain Wetlands
4140	Far North Mangrove Forest	Saline Wetlands	Mangrove Swamps

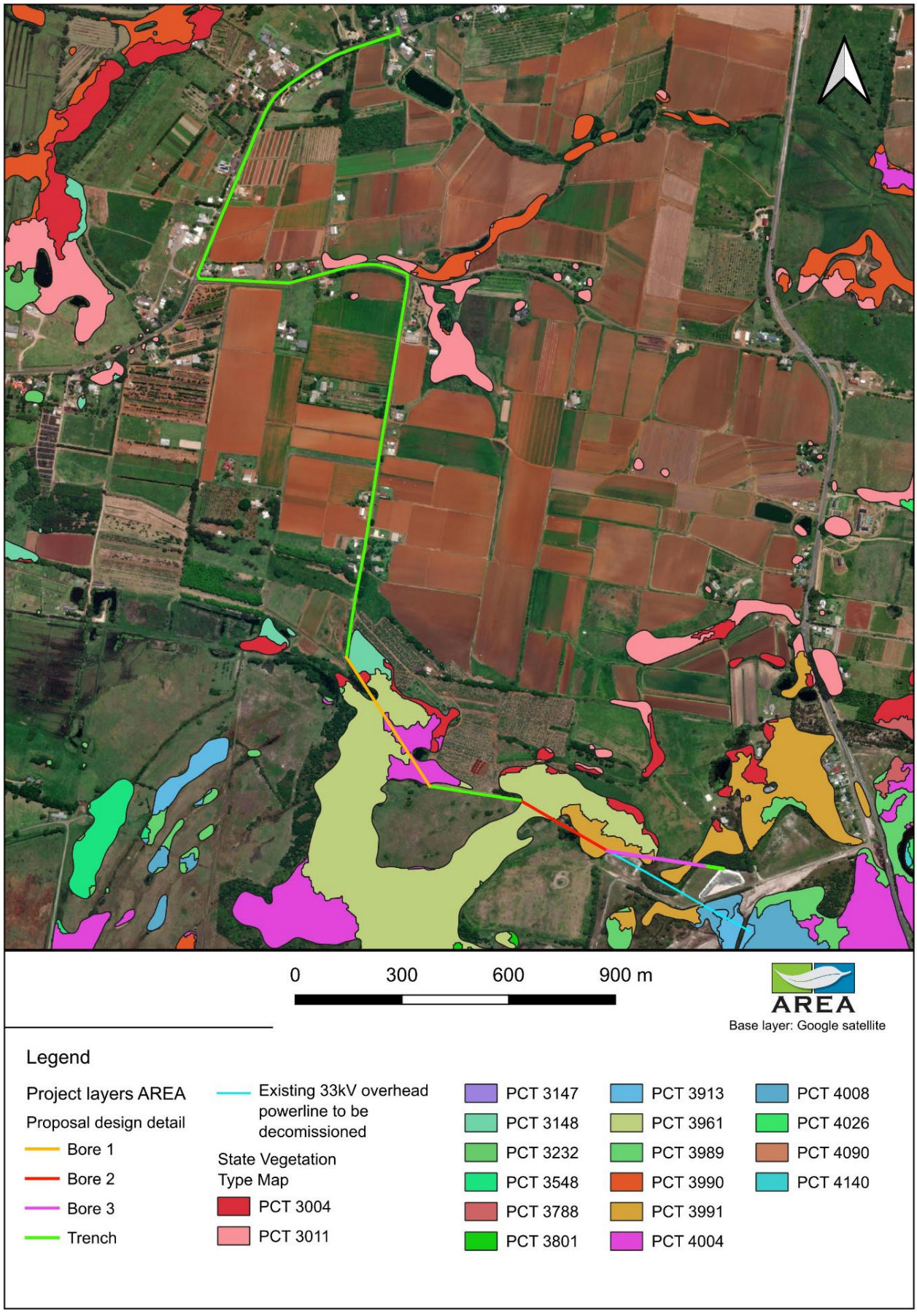


Figure 26: NSW State Vegetation Type Mapping

Threatened Ecological Communities

IBRA and MNES database searches identified 11 Threatened Ecological Communities (NSW listed) and Ecological Communities (Commonwealth listed) as potentially occurring in the proposal site.

NSW database searches predicted eleven Threatened Ecological Communities (TECs), all listed as Endangered under the BC Act, likely to occur in the NSW South Eastern Queensland Bioregion – Burringbar – Conondale Ranges IBRA subregion, which are listed below. Refer Appendix B of ecological impact assessment (attached to this REF as **Appendix E**).

- Byron Bay Dwarf Graminoid Clay Heath Community
- Coastal Cypress Pine Forest in the New South Wales North Coast Bioregion
- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions
- Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion
- Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner bioregions.

Five TECs listed under the EPBC Act were predicted in the EPBC Act Protected Matters Report (refer Appendix B of the ecological impact assessment, attached to this REF as **Appendix E**) and are listed below:

- Threatened Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community - Endangered
- Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland - Endangered
- Lowland Rainforest of Subtropical Australia - Critically Endangered
- Subtropical and Temperate Coastal Saltmarsh - Vulnerable
- Subtropical eucalypt floodplain forest and woodland of the New South Wales North Coast and South East Queensland bioregions – Endangered.

The presence of these predicted TECs is considered further in the context of data collected during the field survey.

Areas of Outstanding Biodiversity Value

No Areas of Outstanding Biodiversity Value (AOBV) are located within the proposal site .

An AOBV associated with the Mitchell's Rainforest Snail occurs approximately 3.5km west of the proposal site in the Stotts Island Nature Reserve. While this AOBV would not be impacted by this proposal, the associated species (Mitchell's Rainforest Snail) has also been recorded within 1500m of the proposal site to the northeast in remnant forest. Impact to Mitchell's Rainforest Snail has been considered under a test of significance later in this report. Refer Appendix D of the ecological impact assessment (attached to this REF as **Appendix E**).

Biodiversity Values Map

The Biodiversity Values (BV) Map and Threshold Tool identifies land with high biodiversity value, particularly land sensitive to impacts from development and clearing. This database is not relevant for assessments under Part 5 of the EP&A Act, however for such assessments it can provide guidance to the assessor about the importance of habitat and the likelihood of presence of protected matters.

A small section of the proposed proposal site intersects with land mapped on the NSW Biodiversity Values Map (refer **Figure 27**). The BVM at this point reflects the presence of the coastal wetlands, which are similarly mapped on the STVM (**Figure 26**).

In this section, the construction methodology is underboring. This construction method seeks to avoid direct and indirect impact on the water quality and hydrological processes associated with wetland values, particularly those seen and experienced at the surface by threatened species and ecological communities.

Standard and project specific safeguards would be employed during construction to ensure inadvertent impact to water quality, water bodies and hydrological processes does not occur, and any incidents are managed effectively and swiftly.

Potential of impact to wetland areas, hydrological processes and aquatic values are discussed further in **Section 6.5.2**.

Key Fish Habitat

Key Fish Habitat (KFH) in NSW refers to critical aquatic environments that support the lifecycle of fish species, including spawning, nursery, feeding, and migration habitats. These habitats are essential for maintaining healthy fish populations and the overall integrity of aquatic ecosystems.

According to the NSW Key Fish Habitat map the proposed cable route is situated within close proximity to KFH at one location in the northern portion of the proposal site (refer **Figure 27**). However, site inspections confirmed that there is a lack of suitable habitat required to correspond with the mapping. Nonetheless, direct impacts to the mapped areas of KFH will be avoided.

Groundwater dependant ecosystems

Groundwater Dependent Ecosystems (GDEs) in NSW refer to ecosystems that rely on groundwater to support their structure, function, or ecological processes. These ecosystems can include various habitats such as wetlands, springs, streams, and riparian zones.

The Bureau of Meteorology (BoM 2019) Atlas of Groundwater Dependant Ecosystems mapping was checked for Groundwater Dependent Ecosystems (GDEs). Desktop results are provided in Appendix B of the ecological impact assessment (attached to this REF as **Appendix E**).

The proposed work does not intersect with any areas mapped as having potential aquatic or terrestrial GDEs.

EPBC Protected Matters

An EPBC Protected Matter Report generated for this proposal considered environmental matters within a 500m buffer of the proposal. This report is provided in Appendix B of the ecological impact assessment (attached to this REF as **Appendix E**) and summarised in **Table 10**.

Potential impacts to species and communities highlighted are considered in the following sections of this report.

EPBC Referral 2012/6328

On 21 May 2015 the Commonwealth Department of Environment approved (with conditions) the Kings Forest residential development (EPBC 2012/6328). The conditions to the approval were last varied on 25 May 2021. The Commonwealth approval is confined to the mitigation of impacts of the Kings Forest residential development on the Koala and Wallum Sedge Frog, both of which are listed threatened species under the EPBC Act.

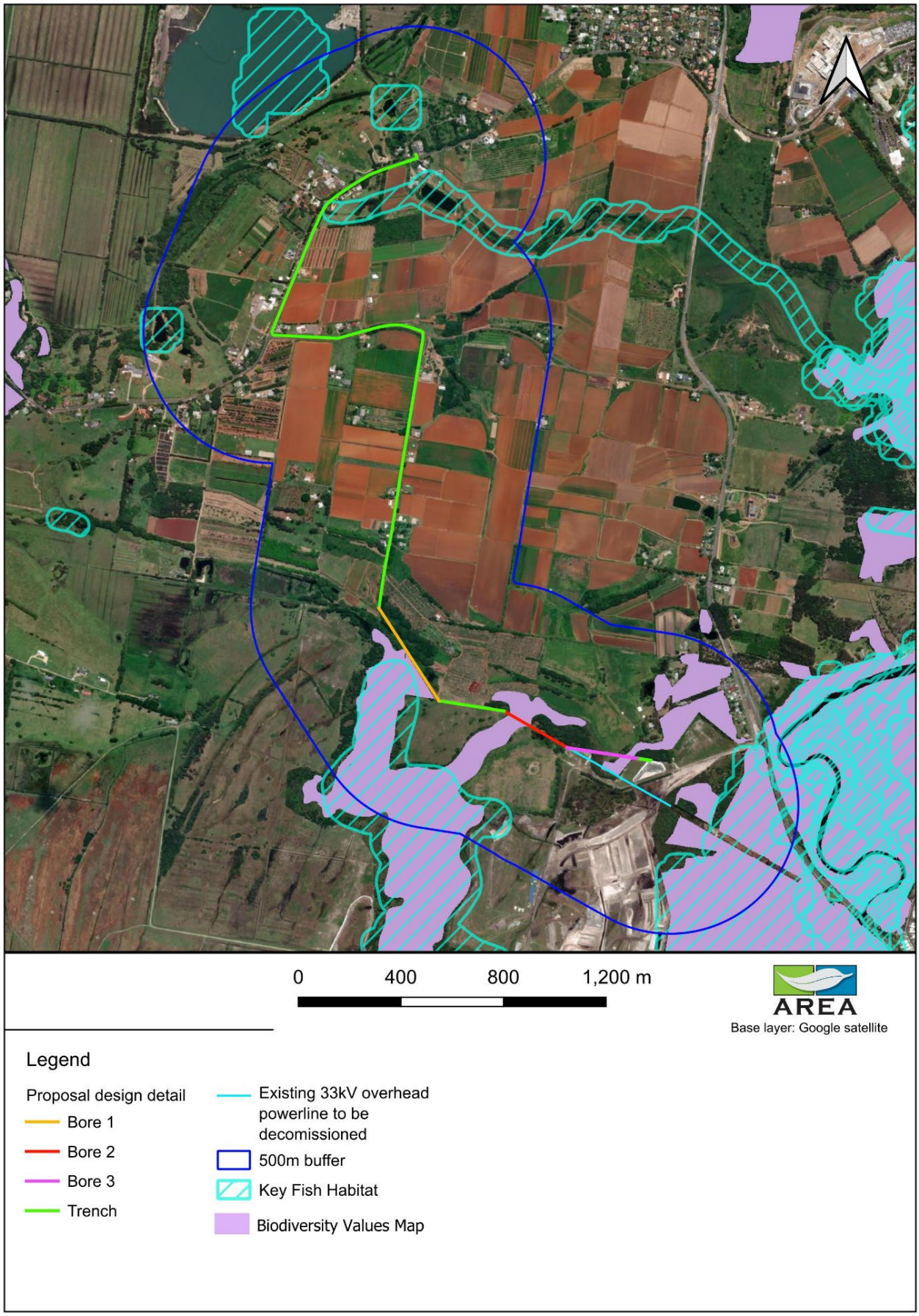


Figure 27: Biodiversity Values Map and Key Fish Habitat

Table 10: EPBC Protected Matters Report summary

MNES	RESULT	RELEVANCE TO THIS ASSESSMENT
World Heritage Properties	None	None
National Heritage Places	None	None
Wetlands of International Importance	None	None
Great Barrier Reef Marine Park	None	None
Commonwealth Marine Area	None	None
Listed Threatened Ecological Communities	5	**Section 6.5.2** and **Section 6.5.3**
Listed Threatened Species	103	**Section 6.5.2** and **Section 6.5.3**
Listed Migratory Species	60	**Section 6.5.2**
Commonwealth Land	None	None
Commonwealth Heritage Places	None	None
Listed Marine Species	91	All birds, considered as Migratory Species, **Section 6.5.2**
Whales and Other Cetaceans	12	None
Critical Habitats	None	None
Commonwealth Reserves Terrestrial	None	None
Australian Marine Parks	None	None
Habitat Critical to the survival of Marine Turtles	None	None
State and Territory Reserves	1	Cudgen Nature Reserve – not within the proposal site, however, is within 500m to the southeast of the proposal site.
Regional Forest Agreements	1	None - North East NSW RFA – proposal site is mapped as freehold land.
Nationally Important Wetlands	1	Cudgen Nature Reserve – not within the proposal site, however, is within 500m to the southeast of the proposal site.
EPBC Act Referrals	10	All either post-approval or completed. Includes the nearby Kings Forest Residential Development Kingscliff, NSW (EPBC 2012/6328).
Key Ecological Features (Marine)	None	None
Biologically Important Areas	5	None – all are whale, shark, turtle and dolphin habitat which does not occur in or within 500m of the proposal site.
Bioregional Assessments	None	None
Geological and Bioregional Assessments	None	None

Previous Reports / Management Plans

This assessment is prepared with consideration of the management plans for Koala and Wallum Sedge Frog prepared for the Kings Forest residential development. These management plans and the consistency of this proposal with those plans are discussed below.

Kings Forest Koala Plan of Management (KPoM) (JWA 2019)

The Kings Forest KPoM was prepared as two volumes. Volume 1 is most relevant for consideration in this report as it presents the specific threatening processes, management actions and reporting protocol as the pertain to the Kings Forest residential development.

Many of the threats and actions within Volume 1 of the KPoM are not applicable to this proposal as they are targeting management of impact to large areas of vegetation within which Koalas are known to occur, where Koala food/ use trees would be impacted or where revegetation of Koala habitat is proposed.

This report and this proposal seek to consider the directions under the KPoM as they are relevant to this proposal. These directions include:

- Field assessment for this proposal confirmed no Koala use trees listed in the Koala (Phascolarctos cinereus) Biodiversity Assessment Method Survey Guide, or the NSW Government document '*A review of koala tree use across New South Wales*' would be impacted by this proposal. It should be noted that these species do occur in vegetation adjacent to the proposal site, and hence the presence of Koalas resting or moving through vegetation in the proposal site should be considered during implementation of this proposal.
- Reporting any sighting of, or incident involving a Koala, in or around the proposal work area to the Biodiversity Conservation and Science Directorate, the Tweed Shire Council and Friends of the Koala.
- Contact Friends of the Koala in the even of injury to wildlife other than Koala.
- Ensuring vehicle movements do not exceed 50km per hour to minimise the risk of vehicle strike.
- No domestic dogs are to be brought onto the site during pre-construction and construction activities.

Kings Forest Wallum Sedge Frog Management Plan (WSFMP) (JWA 2020)

The WSFMP was developed to meet State and Commonwealth conditions of consent for the Kings Forest residential development. For this species, it supersedes the Threatened Species Management Plan which was prepared at an earlier stage of the approval process. Broadly, the WSFMP directs actions which minimise impact to the habitat values for this species and treats to the species and its habitat.

Records of the Wallum Sedge Frog were identified within the boundary of the Kings Forest residential development area. This proposal runs approximately along the northern edge of the boundary of the Kings Forest residential development area, and further north across basalt derived soils which do not provide habitat for this species.

The WSFMP maps areas of potential habitat (Figure 12 in the WSFMP). The closest mapped habitat to this proposal includes:

- Breeding habitat mapping in small pool areas south of this proposal, and which would not be directly or indirectly impacted by this proposal.
- Foraging habitat mapping intersects with the proposal site only in the section which involves removal of existing powerlines. This activity would not include ground disturbance activities and would not change any hydrological processes on this land, or adjacent land.
- Potential habitat mapping. The very edge of this mapped area would be underbored by this proposal.

Kings Forest Threatened Species Management Plans (JWA 2011)

The Kings Forest Threatened Species Management Plans (KFTSMPs) provide specific management action of specific species.

All species considered in the KFTSMPs were also considered in this report. **Table 11** indicates which species were considered not likely to occur in the proposal site, and which were considered to have potential to use the habitat values in the proposal site and were therefore assessed with a test of significance under the relevant Act/s.

Table 11: Species considered in Kings Forest Threatened Species Management Plans

CONSIDERED NOT LIKELY TO OCCUR IN THE PROPOSAL SITE	CONSIDERED UNDER TESTS OF SIGNIFICANCE UNDER THE RELEVANT ACTS
BIRDS	**BIRDS**
Black Bittern	Grass Owl
Glossy Black Cockatoo	Masked Owl
Black-neck Stork	Bush Stone Curlew
Rose-crowned Fruit Dove	**MAMMALS**
Pale-vented Bush Hen	Grey-headed Flying Fox
PLANT	Koala
Square-stemmed Spike Rush	Yellow-bellied Sheath-tailed Bat
Green-leaved Rose Walnut	Common Planigale
Southern Swamp Orchid	Microchiroptera Bats
Stinking Cryptocharia	**AMPHIBIAN**
White Lace Flower	Wallum Froglet
White Yiel Yiel	Wallum Sedge Frog

6.5.1.2 Field Survey

AREA ecologists conducted the field survey on 10 July 2024.

Vegetation Communities

Field survey confirmed the proposal site occurs across two broad soil types which influences the vegetation community which occur, and the species which occupy them. This soil type change generally occurs around an elevation of 10m. This change occurs at the southern end of Reardons Road. The higher elevations in the northern section of the proposal are loam soils derived from basalt, while the lower elevations in the southern section are sandy soils. This change in landscape is also reflected in the NSW (Mitchell) landscape mapping.

Plant Community Types (PCTs)

Very little wooded vegetation occurs in the proposal site. Where PCTs are described in the proposal site in the following sections, it is largely previously cleared land supporting groundcover species only, or with bracken fern and small shrub regrowth. This distinction is most important in the southern sections of the proposal, where the only substantial impact to the limited area of wooded vegetation would occur where edge vegetation would be cleared to allow manoeuvring of the direct drilling machinery, or where access is required to install a new UGOH pole or removal of existing infrastructure. No impact to vegetation within mapped coastal wetland would occur.

PCT mapping from the desktop search was corrected by a field survey in the proposal site based on observations of mid, upper and ground stratum species, and landform and soils. Planted vegetation was not consistent with a PCT.

Three PCTs excluding PCT 0 (not native vegetation) and small patches of planted garden vegetation were determined to occur along sections of the proposal site that would be impacted by surface disturbance:

- PCT 3004 - Far North Bangalow Palm Swamp Forest – 0.03 hectares
- PCT 3988 - Far North Mesophyll Paperbark Swamp Forest – 0.03 hectares
- PCT 4004 - Northern Melaleuca quinquenervia Swamp Forest – 0.17 hectares

Planted vegetation occupies 0.03 hectares and non native vegetation occupies 1.39 hectares.

Representative photos of the PCT are provided in **Table 12** and mapped in **Figure 28**.

The proposal also intersects with PCT 3961 – Coastal Freshwater Wetlands, as mapped by NSW SVTM, **Figure 26** and **29**, however no surface disturbance will occur to this PCT due to the proposed underbore methodology.

Threatened Ecological Communities (TECs)

Of the TECs highlighted by database searches, five are associated with the PCTs determined to be present in the assessment area. The remaining TECs were determined not to be present on this basis, but were also unlikely to be present as key species were not recorded, or soil and landscape features were inconsistent within the proposal site.

Two TECs were determined to be present based on TEC descriptions (including community composition and condition).

Table13 provides an assessment of each associated TEC and whether they are present in the proposal site.

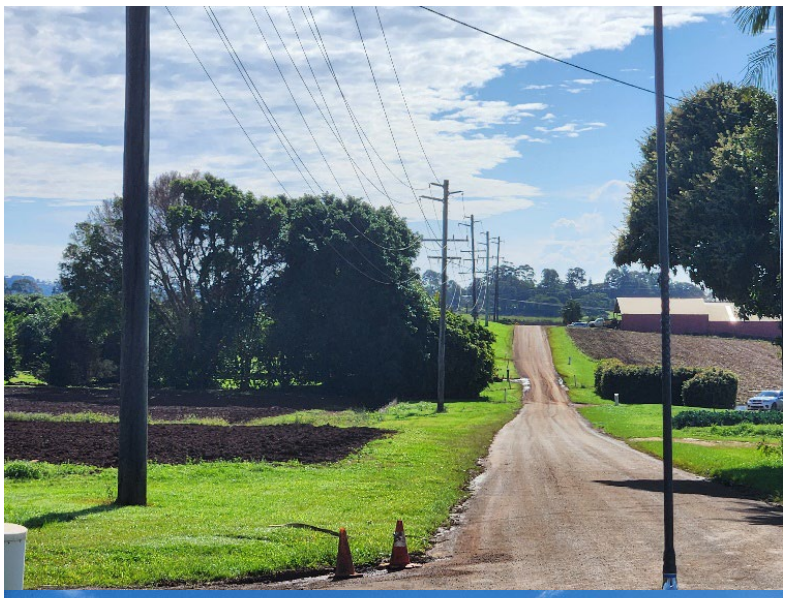
Note the three BC Act listed communities refer to being present in the NSW North Coast bioregion, however, do not identify the South Eastern Queensland bioregion in which this proposal would occur. Review of the supporting documents for each of these communities confirms that the scientific determination for these communities does intend to include the section of the NSW north coast area which occurs in the South Eastern Queensland bioregion, and extends to the border.

TECs confirmed to be present within the proposal site have been considered under the relevant test of significance in Appendix D of the ecological impact assessment (attached to this REF as **Appendix E**).

Table 12: Plant Community Types recorded in the assessment area

PCT ID NAME	REPRESENTATIVE PHOTO	COMMENTS
3004 Far North Bangalow Palm Swamp Forest		This PCT patch was in moderate condition, with much of the canopy dominated by Camphor Laurel Some native understory species were present, with *Macaranga tanarius*.

PCT ID NAME	REPRESENTATIVE PHOTO	COMMENTS
3988 Far North Mesophyll Paperbark Swamp Forest		This PCT is in a historically cleared area, with some impact occurring in areas of shrubby/ young regrowth.
4004 Northern Melaleuca quinquenervia Swamp Forest	 	This PCT is mapped in an area which has been historically cleared and is in two condition states. (see photo on the following page)

PCT ID NAME	REPRESENTATIVE PHOTO	COMMENTS
Planted vegetation		Planted vegetation is associated with private house gardens
Not native vegetation	 	Not native vegetation includes manicured lawns and patches of weeds.

PCT ID NAME	REPRESENTATIVE PHOTO	COMMENTS
Vegetation beneath existing section of overhead powerline to be decommissioned and removed.	 	Mostly weedy under the existing powerline. Impact to vegetation would be minimal or avoided, and no additional ground disturbance would occur.

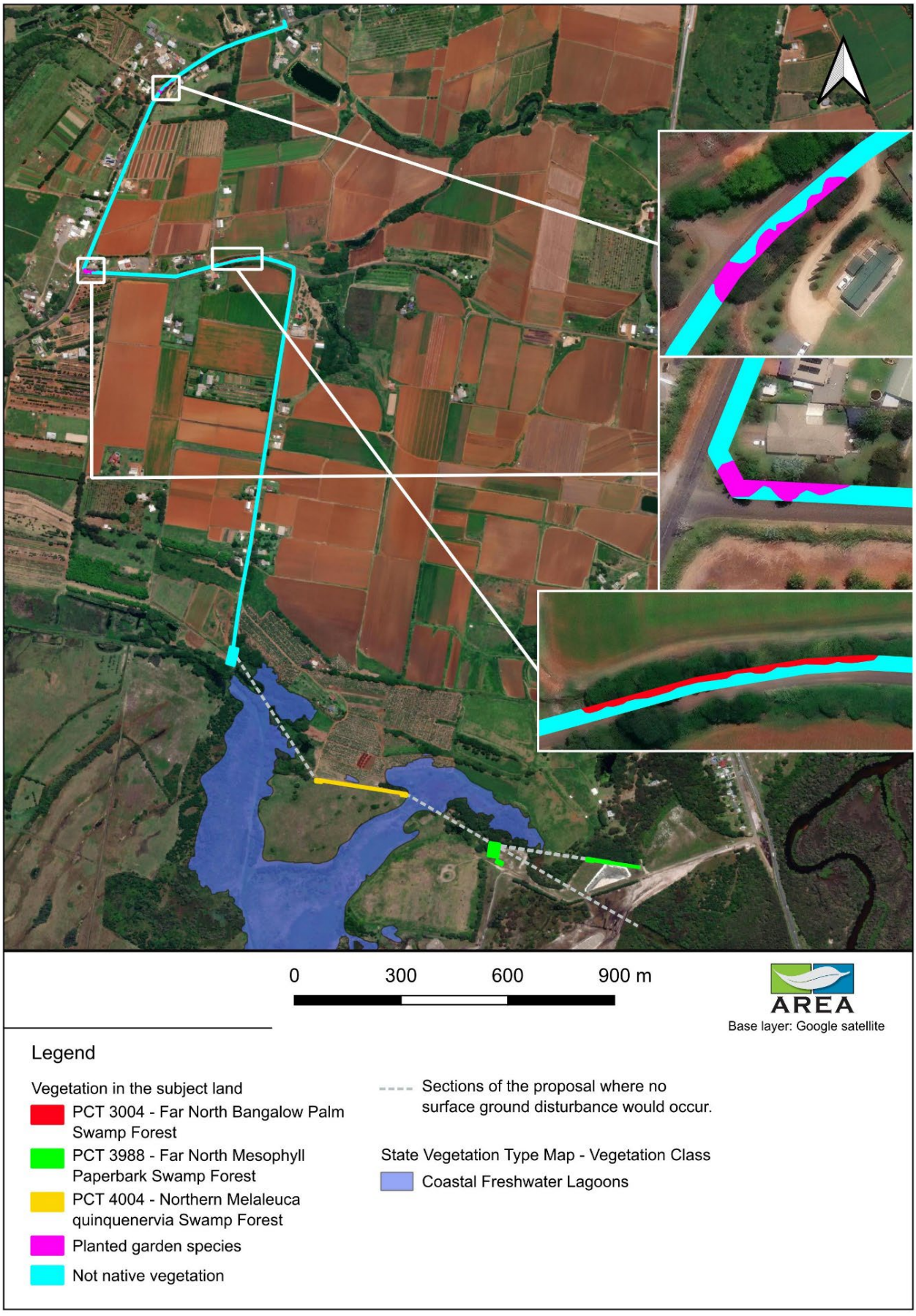


Figure 28: PCTs mapped in the field

Table 13: TEC assessment table

SCIENTIFIC NAME	NSW STATUS	CTH STATUS	ASSOCIATED PCT WITHIN PROPOSAL SITE	PRESENT/NOT PRESENT JUSTIFICATION
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	Endangered	Not listed	3004	**Likely to be present. Condition of the community is not considered a reason to discount the community. Species listed as characteristic species of this community are present in or adjacent sections of the gully to the east. Location, soil and landscape requirements for this TEC are present in the proposal site.**
Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion	Endangered	Not listed	3004	Not present - the small patch of PCT3004 is not located on a floodplain, and, at an elevation of 30m AHD is out of the Design Flood Depth areas of the Tweed Shire Council[1].
Lowland Rainforest of Subtropical Australia	Not listed	Critically Endangered	3004	Not present - the small patch of PCT3004 in the proposal site does not meet the Commonwealth condition requirements. Namely: The canopy and total vegetation cover is dominated by Camphor Laurel, the patch size is less than 1ha, and the diversity of native woody species is likely to be less than 30[2].
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	Not listed	3988 4004	**Likely to be present. Condition of the community is not considered a reason to discount the community. Species listed as characteristic species of this community are present in or adjacent to the proposal site. Location, soil and landscape requirements for this TEC are present in the proposal site.**
Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland	Not listed	Endangered	4004	Unlikely While the vegetation within the area mapped as PCT4004 meets many of the condition requirements, especially where the ground stratum is dominated by bracken as opposed to exotic grasses such as setaria sp., it is lacking a canopy layer due to historic clearing. Key diagnostics for this TEC include a requirement for a minimum crown cover of 10%.

1. https://experience.arcgis.com/experience/f997fac07a2c45ac9f7f2b89f038be8b
2. https://www.environment.gov.au/biodiversity/threatened/communities/pubs/101-listing-advice.pdf

Terrestrial Habitat

AREA ecologists assessed habitat suitability, concentrating on the extent to which endangered species habitat requirements occur within the proposal site. The study identified the following key habitat characteristics in the proposal site:

- Native vegetation within the proposal site is predominantly historically cleared land, which is now occupied by maintained urban lawns/ roadsides or young re-growing forest communities.
- Weeds are prevalent within and surrounding the proposal site. These provide minor habitat value within the proposal site.
- Planted vegetation occurs within the proposal site associated with domestic maintained gardens and shrubby property boundary planting. This vegetation is native and exotic and may contribute to shelter and nesting habitat for some bird species.
- No notable rocky habitat, caves, or cliffs occur within the proposal site.
- No tree hollows occur in the proposal site.
- No significant log/ coarse woody habitat is present in the proposal site; however, it is likely to occur in adjacent patches of vegetation.
- Leaf litter occurs in small patches within the proposal site. Most notably associated with a patch of PCT 3004 - Far North Bangalow Palm Swamp Forest. Leaf litter elsewhere is of low density, meaning it does not provide a moist leaf litter forest floor within the proposal site.

Aquatic habitat

Aquatic habitats can be described in many ways including:

- the natural materials that comprise the habitat (e.g. rocks, coral, gravel, sand and mud),
- the type of vegetation present (e.g. macrophytes, snags, seaweeds, seagrasses, mangroves and saltmarsh),
- the shape and nature of the habitat (e.g. pools and riffles, billabongs, reefs), or
- the overall ecosystem (e.g. wetlands, floodplains, streams, estuaries, lakes, beaches)

The proposal site intersects areas of mapped aquatic habitat, including as wetland habitat (refer **Figures 27** and **29**). The proposal has been designed to avoid impact to waterways and aquatic habitat values by electing to use underbore construction techniques where wetlands, or aquatic habitat values occur.

No waterways or aquatic communities occur within the proposal site (where surface ground disturbance would occur).

No habitat suitable for FM Act listed species occurs in the proposal site.

Ecological survey of land within the mapped wetland areas did not occur as part of this assessment, however these areas were assumed to provide suitable habitat for predicted listed species.

Threatened fauna and flora

One species of threatened fauna was noted during the field assessment. Wallum Froglet was heard calling from outside the proposal site. Approximate location is shown in **Figure 29**.

Note that the location of this call is also approximately the closest area where the Wallum Sedge Frog Management Plan maps breeding habitat for that species. This area would not be directly or indirectly impacted by this proposal.

Suitable habitat areas for Wallum Sedge Frog as identified in the Kings Forest Wallum Sedge Frog Management Plan and how they relate to the location of this proposal are discussed in **Section 6.5.1.1**. No core breeding and foraging Wallum Sedge Frog habitat was identified within the proposal site that is subject to surface earth disturbance.

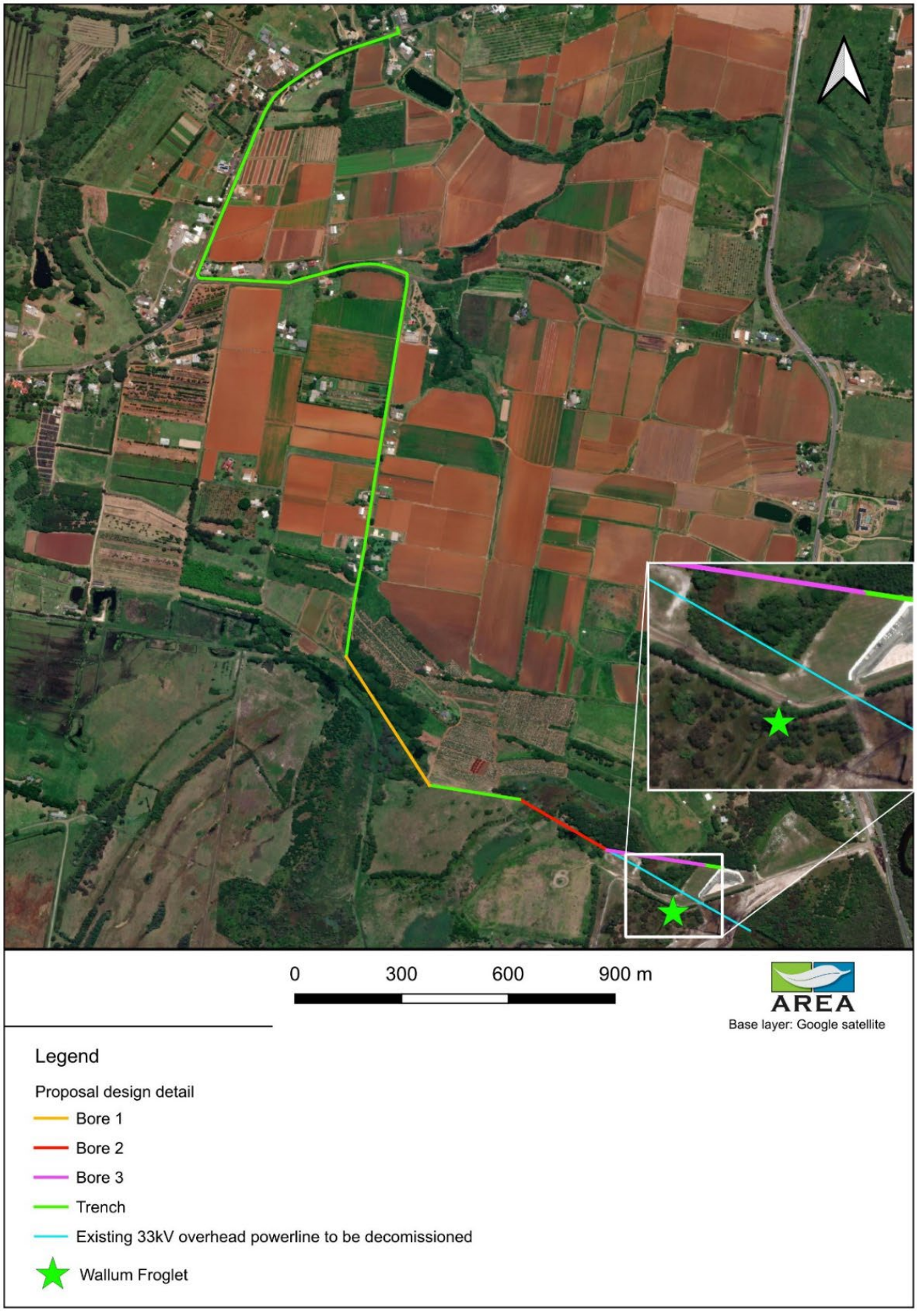


Figure 29: Approximate location of Wallum Froglet call heard during the field assessment

No other threatened species were identified during the field assessment.

Pests, weeds and disease

No notable feral fauna species were observed during the field assessment.

No sign of disease was observed during the field assessment. However, the Chytridiomycosis fungus may occur in the local landscape. No dead or diseased frogs were recorded during the field assessment on the proposal site. The proposal site includes land where surface disturbance may occur, however these will be away from mapped wetland areas and areas of pooled water, where Chytridiomycosis fungus is more likely to occur. This fungus is a waterborne fungus and no interaction with surface water is expected during construction of this proposal.

Weeds dominated the landscape, particularly in the northern section of the proposal.

Priority weeds observed included:

- Camphor Laurel (*Cinnamomum camphora*)
- Lantana (*Lantana camara*)
- Slash pine (*Pinus elliottii*)
- Elephant Grass (*Pennisetum purpureum*)
- Kikuyu (*Pennisetum clandestinum*)
- Setaria sp.
- Fireweed (*Senecio madagascariensis*)

6.5.2 ASSESSMENT OF IMPACT

6.5.2.1 Direct Impacts

Direct impacts are a direct result of construction activities. Direct impacts predicted to be caused by the development are considered in the following sections. Safeguards and mitigation measures to reduce potential impacts are outlined in **Section 6.5.3**

Impact to habitat values

All native vegetation mapped in the assessment area has some role in habitat connectivity, however the proposal will not fragment habitat nor prevent movement of fauna or exclude any fauna from suitable habitat during construction or operation.

Some obstacles to wildlife movement may exist during the construction phase of the development as created by machinery and construction activities. These will be temporary and if an individual's movement is disrupted this will not exclude the animal from habitat or its ability to move through the proposal during or post construction.

Habitat features

The proposal is designed to avoid impact to habitat as much as reasonably practicable As detailed below

- Waterways/wetlands occur within the assessment area (500m) however the proposal has been designed to avoid impact to waterways and aquatic habitat values by electing to use underboring construction techniques.
- Native vegetation within the proposal site is predominantly historically cleared land, which is now occupied by maintained urban lawns/ roadsides or young re-growing forest communities. The proposal would not substantially alter the habitat values provided by native vegetation. Areas disturbed during construction would be allowed to naturally revegetate.

- Weeds are prevalent within and surrounding the proposal site. These provide minor habitat value within the proposal site.
- Planted vegetation occurs within the proposal site associated with domestic maintained gardens and shrubby property boundary planting. This vegetation is native and exotic and may contribute to shelter and nesting habitat for some bird species.
- Leaf litter occurs in small patches within the proposal site. Most notably associated with a patch of PCT 3004 - Far North Bangalow Palm Swamp Forest. Leaf litter elsewhere is of low density, meaning it does not provide a moist leaf litter forest floor within the proposal site.

Fragmentation of habitat

Habitat fragmentation refers to the process by which a large, continuous habitat is divided into smaller, isolated patches, often as a result of human activities such as urbanisation, agriculture, and infrastructure development.

The proposal is unlikely to result in a significant increase in fragmentation nor prevent the movement of fauna or restrict flora species from colonising other areas, for the following reasons:

- the nature and scale of impact will not prevent movement of fauna,
-
- no fauna species will be excluded from suitable habitat at any time and
- the proposal largely follows existing cleared landscapes with all impacted areas expected to regenerate. Where native vegetation would be impacted, it would not increase the fragmentation of the landscape.

Native vegetation

The proposal passes through areas with varying levels of disturbance including road corridors, agricultural land, historically cleared land and areas associated with existing powerline infrastructure.

Proposed construction types include trenching with an approximately four-metre-wide impact footprint and underboring which impacts surface land at either end of the bore (entry and exit points), and associated construction and laydown areas.

The impact to the PCTs recorded in the proposal site is described in **Table 14**.

Table 14: Native vegetation impacted by the proposal

PCT ID	PCT NAME	VEGETATION CLASS	IMPACT (HA)
0	Not native vegetation	N/A	1.39
X	Planted non-indigenous and exotic vegetation	N/A	0.03
3004	Far North Bangalow Palm Swamp Forest	Subtropical Rainforests	0.03
3988	Far North Mesophyll Paperbark Swamp Forest	Coastal Swamp Forests	0.23
4004	Northern Melaleuca quinquenervia Swamp Forest	Coastal Swamp Forests	0.17
		Total Area Impacted	**1.85**
		Total Impact to Native Vegetation	**0.43**

No vegetation will be impacted by the proposal within the section of the route that intersects with the mapped coastal wetland.

Threatened Ecological Communities

Two TECs (refer **Table 15**) were determined to be present in the proposal site, albeit in a historically disturbed and weedy state. A test of significance has been completed for these two TECs, which determined the impact is unlikely to be significant.

Table 15: TECs present in the proposal site

SCIENTIFIC NAME	NSW STATUS	CTH STATUS	ASSOCIATED PCT WITHIN PROPOSAL SITE	HECTARES WITHIN THE PROPOSAL SITE
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	Endangered	Not listed	3004	0.03
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	Not listed	3988	0.40

Threatened species

Forty-nine threatened species were identified as potentially being directly impacted by the proposal based on survey and desktop results and the threatened species assessment. Refer **Table 16** below, and Appendix C of the ecological impact assessment (attached to this REF as **Appendix E**).

Tests of significance undertaken show a significant impact to threatened species from the proposal is considered unlikely. Refer Appendix D of the ecological impact assessment (attached to this REF as **Appendix E**).

Wetland habitat, including mapped coastal wetlands communities, other un-mapped low-lying wet areas which would constitute suitable habitat for species including Wallum Froglet, Wallum Sedge Frog would be underbored. Underboring seeks to avoid disturbance of wetland habitat values, hydrological processes and threatened species occupying the wetland areas. Wet areas suitable for breeding for Wallum Froglet, Wallum Sedge Frog were not recorded in the proposal site, noting that wet areas would have contained water at the time of the assessment given recent rainfall events (daily rain in the nine days leading up to the assessment totalling 144.6mm).

Table 16: Tests of significance for threatened species potentially impacted

SCIENTIFIC NAME	COMMON NAME	BC ACT STATUS	EPBC ACT STATUS	SIGNIFICANT IMPACT
Amphibian				
Crinia tinnula	Wallum Froglet	Vulnerable	Not listed	No
Litoria aurea	Green and Golden Bell Frog	Endangered	Not listed	No
Litoria brevipalmata	Green-thighed Frog	Vulnerable	Not listed	No
Litoria olongburensis	Wallum Sedge Frog	Vulnerable	Vulnerable	No
Mixophyes iteratus	Giant Barred Frog	Vulnerable	Vulnerable	No
Invertebrate				
Argynnis hyperbius	Australian Fritillary	Endangered	Critically Endangered	No

SCIENTIFIC NAME	COMMON NAME	BC ACT STATUS	EPBC ACT STATUS	SIGNIFICANT IMPACT
	Birds			
Anseranas semipalmata	Magpie Goose	Vulnerable	Not listed	No
Artamus cyanopterus cyanopterus	Dusky Woodswallow	Vulnerable	Not listed	No
Burhinus grallarius	Bush Stone-curlew	Endangered	Not listed	No
Circus assimilis	Spotted Harrier	Vulnerable	Not listed	No
Coracina lineata	Barred Cuckoo-shrike	Vulnerable	Not listed	No
Erythrotriorchis radiatus	Red Goshawk	Endangered	Endangered	No
Falco subniger	Black Falcon	Vulnerable	Not listed	No
Hieraaetus morphnoides	Little Eagle	Vulnerable	Not listed	No
Lophoictinia isura	Square-tailed Kite	Vulnerable	Not listed	No
Ninox connivens	Barking Owl	Vulnerable	Not listed	No
Tyto longimembris	Eastern Grass Owl	Vulnerable	Not listed	No
Tyto novaehollandiae	Masked Owl	Vulnerable	Not listed	No
Scoteanax rueppellii	Greater Broad-nosed Bat	Vulnerable	Not listed	No
	Reptiles			
Cacophis harriettae	White-crowned Snake	Vulnerable	Not listed	No
Coeranoscincus reticulatus	Three-toed Snake-tooth Skink	Vulnerable	Vulnerable	No
	Mammals (bats)			
Chalinolobus dwyeri	Large-eared Pied Bat	Vulnerable	Endangered	No
Chalinolobus nigrogriseus	Hoary Wattled Bat	Vulnerable	Not listed	No
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Vulnerable	Not listed	No
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	Vulnerable	Not listed	No
Miniopterus australis	Little Bent-winged Bat	Vulnerable	Not listed	No
Miniopterus orianae oceanensis	Large Bent-winged Bat	Vulnerable	Not listed	No
Myotis macropus	Southern Myotis	Vulnerable	Not listed	No
Nyctimene robinsoni	Eastern Tube-nosed Bat	Vulnerable	Not listed	No
Nyctophilus bifax	Eastern Long-eared Bat	Vulnerable	Not listed	No

SCIENTIFIC NAME	COMMON NAME	BC ACT STATUS	EPBC ACT STATUS	SIGNIFICANT IMPACT
Ozimops lumsdenae	Northern Free-tailed Bat	Vulnerable	Not listed	No
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable	Vulnerable	No
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Vulnerable	Not listed	No
Scoteanax rueppellii	Greater Broad-nosed Bat	Vulnerable	Not listed	No
Syconycteris australis	Common Blossom-bat	Vulnerable	Not listed	No
Mammals other than bats				
Aepyprymnus rufescens	Rufous Bettong	Vulnerable	Not listed	No
Cercartetus nanus	Eastern Pygmy-possum	Vulnerable	Not listed	No
Dasyurus maculatus	Spotted-tailed Quoll	Vulnerable	Endangered	No
Petaurus norfolcensis	Squirrel Glider	Vulnerable	Not listed	No
Phascogale tapoatafa	Brush-tailed Phascogale	Vulnerable	Not listed	No
Phascolarctos cinereus	Koala	Endangered	Endangered	No
Planigale maculata	Common Planigale	Vulnerable	Not listed	No
Potorous tridactylus	Long-nosed Potoroo	Vulnerable	Vulnerable	No
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	Vulnerable	Not listed	No
Pseudomys novaehollandiae	New Holland Mouse	Not listed	Vulnerable	No
Plants				
Cryptostylis hunteriana	Leafless Tongue Orchid	Vulnerable	Vulnerable	No
Cynanchum elegans	White-flowered Wax Plant	Endangered	Endangered	No
Elionurus citreus	Lemon-scented Grass	Endangered	Not listed	No
Geodorum densiflorum	Pink Nodding Orchid	Endangered	Not listed	No
Oldenlandia galioides	Sweet False Galium	Endangered	Not listed	No

Migratory Species

A significant impact to migratory (birds, reptiles, mammals, sharks) species under the EPBC Act is considered unlikely.

Sixty EPBC listed migratory species were identified as potentially occurring in the proposal site. Refer Appendix B of the ecological impact assessment (attached to this REF as **Appendix E**). These species have been considered against the significance criteria in **Table 17**

Table 17: Assessment of Significance, listed migratory birds

CRITERIA	RESPONSE
I. substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	There is little evidence to suggest that the proposal site supports 'important habitat' for migratory species, it would at most likely provide seasonal breeding and feeding grounds. Given their migratory habits, the nature of food and habitat resources and the extent of habitat across their range, it is likely that the existing resources within the proposal site would be utilised infrequently and on a transitory basis only. Migratory birds are extremely mobile in nature and have a large feeding area that would not be solely reliant on the habitat provided in the proposal site.
II. result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or	The local area has a history of habitat modification for rural and urban development, which has benefited a number of feral and invasive flora and fauna species. The proponent will ensure the spread of weeds and feral fauna is not enhanced by the development which will contribute to the overall enhancement of habitat for migratory species.
III. seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	As noted above, the proposal site is not considered to be an area of 'important habitat' for migratory birds, whether they are wetland or terrestrial species. It is unlikely migratory birds would rely on habitat in the proposal site

Impact to waterways

The proposal would not result in impact to waterways, or wetland areas. Where these features occur locally, they would be underbored to avoid impact.

Hydrological process and aquatic values

The assessment area contains native vegetation with a potential for groundwater interaction, however, the development is not expected to place any component of groundwater-dependent communities at risk of local extinction. This is due to the following features of this proposal:

- Impact to areas with aquatic habitat values from surface disturbance activities would be avoided by underboring.
- Cross sectional impact of the underbore and subsequent installation of the cable occurs in a closed system, meaning it would result in limited interaction between inert drilling materials and the surface water or groundwater systems
- Cross sectional impact of the underbore and subsequent installation of the cable would not obstruct any surface or groundwater movement or alter hydrological processes by stopping or slowing the movement of water, or biological process associated with that water.
- Limited vegetation would be impacted by this proposal (all outside mapped coastal wetland environments) and land disturbed by this proposal would be stabilised with cover vegetation and subsequently allowed to naturally revegetate meaning alteration of the hydrological processes is unlikely to occur.
- The proposal would not directly impact any mapped areas of terrestrial or aquatic GDEs. The proposal would not result in changes to groundwater systems.
- Underboring of waterways would be conducted such that vegetation is not disturbed and groundwater processes are not compromised. Standard and project specific safeguards would be employed during construction to ensure inadvertent impact to water quality, water bodies and hydrological processes does not occur, and any incidents such as frac-outs are managed effectively and swiftly.

Soils and drainage

Disturbed soils have the potential to move off the proposal site and impact waterways if not appropriately managed.

Soil disturbance will be managed using standard processes to avoid long term impacts (refer **Section 6.2.3** and **6.3.3**).

Overall, the proposal is not anticipated to impact drainage at the landscape scale.

6.5.2.2 Indirect Impacts

Indirect impacts are those which are not a direct result of the proposal, often produced away from, or as a result of, a complex impact pathway. Indirect impacts are considered in the following sections and mitigation measures outlined in **Section 6.5.3**.

Erosion and sediment

Erosion and sediment control measures would be implemented as required to prevent movement of sediment off site, and particularly to local waterways. Earth displaced during construction would be returned to position and restabilised as soon as practicable following installation. Material removed during the underboring process would be managed to prevent sedimentation issues and appropriately reused / disposed of as required.

Acid Sulfate Soils

Presence of Acid Sulfate Soils is possible only in the southern low-lying areas of the proposal site. It is unlikely to be associated with the basalt derived soils in the northern section of the proposal from the western end of Underbore 1.

Acid sulfate soils would be managed in accordance with an acid sulfate soil management plan.

Frac-out

Underboring of waterways would be conducted such that vegetation is not disturbed and groundwater processes are not compromised. Standard and project specific safeguards would be employed during construction to ensure inadvertent impact to water quality, water bodies and hydrological processes does not occur, and any incidents such as frac-outs are managed effectively and swiftly.

Safeguards against and response to frac-out are detailed in **Section 6.3.3**.

Injury to wildlife

Injury to wildlife is unlikely, but possible, during the construction phase of this proposal. Local wildlife rescue organisations should be contacted in the event that wildlife requires rescue or removal. Management and mitigation measures have been provided in **Section 6.5.3** to minimise the chance that the proposal will cause injury to threatened species.

Changes to hydrology and groundwater dependent ecosystems

Given the temporary, low impact nature and small area of ground surface disturbance of the development, as well as the small number of shrubs and trees to be removed (outside of wetland areas), it is unlikely this proposal will disturb function of groundwater dependent ecosystems.

The impact footprint will be allowed to naturally regenerate and is likely to do so as demonstrated along existing adjacent infrastructure corridors.

The assessment area contains native vegetation with a potential for groundwater interaction, however, the development is not expected to place any component of groundwater-dependent communities at risk of local extinction. As such, no long-term obstruction or change to surface water flow will occur because of this development.

Noise, light and vibration

Construction noise, light and vibration during construction may disturb fauna or prevent them using habitat in the assessment area. This impact would be short term. Sensitive fauna can remove themselves from the local landscape during the construction phase of the proposal. No long term operational noise or altered lighting conditions will be experienced.

Weeds

Inappropriate management of weed control can lead to the dissemination of weeds across the environment. Processes such as clearing vegetation, removing and transporting topsoil, importing and exporting soil and mulch, as well as the movement of vehicles, are all activities that could contribute to the spread of weeds.

6.5.2.3 Impact on Key Threatening Processes

Key Threatening Processes (KTPs) listed under the BC Act, EPBC Act and FM Act were reviewed by AREA (**Appendix E**). Six KTPs were considered to be negligibly or possibly exacerbated by the proposal:

- Anthropogenic Climate Change – BC Act
- Clearing of native vegetation – BC Act
- Invasion of native plant communities by exotic perennial grasses – BC Act
- Invasion, establishment and spread of Lantana camara – BC Act
- Land clearance – EPBC Act
- Novel biota and their impact on biodiversity – EPBC Act

The KTPs can be minimised and managed by the mitigation measures in **Section 6.5.3**.

6.5.2.4 Cumulative Impact

While this proposal occurs in a landscape of urbanisation and historic clearing, a range of measures will be taken to avoid, minimise and mitigate potential impacts, and where vegetation would be disturbed, it would be allowed to re-establish. In considering the impacts of the proposal against known potential future development, cumulative impacts would be low to negligible given the construction methods employed and approach to the powerline installation (i.e., undergrounding).

6.5.3 ENVIRONMENTAL MITIGATION MEASURES

The proposal has followed the principles of 'avoid, minimise, mitigate' to reduce the impact on local biodiversity values.

6.5.3.1 Avoid Impact

The following avoidance measures have been made:

- The proposal has been largely located within land previously cleared for existing road and electricity infrastructure, agricultural activities and/ or urbanisation
- Portions of the proposal will be installed by underboring, thereby reducing the potential to impact native vegetation and wetland elements along these sections.

6.5.3.2 Minimise Impact

The following measures have been made to minimise impact to the environment:

- The proposal has been designed to minimise impact to the limited stands of wooded vegetation (i.e., removal of trees and shrubs has been minimised)
- The proposal largely follows existing powerline and road corridors, minimising impacts to surrounding vegetation.

Notwithstanding, to ensure any potential residual impacts to flora and fauna are further minimised and managed, the following mitigation and management measures are to be implemented:

- Any change in design affecting land outside the proposal site assessed in this report will require further ecological survey - notwithstanding minor changes where the ecological values have been assessed for this proposal.
- No clearing is permitted outside these areas without further assessment
- Stockpile and compound sites would be located using the following criteria:
  - At least 40 m away from the nearest waterway
  - In areas of low ecological conservation significance (i.e., previously disturbed land)
  - On relatively level ground
  - Outside the one in 10-year Average Recurrence Interval (ARI) floodplain if possible
- Stockpiling materials and equipment and parking vehicles would be avoided within the dripline (extent of foliage cover) of any tree.
- Store fuels, chemical and hazardous materials in secure areas
- Control measures will be implemented to manage risks associated with the handling of fuel through using spill trays when undertaking in field re-fuelling
- Essential Energy has a general biosecurity duty under the *Biosecurity Act 2015* to prevent, eliminate or minimise biosecurity risk so far as is reasonably practicable.
- Field crews shall follow procedures as outlined in Essential Energy's Operational Guideline: Biosecurity Risk Management (CERM1000.96) to prevent, eliminate or minimise biosecurity risk so far as is reasonably practicable, with particular reference to vehicle and equipment hygiene practises
- Contact a nominated animal rescue agency / wildlife care group (i.e., Friends of the Koala) or veterinarian if an animal is injured. Friends of the Koala may be contacted for fauna other than Koalas.
- Report any Koala sightings or incidents to BCSD and TSC.
- No domestic dogs are to be allowed on the site during pre-construction or construction.
- Impacts to Wallum Sedge Frog breeding habitat will be avoided through use of HDD methodology.

6.5.4 CONCLUSION

The proposal is unlikely to result in a significant impact to the ecological values present in the proposal site. The impact to listed threatened species, populations or communities recorded or presumed to occur in the proposal site was assessed as not significant. The environmental risk is considered to be low.

6.6 Aboriginal Heritage

AREA (2024) was engaged to undertake an Aboriginal heritage due diligence assessment for the proposal. The key findings of this assessment are presented below, with the full Aboriginal heritage due diligence assessment attached to this REF as **Appendix F**.

6.6.1 EXISTING ENVIRONMENT

6.6.1.1 Landforms, geology, vegetation and soils

The proposal is on two NSW (Mitchell) Landscapes, with relevance to Aboriginal habitation and heritage potential as follows:

- **The Lamington Volcanic Slopes** contain raw materials suitable for the manufacture of Aboriginal stone objects. However, the likelihood of Aboriginal sites being present and detected is lower due to significant ground surface disturbance from intensive agriculture, as well as activities related to cut-and-fill processes such as road construction, paddock levelling, plantations and powerline installation within the proposal area.
- **The Byron-Tweed Alluvial Plains** have a higher likelihood of containing Aboriginal objects in areas that have not been impacted by sand mining. Ainsworth (2014) identified such areas east of the Tweed Coast Road, where they are associated with intact sand dunes. However, the proposal is located west of Tweed Coast Road.

The landscape, topography and hydrology relative to the proposal site is presented in **Figure 30.** Geological units and a summary of and their archaeological potential is presented in **Figure 31** and **Table 18**, respectively.

6.6.1.2 Waterways

The waterways in the vicinity of the proposal are largely naturally occurring but have modified hydrology trough draining activities or by development.

The proposal intersects:

- One Estuarine palaeochannel fill adjacent to the old landfill site, this drainage line is underbored
- One waterbody on Estuarine palaeochannel fill, this drainage line is underbored
- One unnamed first order drainage line on Lismore Basalt, however in the field the headwaters to this was not visible in the landscape where mapped, likely due to paddock levelling activities though intensive agriculture.

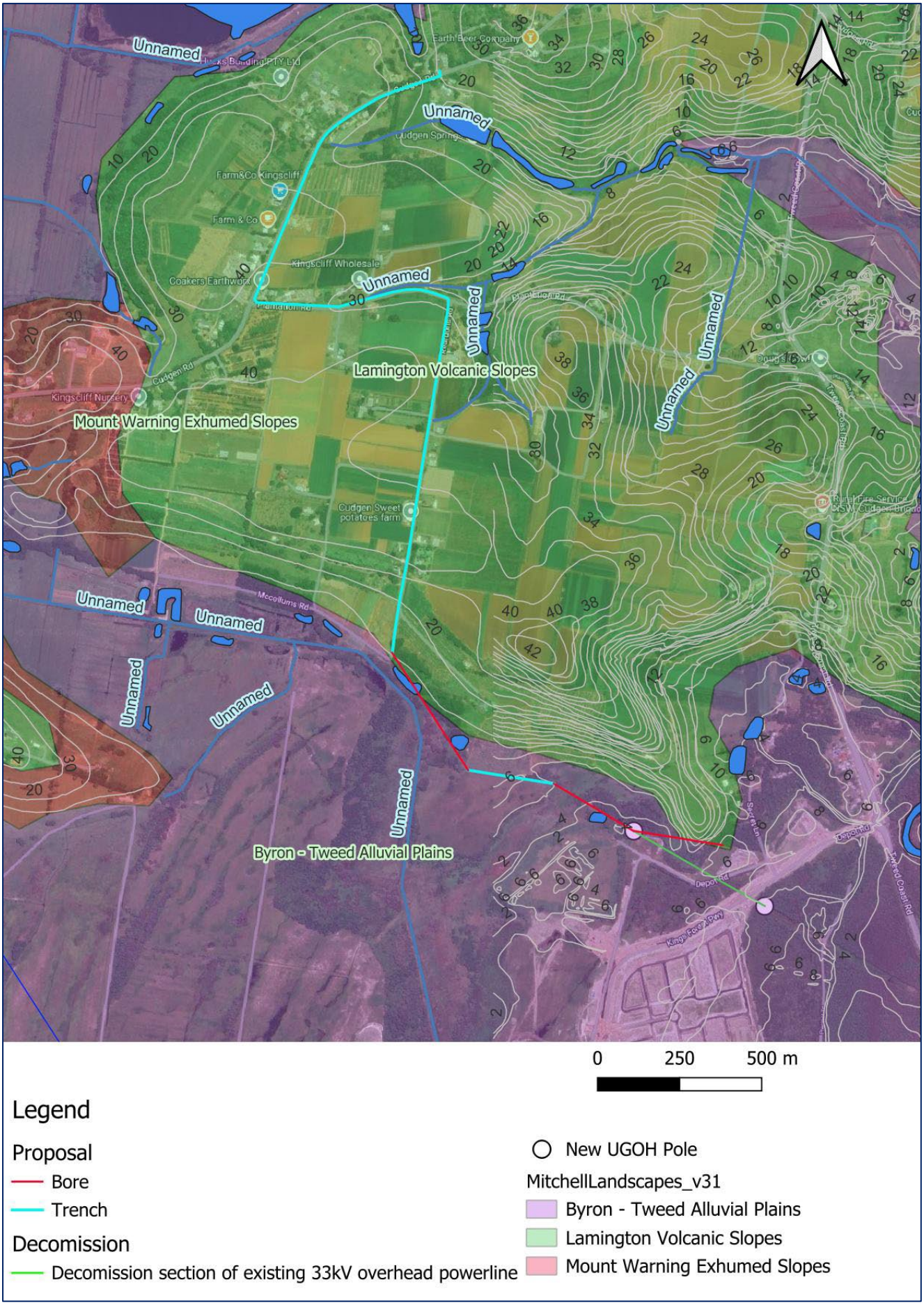


Figure 30: NSW Landscapes, topography and hydrology

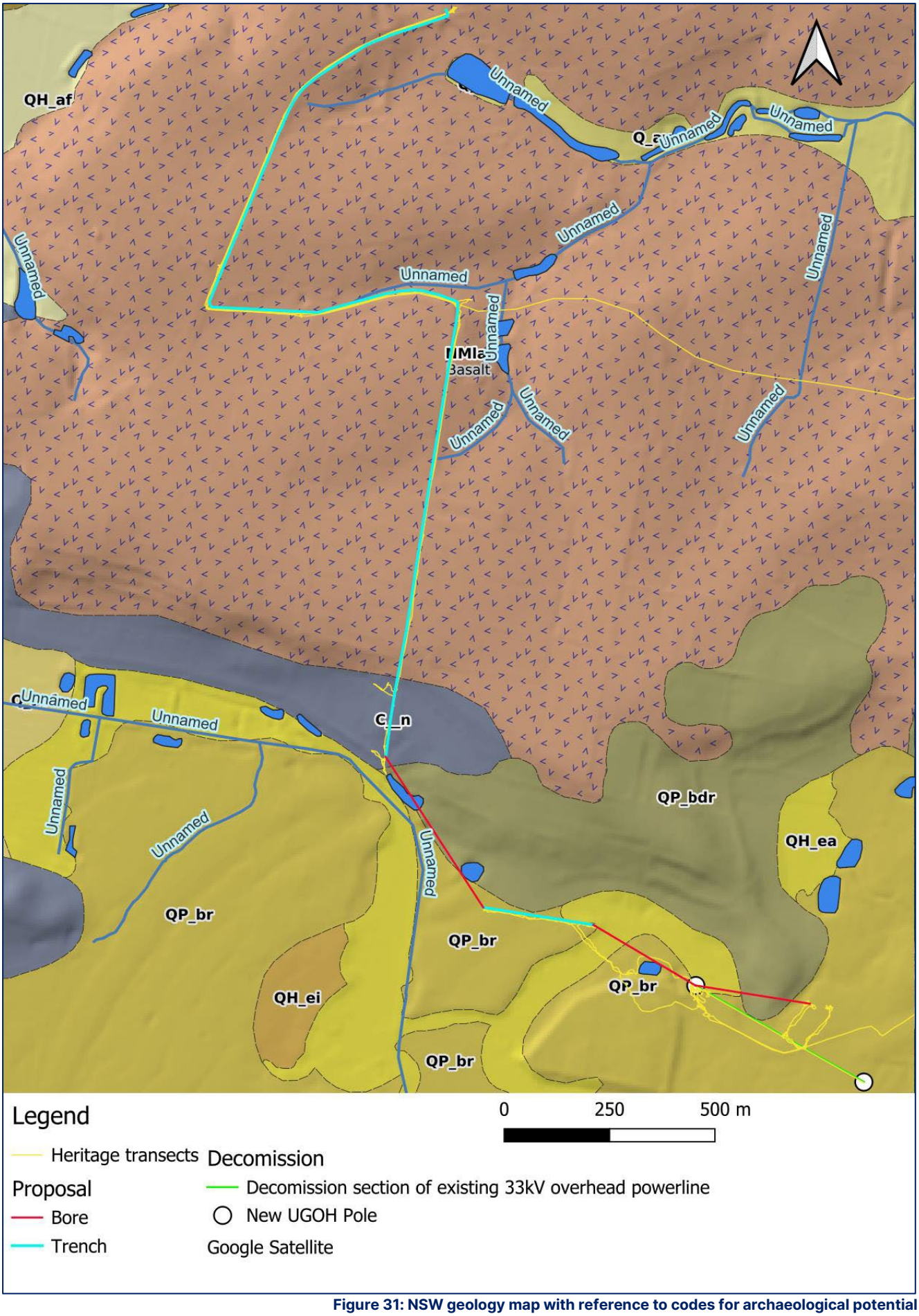


Figure 31: NSW geology map with reference to codes for archaeological potential

Table 18: Summary of geological attributes and their archaeological potential

NSW CODE	UNIT NAME	DESCRIPTION	DOMINANT LITHOLOGY	ARCHAEOLOGICAL RELEVANCE TO THE PROPOSAL
QP_bdr	Coastal deposits - bedrock-mantling dune facies	Indurated marine-deposited and aeolian-reworked fine- to coarse-grained quartz-lithic sand with abundant carbonate, sporadic humic debris in stabilised dunes.	Sand	The landscape and geological features of the stabilised dunes in the area make them important for archaeological investigation. The presence of quartz-lithic sands suggests potential stone tool assemblages, while the environmental conditions offer clues about ancient habitation, resource use, and possibly burial practices.
QP_br	Coastal deposits - beach ridge	Fine- to coarse-grained quartz-lithic-carbonate sand (marine-deposited), shell and shell-fragment-rich beds, polymictic gravel.	Sand	The fine- to coarse-grained quartz-lithic-carbonate sands, shell-rich beds, and polymictic gravel of the area present a landscape with strong archaeological potential, especially in the context of Aboriginal use of marine resources, midden formation, and tool-making activities. The combination of materials suggests an environment where Aboriginal groups likely exploited the rich coastal ecosystem, leaving behind a range of cultural artefacts that could reveal much about their subsistence and adaptation strategies.
QH_ea	Estuarine palaeochannel fill	Organic mud, peat, clay, silt, fine- to medium-grained lithic-carbonate-quartz sand (marine-deposited).	Organic rich sediment	The organic mud, peat, clay, silt, and fine- to medium-grained lithic-carbonate-quartz sand (marine-deposited) suggest a landscape rich in both natural resources and archaeological potential. The wetland-like characteristics and marine influence provide a setting where organic artefacts, stone tools, and midden deposits may be well-preserved. The environmental variability and stratigraphy point to a complex history of Aboriginal occupation, resource use, and adaptation to changing coastal environments. These attributes make this landscape significant for archaeological investigation, particularly in revealing both subsistence strategies and cultural practices.
C__n	Neranleigh-Fernvale beds	Feldspathic and lithic meta-arenite, metasiltstone and conglomerate proximal turbidite, with	Sandstone	The feldspathic and lithic meta-arenite, metasiltstone, conglomerate proximal turbidite, and intercalated chert, jasper, and mafic meta-volcanics in the area present a geologically rich landscape with high archaeological potential. The presence of high-quality stone materials such as chert and jasper indicates the likelihood of stone

NSW CODE	UNIT NAME	DESCRIPTION	DOMINANT LITHOLOGY	ARCHAEOLOGICAL RELEVANCE TO THE PROPOSAL
		structurally intercalated or stratigraphically underlying chert, jasper and mafic meta-volcanics.		tool production sites, including quarries and associated artefact scatters. The complex geological history, including the intercalation of these materials, suggests that this landscape was a valuable resource area for Aboriginal people, both for tool-making and possibly for other cultural uses of stone materials.
NMlal	Lismore Basalt	Predominantly tholeiitic with occasional alkaline types of formations	Basalt	The predominantly tholeiitic with occasional alkaline types of formations in the area represent a geologically rich landscape with high potential for stone tool production and quarry sites. The durability and availability of basalt, particularly tholeiitic varieties, would have made it a key resource for Aboriginal tool-making, with the occasional presence of alkaline basalt providing additional variety for specialised tools or ornaments. The landscape's volcanic origin, with exposed outcrops and rugged features, would likely have served both practical and possibly cultural purposes, offering important insights into how Aboriginal people utilised and valued the geological resources of the area.

6.6.1.3 Climate

The Bureau of Meteorology (BoM) data for the Tweed area, Northern NSW, and southeast QLD shows a subtropical climate characterised by warm, humid summers and mild winters, with significant rainfall. The region receives annual rainfall of around 1,500 to 2,000mm, with a wet season influenced by tropical weather systems and occasional cyclones. This rainfall pattern supports the lush subtropical rainforests and wetlands that are characteristic of the region today.

Prior to European settlement, this climate likely remained largely similar, although there have been long-term variations influenced by factors like El Niño and La Niña. Aboriginal people living in the Tweed region adapted to these wet and warm conditions, using the abundant natural resources supported by the area's climate. The consistent availability of water and rich plant and animal life in the Tweed River floodplains, coastal wetlands, and subtropical rainforests would have made this an ideal location for Aboriginal communities.

The Tweed area experiences mild winter temperatures, typically ranging from 10°C to 20°C, which would have allowed Aboriginal people to live comfortably throughout the year without the need for significant shelter or seasonal migration to warmer areas.

Summer temperatures are generally warm, ranging from 25°C to 30°C, which would have supported a year-round abundance of resources, including plant growth, animal activity, and marine life in coastal and riverine areas.

6.6.1.4 Archaeological Context

Ainsworth (2014) provides a comprehensive review of Aboriginal history and previous reporting in the area.

The archaeological record highlights the long-term occupation of the Tweed Coast by the Bundjalung people, showcasing their reliance on the natural environment and their environmental management. Shell middens, stone artefacts, and burial sites form parts of the archaeological landscape, dating back thousands of years, as summarised below.

Shell middens:

Common features along the Tweed Coast, shell middens contain remains of shellfish (e.g., oysters, pipis), fish bones, and stone tools used for processing food. Middens offer a chronological record of Aboriginal resource use and environmental changes, with some dating back over 4,000 years.

In the proposal, before European settlement, shell middens would be associated with QP_bdr Coastal deposits - bedrock-mantling dune facies, QP_br Coastal deposits - beach ridge and QH_ea Estuarine palaeochannel fill which all were associated with sand-based landforms. (Figure 2-2).

Stone artefact scatters:

Artefact scatters, often located near water sources, include tools made from quartz, chert, and jasper, reflecting the Bundjalung's tool-making practices.

In the proposal, before European settlement, these could occur anywhere along the proposal.

Rock shelters and cave sites:

Found primarily in the volcanic hinterlands, rock shelters preserve rock art, charcoal, and artefacts, offering insight into ceremonial and daily life.

These site types would not be found in association with the proposal.

Burial sites:

Occasionally uncovered in coastal sand dunes, these sites reflect the cultural importance of certain areas for both daily life and funerary practices.

In the proposal, before European settlement, burials would be associated with QP_bdr Coastal deposits - bedrock-mantling dune facies, QP_br Coastal deposits - beach ridge and QH_ea Estuarine palaeochannel fill which all were associated with sand-based landforms.

6.6.1.5 Database Results

A total of 23 Aboriginal sites were recorded within the AHIMS database within approximately 1km of the proposal site (**Figure 32** and **Table 19**). The most common site type identified was artefact scatters (n=21), with two of these also containing middens (shell deposits). These sites were primarily located near creeks, waterways, wetlands, or on sandy areas, indicating a close association with key natural resources.

Two previously recorded sites are located less than 100m from the proposal site (bolded in **Table 19**). Site 04-2-0187 was noted as 'destroyed' prior to this assessment, and Ainsworth (2014) was unable to relocate 04-2-0142, despite good ground surface visibility in the area.

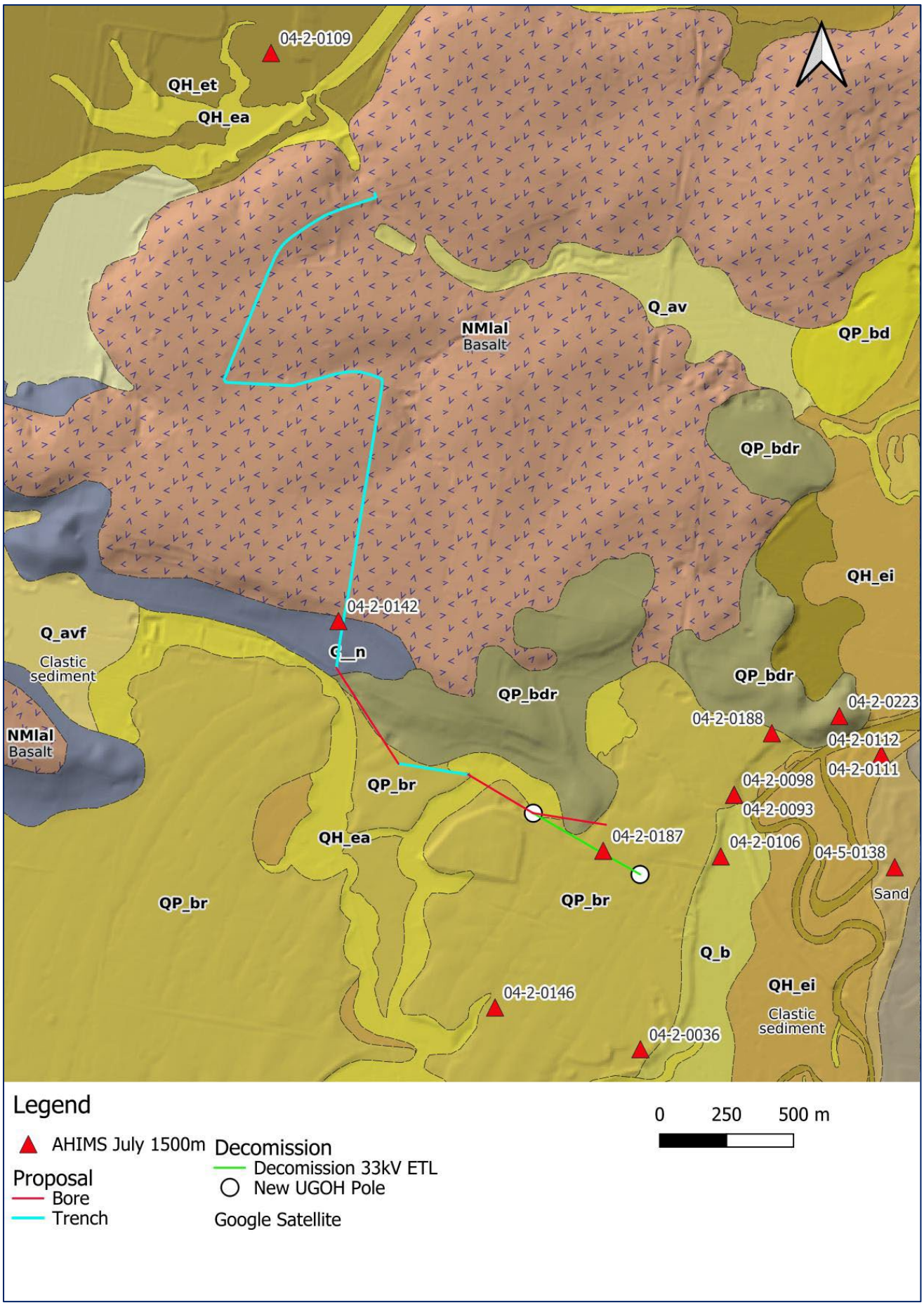


Figure 32: AHIMS data search results with reference to geology

Table 19: Registered AHIMS sites in general vicinity of the proposal site

SITE ID	SITE NAME	CONTEXT	SITE STATUS	SITE FEATURES	SITE TYPES	RECORDERS
04-5-0140	Kings Beach 3	Open site	Valid	Artefact : -	Open Camp Site	Ms. Jacqueline Collins
04-5-0139	Kings Beach 2	Open site	Valid	Artefact : -	Open Camp Site	Ms. Jacqueline Collins
04-5-0138	Kings Beach 1	Open site	Valid	Artefact : - Shell : -	Open Camp Site	Ms. Jacqueline Collins
04-2-0223	Cudgen Ridge South East Tweed ACH Artefacts	Open site	Valid	Artefact : -		Mr. Ian Fox
04-2-0190	Kings Forest 10	Open site	Valid	Artefact : 1		Everick Heritage Pty Ltd
04-2-0189	Kings Forest 9	Open site	Valid	Artefact : 1		Everick Heritage Pty Ltd
04-2-0188	Kings Forest 13	Open site	Destroyed	Artefact : 1		Everick Heritage Pty Ltd, Everick Heritage Pty Ltd
04-2-0187	**King Forest 12**	**Open site**	**Destroyed**	**Artefact : 1**		**Ms. Claire Everett, Everick Heritage Pty Ltd**
04-2-0146	Kings Forest 7	Open site	Partially Destroyed	Artefact : 102		Mr. Adrian Piper, Everick Heritage Pty Ltd
04-2-0142	**KF-CE 1**	**Open site**	**Valid**	**Artefact : 5**		**Ms. Jacqueline Collins**
04-2-0113	SEASIDE CITY 2	Open site	Valid	Shell : - Artefact : -		Mr. Adrian Piper
04-2-0112	seaside city a	Open site	Valid	Shell : -		Mr. Adrian Piper
04-2-0111	seaside city 1	Open site	Valid	Shell : -		Mr. Adrian Piper
04-2-0109	Crescent St 1	Open site	Valid	Artefact : -		Ms. Rebecca Edwards-Booth

SITE ID	SITE NAME	CONTEXT	SITE STATUS	SITE FEATURES	SITE TYPES	RECORDERS
04-2-0106	Kings Forest 3	Open site	Valid	Shell : - Artefact : -	Midden	Mr. Adrian Piper
04-2-0103	Kings Forest 1	Open site	Partially Destroyed	Artefact : -	Open Camp Site	Mr. Adrian Piper, Everick Heritage Pty Ltd
04-2-0102	Kings Forest 2	Open site	Valid	Artefact : -	Isolated Find	Mr. Adrian Piper
04-2-0098	CudgenOld Bogangar Rd	Open site	Valid	Artefact : -	Open Camp Site	Mr. Adrian Piper
04-2-0093	Cudgen	Open site	Valid	Artefact : -	Open Camp Site	Mr. Adrian Piper
04-2-0091	Duranbah 3	Open site	Valid	Artefact : -	Open Camp Site	Mr. Adrian Piper
04-2-0090	Duranbah 2	Open site	Valid	Artefact : -	Open Camp Site	Mr. Adrian Piper
04-2-0089	Duranbah 1	Open site	Valid	Artefact : -	Isolated Find	Mr. Adrian Piper
04-2-0036	Cudgen ck 1	Open site	Valid	Artefact : -	Open Camp Site	Klim Gollan

6.6.1.6 Previous Investigations

Several previous Aboriginal cultural heritage investigations have been undertaken in the immediate area surrounding the proposal site. Key findings of each investigation are summarised below.

Adrian Piper 1997 An archaeological survey at Old Bogangar Road Realignment Cudgen, North Coast NSW)

This report was commissioned to assess the potential presence of Aboriginal sites in the vicinity of Old Bogangar Road, Cudgen, with participation from the Tweed Byron Local Aboriginal Land Council.

One Aboriginal site, Cudgen 1 (#04-2-0093), was identified, consisting of a piece of red ochre, a stone flake (material unspecified), and a broken chalcedony flake. The artefacts were found in a sand exposure along the eastern edge of cleared land. It is considered likely the artefacts were redeposited during past land-clearing activities, as the assessment noted the entire area had been heavily disturbed.

Adrian Piper 2001 An archaeological survey of 'Seaside City' south of South Kingscliff Cudgen, North Coast NSW

This report was part of a Draft Local Environment Plan, with participation from the Tweed Byron Local Aboriginal Land Council.

The study area extended from form the coastline west to Cudgen Creek and was joined immediately to the south by the suburb of Casuarina.

Land use included sand mining and associated disturbances. Three Aboriginal sites were recorded (#04-2-0113, #04-2-0112, #04-2-0111), a Pipi midden and a low-density scatter of shell and stone artefacts adjacent to Cudgen Creek. The midden site had high archaeological significance to NPWS and the Tweed Byron Local Aboriginal Land Council because it was rare in the region as it was intact.

Ainsworth Heritage 2014 Cudgen to Casuarina 33kV Powerline Due Diligence Report

The report evaluates the potential for Aboriginal heritage impacts related to the installation of a proposed 33kV powerline between Cudgen and Casuarina, following a similar route to that being assessed in this proposal.

During the field survey, a single Aboriginal site was identified (Site AHKFTL001), which consisted of a white chert flake. While this artefact was isolated, its discovery contributes to the broader understanding of Aboriginal use of the area. This site does not appear on the AHIMS database, but it is located in the vicinity of #04-2-0106.

Additionally, the report highlights the landscape contains areas with moderate potential for further Aboriginal archaeological sites, particularly given the proximity to water, ridge lines, and dune systems. It mentions artefact scatters, middens, and other cultural heritage sites found nearby, including sites listed in the AHIMS database.

The report recommends proceeding with caution during development due to the likelihood of encountering more Aboriginal cultural materials, and outlines a Stop Work Procedure in case any unexpected finds occur.

Everick 2012 Cultural Heritage Assessment report for the Kings Forest Residential Development

The report outlines extensive archaeological investigations conducted in the area. The report synthesises data from multiple prior surveys and presents findings on recorded Aboriginal sites within the Kings Forest region.

Key Findings:

Aboriginal Sites: Seventeen Aboriginal sites were identified within the project area (refer **Table 19**), of which:

- Six sites will not be disturbed by the Kings Forest residential development and will be preserved in situ.
- Eleven sites have undergone archaeological excavations or surface collections to mitigate potential impacts as part of the nearby residential development.

The identified sites include artefact scatters, shell middens, and isolated artefacts, primarily associated with raised sand dunes and areas near watercourses. The artefacts are made predominantly of chalcedony, chert, and other siliceous materials.

The report recommends preserving six significant sites in areas earmarked for environmental protection. These areas will not undergo development. Fencing, signage, and strict management protocols were recommended to protect the cultural heritage of these sites. Further archaeological monitoring is advised during construction phases to ensure no additional sites are disturbed.

The project area has experienced significant environmental disturbances over the past 50 years, primarily due to sand mining, logging, and agricultural activities. These disturbances have impacted the visibility and integrity of archaeological sites. Despite this, some areas with little disturbance still hold considerable potential for subsurface artefacts.

Despite the small and somewhat disturbed nature of the artefact scatters, they are valued by the Aboriginal community due to the relative scarcity of such sites in the region, emphasised by historical land use impacts such as logging, grazing, and sand mining.

Salvage excavations, surface collections, and management plans were implemented to safeguard Aboriginal cultural heritage. Artefacts collected during these processes were to be curated in a keeping place, and interpretive signage will be installed in consultation with Aboriginal stakeholders to inform the public about the cultural heritage of the area.

Aboriginal stakeholders, particularly the Tweed Byron Local Aboriginal Land Council, were consulted throughout the assessment process. They played a key role in decision-making regarding the preservation and management of significant sites.

The Kings Forest Residential Development encompasses an area of significant cultural heritage value, particularly for the local Aboriginal communities. The development will proceed with cultural heritage management protocols to ensure the preservation of Aboriginal sites and involvement from Aboriginal stakeholders. Further research and archaeological investigations may continue as the development progresses to ensure all cultural heritage is adequately protected and preserved.

6.6.1.7 Predictive Model

Areas of archaeological potential are regarded as any sensitive landform with a reasonable level of intactness (non-disturbed land). The definition of disturbance or disturbed land used here is in accordance with Regulation 58(4) of the NSW *National Parks and Wildlife Regulation 2019.* Sensitive landforms follow the definitions supplied in the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (Due Diligence code of practice) (DECCW, 2010):

- Within 200m of waters
- Located within a sand dune system
- Located on a ridge top, ridge line or headland
- Located within 200m below or above a cliff face
- Within 20m of or in a cave, rock shelter, or a cave mouth.

Much of the proposal site is located within land subject to significant ground disturbance previously impacted by intensive farming, the construction and installation of roads and tracks, electrical infrastructure, pipelines and optic fibre cables, the old tip and sandmining and associated activities. The level of this historic ground surface disturbance will likely be a major impact across the proposal site as these disturbances will impact the preservation of sites.

The results of the AHIMS search of previous studies indicates a high potential for stone artefact scatters on sandy substrates in proximity to both permanent and ephemeral water sources, including creeks, rivers and perched wetlands.

Based on the results of the AHIMS search, the local archaeological context and previous research a model can be developed for predicting where sites might be encountered along the proposal site:

- Aboriginal sites are likely to occur in land that has been subject to moderate to low levels of historic ground surface disturbance.
- Stone artefact scatters, hearths and burials are likely on sandy substrates within one kilometre of water sources, in areas exposed to little or no previous impacts.
- Stone artefact scatters and middens are likely on open ground with good drainage (a sandy substrate).
- Culturally modified trees (carved and scarred) are possible where trees are present. These are unlikely to occur due to the very high levels of tree clearing in the area.
- Grinding grooves are possible in association with waterways and appropriate bedrock. There is a low probability of these being encountered as the predominant geology of the proposal site is basalt and sand. The one exception is Neranleigh-Fernvale beds which is a sandstone derived geological unit. There is a possibility of portable grinding stones, likely associated with camp sites (stone artefact scatters and hearths) or rock shelters.
- Stone and ochre quarries are possible on Lismore Basalt geologies on the Lamington Volcanic Slopes (SEQ Volcanics) where appropriate stone and minerals outcrops occur.
- Rock art is possible where caves and rock shelters occur however few previous rock art sites have been recorded (Flood, 1980:232). These are unlikely to be encountered as there are no rock shelters within the proposal site.

6.6.1.8 Field Survey

A field survey of the proposal as conducted on 10 July 2024 by an AREA archaeologist, accompanied by Essential Energy staff.

Methodology

The aim of the field survey was to identify and record all Aboriginal sites along the proposal site, including surface exposures (such as artefact scatters and shell middens), landscape features (e.g., rock shelters, rock art, and culturally modified trees like scarred or carved trees), and potential archaeological deposits (PADs) where there is a high likelihood of Aboriginal objects or material traces being present.

Special attention was given to areas with ground surface disturbance, compensating for low ground surface visibility. These areas were assessed by considering the presence of flora species that respond to such conditions, which serve as a highly accurate indicator of site disturbance.

The survey was conducted by walking transects across sections of the proposed development area, with vehicles used for transportation between sampling locations and for reconnaissance inspections. Transects were walked directly along the proposal site to maximise coverage.

Due to the linear nature of the proposal site, a sampling strategy was employed. This strategy was based on archaeologically sensitive landforms (as outlined in the predictive model in **Section 6.6.1.7**), culturally sensitive landscapes (as defined by Aboriginal traditional knowledge and previously recorded sites), ground surface visibility (GSV), and the existing levels of disturbance.

- Care was taken to observe areas of cut, fill and paddock levelling along the Lamington Volcanic Slopes (SEQ Volcanics) and sand mining and impacts from the old tip on the Byron - Tweed Alluvial Plains SEQ Clarence Basin NSW Landscapes. Collectively keen observations were taken to identify areas of significant ground disturbance.
- All mature trees within the proposal site were inspected to determine if they were Culturally Modified Trees (scarred or carved).
- All high archaeological or culturally sensitive landforms with low to moderate levels of historic disturbance were assessed in full, on foot.
- All previously recorded sites in the vicinity of the proposal site were inspected to determine the extent and condition of the site.
- Where ground surface visibility was low, irrespective of previous levels of disturbance all exposures identified during the reconnaissance inspections were inspected. In addition, nearby areas of higher GSV were inspected to provide a sample from which results could potentially be extrapolated.
- Low archaeological or culturally sensitive landforms with high levels of historic disturbance were sampled.

A GPS was used to ensure the survey covered the proposal site. Photographic and written records were made of the landscape features relevant to archaeological potential. These features include landform, soil information, land surface conditions, GSV, ground disturbance levels and any newly or previously recorded sites.

GSV varied. In some areas it was 100 per cent (mostly associated with ploughed land) while other areas there it was variable and largely dependent on exposures (**Plates 17** to **22**).

Ground surface disturbance (GSD) was high throughout the proposal site.



Plate 17: Proposed alignment on Lamington Volcanic Slopes. High GSV and GSD



Plate 18: Proposed bore entry on Byron-Tweed Alluvial Plains. High GSV and GSD



Plate 19 Proposed bore entry on Byron-Tweed Alluvial Plains. Moderate GSV high GSD



Plate 20: Proposed alignment on Lamington Volcanic Slopes. Low GSV and high GSD



Plate 21: Proposed alignment on Lamington Volcanic Slopes. Low GSV and high GSD



Plate 22: Proposedalignment on Byron-Tweed Alluvial Plains. Low GSV high GSD

6.6.2 ASSESSMENT OF IMPACT

No Aboriginal sites were recorded during the field survey, and none were thought to be undetected due to the significant GSD along the proposal site.

6.6.2.1 Previously Recorded Sites

Two previously recorded sites (04-2-0187 and 04-2-0142) are located within, or in the near vicinity of the proposal site (refer **Figure 33**). The location of both sites were surveyed by AREA (2024). It is highly unlikely either site will be impacted by the proposal as explained below.



Figure 33: Location of previously recorded AHIMS Sites Within or Near Vicinity of Proposal Site

AHIMS #04-2-0187 King Forest 12 recorded by Everick (2012)

This site is listed as destroyed in the AHIMS search.

It was recorded by Everick (2012) on an open sand flat on the northern side of Depot Road and consisted of a low-density scatter of stone artefacts (<1 artefact/sq m). The area at the time it was recorded had been heavily disturbed by activities such as sand mining, road construction, and possibly pine cultivation. The site is approximately 100m from a water source.

Everick noted that, the opinion of the Registered Stakeholders regarding the Cultural Significance of Kings Forest 12 was that, due to the high level of disturbance, artefacts found at the site should be collected and stored in an appropriate Keeping Place.

Everick (2012) recorded a total of eight artefacts on the soils surface, predominantly made of chalcedony and representing two technological classes. It was considered unlikely that these surface artefacts indicate the presence of significant subsurface deposits.

Everick (2012) Management Recommendations:

- Surface collection of artefacts and storage in a suitable Keeping Place (undertaken).
- Further recommendations and details can be found in the Cultural Heritage Assessment and Excavation Reports.

A comparison of the site's location at the time it was recorded by Everick in 2012 and AREA in July 2024 is shown on **Plates 23** and **24**, respectively.

Based on the information available, the site is considered to have been subject to a surface collection, or destroyed, and therefore highly unlikely to be impacted by the proposal.

AHIMS #04-2-0142 KF-CE 1 recorded by Jacqueline Collins in 2005

The site card states the Aboriginal objects were recorded on an undulating plain within a dune landform unit. This is inconsistent with the mapped coordinates which currently places it in the Lamington Volcanic Slopes NSW Landscape / Lismore Basalts geological unit.

The site card also references grassland, revegetation, and forestry, which does not align with the actual landform mapped by the coordinates, as this area is a ploughed agricultural paddock (refer **Plate 25**) as it had been in 2005 upon reviewing historical aerial photography.

The description provided for relocation of the site is similarly inconsistent. The directions indicate: *From Tweed Coast Road south of Cudgen, travel 2.5 km, then turn right onto Depot Road and follow it to the end. Turn right heading west, travel 1 km to a track, then go north for 1.3 km to the end, and turn right along the boundary fence track for 160 m – artefacts are located on the track*. However, the site is plotted off Reardon's Road, which is located at least one kilometre north-west from Depot Road, at the nearest point. (Note – consideration was given to the old Depot Rd being accessed).

The coordinates listed on the site card are inconsistent with the location description on the site card. The site was unable to be relocated at the coordinates provided on the site card during the field survey. The site is likely located within a dune landform unit well away from the where the site is recorded in AHIMS, on the Lamington Volcanic Slopes NSW Landscape / Lismore Basalts geological unit. AHIMS data is known to contain errors for a suite of reasons and requires users to check the source data and ancillary descriptors and not just rely upon the coordinates provided.

It is highly unlikely the site will be impacted by the proposal.



Plate 23 Image from Everick's (2012) AHIMS site card for site 04-2-0187



Plate 24 Image from AREA (2024) showing where site 04-2-0187 is plotted, noting the carparking area is likely where the Everick (2012) photo was taken



Plate 25: Location of previously recorded Aboriginal site 04-2-0142 per AHIMS database (not likely the actual site location)

6.6.2.2 Discussion

The predictive model outlined in **Section 6.6.1.7** provides a solid framework for interpreting the results along the proposal site. The construction methods chosen have been carefully designed to minimise the risk of harm to Aboriginal objects by focusing activities in areas where significant ground surface disturbance has already occurred. The proposed cable alignment has been selected to minimise impacts to local residents and to utilise a highly disturbed corridor. Where sensitive areas are present or technical engineering difficulties arise, underboring is used, which further reduces the potential to impact on Aboriginal heritage.

Cultural heritage values require management for any proposal where they have been identified. Whether an impact is direct, indirect, or possible, Aboriginal sites will require some level of intervention to avoid harm where possible. As a general principal, avoidance of impact to sites of Aboriginal cultural heritage is the preferred method of management and has been implemented in the first instance as evident by both route selection and construction methodology chosen. This is advocated in the Burra Charter (Australia ICOMOS, 2013) as well as various other guidelines and codes of practice.

No Aboriginal objects were recorded during the assessment. While subsurface archaeological remains and unrecorded surface remains are always possible, no unrecorded, intact remains of archaeological significance are predicted to occur in the proposal. Consequently, impacts to Aboriginal objects is not likely to occur. Further archaeological investigation is not considered reasonable given the low likelihood of archaeologically significant remains, the highly disturbed landscape and the scale of the proposal.

6.6.3 ENVIRONMENTAL MITIGATION MEASURES

In order to mitigate any potential impacts on Aboriginal heritage, the following mitigation measures will be employed:

- All construction work would be undertaken within the assessed areas of the proposal site only
- If changes are made to the proposed works which could impact locations outside of the current proposal site, further archaeological investigation may be required.
- If any objects of suspected Aboriginal heritage origin be encountered during the proposed works, work in the area of the find should cease and the unexpected finds protocols should be implemented. Refer Appendix B of the Aboriginal due diligence assessment (attached to this REF as **Appendix F**)
- If suspected human remains are located during any stage of the proposed works, work must stop immediately, and the NSW police must be notified.

6.6.4 CONCLUSION

The proposal is not anticipated to have any impact upon Aboriginal heritage in the area. Given the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low.

6.7 Non-Aboriginal Heritage

6.7.1 EXISTING ENVIRONMENT

Non-Aboriginal heritage refers to any deposit, object or material evidence which relates to the settlement of New South Wales, not being Aboriginal settlement, and is of state or local heritage significance (Section 4 of the Heritage Act).

A desktop search of Australia's World Heritage Sites (Commonwealth DCCEEW, 2024b), National Heritage List (Commonwealth DCCEEW, 2024c), NSW State Heritage Inventory (Heritage NSW, 2024b), and the Tweed LEP was conducted to determine the extent of non-Aboriginal heritage in the vicinity of the proposal.

6.7.2 ASSESSMENT OF IMPACT

A review of the above-mentioned heritage registers indicated no sites of world, national, state or local heritage significance are located within, or intersected by, the proposal site.

The closest items of non-Aboriginal heritage are two locally listed sites on the Tweed LEP:

- Item 22: "Dry Stone Walls", located at 463 Cudgen Road, 501 Cudgen Road (Lots 7 and Lot 8, DP 812933), on the opposite side of Cudgen Road to the proposal site (refer **Plate 26, Figures 34** and **35**)
- Item 101: "High Conservation Value Old Growth Forest", forming part of Cudgen Nature Reserve to the south of the proposal site (refer **Figure 36**).

The above listed sites will not be impacted by the proposal.

6.7.3 ENVIRONMENTAL MITIGATION MEASURES

The following mitigation measures would be applied:

- All construction work would be undertaken within the assessed areas of the proposal site only
- In the unlikely event that a previously unknown heritage site or object is located during construction of the proposal, works would cease immediately in that area and a representative from Essential Energy's Environmental Services would be notified. Works with the potential to disturb the object would not resume until the object had been properly identified, and appropriate action taken.

6.7.4 CONCLUSION

The proposal is unlikely to have a significant impact upon non-Aboriginal heritage in the area. Given the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low.



Plate 26: Local Heritage Item I22, Cudgen dry stone walls 463 & 501 Cudgen Road



Figure 34: Location of local heritage item I22 relative to the proposal site

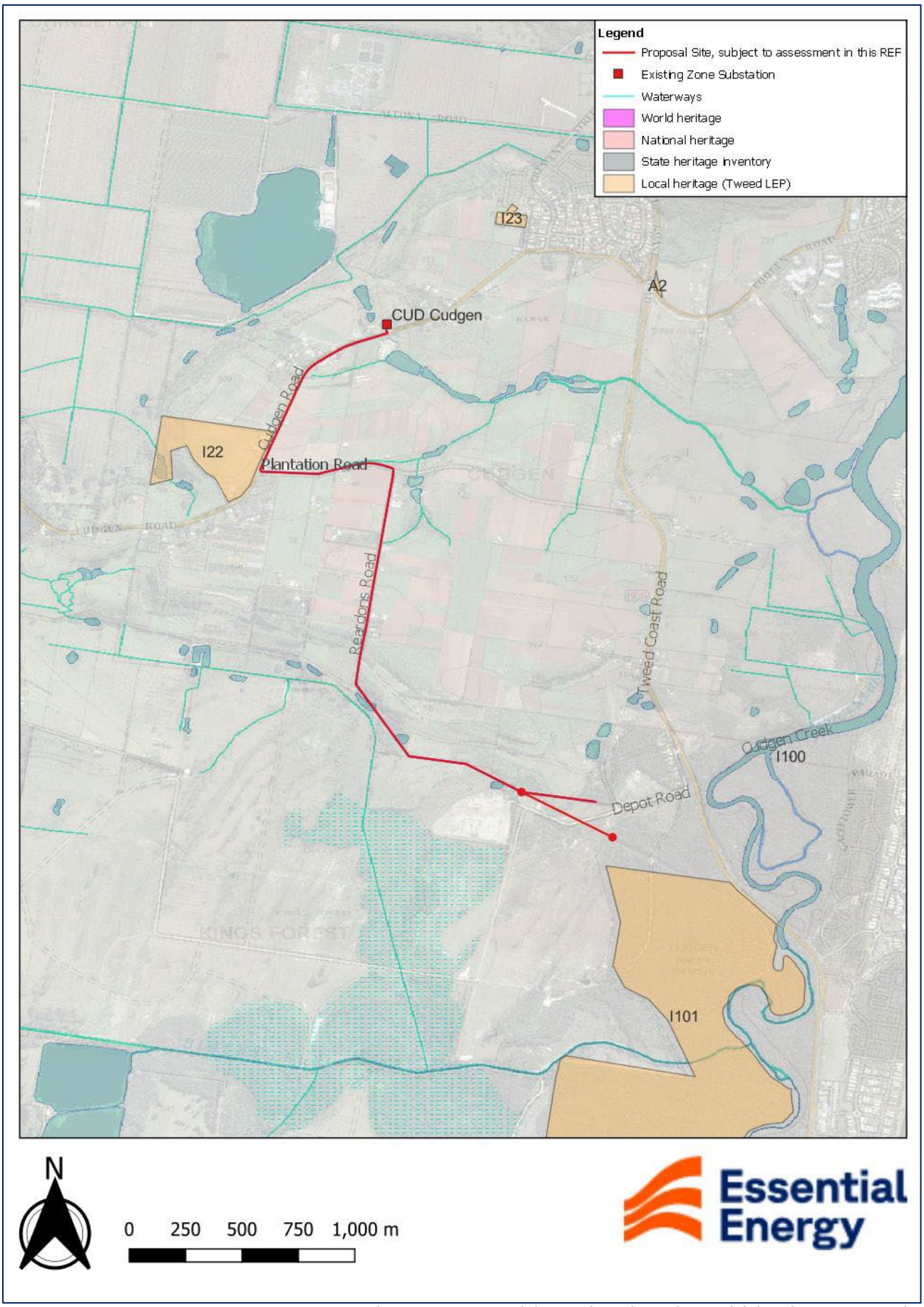


Figure 35: Non-Aboriginal heritage items in the vicinity of the proposal site

6.8 Contamination

6.8.1 EXISTING ENVIRONMENT

A search of the NSW EPA 'Contaminated Land – Record of Notices' (EPA, 2024a) and 'List of NSW Contaminated Sites Notified to EPA' (EPA, 2024b) did not identify any contaminated sites within, or in the near vicinity of, the proposal site.

A search of NSW Department of Primary Industries (DPI) Cattle Tick Dip Site Locator did not indicate any tick dip sites within or in the near vicinity of the proposal site. Two tick dip sites are located in the broader study area landscape (refer **Figure 36**):

- Cudgen Creek (site 1333), located approximately 1km east of the proposal site, on the opposite side of Tweed Coast Road. This site is closed, which according to the NSW Department of Primary Industries (DPI) – Animal and Livestock, means the dip is still standing, capable of dipping operations either immediately or with some minor refurbishment
- South Cudgen (site 374), located approximately 1.4km west of the proposal site, off Cudgen Road. This site has been demolished, which according to NSW DPI – Animals and Livestock, means the dip site has been partially or wholly dismantled or demolished prior to the introduction of the decommissioning policy. In many cases there is no physical signs of the dip ever being there.

While no known contamination is present within the proposal site, current and historical land uses along the route of the proposal may have resulted in the contamination of soils. The northern portion of the proposal site is limited to existing road reserves and powerline corridors. The contaminants that may be encountered potentially include hydrocarbons and heavy metals in and chemicals associated with wood preservation in the immediate vicinity of existing power poles.

The southern portion of the proposal site (from the end of Reardons Road) is located on farming land and the broader Kings Forest development site. It has been heavily modified and disturbed through pervious land uses, including grazing, farm dam construction, sand mining and Slash Pine plantation and harvesting

Gilbert and Sutherland (2011b) conducted a review of a number of contamination studies undertaken between 1992 and 2003 for the broader Kings Forest development site. This preliminary assessment identified a number of areas adjacent to and within the broader development site which had the potential for contamination:

- A capped, decommissioned council landfill site (known as Old Bogangar Road Landfill)
- Northern and southern banana plantations
- A fuel storage area and former nursery
- A former orchard
- A former cattle dip site.

The location of these sites relative to the section of the proposal site as it traverses the Kings Forest development site is presented in **Figure 37**.

Of the above listed sites, the closest to the proposal site are the northern banana plantation located to the west of the proposal site as it approaches the end of Reardons Road, and the Old Bogangar Road Landfill located on the land parcel immediately south of the proposal site, in the vicinity of underbore 2. Soil sampling undertaken by Gilbert and Sutherland (2011b), within the northern Banana plantation area indicated contaminants of concern to be below guidelines adopted at the time of the report.

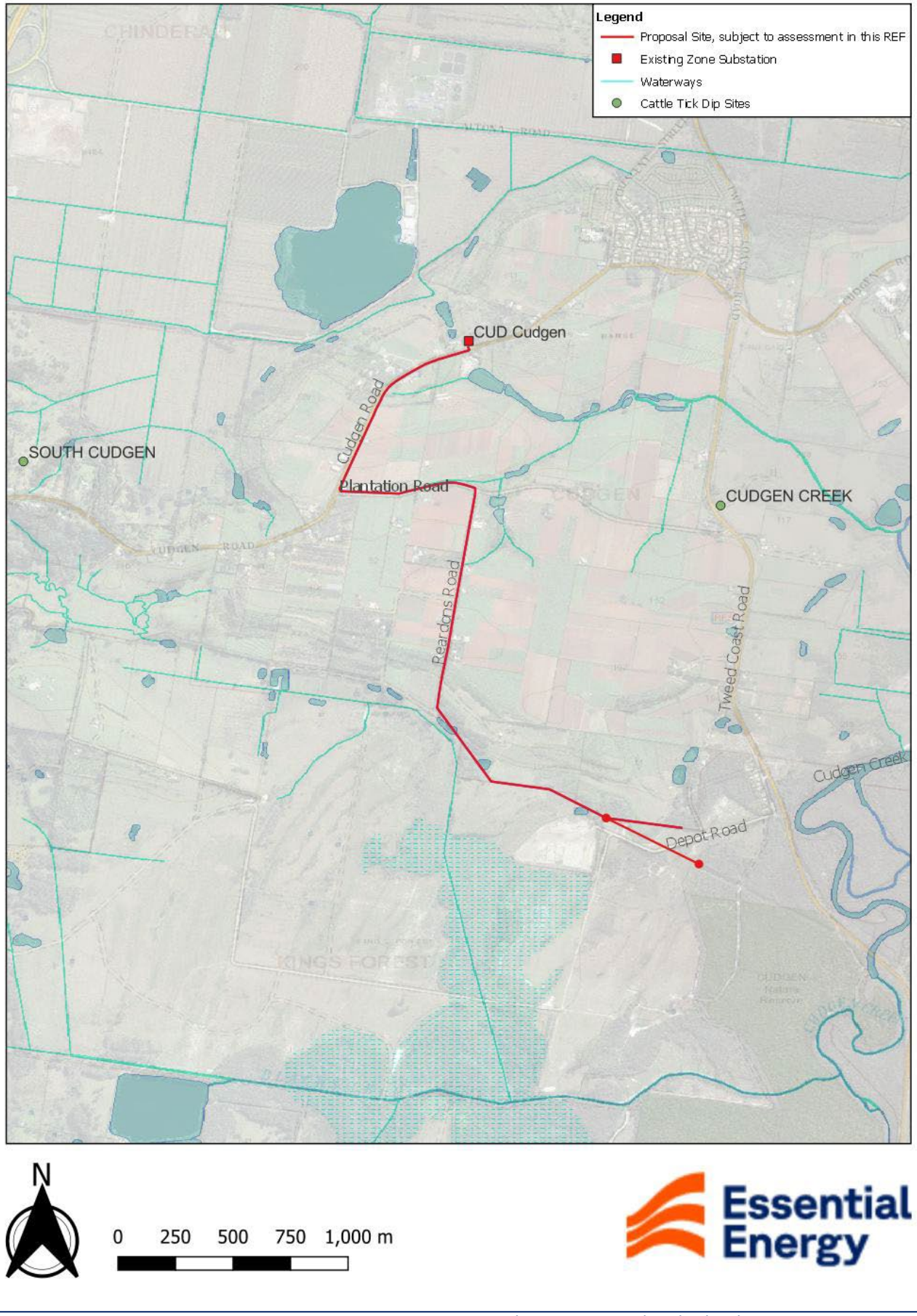


Figure 36: Cattle tick dip sites in the broader study area

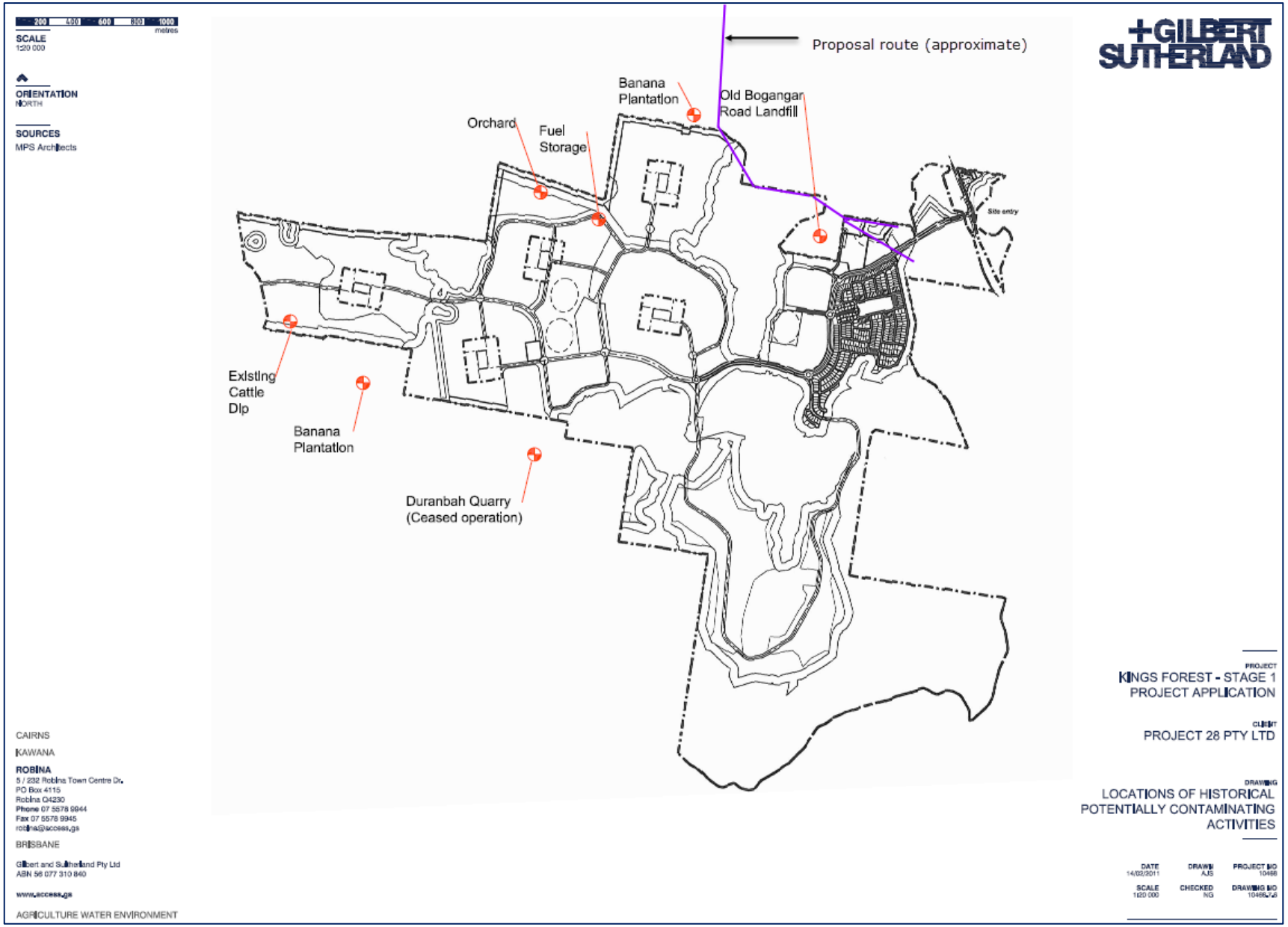


Figure 37: Site of potential contamination identified for the Kings Forest development

According to Gilbert and Sutherland (2011b), the Old Bogangar Road Landfill operated between the 1960's and the mid 1980's when it was closed to public disposal of general waste. Soil and other hard fill was deposited at the site up to 2004, when the landfill was decommissioned and capped by TSC. Given the former landfill's location in close proximity to the broader Kings Forest development it was considered that it had potential to contaminate groundwater within or near the Kings Forest development and therefore required further assessment.

Gilbert and Sutherland (2011b) reviewed several site investigation reports, including groundwater monitoring results, prepared between 2001 and 2008 for the former landfill site. From this review it was identified that landfill leachate might be having some influence on concentrations of nutrients (namely ammonia and nitrate) in two of the groundwater monitoring bores adjacent to the boundary of the landfill site. However, Gilbert and Sutherland (2011b) noted that the ammonia (NH4) is a non-toxic form of ammonia and poses an insignificant risk to human health and a minor risk in environmental impact, given that the water is contained within the groundwater.

Ultimately Gilbert and Sutherland (2011b) concluded that the groundwater associated with the landfill site would have no significant impact upon the boarder Kings Forest development given that groundwater flows in a westerly direction from the Kings Forest site towards and through to the western side of the landfill site, and the land use adjacent to the landfill will be community infrastructure and the likelihood of private or residential and exposure to the leachate will be avoided.

In the EAR prepared for the broader Kings Forest development site (JBA Planning, 2011) it was noted that the broader development site had been historically used for sand mining, with distinctive areas of disturbance found within the eastern portion of the site, in the general vicinity of the proposed ZS site. JBA Planning (2011) indicate that sand mining activity has the potential to give rise to radiation impacts. To support the EAR, Gilbert and Sutherland (2011b) undertook a quantitative radiation assessment (surface radiation survey and sub-surface investigation including 24 boreholes) to assess the potential for radiation within the disturbed areas on the broader Kings Forest Development site. The investigation confirmed that all areas potentially disturbed by sand mining exploration or extraction have been identified and no radioactivity has been identified at levels that would create a health risk, and no further investigation was necessary (Gilbert and Sutherland, 2011b).

6.8.2 ASSESSMENT OF IMPACT

There are no known records of contamination intersecting with the proposal route. Although no known contamination is present along the route, given the historic use of the site for road reserves, powerline corridors in the northern portion, and agricultural use in the southern portion, potential contaminates may include hydrocarbons, heavy metals and chemicals associated with wood preservation, along with insecticides, fungicides and herbicides. However, given the considerable ground disturbance that has taken place through use of the project site as farmland and road reserve, with no known areas of contamination, the risk of encountering significant areas of contamination is considered low, and could be managed on-site during construction.

The potential for offsite sources of contamination to impact the proposal site is considered low. Given the location of the historic banana plantation to the west of the proposal site, and the shallow trenching methodology to be adopted, it is considered unlikely any contamination from this source will be encountered. Any potential groundwater leachate from the Old Bogangar Road Landfill site is unlikely to impact the proposal site as groundwater was determined to flow in a westerly direction from the landfill site (Gilbert and Sutherland, 2011b). The proposal site is located to the north of the former landfill site. The quantitative radiation assessment undertaken by (Gilbert and Sutherland, 2011b) confirmed that all areas potentially disturbed by sand mining exploration or extraction have been identified and no radioactivity has been identified at levels that would create a health risk. It is therefore considered unlikely the proposal would be impacted by radiation or create a radiation exposure.

Spillage of diesel, lubricating oils or other chemicals could occur during refuelling and/or maintenance of construction plant/equipment and vehicles, whilst leakage of fuels or oils could occur from poorly maintained construction plant/equipment and vehicles. Any on-site chemical spill or leak could adversely

affect the water quality of surrounding waterways. The risk of chemical spills and leaks is expected to be minor, provided that adequate mitigation measures are implemented (see **Section 6.8.3**).

6.8.3 ENVIRONMENTAL MITIGATION MEASURES

The following mitigation measures will be adopted if and where required:

- It is intended to reuse surplus spoil beneficially on site, where possible.
- Essential Energy's CEOP8064 Management of Excavated Material; Guideline for Construction Sites will be consulted to determine the most appropriate beneficial reuse or disposal method for excavated materials
- In the event of encountering any suspected contamination in the work area, it will be separated and contained on site until it can be classified in accordance with the EPA (2014) Waste Classification Guidelines, and then disposed of at a facility that is lawfully able to accept the waste
- Control measures will be implemented to manage risks associated with the handling of fuel through using spill trays when undertaking in field re-fuelling
- Sediment and erosion control structures will be established and maintained in accordance with The Blue Book to minimise potential impacts on receiving watercourses.

6.8.4 CONCLUSION

The proposal is not anticipated to have any impact upon contamination in the area. Given the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low.

6.9 Electric and Magnetic Fields

Aurecon (2024) was engaged to undertake an electric and magnetic field assessment for the proposal. The key findings of this assessment are presented below. The full assessment is attached to this REF as **Appendix G**.

6.9.1 EXISTING ENVIRONMENT

6.9.1.1 Introduction

Electric and Magnetic Fields (EMF) are part of the natural environment and are present in the Earth's core and the atmosphere. EMF is also produced wherever electricity or electrical equipment are in use. Powerlines, electrical wiring, household appliances and electrical equipment all produce EMF.

The EMF associated with electrical equipment, whilst interrelated, are not dependent on each other and can exist independently. The electric field is associated with the voltage of the equipment and the magnetic field is associated with the current (amperage). In combination, these fields cause energy to be transferred along electric wires.

An electric field is a region where electric charges experience an invisible force. The strength of this force is related to the voltage, or pressure, which forces electricity along wires. Electric fields are strongest closest 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, so they are readily shielded and, for all practical purposes, do not penetrate buildings. They 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. (WHO, 2007)) Being related to voltage, the electric fields associated with HV aerial lines and electrical substations remain relatively constant over time, except where the operating voltage changes.

A magnetic field is a region where magnetic materials experience an invisible force produced by the flow of electricity (known as electric current and measured in Amperes). The strength of a magnetic field depends on the size of the current and decreases as distance from the source increases. The magnetic field strength resulting from an electrical installation varies continually with time and is affected by a number of factors including:

- The total electric load
- The size and nature of the equipment
- The design of the equipment
- The layout and electrical configuration of the equipment and its interaction with other equipment

While electric fields are blocked by common materials, this is not the case with magnetic fields. This is why locating equipment in enclosures or underground will eliminate any external electric field but not the magnetic field.

Alternating electric and magnetic fields are produced by any electric wiring or equipment carrying alternating current (AC). This current does not flow steadily in one direction but oscillates backwards and forwards at a frequency[1] of 50Hz and hence the fields produced by AC systems oscillate at the same frequency. This frequency falls into a range referred to as extremely low frequency (ELF), so the electric and magnetic fields are referred to as ELF fields.

6.9.1.2 Electromagnetic Radiation

It is not uncommon for the EMF associated with electrical equipment to be confused with electromagnetic radiation (EMR). The fact that, in many jurisdictions, agencies which regulate the various forms of EMR are also involved in the setting of guidelines/standards for EMF tends to add to this confusion.

EMR is a term used to describe the movement of electromagnetic energy through the propagation of a wave. This wave, which moves at the speed of light in a vacuum, is composed of electric and magnetic waves which oscillate (vibrate) in phase with, and perpendicular to, each other. This is in contrast to EMF, where the electric and magnetic components are essentially independent of one another.

EMR is classified into several types according to the frequency of its wave; these types include (in order of increasing frequency): radio waves, microwaves, terahertz radiation, infra-red radiation, visible light[2], ultraviolet radiation, X-rays, and gamma rays. Whereas EMR causes energy to be radiated outwards from its source e.g., light from the sun or radio-frequency signals from a television transmitter, EMFs cause energy to be transferred along electric wires.

In the context of the EMF/health issue, the distinction between EMF and EMR is addressed by the New Zealand Ministry of Health in its public information booklet "Electric and Magnetic Fields and Your Health" (NZ Ministry of Health, 2009) as follows:

> *"The electric and magnetic fields around power lines and electrical appliances are not a form of radiation. The word "radiation" is a very broad term, but generally refers to the propagation of energy away from some source. For example, light is a form of radiation, emitted by the sun and light bulbs. ELF fields do not travel away from their source but are fixed in place around it. They do not propagate energy away from their source. They bear no relationship, in their physical nature or effects on the body, to true forms of radiation such as x-rays or microwaves."*

6.9.1.3 Overview of EMF Health Issue

Research into EMFs and health is a complex area involving many scientific disciplines – from biology, physics and chemistry to medicine, biophysics, and epidemiology. Many of the health issues of interest to researchers are quite rare. In this context, it is well accepted by scientists that no study considered in isolation will provide a meaningful answer to the question of whether or not EMFs can contribute to adverse health effects. In order to make an informed conclusion from all of the research, it is necessary to consider the science in its totality. Over the years, governments and regulatory agencies around the world have commissioned independent scientific review panels to provide such overall assessments.

[1] Frequency is a measure of the number of times per second a wave oscillates or vibrates. The most common unit of measurement of frequency is the Hertz (Hz) where 1 Hz is equal to 1 cycle per second
[2] Visible light is a group (spectrum) of frequencies which can be sensed by the eyes of humans and various other creatures.

Extremely Low Frequency (ELF) Fields

The possibility of adverse health effects due to the EMFs associated with extremely low frequency electrical equipment has been the subject of extensive research throughout the world. To date, while adverse health effects have not been established, the possibility that they may exist cannot be ruled out.

While EMFs involve both electric and magnetic components, electric fields are relatively constant over time, are readily shielded and, in the health context, are generally no longer associated with the same level of interest as magnetic fields. Nevertheless, high electric field strengths, such as those associated with high voltage equipment in major substations can approach a level at which "nuisance shocks" can occur and this phenomenon needs to be managed. Magnetic fields are not readily shielded, are more ubiquitous and remain the subject of some debate. Accordingly, much of the remainder of this section is directed towards magnetic fields.

The most recent scientific reviews by authoritative bodies are reassuring for most potential health issues. However, statistical associations[3] between prolonged exposure to elevated magnetic fields and childhood leukaemia have persisted. This led the International Agency for Research on Cancer (IARC) [World Health Organisation (WHO) IARC, 2001] in 2002 to classify magnetic fields as a "possible carcinogen"[4]

The fact that, despite over 30 years of laboratory research, no mechanism for an effect has been established, lends weight to the possibility that the observed statistical associations reflect some factor other than a causal relationship. This point is made in the 2001 report of the UK National Radiological Protection Board's (NRPB) Advisory Group, chaired by eminent epidemiologist, the late Sir Richard Doll (United Kingdom National Radiological Protection Board, 2001)

> *"In the absence of clear evidence of a carcinogenic effect in adults, or of a plausible explanation from experiments on animals or isolated cells, the evidence is currently not strong enough to justify a firm conclusion that such fields cause leukaemia in children" (page 164)*

6.9.1.4 Health Guidelines for Extremely Low Frequency Electric and Magnetic Fields

The WHO recognises two international EMF/Health guidelines:

- *Guidelines for Limiting Exposure to Time-varying Electric and Magnetic Fields (1Hz to 100kHz)* produced by the International Commission on Non-Ionising Radiation Protection (ICNIRP, 2010)
- *Standard C95.1*, produced by the International Committee on Electromagnetic Safety, Institute of Electrical and Electronics Engineers (IEEE) in the USA.

In July 2015, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) officially adopted the more conservative of the above two, the ICNIRP 2010 Guidelines, in full, stating:

> *"The ICNIRP ELF guidelines are consistent with ARPANSA's understanding of the scientific basis for the protection of the general public (including the foetus) and workers from exposure to ELF EMF."* (ARPANSA, 2015)

In line with the regulator's advice, Essential Energy has applied the current international ICNIRP guideline reference levels to this assessment.

The reference levels for both electric and magnetic fields contained in the current ICNIRP guidelines are summarised in **Table 20**.

[3] It should be noted that a statistical association does not necessarily reflect a cause-and-effect relationship.
[4] IARC publishes authoritative independent assessment by international experts of the carcinogenic risks posed to humans by a variety of agents, mixtures, and exposures.

Table 20: Health Guideline Reference Levels

PARAMETER	ICNIRP 2010 REFERENCE LEVELS
Electric Fields – General Public	5 kV/m (kilovolts per metre)
Electric Fields – Occupational	10 kV/m
Magnetic Fields – General Public	2,000 milligauss (mG)
Magnetic Fields – Occupational	10,000 mG

In applying the guidelines, it is to be noted that, unlike earlier versions, the various limits are now independent of duration of exposure.

It is also important to recognise that the numerical limits, e.g., 2,000 mG, are based on established health effects. In ICNIRP's fact sheet on the guidelines (ICNIRP, 2010), it notes that:

> *"It is the view of ICNIRP that the currently existing scientific evidence that prolonged exposure to low frequency magnetic fields is causally related with an increased risk of childhood leukaemia is too weak to form the basis for exposure guidelines. Thus, the perception of surface electric charge, the direct stimulation of nerve and muscle tissue and the induction of retinal phosphenes are the only well established adverse effects and serve as the basis for guidance."*

Being based on established biological effects (which occur at field levels much higher than those normally encountered in the vicinity of electrical equipment), the (numerical) exposure limits in the guidelines and standards cannot be said to define safe limits for possible health effects, should these exist, from magnetic fields at levels normally encountered in the vicinity of electrical equipment.

It is in this context that precautionary measures for ELF magnetic fields such as "Prudent Avoidance" have arisen.

6.9.1.5 Prudent Avoidance for Extremely Low Frequency Magnetic Fields

Regarding the potential health effects from ELF magnetic fields, while compliance with the relevant guideline is important in protecting people from established health effects, it does not necessarily address possible health effects, should they exist, from fields at levels normally encountered in the vicinity of electrical equipment. The possibility of such effects has been comprehensively studied over several decades worldwide but, to this day, there is no clear understanding of how ELF electric or magnetic fields at low levels could pose a threat to human health.

Since the late 1980s, many reviews of the scientific literature have been published by authoritative bodies. There have also been several inquiries such as those by Sir Harry Gibbs in NSW (Gibbs, 1991) and Professor Hedley Peach in Victoria (Peach, 1992). These reviews and inquiries have consistently found that:

- Adverse health effects have not been established
- The possibility cannot be ruled out
- If there is a risk, it is more likely to be associated with the magnetic field than the electric field

Both Sir Harry Gibbs and Professor Peach recommended a policy of prudence or prudent avoidance, which Sir Harry Gibbs described in the following terms:

> "... [doing] whatever can be done without undue inconvenience and at modest expense to avert the possible risk ..."

In 1999, the United States of America (USA) National Institute of Environmental and Health Sciences (NIEHS) (1999) found:

> *"In summary, the NIEHS believes that there is weak evidence for possible health effects from ELFEMF exposures, and until stronger evidence changes this opinion, inexpensive and safe reductions in exposure should be encouraged." (Page 38)*

The practice of 'prudent avoidance' has been adopted by the (Australian) Energy Networks Association (ENA) and most Australian power utilities, including Essential Energy.

The World Health Organisation has also addressed the notion of prudence or precaution on several occasions, including in its 2007 publication Extremely low frequency fields. Environmental Health Criteria, Vol. 238 (WHO, 2007), which states:

> *"...the use of precautionary approaches is warranted. However, 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."*

It also states:

> *"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."*

Given the inconclusive nature of the science, it is considered that a prudent approach continues to be the most appropriate response in the circumstances. Under this approach, subject to modest cost and reasonable convenience, power utilities and transport authorities should design their facilities to reduce the intensity of the fields they generate, and locate them to minimise the fields that people, especially children, encounter over prolonged periods. While these measures are prudent, it cannot be said that they are essential or that they will result in any benefit.

In the Australian context, ENA's position, as adopted in their EMF Management Handbook (Energy Networks Association, 2016), states:

> *"Prudent avoidance does not mean there is an established risk that needs to be avoided. It means that if there is uncertainty, then there are certain types of avoidance (no cost / very low-cost measures) that could be prudent."*

It also states:

> *"Both prudent avoidance and the precautionary approach involve implementing no cost and very low cost measures that reduce exposure while not unduly compromising other issues."*

6.9.2 ASSESSMENT OF IMPACT

Aurecon (2024) undertook an EMF Assessment to check the EMF levels of the proposed underground cables against the ICNIRP public exposure guidelines as recommended by the ARPANSA. The following summarises the key findings of the assessment.

6.9.2.1 EMF Assessment Model

Input Information

The EMF model calculations are based on the following input data

- Cable details
- Proposed cable loading information for both 33kV and 66kV operation under system normal average, system normal peak, and emergency (N-1) conditions.
- Cable route – The proposed 33/66 kV cable route primarily passes through rural and sparsely populated land, minimising residents' potential exposure to EMF.
- Easement widths
- Existing and proposed cable trench dimensions
- Cable spacing

The cable works have been divided into three cable trench layouts, based on the specific configurations, for analysis, as described in **Table 21**.

Table 21: Cable loading conditions

SECTION	LOCATION	MINIMUM DEPTH TO TOP OF PHASE (mm)	EASEMENT WIDTH (mm)	PROPOSED CABLE
AA	▸ Cudgen Road to Plantation Road ▸ Plantation Road to Reardon Road ▸ Various sections of off-road terrain between Reardon Road and Secret Lane ▸ Along Depot Road until Secret Lane	900	700	3 x 66kV 1C 630mm^2 TRXLPE[1]/HDPE[2]
BB	▸ Cross from West side of Cudgen Road to Plantation Road	900	700	3 x 66kV 1C 630mm^2 TRXLPE/HDPE
CC	▸ Various sections of off-road terrain between Reardon Road and Depot Road	900	350	3 x 66kV 1C 630mm2 TRXLPE/HDPE

1. Tree Retardant Cross-Linked Polyethylene
2. High-density polyethylene

Section AA and section BB follow the cable arrangement shown in **Figure 38**. Section CC follows the cable arrangement shown in **Figure 39**.

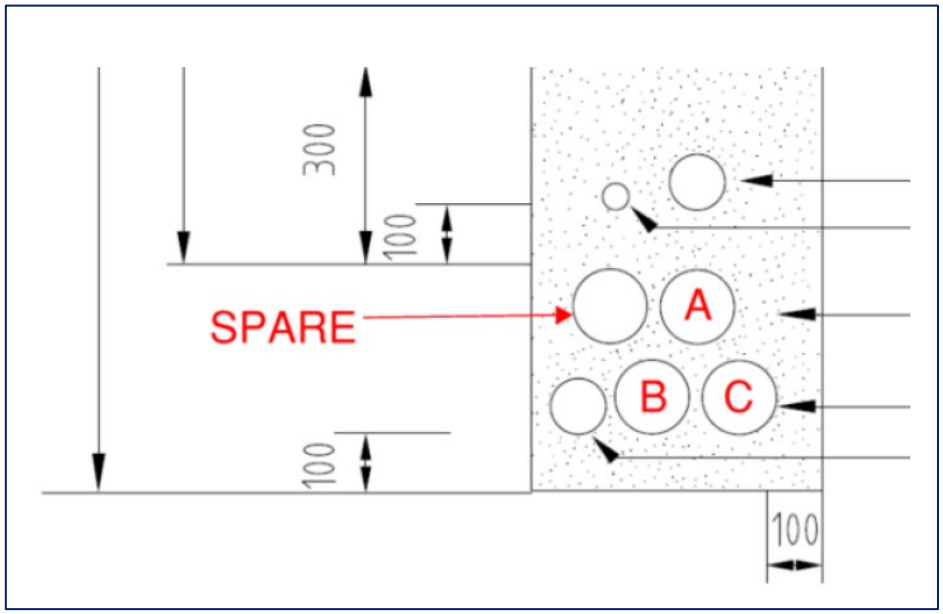


Figure 38: Section AA and section BB cable arrangement

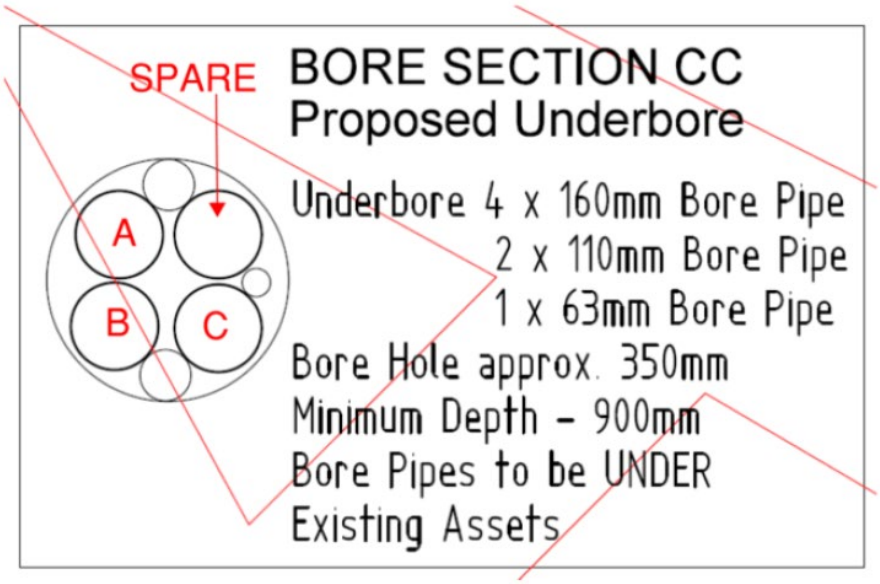


Figure 39: Section CC cable arrangement

Approach

To gain a comprehensive understanding of the magnetic field contributions from the proposed cables, the predicted field levels associated with the various sections of the Kings Forest cable route have been modelled separately as per **Table 21**, using the cable arrangements as per **Figures 39** and **40**.

In selecting the load conditions to be modelled for this assessment, Aurecon has examined the various possible combinations of load currents. For the purposes of reporting, Aurecon has selected the system normal average and maximum load cases as they cover most of the time. Emergency condition (N-1) load cases were also examined to determine the maximum magnetic field contribution experienced under any circumstances.

Based on the design and loading information, the magnetic field contribution of the feeder was modelled using established in-house software, which has been extensively validated against other comparable software.

In all cases, fields have been modelled at a height of one metre above ground level in accordance with international standards.

Data and Assumptions for Modelling

The loadings in the proposed cables have been taken as the system normal average and system normal peak values as applicable and listed in **Table 22.**

Table 22: Cable loading conditions

LOADING CONDITION	33KV OPERATION (A)	66KV OPERATION (A)
System Normal Average[1]	210	170
System Normal Peak	400	330
Emergency (N-1) Peak[2]	630	500

1. System operating at its normal operation and covers most of the time.
2. This is the highest possible loading condition which is estimated to occur 16 hours annually, making it a rare scenario.

As shown in the above table, following uprating to 66kV operation, the magnetic field contributions will decrease. Aurecon (2024) state that this is because, for a given load, the current (A) at 33kV is higher than that at 66kV.

6.9.2.2 EMF Model Results

Magnetic Fields

The results obtained from the magnetic field modelling of the proposed cables, under both 33 kV and 66 kV operation, are shown in the following sections. The magnetic field contributions are presented in the form of profiles indicating the magnetic field contribution along a line across the easement, perpendicular to the proposed cables.

Sections AA and BB

The predicted magnetic fields contributions of the proposed underground cable Sections AA and BB under various loading conditions for 33kV and 66kV operation are shown in **Figure 40**. Under system normal average loading conditions, the predicted magnetic field contribution directly above the cable trench is 27.2mG for 33kV operation and 22mG for 66kV. At a distance 5m from the trench centreline, where the closest dwelling is located, the predicted field decreases to 4.1mG for 33 V operation and 3.3mG for 66kV.

For system normal peak loading conditions, the predicted magnetic field contribution directly above the cable trench is 51.8mG for 33kV operation and 42.7mG for 66kV. At a distance 5m from the trench centreline, where the closest dwelling is located, the predicted field decreases to 7.8mG for 33 kV operation and 6.4mG for 66 kV.

Under contingency maximum loading conditions, magnetic field contributions of up to 1.6 times those shown in **Figure 40** could be experienced for short periods.

Section CC

The predicted magnetic field contributions along the proposed underground cable Section CC under various loading conditions and 33kV and 66kV operation are shown in **Figure 41**. Under system normal average loading conditions, the predicted magnetic field contribution directly above the cable trench is 25.0mG for 33kV operation and 20.2mG for 66kV. Section CC is not installed near any dwellings, nor is it anticipated that any future dwellings will be located near this section of the proposed cable route.

For system normal maximum loading conditions, the predicted magnetic field contribution directly above the cable trench is 47.5mG for 33kV operation and 39.2mG for 66kV.

Under emergency loading conditions, the predicted magnetic field contribution directly above the cable trench is 1.6 times the system normal peak magnetic field contribution for 33kV and 1.5 times for 66kV.

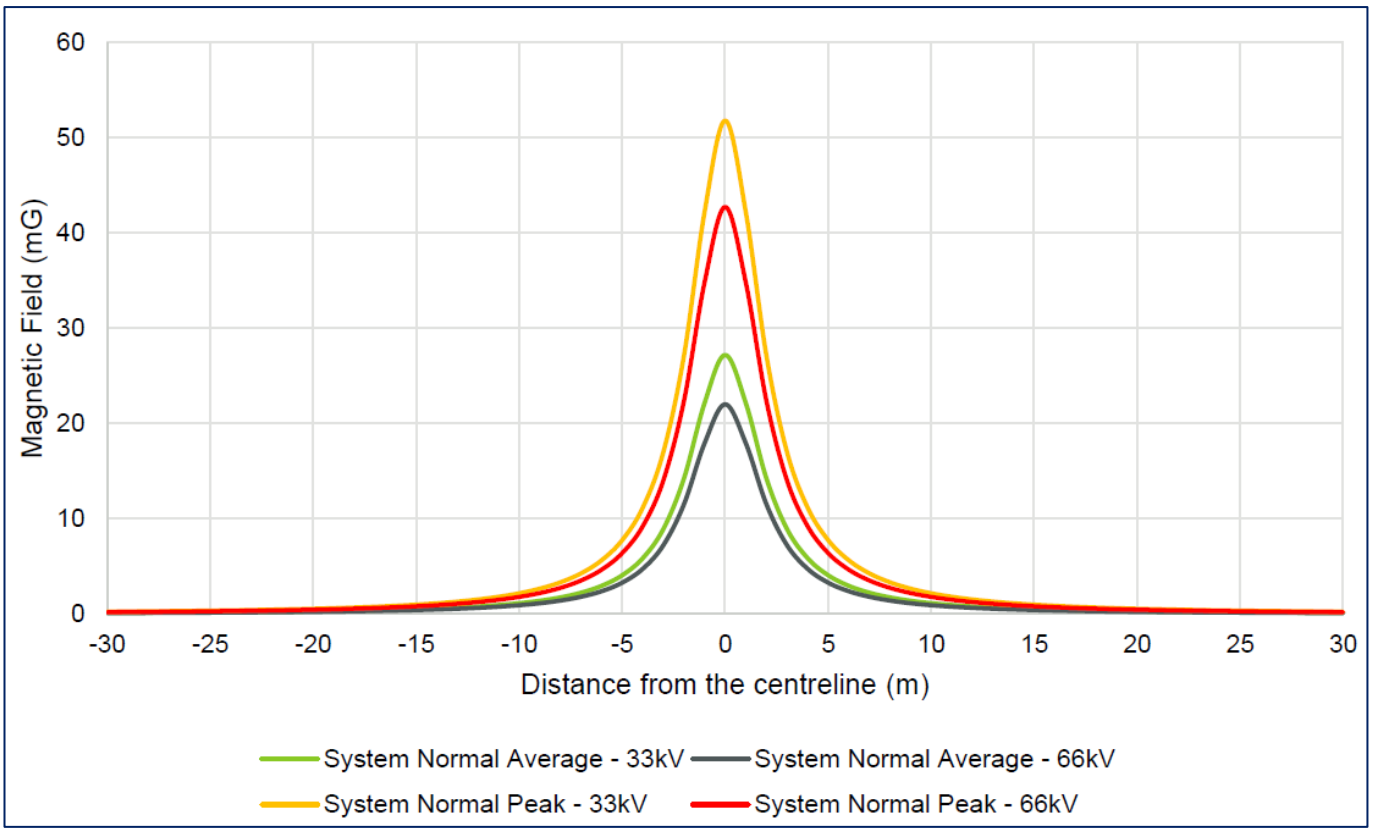


Figure 40: Predicted magnetic field profile for section AA and section BB under 33kV and 66kV operation

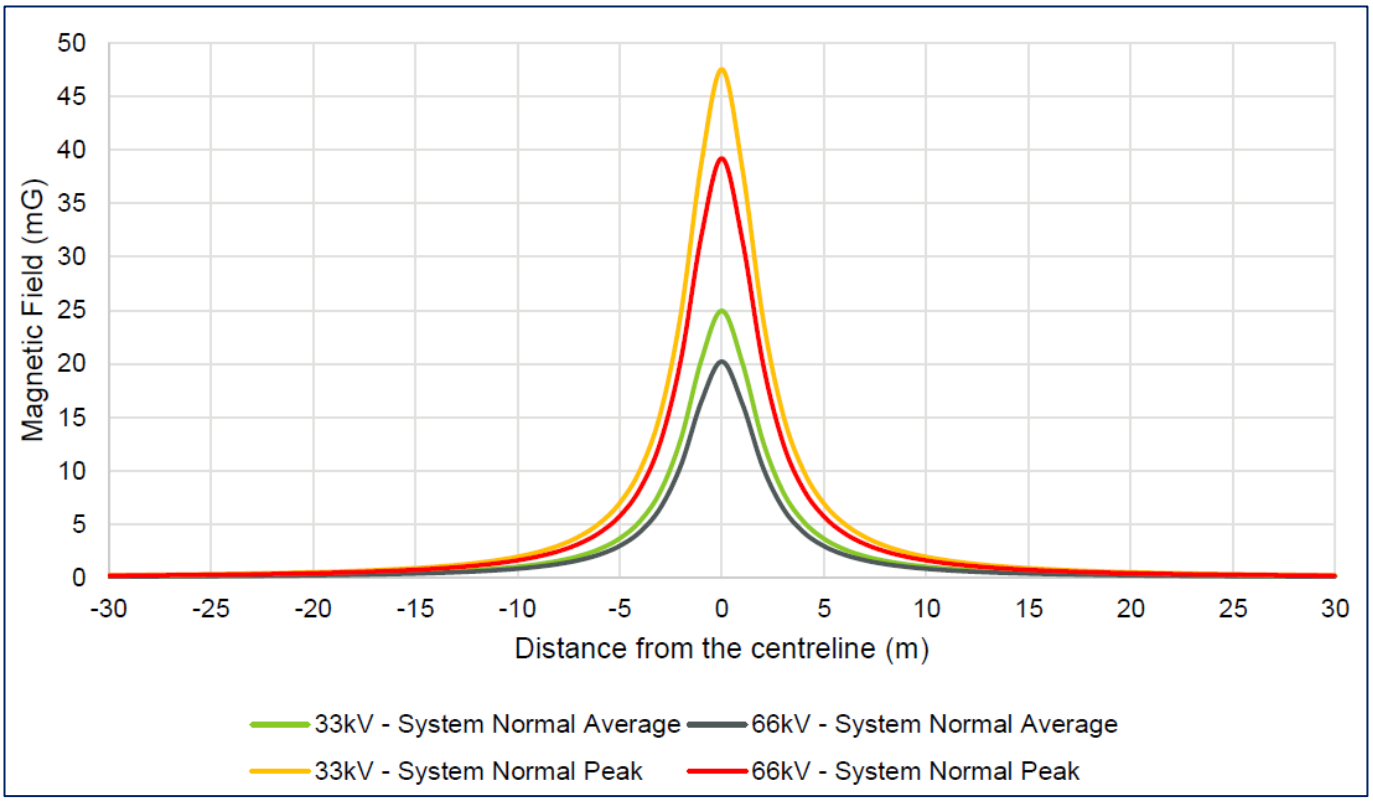


Figure 41: Predicted magnetic field profile for section CC under 33kV and 66kV operation

The modelled relevant magnetic field contributions directly above the cable are summarised in **Table 23** below.

Table 23: Summarised magnetic field contributions directly above the cable.

CABLE SECTION	VOLTAGE	ICNIRP GUIDELINE REF. LEVEL	SYSTEM NORMAL AVERAGE		SYSTEM NORMAL PEAK		EMERGENCY PEAK LOAD	
			MODELLED MAGNETIC FIELD (mG)	% OF ICNIRP GUIDELINE REF. LEVEL	MODELLED MAGNETIC FIELD (mG)	% OF ICNIRP GUIDELINE REF. LEVEL	MODELLED MAGNETIC FIELD (mG)	% OF ICNIRP GUIDELINE REF. LEVEL
Section AA & BB	33	2,000	27	1.4	52	2.6	82	4.1
	66	2,000	22	1.1	13	2.1	65	3.2
Section CC	33	2,000	25	1.3	48	2.4	75	3.7
	66	2,000	20	1.0	39	2.0	59	3.0

As shown in **Table 23**, the highest predicted magnetic field contribution of the proposed underground cable (during emergency peak load) is less than 4.1% of the ICNIRP Guideline Reference Level directly above the proposed cables under 33kV operation, and less than 3.7% under 66kV operation.

It can also be seen that the magnetic field contribution under 66kV operation are lower than those for 33kV operation. As stated above this is due to the load current during 33kV operation being higher than for 66kV operation.

Electric Fields

Aurecon (2024) have stated that due to the underground cable construction methodology, the electric fields associated with the cables will be contained within cable itself and, accordingly, the proposed cable will not produce external electric fields.

6.9.3 ENVIRONMENTAL MITIGATION MEASURES

No electric fields are expected to be generated and predicted magnetic fields levels are well below the adopted ICNIRP guidelines. As such no specific mitigation measures are recommended. Notwithstanding, Essential Energy has adopted the policy of prudent avoidance and, in this context, over the course of the project, has or will:

- Adopted an underground cable design rather than overhead powerlines.
- Installed the cable as far as practicable from dwellings.
- Selected the proposed cable route to pass primarily through rural and sparsely populated land, minimising potential EMF exposure to residents.
- Overtime the cable will be uprated to operate at 66kV, thereby reducing the load currents and, hence, its magnetic field contribution.

6.9.4 CONCLUSION

The proposal will comply with all relevant national and international guidelines. No electric fields are expected to be generated and predicted magnetic field levels are well below the adopted ICNIRP Guideline Reference Levels. The overall environmental risk is considered to be low.

6.10 Visual and Aesthetics

6.10.1 APPROACH

The following visual amenity assessment approach was applied to evaluate the potential visual impacts associated with the project. It is based on a professionally recognised system developed by the United States Forest Service (1974), and similar methods adopted by the Forestry Commission of Tasmania (1983) and the NSW Department of Planning (1980).

The approach used in this assessment is as follows:

- The existing visual environment of the site is described (in terms of landscape character, scenic quality, visual and landscape sensitivity and major view points);
- A brief description is made of the proposed visual changes; and
- An impact assessment is then undertaken, assessing both the changes to the site itself, and any impacts to views from surrounding areas.

The visual impact of the proposed activity has been determined though the interaction of visual modification and visual sensitivity. These are discussed in more detail in the following sections. The 'visual impact matrix', illustrated in **Table 24** is used to determine the potential visual impact of the proposed activity by combining a ranking of high, medium and low for both visual modification and visual sensitivity.

Table 24: Visual Impact Matrix

		VISUAL SENSITIVITY		
		High	**Medium**	**Low**
VISUAL MODIFICATION	**High**	**High Impact**	**High Impact**	**Moderate Impact**
	Medium	**High Impact**	**Moderate Impact**	**Minor Impact**
	Low	**Moderate Impact**	**Minor Impact**	**Minor Impact**

6.10.1.1 Visual modification

Visual modification expresses the visual interaction between the proposal and the existing visual environment. It is the visual contrast between pre and post-development, and is a combination of the appearance of the development (size, form, colour, texture), absorptive capacity of the landscape setting, and the distance from which the development is viewed. Visual modification is expressed here as high, medium or low.

High visual modification

A high degree of visual modification would result if the proposed developments are a major element and contrast strongly with the existing landscape. The contrast is likely to occur if there is little or no natural screening or integration created by vegetation, or if there is an open plain. For example, powerlines passing over vegetated ridge tops also usually represent a high visual modification, particularly if it is a new powerline passing through otherwise undisturbed vegetated terrain and the viewer is parallel to the line.

Medium visual modification

A medium degree of visual modification would result if the proposed developments are visible and contrast with the landscape but are integrated to some degree. This would happen if the surrounding vegetation and/or topography provide some measure of visual screening, backgrounding or other form of visual integration of the development with its setting. An example of a medium visual modification is an urbanised streetscape with existing powerlines and/or established trees on the roadside.

Low visual modification

A low degree of visual modification occurs if there is minimal visual contrast and a high level of integration of size, form, colour or texture between the development and the environment. This would occur if there is a high degree of visual integration of the development into the existing landscape or a low level of visual modification of the existing visual setting is achieved. A low visual modification may reflect a situation where the development may be noticeable, but it does not markedly contrast with the existing landscape, as is the case with upgrading existing powerlines.

Throughout the study area, the degree of visual modification is highly dependent on the distance the viewer is from a new development. As the distance from the new development to the viewing location increases, the development becomes less prominent, and therefore its visual modification is less.

Visual modification is also affected by the angle at which a new development is viewed. In general, the visual modification when viewing the new development at right angles is less than when viewing in parallel, depending on the distance from the new development.

6.10.1.2 Visual Sensitivity

Visual sensitivity is a measure of how critically a change to the existing landscape would be viewed from various viewpoints. This is dependent on a number of viewer characteristics, such as the number of viewers affected, land use, existing vegetation patterns, distance of the development from viewers, and the visibility of the development from critical viewing locations.

High visual sensitivity

Occupiers of residential properties with long viewing periods adjacent or within close proximity to the proposal. High sensitive areas can also apply to users of outdoor recreational areas, including reserved land or nature recreation such as walking, swimming, fishing or trail riding. This is particularly the case where their attention is focussed, in part, on the landscape and amenity that is being affected by the proposed development.

Medium visual sensitivity

Medium sensitivity would apply to circumstances in which viewers have intermittent exposure, such as outdoor workers and outdoor recreation users, however, for the recreational user, attention is focussed predominantly on the activity they are viewing, such as a sporting event, rather than the proposed development. In addition, medium sensitivity would also apply to occupiers of residential properties with long viewing periods at a distance from or partially screened from the proposed development or project area.

Low visual sensitivity

Low sensitive viewers include predominantly those groups that have a short term view of the proposed development. This would be limited to mainly road users, trains or transport routes that are passing through or adjacent to the study area. Low sensitivity would also apply where viewers are adequately screened from the proposed development so that their viewing periods are limited to short periods.

6.10.2 EXISTING VISUAL ENVIRONMENT (LANDSCAPE DESCRIPTION)

The proposal site can be separated into two distinct terrain types comprising undulating residual hills over the northern portion and low-lying undulating aeolian and alluvial profiles over the southern portion. The boundary between the two terrain types is clearly defined by the plunging south facing slopes that terminate at the coastal wetlands associated with the aeolian and alluvial profiles (refer **Figure 15**).

The northern portion of the proposal site is situated on cleared and disturbed land associated with the road reserves of several local roads. The surrounding land is also predominately cleared and used for agricultural purposes. The southern portion proposal site intersects with a mixture of vegetated and cleared rural land, as well as passing adjacent to, and/or intersecting with, two farm dams and a small section of mapped coastal wetland.

There are a number of rural and rural-residential residences located immediately adjacent to the northern portion of the proposal site along Cudgen, Plantation and Reardons Roads. Distances to sensitive receivers from the northern portion of the proposal site range from approximately 5m to 30m. The closest sensitive receivers to the southern portion of the proposal site are rural residences between approximately 130m and 140m away.

6.10.3 ASSESSMENT OF IMPACT

6.10.3.1 Visual modification

The proposed new electricity and communication cables will be installed underground. In the short-term there will be a high degree of visual change associated with site preparatory and civil works associated with excavation, trenching, underboring, and auguring of holes for the two new UGOH poles. Once disturbances areas are reinstated, over the longer term there will be negligible to no visual changes with operation of the underground cables. Installation of the new UGOH poles will have a high degree of integration with the existing overhead network. The proposal will also result in the removal of approximately 460m section (three spans, two poles) of existing overhead high voltage powerline.

As such, visual modification is expected to be medium to high over the short term, and low over the longer term.

6.10.3.2 Visual sensitivity

The northern portion of the proposal site, as it extends along the road reserves of Cudgen, Plantation and Reardons Road, traverses in close proximity (approximately 5m-30m) to a number of rural and rural residential premises. The proposal site intersects with driveways of the majority of these residences. There are less sensitive receivers located along the southern portion of the proposal site. These receivers are also located at greater distances (approximately 130-140m) from the proposal site, with limited views to the proposal site due to surrounding vegetation restricting views.

In the short term (i.e., during construction) visual sensitivity of the proposal from the perspective of sensitive receivers along Cudgen, Plantation and Reardons Road is considered medium. Over the longer term, after construction work has been completed, the new underground cables are in operation and ground disturbance areas reinstated, visual sensitivity from these receivers is expected to be low. Installation of the two new UGOH poles will be located on land forming part of the overall Kings Forest development site and within an existing overhead powerline corridor. The UGOH poles will be situated on land away from future residential land use, and as such visual sensitivity is expected to be low.

6.10.4 SUMMARY OF POTENTIAL IMPACTS

Visual modification has been assessed as being medium to high over the short term and low over the longer term, whilst visual sensitivity is considered to be medium of the short term and low over the longer term. In accordance with the visual impact matrix, the proposed activity is likely to result in moderate to high visual impact over the short term, with a minor visual impact over the longer term.

Whilst the proposal has been determined to have a moderate to high visual impact over the short term, permanent, longer term visual impacts will be negated by installing the cables underground. The proposal will also have a positive visual impact by removing a 460m section of existing overhead powerline.

6.11 Waste

6.11.1 ASSESSMENT OF IMPACT

Waste material generated from the proposal would generally comprise the following:

- General construction waste including but not limited to cardboard, paper, wood, mesh, steel, concrete, and other damaged or excess construction materials
- General refuse generated by personnel including putrescible wastes, food scraps, packaging and other domestic wastes

- Surplus excavated soil material from cut and fill (although not expected), excavation and trenching works
- Two redundant timber poles, and approximately 460m of redundant overhead powerlines.

Any surplus soil that cannot be reused on site will be assessed against the virgin excavated natural material (VENM) criteria, any relevant waste exemption and order, or classified and disposed of at a facility lawfully able to accept the waste.

Operation of the proposal is not expected to generate any substantial quantities of waste material.

6.11.2 ENVIRONMENTAL MITIGATION MEASURES

The following mitigation measures will be employed to minimise and manage impacts to waste:

- All wastes that are generated as a result of the project that require offsite disposal will be classified in accordance with the Waste Classification Guidelines (EPA, 2014)
- All waste material will be reused, recycled, or disposed of at a facility lawfully capable of receiving the waste.

6.11.3 CONCLUSION

The proposal is not anticipated to generate a large quantity of waste. Given the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low.

6.12 Bushfire

6.12.1 EXISTING ENVIRONMENT

The northern portion of the proposal site is not located on mapped bushfire prone land. The southern portion of the proposal site is located on land mapped as Category 1 and 2 vegetation, with vegetation buffers (refer **Figure 42**)

6.12.2 ASSESSMENT OF IMPACT

The northern portion of the proposal comprises the installation of underground cables within the road reserves of Cudgen, Plantation and Reardons Road, where short grass cover is the predominate vegetation type, and outside mapped bushfire prone areas. In the southern portion of the proposal site, the cables will be installed primarily using underbores, with small sections of trenching in between. These areas are mapped as Category 1 and 2 vegetation, with vegetation buffers.

The proposal is consistent with the performance criteria listed for electricity services in the Planning for Bushfire Protection: A guide for councils, planners, fire authorities and developers (Rural Fire Service, 2019), as being installed underground, operation of the cables limits the possibility of ignition.

6.12.3 ENVIRONMENTAL MITIGATION MEASURES

During construction, activities with the potential to generate a spark will be avoided, where possible, in the bushfire prone areas, during times of heightened bushfire risk.

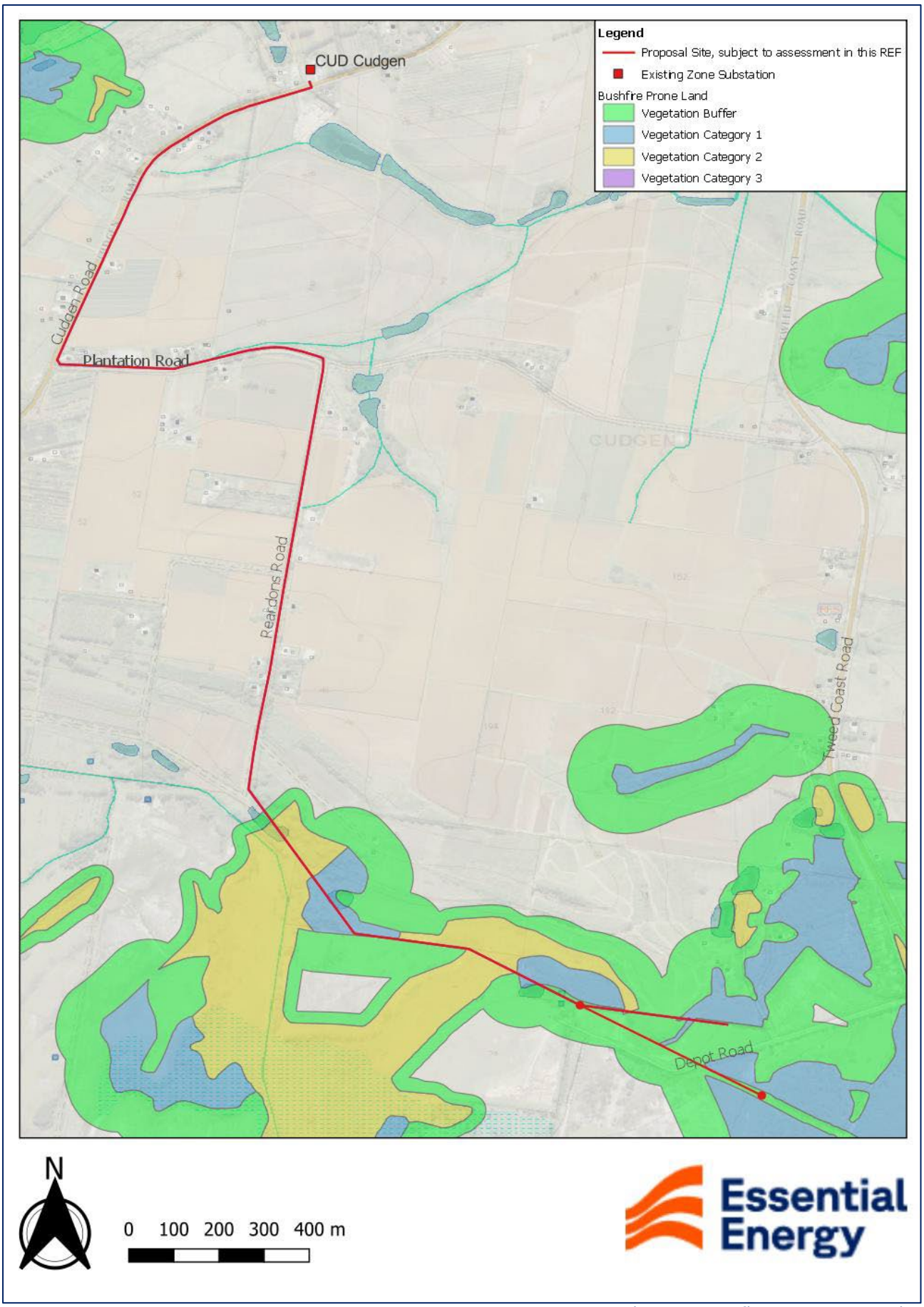


Figure 42: Bushfire Prone Land Mapping

6.13 Traffic and Access

6.13.1 EXISTING ENVIRONMENT

The proposal site is located in a rural setting, dominated by cleared paddocks used for cropping and grazing. The northern portion of the proposal site is situated on cleared and disturbed land associated with the road reserves of Cudgen, Plantation and Reardons Roads. Tweed Coast Road, serving as the main distributor of traffic in the local area between Kingscliff in the north and Hastings Point / Pottsville in the south, is located approximately 475m east of the proposal site at its closest point, though it is mostly further away than this. Depot Road is located immediately adjacent and intersected by the proposed works (removal of aboveground infrastructure) at the southern extent. Depot Road is being decommissioned and will be replaced and realigned with the new Kings Forest Parkway, currently being constructed as part of the Kings Forest development. Mccollums Road, an unsealed road, is located west of the proposal site, at its junction with the end of Reardons Road, in the vicinity of the entry area for underbore 1.

6.13.2 ASSESSMENT OF IMPACT

The northern portion of the proposal site can be accessed via Cudgen, Plantation and Reardons Roads, and associated road reserves. The southern portion of the proposal site will be accessed via existing overhead powerline corridors, Depot Road (which will become the new Kings Forest Parkway), and private property, including Leda owned land forming part of the Kings Forest Development.

During construction, the work site will receive multiple vehicle movements per day ranging from light utility vehicles through to heavy commercial machinery, trucks and semitrailers. Local road users may be subject to minor delays during the delivery of equipment or materials to the proposal site.

Temporary closure of the eastern extent of Mccollums Road, at the intersection with the southern end of Reardons Road, may be required during underbore work activities.

During operation, the proposal would only be accessed irregularly by maintenance personnel.

The proposal would not strain the capacity of the road system or have significant negative impact on the existing condition of the road assets.

6.13.3 ENVIRONMENTAL MITIGATION MEASURES

The following mitigation measures will be employed:

- A Traffic Management Plan (TMP) for the construction phase would be prepared prior to works commencing. The TMP would outline requirements for the safe and continued use of local transport corridors during construction
- If temporary closure of the eastern extent of Mccollums Road, at the intersection with the southern end of Reardons Road, is required to facilitate underbore works, local road users will be advised in advance through signage and consent obtained from the TSC.

6.13.4 CONCLUSION

The proposal would have traffic and access impacts during construction and maintenance operations. The impacts would be short-term and minor. Upon implementation of the mitigation measures outlined in this assessment, the overall environmental risk is considered to be low.

6.14 Land Use

6.14.1 EXISTING ENVIRONMENT

The NSW Landuse 2017 map captures how land in the state is utilised across various sectors such as residential, commercial, agricultural, industrial, and conservation. The NSW State Land use maps the following land uses that are intersected by the proposal:

- Nature conservation
- Grazing native vegetation
- Plantation forests
- Grazing modified pastures
- Cropping
- Perennial horticulture
- Seasonal horticulture
- Land in transition
- Residential and farm infrastructure
- Transport and communication
- River
- Other minimal use

The northern portion of the proposal site from Cudgen ZS to approximately the end of Reardons Road is zoned RU1 – Primary Production according to the Tweed LEP 2014. The southern portion of the proposal site, as it traverses Leda owned land is zoned 7(a) – Environmental Protection (Wetlands and Littoral Rainforests), 7(l) – Environmental Protection (Habitat), and 2(c) – Urban Expansion according to the "State Environmental Planning Policy (Major Development) 2005 Kings Forest Land Application Map", listed in *State Environmental Planning Policy (Precincts—Regional) 2021*.

6.14.2 ASSESSMENT OF IMPACT

The majority of the proposal is located within the existing road reserves of Cudgen, Plantation and Reardons Road, or within an existing overhead powerline corridor. Essential Energy will be seeking new easements, or updated easement conditions for the parts of the underground cable located on private property in the southern portion of the proposal site.

Some sections of the southern portion of the proposal site are located within land zoned 7(a) – Environmental Protection (Wetlands and Littoral Rainforests), 7(l) – Environmental Protection (Habitat), and 2(c) – Urban Expansion. Under Part 4 of the EP&A Act, development within these land use zones would require development consent. However, application of the T&I SEPP overrides the need to consider zoning controls, as developments covered by the T&I SEPP are permissible on any land without consent. Consideration of the ecological values within land zoned 7(a) and 7(l), including an assessment of potential impacts to threatened species, populations, communities, and their habitats has been undertaken in **Section 6.5** and **Appendix E** of this REF.

6.14.3 ENVIRONMENTAL MITIGATION MEASURES

The following measures should be adhered to during the construction phase of the proposed activity:

- Consultation about the proposed works and schedule will be undertaken with nearby residential receivers, where required
- The site should be left in a tidy condition at the conclusion of construction activities.

6.14.4 CONCLUSION

Any impacts on land use are likely to be low and manageable. Given the nature of existing land uses and proposed future use of the surrounding area, the overall environmental risk is considered to be low.

6.15 Social and Economic

6.15.1 EXISTING ENVIRONMENT

The proposal site is located on the far north coast of NSW, within the Tweed LGA, in an area referred to as Kings Forest. The nearest population centres to the proposal site are Cudgen and Kingscliff, located approximately 760m and 2.2km northeast of the northern extent of the proposal site, respectively; South Kingscliff Beach and Casuarina, are located approximately 2.3km and 1.4km east of the eastern extent of the proposal site, respectively. Cabarita Beach / Bogangar is located approximately 4.5km to the south of the southern extent of the proposal site. The Queensland / NSW border is located approximately 10km north of the northern extent of the proposal site, at its closest point.

According to the 2021 Census, the Tweed Shire usual resident population was 97,392, living in 44,661 dwellings, with an average household size of 2.35. The TSC Estimated Resident Population (ERP) for 2022 was 97,969, with a population density of 74.80 persons per square km. In 2021, Tweed Shire had lower proportion of children (under 18) and a higher proportion of persons aged 60 or older than Regional NSW. The largest age group in Tweed Shire was 60 to 64 year olds. The group that changed the most since 2016 was 70 to 74 year olds, increasing by 1,141 people. The three largest ancestries in Tweed Shire in 2021 were English, Australian and Irish. In 2021, 15.4% of people in Tweed Shire were born overseas, compared with 12.2% in Regional NSW (id consulting pty ltd, 2021).

In 2021 40,681 people living in Tweed Shire were employed, of which 50% worked full-time and 42% part-time. More Tweed Shire residents worked in health care and social assistance than any other industry in 2021, accounting for 17.4%. Construction and retail trade were the next two largest industry sectors, employing 11.8% and 10.3% of the workforce, respectively. There were more professionals in Tweed Shire in 2021 than any other occupation, accounting for 19.4% of all occupations. Technicians and trade workers, followed by community and personal service workers accounted for 15.4% and 14.1 % of occupations, respectively (id consulting pty ltd, 2021).

TSC (2020b) has indicated the projected population growth and corresponding need for development in the Tweed over the next 20 years is significant. Much of this growth is likely to be concentrated in the new urban release areas of Cobaki Lakes, Kings Forest and Dunloe Park. These growth areas span Tweed's coastal range from north to south and have been in the planning for over two decades. This coastal concentration of growth adjacent to existing urban areas will augment the Tweed's already diverse urban communities (TSC, 2020b).

Gold Coast Airport serves as the major international access to the Tweed and also offers daily domestic services across Australia. The Tweed gains many advantages from its proximity to southeast Queensland and the Gold Coast, including a range of services and employment opportunities for Tweed residents that do not exist in many other regional areas within the State. Up to 23% of the Tweed's working population cross the border for employment in Queensland each day, while 17% of people working in the Tweed live in Queensland. The Tweed is a hub for tourism activity, being positioned between the Gold Coast and Byron Shire (TSC, 2020b).

According to the *Tweed Community Strategic Plan 2022 – 2032* (TSC, 2022), access to more affordable housing was one of the top three priority issues raised by the community for the Tweed over the next 10 years. The Tweed LGA is categorised as one of 25 LGAs in NSW which has a high need for affordable housing. The need relates to housing for both rental and purchase, however the most significant need is for affordable rental accommodation for existing low and very low income households in the locality (JBA Planning, 2011). Furthermore, pending the opening of a new $725 million hospital in the Tweed, concerns have been expressed over the ability to attract enough personnel to the region to staff the new hospital. Housing affordability and availability can be a significant barrier to attracting and retaining vital healthcare workers.

6.15.2 ASSESSMENT OF IMPACT

An improvement to the electricity supply network provides many benefits to the broader community through a secure and reliable electricity supply. The construction and operation of the new underground cables will be undertaken primarily within the road reserves of several local, roads, with some sections in the southern portion of the proposal site located on private property, including on Leda owned land, within the broader Kings Forest development site.

In the absence of further augmentation to the high voltage supply network, there is an increased risk of supply interruptions, and it is unlikely that further development of the Kings Forest could proceed. This would detrimentally impact on economic and social development of the region, and potentially prove to be disruptive to existing commercial enterprises and to residences throughout the local area.

TSC has adopted a number of strategic plans relating to housing and employment lands, including but not limited to *Tweed Shire Council Local Strategic Planning Statement – 2020* (TSC, 2020b), *Tweed Urban and Employment Land Release Strategy 2009* (TSC, 2009). The Kings Forest development features prominently in the plans, recognising the importance of the master planned development to council for providing affordable housing and employment opportunities. The Kings Forest development is also recognised in the NSW State Government's *North Coast Regional Plan 2041* (NSW DPE, 2022).

Construction, operation and maintenance of the new underground cables forms an integral component to the KFHVSP that will service the broader Kings Forest development. Through the KFHVSP, the proposal indirectly supports Planning Priority 15 of TSC's *Local Strategic Planning Statement – 2020* (TSC, 2020), to deliver housing supply and infrastructure to meet the needs of a growing population, and Objective 2 of the *North Coast Regional Plan 2041*, to provide for more affordable and low cost housing (NSW DPE, 2022).

The proposal is unlikely to affect community resources; this may include the use of community infrastructure roads, water, and waste management services. The proposal is unlikely to cause substantial change or disruption to the community through loss of neighbourhood cohesion, access to facilities, community identity, or cultural character. Furthermore, timing of construction will aim to coincide with civil and other site preparatory works for the broader Kings Forest development. While this will negligibly add to cumulative impacts of current construction works at the broader Kings Forest development site, it will lessen the impacts on future residents of the broader development, as it is planned to have the KFHVSP constructed and operational prior to occupation of houses in the planned nearby future residential subdivisions.

Electricity is an essential service in the human environment, by enhancing productivity, comfort, safety, health and the economy. The benefits of a secure and reliable electricity supply are evident in every aspect of our lives. Construction and operation of the new underground cable, forms an integral component to KFHVSP, required to supply electricity to the broader Kings Forest development. It will ensure the local electricity infrastructure meets the current and future needs for the new Kings Forest development. The new underground cable will also strengthen Essential Energy's existing electricity network in the broader area, as well as increase its capacity, which will help support future electricity connections. The Kings Forest development will allow thousands of new customers to connect to Essential Energy's network, which will ultimately contribute to reducing electricity prices for all customers and increase reliability.

6.15.3 MITIGATION MEASURES

The following mitigation measures will be employed to manage and minimise potential negative social and economic impacts:

- Management of construction traffic in the vicinity of construction works, including communication with existing local residents and road users
- Signs and barriers would be erected around construction work sites, where appropriate, to minimise the possibility of personnel injuries and prevent placing the public at risk.

6.15.4 CONCLUSION

Construction will be temporary in nature, and long-term impacts are not expected. Negative social impacts would be short-term and minor. Longer term positive impacts are expected due to the proposal supporting

a new significant affordable housing development in the Tweed and the removal of an existing section of overhead powerline. Given the mitigation measures outlined in this assessment, the overall social and economic risk is considered to be low.

6.16 Cumulative Impacts

Cumulative impacts may be experienced due to the interaction of elements within the proposal, or with other existing or proposed developments within the locality.

6.16.1 INTERACTIONS WITHIN OR IN CONNECTION WITH THE PROPOSAL

The proposal forms an integral component of the KFHVSP that will service the broader Kings Forest development. The KFHVSP also includes a further 400m of new high voltage underground cables that have been previously installed, and the proposed new Kings Forest ZS, which are subject to separate assessments, also prepared under Part 5 (Division 5.1) of the EP&A Act.

The approximate 400m section of previously installed new underground cables are located on Leda owned land, at the southern portion of the overall underground cable route, in the vicinity of the proposed new Kings Forest ZS. The design, environmental assessment, and installation of these sections were expedited to align with the construction schedules of early site preparatory activities and civil works associated with the Kings Forest development. That is, as significant land disturbance associated with civil works for new roads and other infrastructure commenced, this provided an optimal period to include components of the broader high voltage network. The REF for this component actually assessed approximately 750m of proposed new underground cables, but only approximately 400m were installed. It was decided that the remaining 350m, the majority of which was proposed to be installed by underbore methodology, would be best left until further specialist advice was received on HDD design. As such, the remaining 350m, which largely comprised underbore 3, as described in this report, has been reassessed as part of this REF, now that further detail is known on construction methodology and design.

Potential environmental impacts identified in the separate REF prepared for the approximate 400m section of underground cables previously installed (Essential Energy, 2023), included short term impacts to air quality (namely dust), noise, soil and water, and visual amenity impacts associated with construction activities. Potential short and long term impacts to ecology and Aboriginal heritage were avoided due to the route of the underground cables being installed in areas of previous disturbance (i.e., existing powerline corridors) or locations subject to disturbance as a result of site preparatory and civil works of the approved Kings Forest development. No short or long term negative social, land use or contamination issues were identified. The approximately 400m section of underground cables were installed towards the end of 2023. No negative environmental impacts were identified during installation activities. The 400m section of underground cable will not be energised until the remaining sections of the underground cables subject to assessment in this REF are installed, and the new Kings Forest ZS is constructed.

The design and REF of the proposed new Kings Forest ZS (Essential Energy, 2024) has been completed. The design, REF, and construction works for the ZS were expedited due to the longer construction timeframes for the ZS, and also to coincide with construction activities at the broader Kings Forest development, while route and design refinement were still being finalised for the proposed high voltage underground cables. Similar to the REF for the smaller sections of cables previously installed, as discussed above, the predominate potential environmental impacts identified in the ZS REF were short term impacts to air quality (dust), noise, soil and water, and visual amenity impacts associated with construction activities. Potential short and long term impacts to ecology and Aboriginal heritage were avoided due to the siting of the ZS on land subject to historical disturbance due to a Slash Pine plantation, and more recent disturbance associated with the site being used for a laydown yard for civil construction works for the approved Kings Forest development). Any potential negative impacts to bushfire, traffic and access, land use, social and economic associated with construction, operation and maintenance of the ZS site were anticipated to be negligible and manageable with implementation of mitigation measures.

Longer term impacts on visual amenity from construction operation and maintenance of the ZS was considered and deemed not significant, due to siting of the ZS in an employment lands precinct of the Kings Forest development, and with implementation of design measures (i.e., screening). Potential EMF impacts of the ZS were considered and deemed to be negligible and within relevant EMF exposure

guidelines for ZS operation and maintenance. At the time of preparation of this REF, construction activities at the ZS site had commenced and were ongoing.

Overall, construction, operation and maintenance of the KFHVSP, of which the proposed underground cables form an integral component, is expected to have positive social and economic benefits through the support of new affordable housing and employment lands in the Tweed Shire.

6.16.2 INTERACTIONS WITH OTHER DEVELOPMENTS WITHIN THE LOCALITY

The most significant development proposed in the nearby landscape is the Kings Forest development. The 4,500 dwelling, 856 hectare (ha) master planned community development received concept plan approval (MP 06_0318) and Stage 1 project approved (MP 08_0194) under the former Part 3A approval pathway of the EP&A Act. In 2018 the Stage 1 project approval (MP 08_0194) was transitioned from the Part 3A to SSD under Part 4 of the EP&A Act.

The EAR (JBA Planning, 2011), and supporting detailed technical studies, provides a comprehensive analysis of the existing environment and likely environmental impacts associated with Stage 1 of the broader Kings Forest development. The EAR and supporting technical studies identified a range of environmental impacts associated with Stage 1 works, being: air quality; noise; geotechnical; acid sulfate soils; surface water and groundwater; biodiversity; Aboriginal and non Aboriginal heritage; contamination, visual amenity; bushfire, traffic and land use changes. Potential impacts to several of these environmental aspects will also occur through the construction, operation and maintenance of the proposed underground high voltage cables subject to assessment in this REF, and therefore could be considered cumulative. These include air quality (dust), noise; soil and water; acid sulfate soils; visual amenity during construction, and visual amenity and land use change during operation. While some cumulative impacts are likely, these will be minimised to the greatest extent possible, and would not be significant. Furthermore, the route selected is primarily within already cleared and disturbed road reserves and powerline corridors, and through implementation of construction methodologies (i.e., underbores), the proposal avoids impacts to areas of remnant vegetation and mapped coastal wetlands, and minimises impacts to private property. Through design and construction methodologies, alternative routes, containing more sensitive environmental values, have been avoided, reducing the potential for further cumulative impacts.

6.16.3 CONCLUSION

Based on the range of environmental impacts associated with the proposal subject to assessment in this REF, and the interaction of elements within or in connection with the proposal, or with other existing or proposed developments within the locality, the potential for some cumulative impacts exist. These include: air quality (dust); noise; soil and water; acid sulfate soils; and visual amenity during construction. However, given the relatively small disturbance footprint and the localised extent of potential impacts during construction and operational phases of the proposal, the potential cumulative impact to other environmental factors during construction and operation of the proposal has been minimised to the greatest extent possible, and would not be significant. Any residual, minor impacts identified in this section of the REF can be mitigated and managed through the range of measures outlined Chapter 6 and summarised in **Table 25.**

6.17 Summary of Environmental Mitigation Measures

The environmental mitigation measures outlined in this document would be incorporated into the Project Construction Environmental Management Plan (CEMP). These safeguards would minimise any potential adverse impacts arising from the proposed works on the surrounding environment. The mitigation measures are summarised in **Table 25**.

Table 25: Summary of Environmental Mitigation Measures

ASPECT	ENVIRONMENTAL MITIGATION MEASURE	TIMING
General	▸ All environmental mitigation measures must be incorporated within the Construction Environmental Management Plan (CEMP), or relevant works plan as applicable for the proposed works.	Pre-works.
General	▸ Environmental awareness training must be provided to all field personnel, contractors and subcontractors.	Pre-works and during works as required.
Consultation	▸ Consultation has been ongoing with the Leda for many years regarding the route, particularly with reference to its alignment within the Kings Forest development site	Project planning and pre-works.
	▸ Preliminary landholder consultation regarding the proposed underground cable route has been undertaken and is continuing, including with private property holders where an easement is required.	Project planning, pre-works and during works.
	▸ Residents along the proposed cable route would also be advised of the works schedule and provided with details of a site contact prior to construction commencing.	Project planning, pre-works and during works.
Licences, Permits, Approvals and Notifications	▸ Notification to the local council in accordance with clause section 45 of the *Electricity Supply Act 1995.*	40 days prior to works commencing. This notification has been sent.
	▸ Notification to the Environment and Heritage division of the NSW DCCEEW	21 days notification for works on land adjacent to Cudgen Nature Reserve
Air Quality	▸ Any potential dust-borne materials transported to and from the activity site will be covered at all times during transportation	During works.

	▸ All vehicles and machinery will be maintained according to manufacturer requirements to ensure emissions are kept within acceptable limits.	
Geology and Soil	▸ Risks associated with sediment and erosion will be managed in accordance with The Blue Book – Managing Urban Stormwater: Soils and Construction (Landcom 2004). In particular, controls including, but not limited to the following, will be implemented: › Diversion of upslope runoff around the proposal site in a way that minimises erosion › Sediment control fences or other measures shall be installed at the downslope perimeter of disturbed areas, including any temporary stockpiles. › Maintenance of all erosion control measures at operational capacity until land is stabilised. ▸ Disturbed areas will be progressively stabilised as soon as practicable following construction activities ▸ A site specific erosion and sediment control plan will be included as part of the Construction Environmental Management Plan (CEMP). ▸ Essential Energy's CEOP8064 Management of Excavated Material; Guideline for Construction Sites will be consulted to determine the most appropriate beneficial reuse or disposal method for any surplus excavated materials ▸ A site specific acid sulfate soil management plan should be included as part of the CEMP for the southern portion of the proposal site (i.e., south of southern end of Reardons Road), consistent with that presented in **Appendix D**.	During works.
Water Quality and Hydrology	▸ Control measures will be implemented to manage risks associated with the handling of fuel through using spill trays when undertaking in field re-fuelling ▸ Disturbed areas will be managed in accordance with the requirements of the Blue Book to minimise potential impacts to waterways. Sediment fencing will be erected, where required, downslope of disturbed areas, and impacts would be minimised where practicable. The use of filter bags may be required to discharge collected sediment-laden water where there are insufficient grassed areas available ▸ All areas where ground disturbance has occurred would be progressively stabilised following completion of works.	During works.

	▸ Any water collected in excavations and trenches during rainfall and surface water ingress should be pumped to a grassed area on-site (where a suitable area is available) to allow for infiltration, reused for dust suppression, or pumped to stormwater using a sediment sock. All options should be conducted in a manner that does not result in turbid water entering the stormwater system or nearby waterway. ▸ Weather conditions and forecasts will be monitored to minimise work undertaken during heavy rainfall and to allow demobilisation of plant and equipment from flood prone areas in which overland flooding is forecast ▸ A site specific erosion and sediment control plan and acid sulfate soil management plan will be included as part of the Construction Environmental Management Plan (CEMP). ▸ A drilling management plan / procedures would be developed as part of the CEMP that details measures to minimise risk of frac-outs, and management of drilling slurry. This would include, but not be limited to, the following: › HDD construction, including angles of entry and exit, depth and horizontal alignment to be undertaken consistent with the HDD bore plan (refer Appendix B), unless updated information or advice is provided by a competent underbore specialist to indicate otherwise. › The drilling process, pressures and return rates should be continually monitored, and a dedicated spotter deployed to inspect ground surface along the underbore route, to enable early identification of potential frac-outs › If a turkey's nest is required to manage drilling slurry on site, this is to be appropriately constructed, and lined to ensure no offsite discharge of sediment laden water › Any liquid waste generated will be disposed of at a facility capable of lawfully receiving liquid waste, or appropriately dried out and reused on site or assessed in accordance with a relevant waste order and exemption (does not apply to areas of known or potential ASS) › Underbore entry and exit areas will be restored to as close as possible to their original condition following completion of work. ▸ It is anticipated that 3ML or less of groundwater will be taken via an aquifer interference activity. As such a water access licence exemption applies.	
Noise and Vibration	▸ In considering the short term and transient nature of the work as it progresses along the proposed underground cable route, construction work that has the potential to create audible noise at the nearest sensitive receiver, will be between 7am and 6pm Monday to Saturday. On	During works.

	occasions works outside these hours may be undertaken where the following requirements are met: › Neighbours (and other sensitive receivers) adjacent to the works or the local council or the NSW Environment Protection Authority (EPA) have been notified › The works are justified on the basis that they are emergency works, or, because of supply security network outages or construction limitations, it is deemed that the works can only be achieved outside these hours, or, affected landowners have provided consent for the works to occur in exchange for a shorter construction timeframe. ▸ All plant and equipment will be operated and maintained in accordance with the manufacturer's specifications. Any noise complaint will be investigated with additional control measures put in place if required.	
Flora and Fauna	The following measures have been made to minimise impact to the environment: ▸ The proposal has been designed to minimise impact to the limited stands of wooded vegetation (i.e., removal of trees and shrubs has been minimised) ▸ The proposal largely follows existing powerline and road corridors, minimising impacts to surrounding vegetation.	Project planning and design.
	Notwithstanding, to ensure any potential residual impacts to flora and fauna are further minimised and managed, the following mitigation and management measures are to be implemented: ▸ Any change in design affecting land outside the proposal site assessed in this report will require further ecological survey - notwithstanding minor changes where the ecological values have been assessed for this proposal. ▸ No clearing is permitted outside these areas without further assessment ▸ Stockpile and compound sites would be located using the following criteria: › At least 40 m away from the nearest waterway › In areas of low ecological conservation significance (i.e., previously disturbed land) › On relatively level ground › Outside the one in 10-year Average Recurrence Interval (ARI) floodplain if possible ▸ Stockpiling materials and equipment and parking vehicles would be avoided within the dripline (extent of foliage cover) of any tree.	Project planning and design. During works.

	▸ Store fuels, chemical and hazardous materials in secure areas ▸ Control measures will be implemented to manage risks associated with the handling of fuel through using spill trays when undertaking in field re-fuelling ▸ Essential Energy has a general biosecurity duty under the Biosecurity Act 2015 to prevent, eliminate or minimise biosecurity risk so far as is reasonably practicable. ▸ Field crews shall follow procedures as outlined in Essential Energy's Operational Guideline: Biosecurity Risk Management (CERM1000.96) to prevent, eliminate or minimise biosecurity risk so far as is reasonably practicable, with particular reference to vehicle and equipment hygiene practises ▸ Contact a nominated animal rescue agency / wildlife care group (i.e., Friends of the Koala) or veterinarian if an animal is injured. Friends of the Koala may be contacted for fauna other than Koalas. ▸ Report any Koala sightings or incidents to BCSD and TSC. ▸ No domestic dogs are to be allowed on the site during pre-construction or construction. ▸ Impacts to Wallum Sedge Frog breeding habitat will be avoided through use of HDD methodology.	
Aboriginal Heritage	▸ All construction work would be undertaken within the assessed areas of the proposal site only ▸ If changes are made to the proposed works which could impact locations outside of the current proposal site, further archaeological investigation may be required. ▸ If any objects of suspected Aboriginal heritage origin be encountered during the proposed works, work in the area of the find should cease and the unexpected finds protocols should be implemented. Refer Appendix B of the Aboriginal due diligence assessment (attached to this REF as **Appendix F**) ▸ If suspected human remains are located during any stage of the proposed works, work must stop immediately, and the NSW police must be notified.	During works.
Non-Aboriginal Heritage	▸ All construction work would be undertaken within the assessed areas of the proposal site only ▸ In the unlikely event that a previously unknown heritage site or object is located during construction of the proposal, works would cease immediately in that area and a representative from Essential Energy's Environmental Services would be notified. Works with the potential to	During works.

	disturb the object would not resume until the object had been properly identified, and appropriate action taken.	
Contamination	▸ It is intended to reuse surplus spoil beneficially on site, where possible. ▸ Essential Energy's CEOP8064 Management of Excavated Material; Guideline for Construction Sites will be consulted to determine the most appropriate beneficial reuse or disposal method for excavated materials ▸ In the event of encountering any suspected contamination in the work area, it will be separated and contained on site until it can be classified in accordance with the EPA (2014) Waste Classification Guidelines, and then disposed of at a facility that is lawfully able to accept the waste ▸ Control measures will be implemented to manage risks associated with the handling of fuel through using spill trays when undertaking in field re-fuelling ▸ Sediment and erosion control structures will be established and maintained in accordance with The Blue Book to minimise potential impacts on receiving watercourses.	During works.
Electric and Magnetic Fields	No electric fields are expected to be generated and predicted magnetic fields levels are well below the adopted ICNIRP guidelines. As such no specific mitigation measures are recommended. Notwithstanding, Essential Energy has adopted the policy of prudent avoidance and, in this context, over the course of the project, has or will: ▸ Adopted an underground cable design rather than overhead powerlines. ▸ Installed the cable as far as practicable from dwellings. ▸ Selected the proposed cable route to pass primarily through rural and sparsely populated land, minimising potential EMF exposure to residents. ▸ Overtime the cable will be uprated to operate at 66kV, thereby reducing the load currents and, hence, its magnetic field contribution.	Project planning and design. During Operation.
Visual	▸ Installation of the cables underground negates any long-term visual amenity impacts ▸ The installation of the two new UGOH poles will have a high degree integration with the existing overhead powerline network in the area	Project planning and design.

Waste	▸ All wastes that are generated as a result of the project that require offsite disposal will be classified in accordance with the Waste Classification Guidelines (EPA, 2014) ▸ All waste material will be reused, recycled, or disposed of at a facility lawfully capable of receiving the waste.	During works.
Bushfire	▸ During construction, activities with the potential to generate a spark will be avoided, where possible, in the bushfire prone areas, during times of heightened bushfire risk.	During works.
Traffic and Access	▸ A Traffic Management Plan (TMP) for the construction phase would be prepared prior to works commencing. The TMP would outline requirements for the safe and continued use of local transport corridors during construction ▸ If temporary closure of the eastern extent of Mccollums Road, at the intersection with the southern end of Reardons Road, is required to facilitate underbore works, local road users will be advised in advance through signage and consent obtained from the TSC.	Pre-works and during works.
Land Use	▸ Consultation about the proposed works and schedule will be undertaken with nearby residential receivers, where required ▸ The site should be left in a tidy condition at the conclusion of construction activities.	Pre-works, and during works. Post construction.
Social and Economic	▸ Management of construction traffic in the vicinity of construction works, including communication with existing local residents and road users ▸ Signs and barriers would be erected around construction work sites, where appropriate, to minimise the possibility of personnel injuries and prevent placing the public at risk.	Pre-works and during works.

7. Ecologically Sustainable Development

Ecologically sustainable development (ESD) is an attempt to provide the best outcomes for the human and natural environments both now and into the indefinite future. One of the most often cited definitions of sustainability is development that "meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainability relates to the continuity of economic, technical, social, institutional and environmental aspects of human society, as well as the non-human environment.

The existing environment has been described throughout **Section 6** of this REF for the various aspects of the natural environment assessed as part of this proposed activity.

The proposal has been assessed against the following four principles of ESD listed in the Protection of the Environment Administration Act 1991.

The four principles of ESD are:

- The precautionary principle: section 6(2)(a)(i)(ii)
- The principle of inter-generational equity: section 6(2)(b)
- The principle of biological diversity and ecological integrity: section 6(2)(c)
- The principle of improved valuation of environmental resources: section 6(2)(d)(i)(ii)(iii).

An assessment of the proposal against the principles is provided below.

7.1 Precautionary Principle

The precautionary principle states that:

'If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

In the application of the precautionary principle, public and private decisions should be guided by:

1) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and

2) an assessment of the risk weighted consequence of various options.'

For the precautionary principle to be applicable, two pre-conditions must be satisfied; "*first it is not necessary that serious or irreversible environmental damage has actually occurred – it is the threat of such damage that is required. Secondly, the environmental damage threatened must attain the threshold of being serious or irreversible*"[5].

If there is no threat of serious or irreversible environmental damage, there is no basis upon which the precautionary principle can apply.

Environmental investigations, including a quantitative ecological impact and Aboriginal heritage due diligence, and EMF assessments, have been undertaken during the preparation of this REF to ensure that the potential environmental impacts are understood with a high degree of certainty. The spatial scale of impacts would be local and isolated to the immediate construction area. Therefore, it can be concluded that this proposal will not result in a threat of serious or irreversible damage.

Mitigation measures have also been proposed in this REF to minimise the identified potential impacts of the project. A Construction Environmental Management Plan (CEMP) will be developed and implemented as a

[5] *Telstra Corporation Limited v Hornsby Shire Council* [2006] NSWLEC 133, Preston CJ at 129

precautionary measure, and no mitigation measures have been deferred due to a lack of scientific certainty. The proposal is therefore consistent with the precautionary principle.

7.2 Principle of Inter-generational Equity

The principle of inter-generational equity states that:

'The present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.'

To the extent possible, all environmental impacts and appropriate mitigation measures have been identified. The proposal would not harm the health, diversity and productivity of the environment to such an extent that future generations would not be able to benefit.

The proposal is therefore consistent with the principle of inter-generational equity.

7.3 Principle of Biological Diversity and Ecological Integrity

The principle of biological diversity and ecological integrity states that:

'*Conservation of biological diversity and ecological integrity should be a fundamental consideration*.'

The proposal primarily comprises the installation of underground cables on predominately cleared and disturbed land associated with road reserves and powerline corridors, or minimises and avoids impacts to remnant vegetation and wetland environments through design and construction methodologies. A quantitative ecological impact assessment has been prepared (**Appendix E**) which concluded the proposal will not result in a significant impact to the ecological values present in the proposal site. The impact to listed threatened species, populations and communities recorded or presumed to occur in the proposal site was assessed as not significant. Impacts upon ecological integrity would therefore be negligible, as described in **Section 6.5**.

7.4 Improved Valuation of Environmental Resources

The principle of improved valuation of environmental resources states that:

'*Environmental factors should be included in the valuation of assets and services such as:*

- *Polluter pays – that is, those who generate pollution and waste should bear the cost of containment, avoidance and abatement*
- *The users of goods and services should pay prices based on the full life cycle of costs of providing those goods and services, including the use of natural resources and assets and the ultimate disposal of any waste*
- *Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms that enable those best placed to maximise benefits or minimise cost to develop their own solutions and responses to environmental problems.'*

The proposal has been designed taking into consideration the least possible impact on the environment. All costs associated with the containment, avoidance and abatement of pollution have been factored into the design of this proposal. The proposal will have the positive benefit of supporting the broader Kings Forest development, creating regional economic opportunities, job growth and new affordable housing in the area.

8. Construction Environmental Management Plan

8.1 Introduction

A Construction Environmental Management Plan (CEMP) outlines the environmental objectives of a project, the environmental mitigation measures to be implemented, the timing of implementation, responsibilities for implementation and management, and a review process to determine the effectiveness of the strategies.

The construction contractor(s) would be required to develop a project-specific CEMP that addresses the scope of works to be undertaken. The CEMP would detail how the works would be undertaken to comply with all environmental laws, Essential Energy's environmental policy, and the environmental mitigation measures described in this REF.

The key objectives of the CEMP would include:

- Ensuring that the works are carried out in accordance with legislative requirements and relevant non-statutory policies
- Ensuring that the works are carried out in accordance with the requirements detailed in this REF, including all requirements outlined in any relevant approvals, permits or licences and the mitigation measures described in Section 6
- Ensuring that employees engaged to undertake the works comply with the conditions detailed in the CEMP
- Identifying management responsibilities and reporting requirements to demonstrate compliance with the CEMP

It is also noted that the CEMP would be a working document and may be amended over the course of the project.

If a particular activity falls outside the scope of the REF and CEMP, and it would increase the environmental impact, the activity is not permitted to continue without an appropriate environmental assessment under the EP&A Act.

8.2 Implementation of the CEMP

The CEMP would be a working document and would be amended should strategies initially implemented be found to be inadequate to manage environmental impacts. The CEMP would typically:

- Establish environmental goals and objectives
- Detail the conditions of approval
- List actions, timing and responsibilities for implementation that arise from the mitigation measures recommended in this REF
- Detail statutory requirements
- Provide a framework for reporting on relevant matters on an ongoing basis
- Detail training requirements for personnel in environmental awareness and best practice environmental management systems
- Outline emergency procedures, including contact names and corrective actions
- Detail process surveillance and auditing procedures
- List complaint handling procedures
- Detail quality assurance procedures.

8.2.1 AUDITING SCHEDULE OF THE CEMP

Auditing of the proposal would be undertaken to establish whether the contractor is conducting activities in accordance with their current environmental management plans and whether the management plans are providing an effective tool to control adverse environmental impacts.

The following activities are proposed to achieve the audit's purpose:

- Review the on-site implementation of the contractor's CEMP
- Review the documentation process to determine if planned works have received endorsement to proceed
- Monitor the compliance of construction activities with the project determination and environmental legislation
- Review the outcomes of any previous audit(s) and determine if there has been any change in the environmental performance of the construction contractor
- Identify opportunities to improve on-site environmental management practices.

The benefits of conducting the environmental audit are to allow:

- Feedback on the CEMP implementation process to assist both the contractor and project manager to improve the future preparation of site environmental management documentation
- Improve the planning of construction projects through documentation and impact assessment to ensure best environmental management practices are implemented on site
- Improve environmental management processes on site.

9. Environmental Checklist

In accordance with section 5.5 of the EP&A Act and clause 171 of the EP&A Reg when assessing the environmental impact of an activity on the environment, Essential Energy must consider the factors identified in **Table 26** and **27** below.

Table 26: Section 5.5 requirements

REQUIREMENT	SECTION REFERENCE
For the purpose of attaining the objects of this Act relating to the protection and enhancement of the environment, a determining authority in its consideration of an activity shall, notwithstanding any other provisions of this Act or the provisions of any other Act or of any instrument made under this or any other Act, examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity	Section 2, 6, 7 and 8
Without limiting the above, a determining authority shall consider the effect of an activity on any wilderness area (within the meaning of the *Wilderness Act 1987*) in the locality in which the activity is intended to be carried on	N/A – there are no wilderness areas within or close to the activity area

Table 27: Clause 171 Checklist

SECTION 171	SECTION REFERENCE
The environmental impact on a community *The works are located in a predominately rural landscape, intersected by the local road and electricity networks. The northern portion of the proposal site is located within the cleared and disturbed road reserves. The southern portion proposal site intersects with a mixture of vegetated and cleared rural land, as well as passing adjacent to, and intersecting with a small section of, mapped coastal wetlands. There are a number of rural and rural-residential residences located immediately adjacent to the northern portion of the proposal site along Cudgen, Plantation and Reardons Roads. Distances to sensitive receivers from the northern portion of the proposal site range from approximately 5 to 30m. The closest sensitive receivers to the southern portion of the proposal site are rural residences between approximately 130m and 140m away. Impacts on the community have been considered by this REF. These include short term impacts to air quality (dust), noise and vibration, soil and water, visual amenity, land use, and social impacts associated with construction activities. With the exception of noise and visual, these have been assessed to be low. Noise has been assessed as low to moderate in the short term and low in the longer term (during operation), while visual impact has been assessed as moderate to high in the short term (during construction) and low in the longer term (during operation). No short or long term contamination, or EMF impacts to the community have been identified. The proposal has positive benefits to the community in that being an integral component of the KFHVSP, it will support the Kings Forest development, which is creating regional economic opportunities, job growth and new affordable housing in the area. The proposal will also result in the removal of approximately 460m of existing overhead powerlines.*	Sections 6.1, 6.2, 6.3, 6.4, 6.6, 6.7, 6.8, 6.9, 6.10, 6.11, 6.12, 6.13 6.14 and 6.15

The transformation of a locality *In the short term there will be a high degree of visual change associated with site preparatory works, civil works and installation of underground cables, and the two new UGOH poles. Once installation is complete and disturbed areas reinstated there will be no change to the visual environment associated with the installation of the underground cables. Installation of the two new UGOH will have a high degree of integration with the existing overhead electricity network. As such, there is not expected to be any significant transformation of a locality over the longer term.* *The proposal will not introduce a new land use nor result in a change of permitted activities. The proposal will assist in the facilitation of the Kings Forest residential area, which is currently under construction. However, the residential development has been identified in strategic planning documents and development applications over the preceding years.*	Sections 6.10, 6.14 and 6.15
The environmental impact on the ecosystems of the locality *The proposed underground cables will be located predominately within the existing cleared and heavily modified and disturbed land associated with existing road and electricity corridors. Where the proposal intersects with mapped coastal wetlands it will be underbored to avoid impacts to vegetation. Impacts to threatened species, populations and ecological communities from the construction, operation and maintenance of the proposed underground cables have been assessed in this REF, and will be not likely to result in a significant impact.*	Sections 6.5 and 7.
Reduction of the aesthetic, recreational, scientific, or other environmental quality or value of a locality *An overall reduction in aesthetic and recreational quality of the locality is unlikely to occur during the proposed works. Localised impacts may occur at the construction sites, however these impacts will be temporary and of short duration, and can be managed through implementation of mitigation measures in this REF.*	Sections 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 6.10, 6.14, 6.15 and 6.16
The effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations *No Aboriginal objects were recorded during the assessment. While subsurface archaeological remains and unrecorded surface remains are always possible, given the landscape and historic disturbance, no unrecorded, intact remains of archaeological significance are predicted to occur in the proposal. Consequently, impacts to Aboriginal objects is not likely to occur. Further archaeological investigation is not considered reasonable given the low likelihood of archaeologically significant remains and the scale of the proposal.* *No sites of world, national, state or local heritage significance are located within, or intersected by, the proposal site. The proposal is unlikely to have a significant impact upon non-Aboriginal heritage in the area.*	Sections 6.6, 6.7
The impact on the habitat of protected fauna (within the meaning of the *Biodiversity Conservation Act 2016*)	Section 6.5

The proposed activity is not likely to significantly impact threatened fauna species and their habitat.	
The endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air *It is not anticipated that the proposal will endanger any species of animal, plant or other form of life, whether living on land, in water, or in the air.*	Section 6.5
Long-term effects on the environment *While localised impacts may occur at the construction sites, these impacts will be temporary and of short duration. Long-term adverse environmental effects are not anticipated.*	Sections 6 and 7
Degradation of the quality of the environment *This risk is considered low with the implementation of the management measures included in this REF.*	Sections 6.1, 6.2, 6.3, 6.5 and 6.8.
Risk to the safety of the environment *There is the potential risk to the environment from spillage of materials during construction of the proposal. Implementation of the mitigation measures contained in Section 6 of this REF will ensure that potential environmental risks are minimised.*	Sections 6.1, 6.2, 6.3, 6.8, 6.11, 6.12, 6.13, 6.14 and 7.
Reduction in the range of beneficial uses of the environment *No long-term reduction in the range of beneficial uses of the environment is anticipated as a result of the proposal.*	Section 6 and 7
Pollution of the environment *Risk of pollution to the environment is considered low and can be managed with implementation of mitigation measures provided in this REF.*	Section 6
Environmental problems associated with the disposal of waste *Waste generated by the proposed works will be minor. All wastes that are generated by the project will be appropriately disposed of in accordance with the Waste Classification Guidelines (EPA, 2014).*	Section 6.11
Increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply *The proposal is unlikely to increase demands upon rare natural resources.*	Section 6
The cumulative environmental effect with other existing or likely future activities *Based on the range of environmental impacts associated with the proposal subject to assessment in this REF, and the interaction of elements within or in connection with the proposal, or with other existing or proposed developments within the locality, the potential for some cumulative impacts exist. These include: air quality (dust); noise; soil and water; and visual*	Section 6.16

*amenity during construction, and visual amenity and land use change during operation. However, given the relatively small disturbance footprint and the localised extent of potential impacts during construction and operational phases of the proposal, the potential cumulative impact to other environmental factors during construction and operation of the proposal has been minimised to the greatest extent possible, and would not be significant. Any residual, minor impacts identified in this REF can be mitigated and managed through the range of measures outlined in this **Chapter 6** and summarised in **Table 25**.*	
The impact on coastal processes and coastal hazards, including those under projected climate change conditions *The proposal site is located within the coastal zone (coastal environment area), however, coastal vulnerability area mapping is currently not available and the Tweed Coast and Estuaries Coastal Management Program (TCECMP) is currently under development. Notwithstanding, the proposal is not inconsistent with the management objectives set out in the Tweed Coast Estuaries Coastal Zone Management Plan 2013, which will be superseded by the TCECMP once developed.* *According to TSC flood mapping, with the exception of a small section of underbore 1, the majority of the proposal site is not affected by flooding for the design flood or climate change events (refer (refer Figures 6-8 and 6-9, respectively. The design flood event is based on the 1% Annual AEP. The climate change flood event level in the projected 2100 design flood event considering expected sea level rise and increased rainfall intensity. Following 2007 guidance from the NSW State Government, this event is based on 0.91m rise in sea levels and a 10% increase in rainfall intensity (TSC, 2024).*	Section 3.3 and 6.3
Applicable local strategic planning statements, regional strategic plans or district strategic plans made under the Act, Division 3.1 *TSC has adopted a number of strategic plans relating to housing and employment lands as identified in Section 6.15. Kings Forest features prominently in the plans, recognising the importance of the master planned development to council for providing affordable housing and employment opportunities.* *Construction and operation of the new Kings Forest ZS, forms an integral component to the high voltage electricity connection works for the broader Kings Forest development. Through the provision of this new high voltage electricity connection, the proposal indirectly supports Planning Priority 15 of Tweed Shire Council Local Strategic Planning Statement – 2020 (TSC, 2020), to deliver housing supply and infrastructure to meet the needs of a growing population, and Objective 2 of the North Coast Regional Plan 2041, to provide for more affordable and low cost housing (NSW DPE, 2022).*	Section 6.15
Other relevant environmental factors *No other relevant environmental factors have been identified during the preparation of this REF*	N/A

10. Conclusion

This REF has been prepared to assess the environmental impacts associated with the construction, operation and maintenance of the new underground high voltage cables and associated work. Essential Energy is a determining authority as defined in the EP&A Act. The activity has been assessed under Part 5, Division 5.1 of the EP&A Act.

The proposal would enable the upgrade of the local electricity network to both support the Kings Forest development and increase overall network capacity, placing Essential Energy in a better position to meet customers' future electricity needs.

The proposal complies with the provisions of section 5.5 of the EP&A Act and clause 171 of the EP&A Reg as shown in **Section 9**.

The proposal and its associated environmental impacts, including any potential cumulative impacts are unlikely to have a significant impact on the environment. In conjunction with the approximately 400m section of underground high voltage cables previously installed, and the proposed new Kings Forest ZS, collectively making up the other components of the KFHVSP, the proposal would support the Kings Forest development, and strengthen Essential Energy's electricity network in the broader area. The proposal would maximise the social and economic benefits, whilst minimising any adverse environmental impacts.

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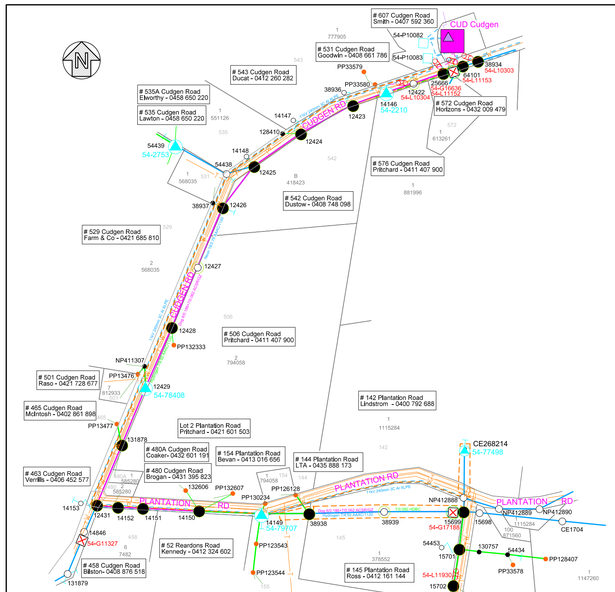
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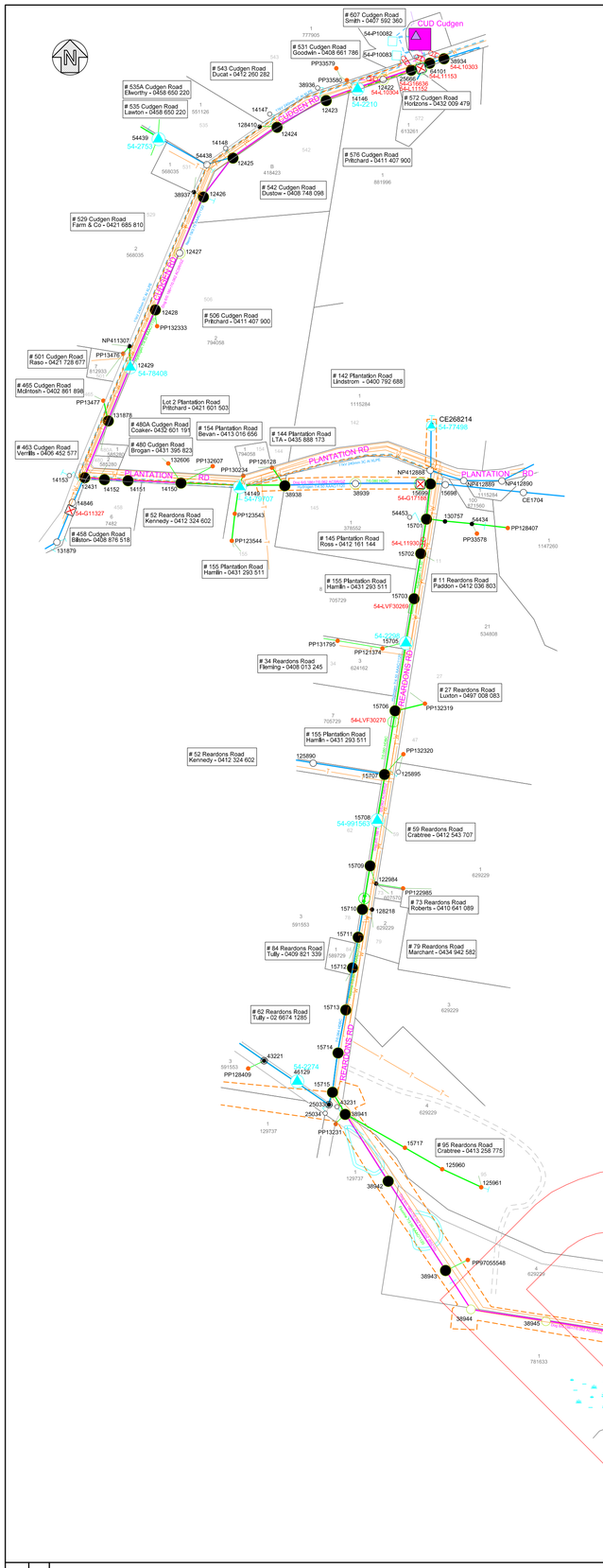
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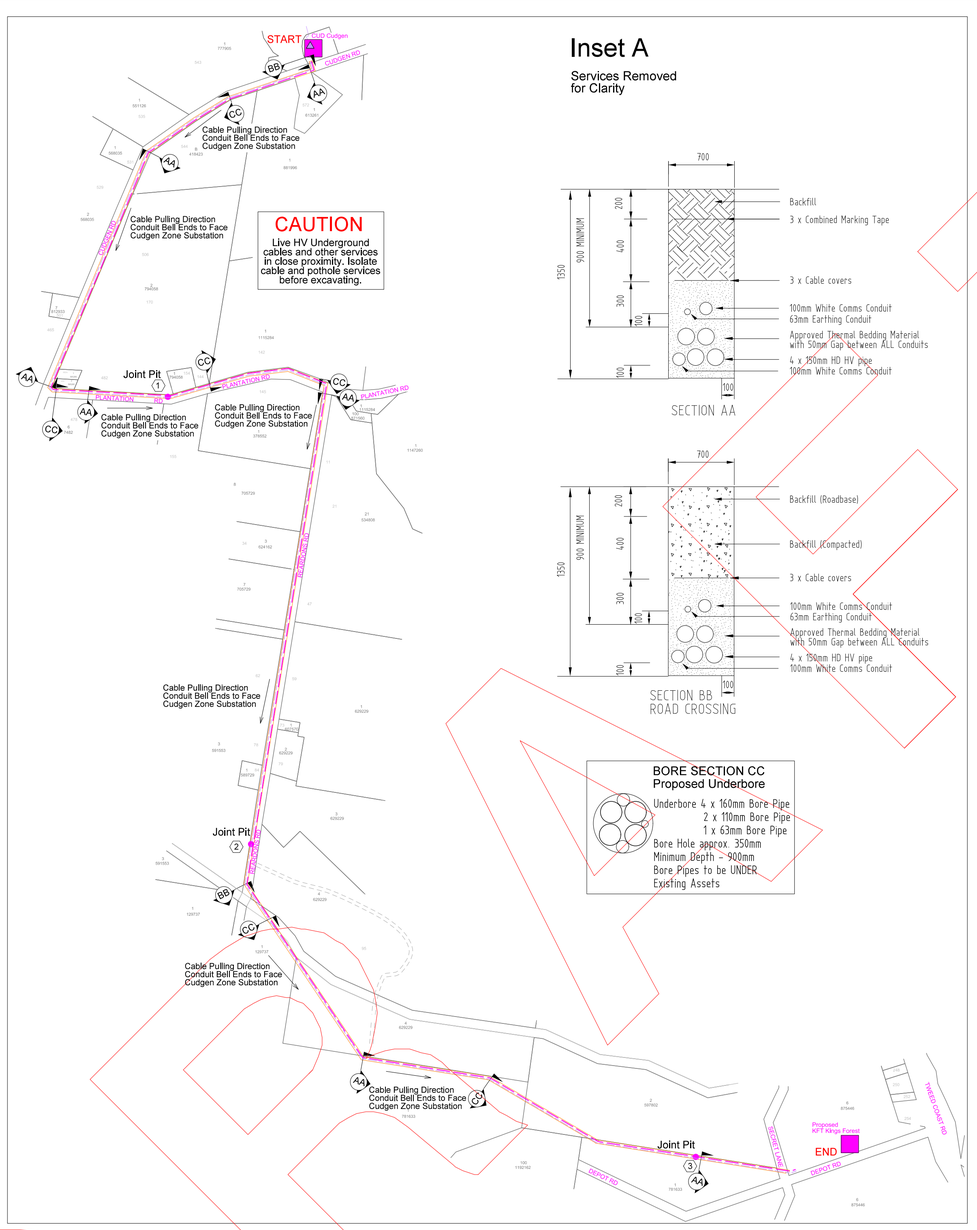
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- WHO 2001, International Agency for Research on Cancer, Lyon, France: IARC Monographs on the evaluation of carcinogenic risks to humans. Non-Ionising Radiation Part 1: Static and Extremely Low Frequency (ELF) Electric and Magnetic Fields.
- Yan, Xufeng, Samuel T Ariaratnam, Shun Dong and Cong Zeng, 'Horizontal directional drilling: State-of-the-art review of theory and applications' (2018) 72 Tunnelling and underground space technology, 162.

Appendix A: Design Plans


607 Cudgen Road
Smith - 0407 592 360
CUD Cudgen
54-P10082
531 Cudgen Road
Goodwin - 0408 661 786
54-P10083
543 Cudgen Road
Ducat - 0412 260 282
535A Cudgen Road
Elworthy - 0458 650 220
535 Cudgen Road
Lawton - 0458 650 220
CUDGEN RD
54-2753
576 Cudgen Road
Pritchard - 0411 407 900
572 Cudgen Road
Horizons - 0432 009 479
542 Cudgen Road
Dustow - 0408 748 098
529 Cudgen Road
Farm & Co - 0421 685 810
506 Cudgen Road
Pritchard - 0411 407 900
501 Cudgen Road
Raso - 0421 728 677
54-78408
455 Cudgen Road
McIntosh - 0402 861 898
Lot 2 Plantation Road
Pritchard - 0421 601 503
480A Cudgen Road
Coaker - 0432 601 191
480 Cudgen Road
Brogan - 0431 395 823
463 Cudgen Road
Vanilla - 0406 452 577
458 Cudgen Road
Bilston - 0458 876 516
142 Plantation Road
Lindstrom - 0400 792 688
154 Plantation Road
Bevan - 0413 016 656
144 Plantation Road
LTA - 0435 888 173
PLANTATION RD
52 Reardons Road
Kennedy - 0412 324 602
54-79107
155 Plantation Road
Hamlin - 0431 293 511
145 Plantation Road
Ross - 0412 161 144
54-L11930
155 Plantation Road
Hamlin - 0431 293 511
54-VF30269
11 Reardons Road
Paddon - 0412 036 803
34 Reardons Road
Fleming - 0408 013 245
27 Reardons Road
Luxton - 0497 008 083
155 Plantation Road
Hamlin - 0431 293 511
52 Reardons Road
Kennedy - 0412 324 602
59 Reardons Road
Crabtree - 0412 543 707
73 Reardons Road
Roberts - 0410 641 089
84 Reardons Road
Tully - 0409 821 339
79 Reardons Road
Marchant - 0434 942 682
62 Reardons Road
Tully - 02 6674 1285
54-81594
95 Reardons Road
Crabtree - 0413 258 775
54-81591
CE268214
54-77498
CE1704
54-L11930
54-L11153
54-L10303
54-L10304
54-L11636
54-L11720
54-2210
54-L11780
54-L11930
54-VF30270
54-81594
54-81591
54-2974
46129
54-79107
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NP413331
NP413332
NP413333
NP413334
NP413335
NP413336
NP413337
NP413338
NP413339
NP413340
NP413341
NP413342





Inset A

Services Removed
for Clarity

SECTION AA

SECTION BB
ROAD CROSSING

BORE SECTION CC
Proposed Underbore

Underbore 4 x 160mm Bore Pipe
2 x 110mm Bore Pipe
1 x 63mm Bore Pipe
Bore Hole approx. 350mm
Minimum Depth - 900mm
Bore Pipes to be UNDER
Existing Assets

UNDERGROUND CONSTRUCTION SCHEDULE

ASSET NO.	CEOM NO.	AS'BLY NO.	CONSTRUCTION NOTES
Site 1	7501.20		Install Subtransmission Cable Joint Pit 66kV Single Circuit Install 3 x 66kV 1C 630mm² Cu TRXLPE-PVC/HDPE Straight Joint NOTE: Follow Manufacturers Instructions for Cable Joints. Joints to be staggered by 1m inside joint bay. Cables to be direct buried and cables snaked for 10m either side of joint bay. Communcation Conduits to Deviate to the Side of the Jointing Pit.
	7501.21		Install Subtransmission Link Box Pit 66kV
	7501.19		Install Subtransmission Cable Joint Pit 66kV Earthing NOTE: Cross Bonded Screen Earthing to be Utilised
Site 2	7501.20		Install Subtransmission Cable Joint Pit 66kV Single Circuit Install 3 x 66kV 1C 630mm² Cu TRXLPE-PVC/HDPE Straight Joint NOTE: Follow Manufacturers Instructions for Cable Joints. Joints to be staggered by 1m inside joint bay. Cables to be direct buried and cables snaked for 10m either side of joint bay. Communcation Conduits to Deviate to the Side of the Jointing Pit.
	7501.21		Install Subtransmission Link Box Pit 66kV
	7501.19		Install Subtransmission Cable Joint Pit 66kV Earthing NOTE: Cross Bonded Screen Earthing to be Utilised
Site 3	7501.20		Install Subtransmission Cable Joint Pit 66kV Single Circuit Install 3 x 66kV 1C 630mm² Cu TRXLPE-PVC/HDPE Straight Joint NOTE: Follow Manufacturers Instructions for Cable Joints. Joints to be staggered by 1m inside joint bay. Cables to be direct buried and cables snaked for 10m either side of joint bay. Communcation Conduits to Deviate to the Side of the Jointing Pit.
	7501.21		Install Subtransmission Link Box Pit 66kV
	7501.19		Install Subtransmission Cable Joint Pit 66kV Earthing NOTE: Single Point Screen Earthing to be Utilised

UNDERGROUND CABLE & CONDUIT SCHEDULE

FROM	TO	CABLE & CONDUIT DETAILS	ROUTE LENGTH
CZS	Site 1	Install 3 x 66kV 1C 630mm² Cu TRXLPE-PVC/HDPE Breakaway Fuse Rating 25kN Design Tension xxkN Hauling Lubricant xxL In Existing 150mm PVC Orange Conduits & 160mm Bore Pipes (Section AA, BB & CC)	1333m
Site 1	Site 2	Install 3 x 66kV 1C 630mm² Cu TRXLPE-PVC/HDPE Breakaway Fuse Rating 25kN Design Tension xxkN Hauling Lubricant xxL In Existing 150mm PVC Orange Conduits & 160mm Bore Pipes (Section AA, BB & CC)	1333m
Site 2	Site 3	Install 3 x 66kV 1C 630mm² Cu TRXLPE-PVC/HDPE Breakaway Fuse Rating 25kN Design Tension xxkN Hauling Lubricant xxL In Existing 150mm PVC Orange Conduits & 160mm Bore Pipes (Section AA, BB & CC)	1333m
Site 3	KFZS	Install 3 x 66kV 1C 630mm² Cu TRXLPE-PVC/HDPE Breakaway Fuse Rating 25kN Design Tension xxkN Hauling Lubricant xxL In Existing 150mm ID Rigid PVC HD Orange Conduits (Section AA) Install 1 x 1C 95mm² Cu PVC Earth Cable In Existing 63mm Rigid PVC HD Orange Conduits (Section AA)	300m
CZS	KFZS	Install 2 x 144 Core Optic Fibre - NMDCxxPB144BE Breakaway Fuse Rating 5.6kN Design Tension xxkN Hauling Lubricant xxL In Existing 100mm PVC White Conduits & 110mm Bore Pipes (Section AA, BB & CC)	4300m

UNDERGROUND PROJECT NOTES

1 Construction Schedules, CEOM NO and Assembly refer to standard drawings in the Essential Energy Overhead Construction Manual CEOM7099 and Underground Construction Manual CEOM7199.

2 Dial Before You Dig Job Reference Number 346425574 Expiry Date: 18/08/2023.

3 All services marked on the plan are indicative only and shall be physically located prior to excavation.

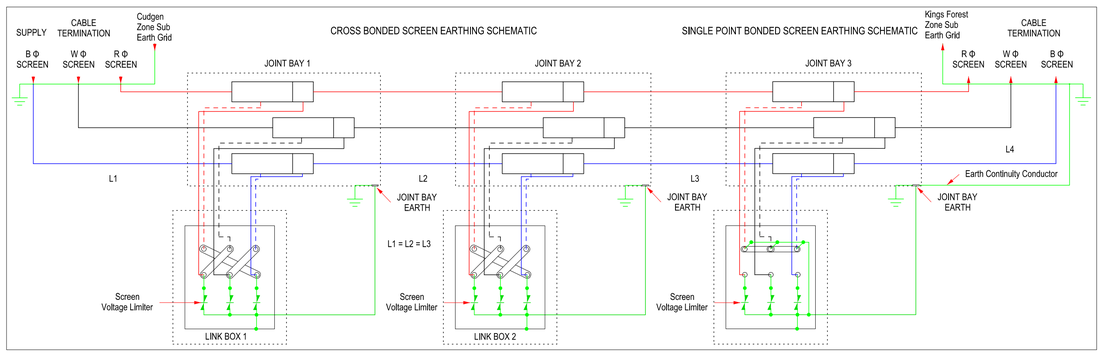
4 The Design Safety Report and Risk Register are available within the WHSE Compliance Tool for this project. The Compliance Tool is accessible via a link in RedBack. Construction teams are to review, update and implement the sections of the Compliance Tool that are relevant to the project activities, and in particular are to review hazards and implement controls noted on the Design Safety Report.

5 ENVIRONMENTAL FACTORS
Control measures for each environmental factor identified for this project are included in the workpack in the Review of Environmental Factors (REF) Worksheet, along with any approvals, notifications, agreements, licences, permits and relevant conditions.
These documents must be read and understood before any work commences.

6 Operational Procedure: Equipotential and Personal Protective Bonding. CEOP2377.

7 Works Supervisor will arrange for, obtain, manage and have carried out, but not limited to;
(a) Civil Works Contractor RFQ and/or Pre-Start Audits.
(b) Waste Classification, Track, Record, Treat, Recycle and/or Disposal.
(c) Hydro Excavation and Vacuum Extraction.
(d) Temporary fencing, trench shoring, barricades and/or barriers.

8 Essential Energy Contacts:
Design - Matt Austin - Phone: 0400 588 730 - Tweed Heads Depot
Project Manager - Glen Potter - Mobile: 0419 218 955



LEGEND

- Site Numbers
- Joint/Link Box Pits
- Transmission Pole
- Trans-HV-LV Pole
- Trans-LV Pole
- Trans-HV Pole
- HV Pole
- HV Pole
- LV Pole
- Private Pole
- Bollard Pole
- LV Pillar
- Switching Station
- Pole Substation
- NO Enclosed Switch
- HV Links
- Ground Stay
- Overhead Stay
- Proposed Easement
- Conduit
- Access Track
- SEPP 14 Wetlands
- Dam
- Fibre Optic Cable
- 33kV UG Cable
- 11kV UG Cable
- LV UG Cable
- 33kV OH Cable
- 11kV OH Cable
- LV OH Cable
- T Telstra
- W Water

REVISION DETAILS
A: ORIGINAL ISSUE

NOTE:
1 THE INTENDED PURPOSE OF THIS PLAN IS THAT OF A CONSTRUCTION DRAWING DEPICTING ELECTRICAL RETICULATION REQUIREMENTS. THIS PLAN IS NOT TO BE USED BY ANY OTHER PERSON OR CORPORATION. ESSENTIAL ENERGY ACCEPTS NO RESPONSIBILITY FOR ANY LOSS OR DAMAGE SUFFERED HOWSOEVER ARISING TO ANY PERSON OR CORPORATION WHO MAY USE OR RELY ON THIS PLAN IN CONTRAVENTION OF THIS CLAUSE OR CLAUSES 2, AND 3, HEREOF.

2 DIMENSIONS, AREAS AND NUMBERS OF LOTS SHOWN ON THIS PLAN ARE APPROXIMATE ONLY AND MAY VARY. THE ELECTRICAL DESIGN SHOWN MAY BE SUBJECT TO VARIATION DEPENDING ON SITE CONDITIONS ENCOUNTERED DURING INSTALLATION WORKS.

3 THIS PLAN MAY NOT BE REPRODUCED UNLESS THIS NOTE IS INCLUDED.

CERTIFIED BY ESSENTIAL ENERGY

CERTIFICATION No.	1293
DATE CERTIFIED	
CERTIFIED BY	

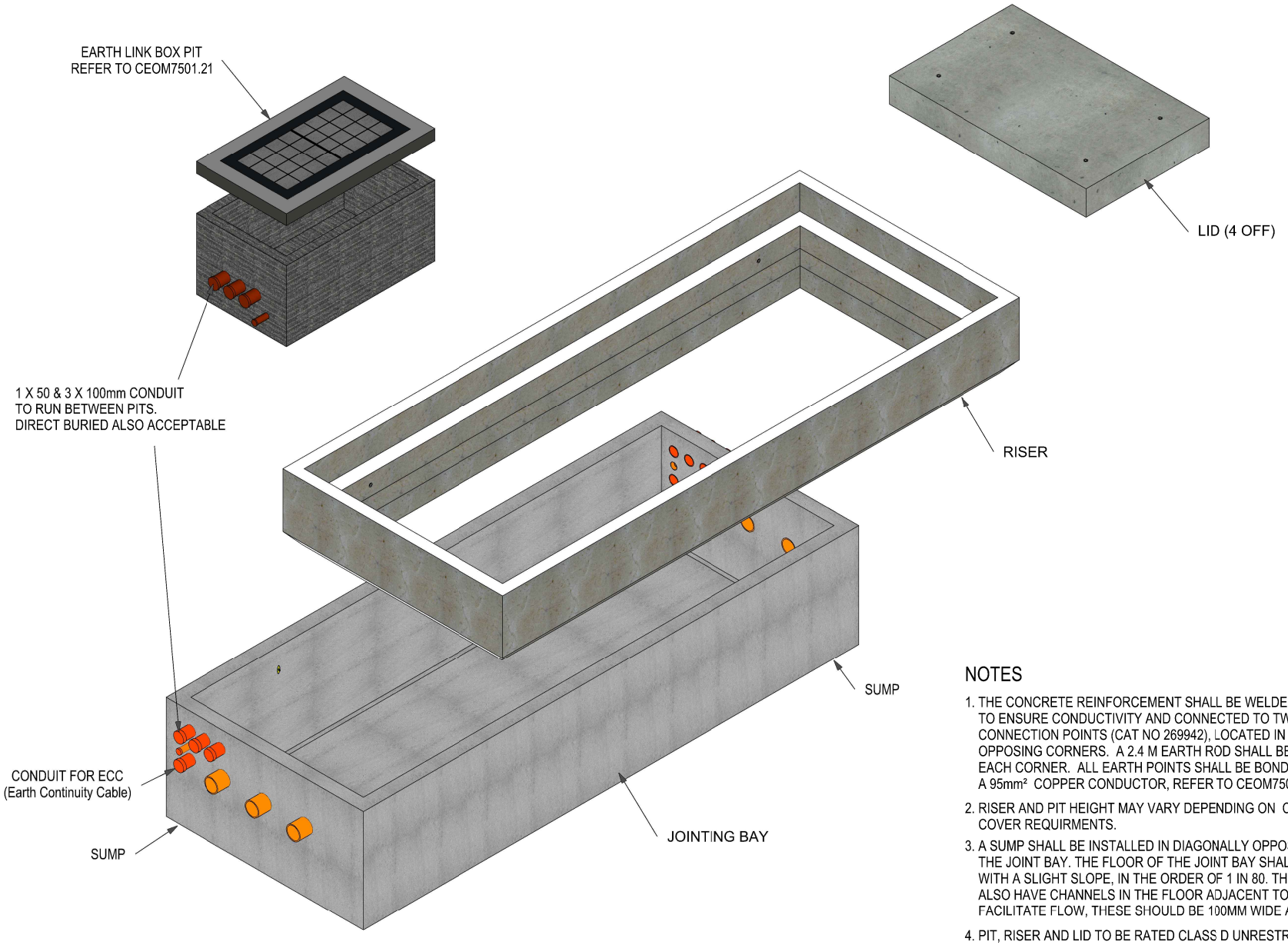
This certification is subject to ESSENTIAL ENERGYS Standard Cert Terms

Customer Funded Project
Install 3 x 66kV 1C 630mm XLPE &
2 x 144 Core Optic Fibre in Existing
Conduits for new 33kV Feeder between
Cudgen ZS & Kings Forest ZS

PROJECT COST No	793524
SCALE	Not To Scale
DRAWN BY	M Austin
DATE ISSUED	
CHECKED BY	
FEEDER No	7RC
FEEDER NAME	Cudgen-Kings Forest
MAINTENANCE AREA	3376

essential energy

DRAWING NAME/No. 793524_FPlan
REVISION A
SHEET 2 OF 4
FSC CODE SBL - Tweed Heads
DATE PRINTED 7/11/2024
FILE ...\PM_Plans\793524_FPlan.dgn
LAST SAVED 7/11/2024
TIME 11:41:49 AM
A1
ORIGINAL SIZE



NOTES

1. THE CONCRETE REINFORCEMENT SHALL BE WELDED TOGETHER TO ENSURE CONDUCTIVITY AND CONNECTED TO TWO EP3 CONNECTION POINTS (CAT NO 269942), LOCATED IN THE PIT WALL ON OPPOSING CORNERS. A 2.4 M EARTH ROD SHALL BE INSTALLED IN EACH CORNER. ALL EARTH POINTS SHALL BE BONDED TOGETHER BY A 95mm² COPPER CONDUCTOR, REFER TO CEOM7501.19.
2. RISER AND PIT HEIGHT MAY VARY DEPENDING ON COUNCIL ROAD COVER REQUIRMENTS.
3. A SUMP SHALL BE INSTALLED IN DIAGONALLY OPPOSING CORNERS OF THE JOINT BAY. THE FLOOR OF THE JOINT BAY SHALL BE INSTALLED WITH A SLIGHT SLOPE, IN THE ORDER OF 1 IN 80. THE FLOOR SHALL ALSO HAVE CHANNELS IN THE FLOOR ADJACENT TO THE WALLS TO FACILITATE FLOW, THESE SHOULD BE 100MM WIDE AND 50MM DEEP.
4. PIT, RISER AND LID TO BE RATED CLASS D UNRESTRICTED ROAD USE AS PER AS3996-2006
5. FINAL CONCRETE AND REINFORCING SIZE AND CONSTRUCTION SHALL BE APPROVED BY A STRUCTURAL ENGINEER. INTERNAL DIMENSIONS OF PIT AND RISER MUST REMAIN UNCHANGED, CONCRETE THICKNESS ON THIS DRAWING IS A GUIDE ONLY. ALL DIMENSIONS SHALL NOT DEVIATE MORE THAN 1/200 TIMES THE SPECIFIED DIMENSION OR ±5mm WHICHEVER IS GREATER AS PER AS3600 - 2009.

AMENDMENT DETAILS		
2	DRAWN	W.GATLEY
	CHCKD	W.GATLEY
	DATE	17/02/2015

LINK BOX CHANGED.
CONDUITS FOR EARTH AND CONCENTRIC LEADS CONFIGERATION CHANGED AND SIZE WAS 50mm.
NOTE 1 & 5 COMMENTS ADDED.
REFER TO SHEET 2, 3 & 4.

SCALE	NTS
ISSUED	21/05/2013
DRAWN BY	W.GATLEY
CHECKED BY	S.PARKER

AUTHORISED BY

Graeme Barnewall

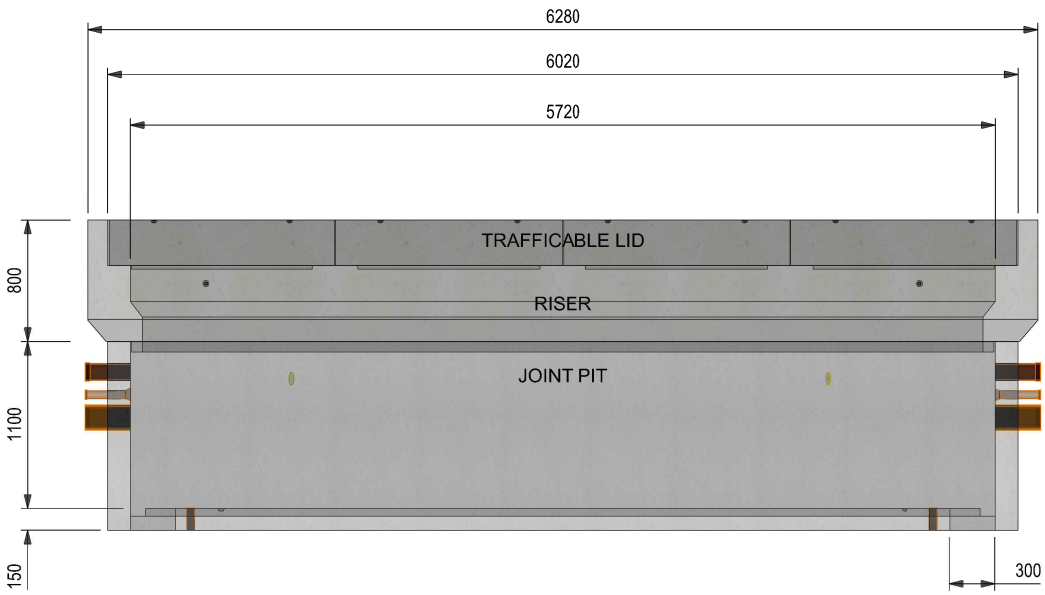
PRINCIPAL ENGINEER UNDERGROUND CONSTRUCTION STANDARDS

DATE 18/02/2015

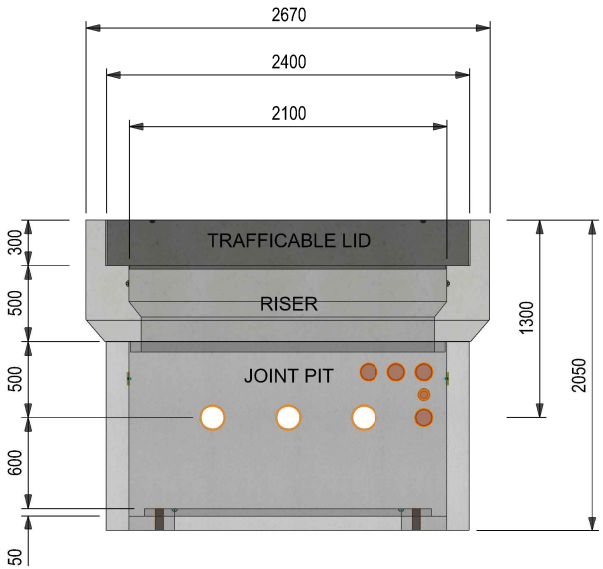
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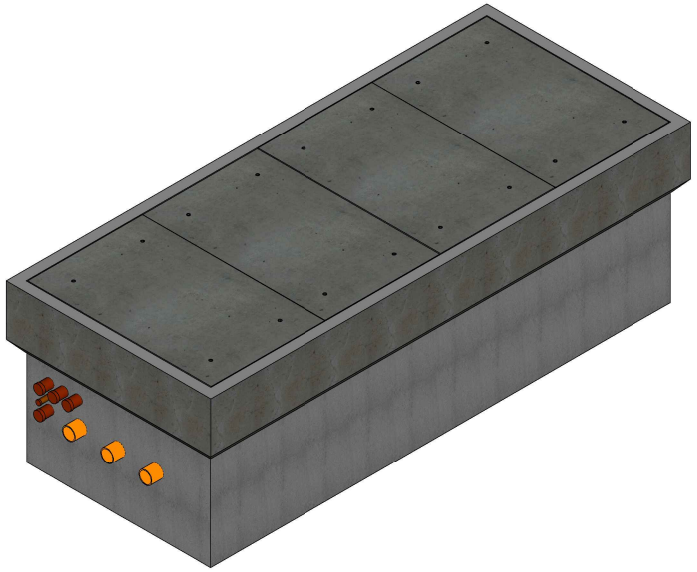
SUBTRANSMISSION CABLE JOINT PIT 66 & 132kV SINGLE CIRCUIT



FRONT VIEW



END VIEW



ISOMETRIC VIEW

AMENDMENT DETAILS		
2	DRAWN	W.GATLEY
	CHCKD	W.GATLEY
	DATE	17/02/2015

VIEWS UPDATED TO DEPICT CHANGED CONDUIT CONFIGURATION
REFER TO SHEET 1, 3 & 4.

SCALE	NTS
ISSUED	21/05/2013
DRAWN BY	W.GATLEY
CHECKED BY	S.PARKER

AUTHORISED BY

Graeme Barnewall

PRINCIPAL ENGINEER UNDERGROUND CONSTRUCTION STANDARDS

DATE	18/02/2015

CEOM7501.20

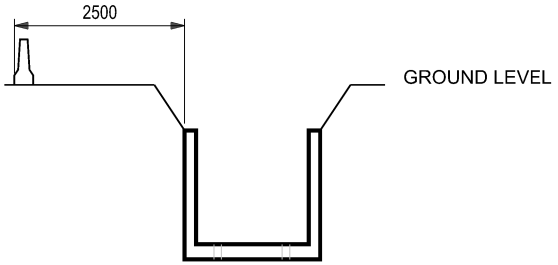
#	2 of 6	A4

SUBTRANSMISSION CABLE JOINT PIT 66 & 132kV SINGLE CIRCUIT

CONSTRUCTION STAGES

VEHICLES, CONSTRUCTION EQUIPMENT & STACKED MATERIALS TO BE KEPT 2500 MIN CLEAR ON ALL SIDES BY MEANS OF SUITABLE BARRIERS.

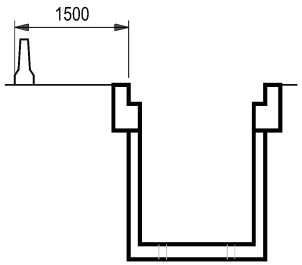
MAX 5kPa CONSTRUCTION LOADING = FOOT TRAFFIC & HAND TOOLS ONLY



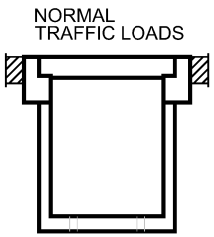
PIT INSTALLATION

VEHICLES, CONSTRUCTION EQUIPMENT & STACKED MATERIALS TO BE KEPT 1500 MIN CLEAR ON ALL SIDES BY MEANS OF SUITABLE BARRIERS.

MAX 5kPa CONSTRUCTION LOADING = FOOT TRAFFIC & HAND TOOLS ONLY



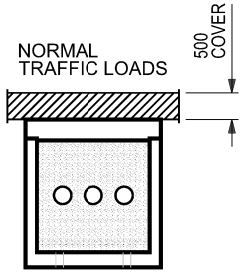
RISER IN POSITION (WITHOUT LIDS)



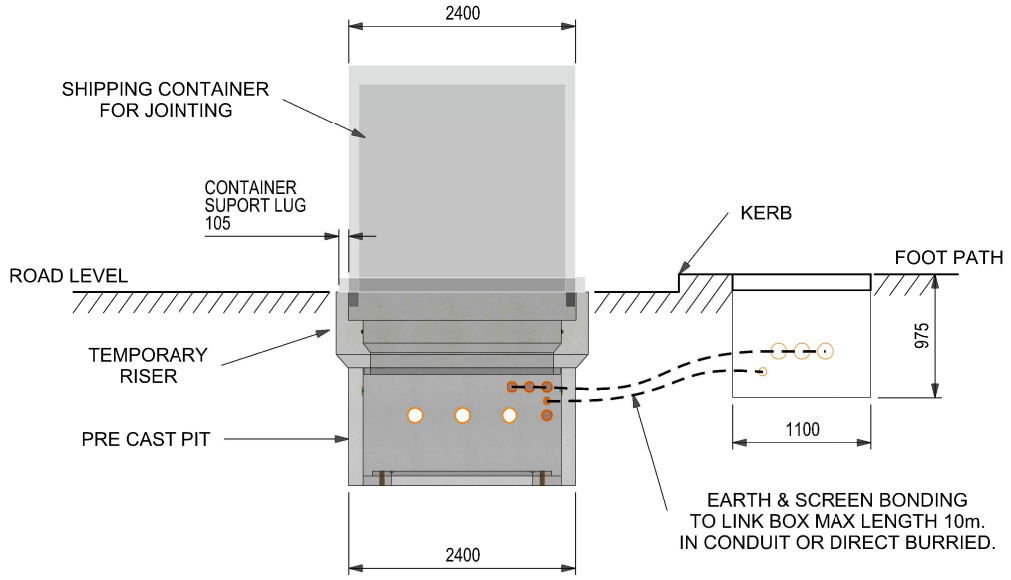
LID & RISER IN POSITION

FILL PIT WITH A LOW STRENGTH MIX OF APPROVED THERMAL MATERIAL.

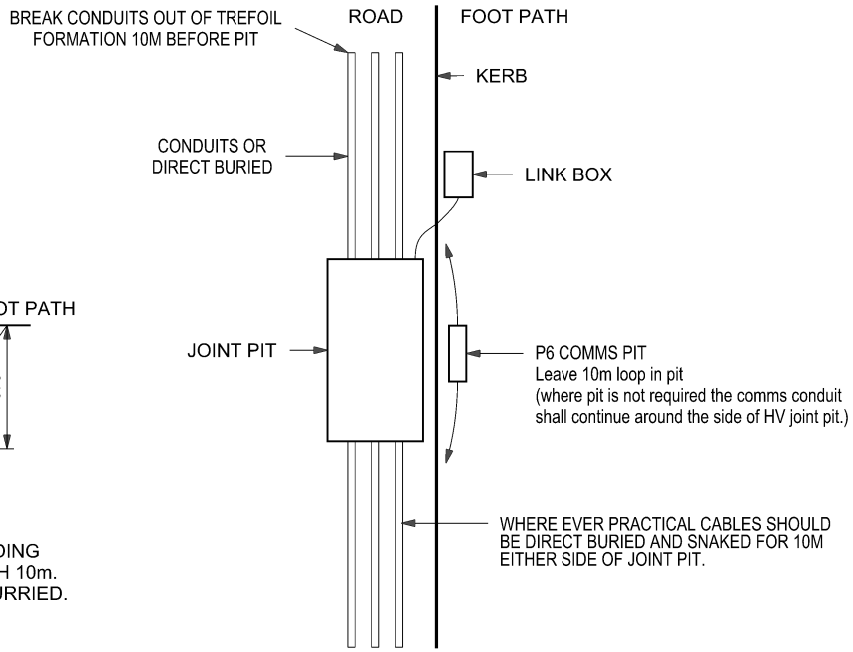
MAX TR 1.2 K.m/W.
MAX STRENGTH 2MPa.



JOINING COMPLETE



CABLE JOINT INSTALLATION



PLAN VIEW

AMENDMENT DETAILS		
2	DRAWN	W.GATLEY
	CHCKD	W.GATLEY
	DATE	17/02/2015

EXTRA COMMENTS ADDED TO PLAN VIEW. EARTH & SCREEN BONDING CABLE WAS IN 50MM CORRUGATED.
REFER TO SHEET 1,2 & 4

SCALE	NTS
ISSUED	21/05/2013
DRAWN BY	W.GATLEY
CHECKED BY	S.PARKER

AUTHORISED BY

Graeme Barnewall

PRINCIPAL ENGINEER UNDERGROUND CONSTRUCTION STANDARDS

DATE	18/02/2015

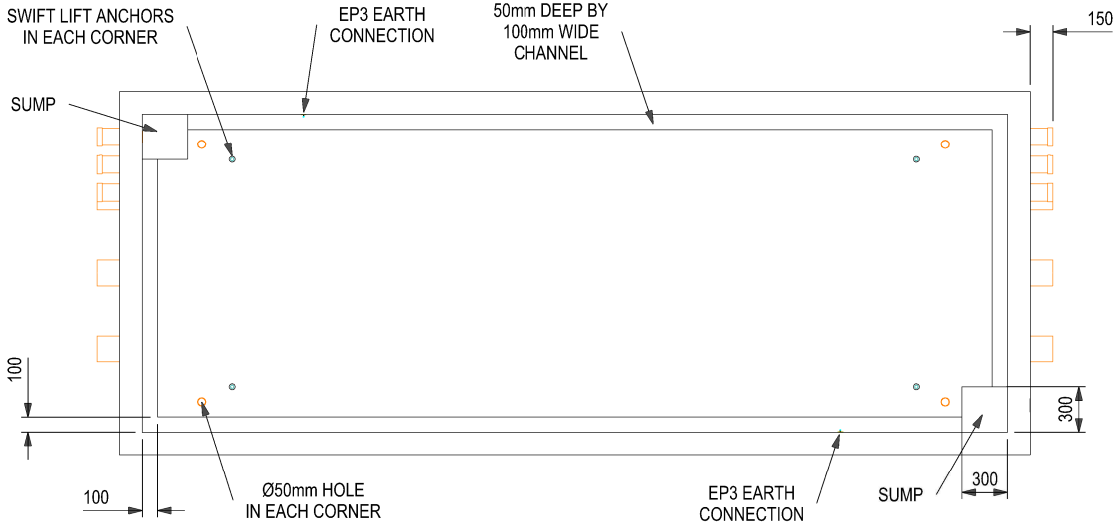
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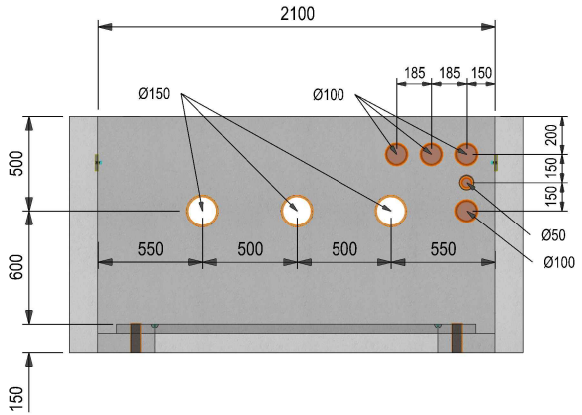
SUBTRANSMISSION CABLE JOINT PIT 66 & 132kV SINGLE CIRCUIT

essential energy

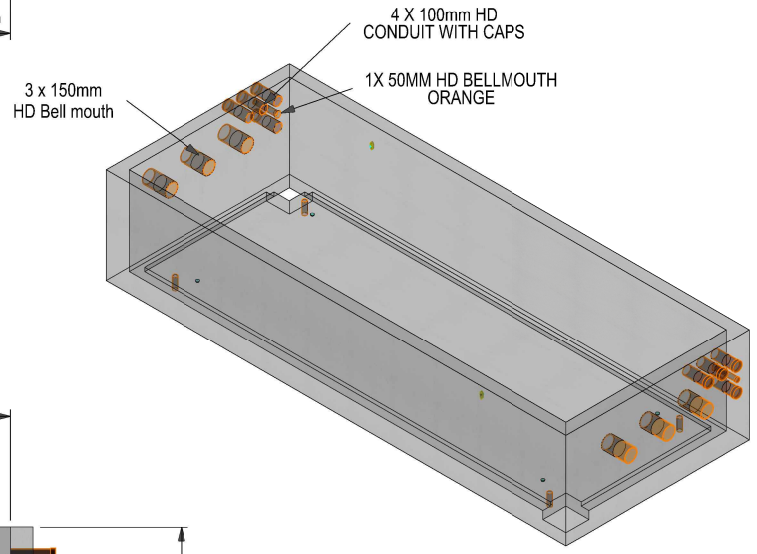
PIT DETAILS



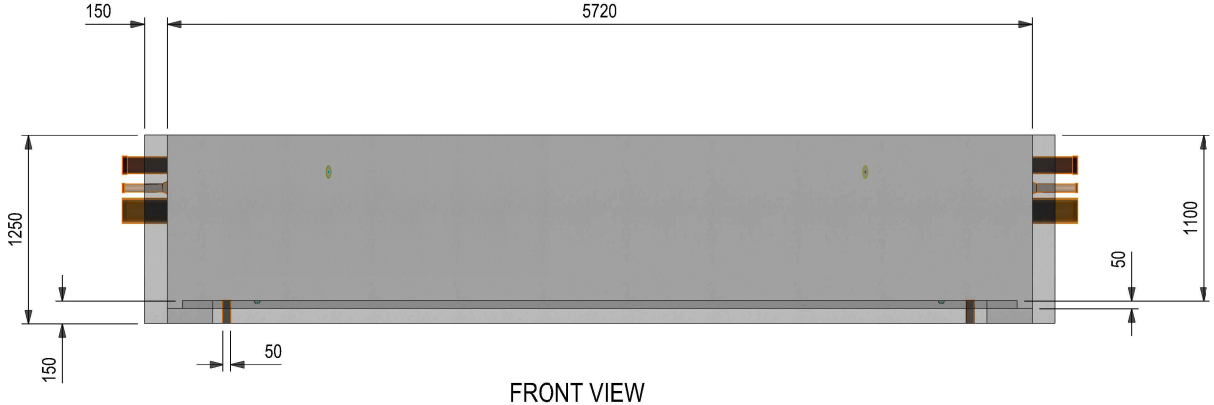
TOP VIEW



END VIEW



ISOMETRIC VIEW



FRONT VIEW

AMENDMENT DETAILS		
2	DRAWN	W.GATLEY
	CHCKD	W.GATLEY
	DATE	17/02/2015

COMMS CONDUIT ENTRY REMOVED. CONFIGERATION OF EARTHING CONDUITS AND SIZE CHANGED REFER SHEET 1,2 & 3.

SCALE	NTS
ISSUED	21/05/2013
DRAWN BY	W.GATLEY
CHECKED BY	S.PARKER

AUTHORISED BY

Graeme Barnewall

PRINCIPAL ENGINEER UNDERGROUND CONSTRUCTION STANDARDS

DATE	18/02/2015

CEOM7501.20

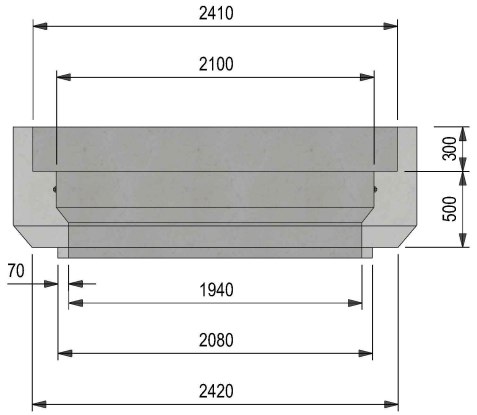
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SUBTRANSMISSION CABLE JOINT PIT 66 & 132kV SINGLE CIRCUIT

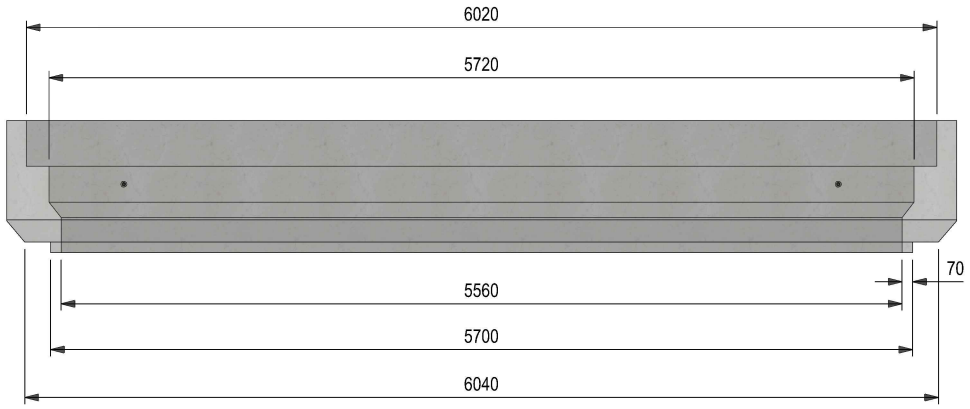
RISER DETAILS



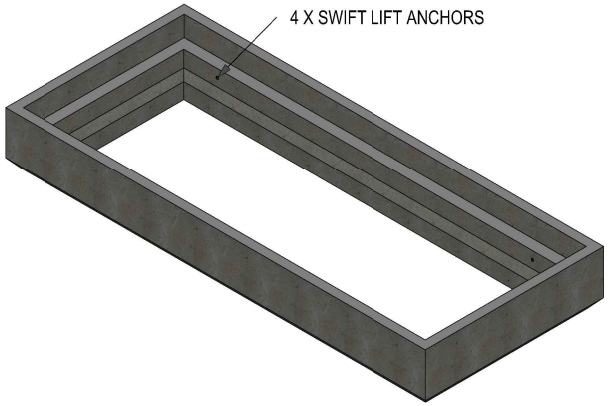
TOP VIEW



END VIEW



FRONT VIEW



ISOMETRIC

AMENDMENT DETAILS		
2	DRAWN	W.GATLEY
	CHCKD	W.GATLEY
	DATE	17/02/2015
REFER TO SHEET 1,2,3 & 4		

SCALE	NTS
ISSUED	21/05/2013
DRAWN BY	W.GATLEY
CHECKED BY	S.PARKER

AUTHORISED BY

Graeme Barnewall

PRINCIPAL ENGINEER UNDERGROUND CONSTRUCTION STANDARDS

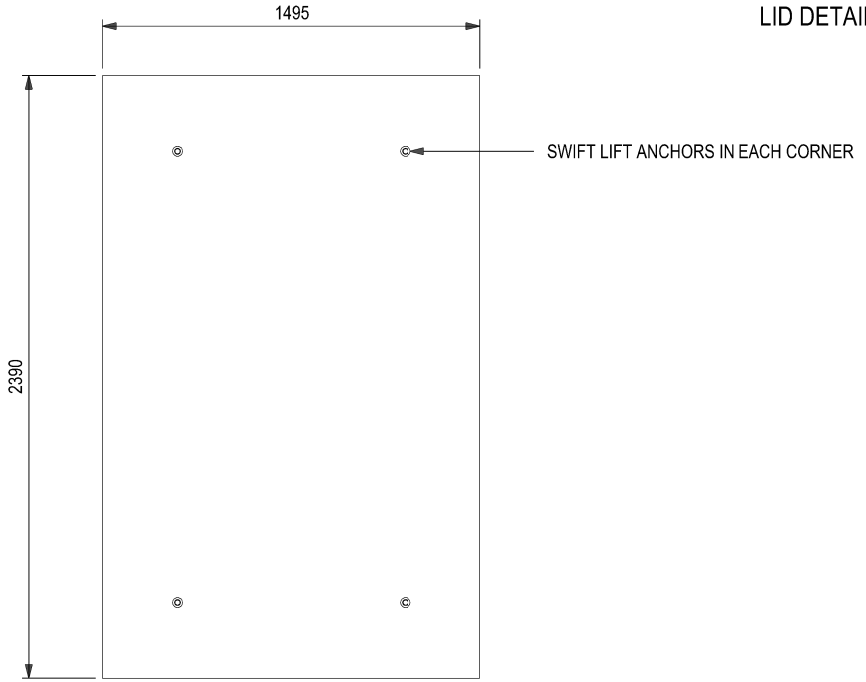
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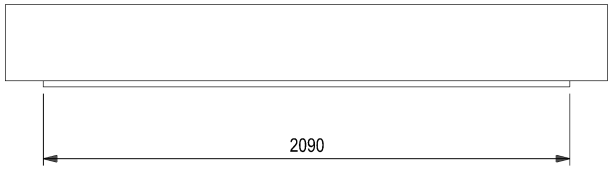
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SUBTRANSMISSION
CABLE
JOINT
PIT
66 & 132kV
SINGLE CIRCUIT

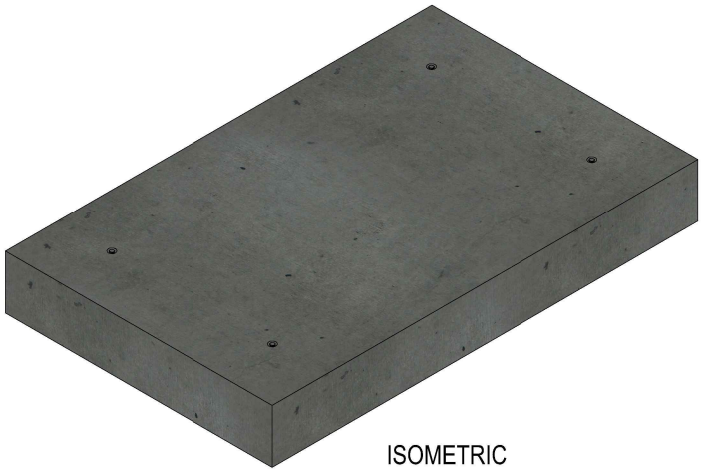
LID DETAILS



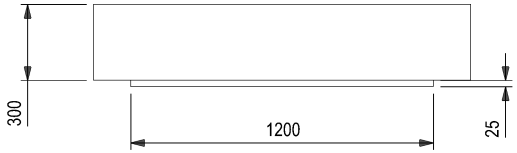
TOP VIEW



END VIEW



ISOMETRIC



FRONT VIEW

AMENDMENT DETAILS		
2	DRAWN	W.GATLEY
	CHCKD	W.GATLEY
	DATE	17/02/2015
REFER TO SHEET 1,2,3 & 4		

SCALE	NTS
ISSUED	21/05/2013
DRAWN BY	W.GATLEY
CHECKED BY	S.PARKER

AUTHORISED BY

Graeme Barnewall

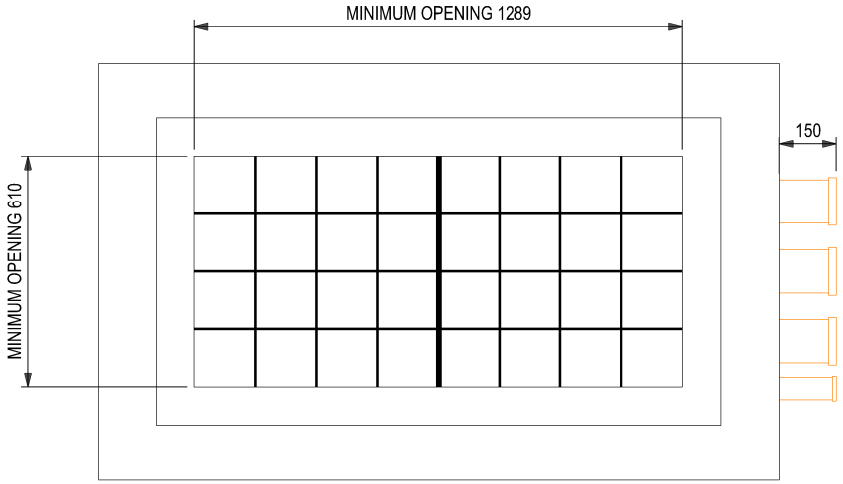
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DATE 18/02/2015

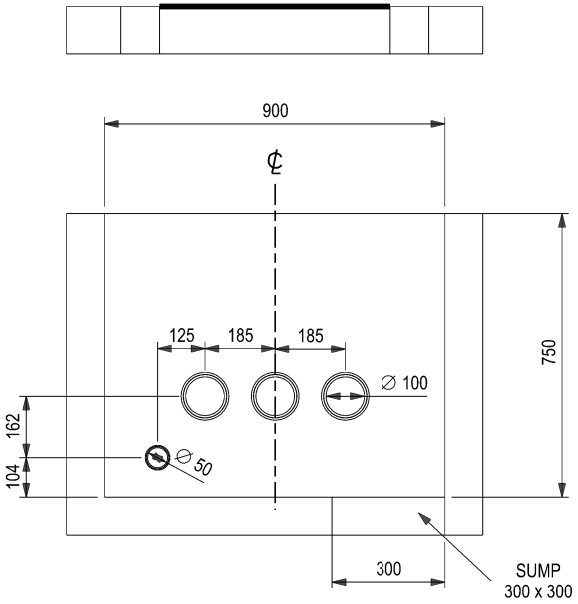
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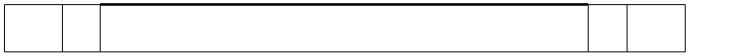
SUBTRANSMISSION
CABLE
JOINT
PIT
66 & 132kV
SINGLE CIRCUIT

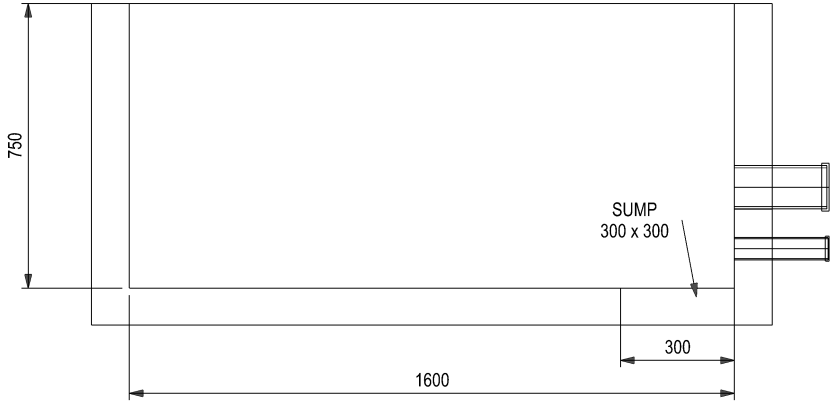


TOP VIEW



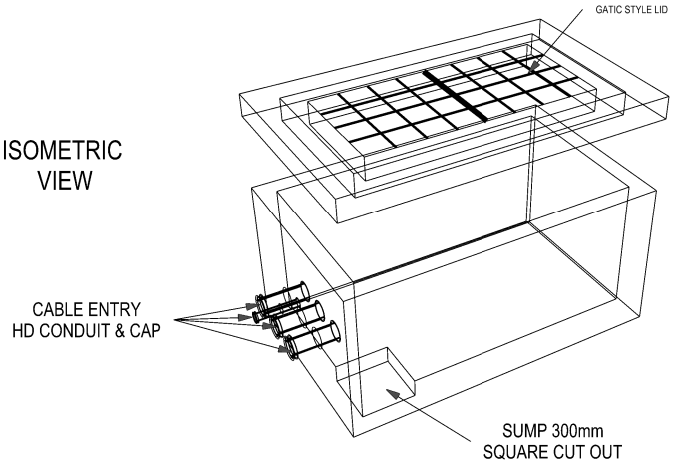
END VIEW





SIDE VIEW

ISOMETRIC VIEW



NOTES

1. PIT AND LID TO BE RATED CLASS D UNRESTRICTED ROAD USE AS PER AS3996-2006
2. FINAL CONCRETE AND REINFORCING SIZE AND CONSTRUCTION SHALL BE APPROVED BY A STRUCTUAL ENGINEER. INTERNAL DIMENSIONS OF PIT MUST REMAIN UNCHANGED.
3. CABLE ENTRY SHALL HAVE CAPPED, HD ORANGE CONDUIT, 3 of 100mm & 1 of 50mm PROTRUDING 150mm.
4. ALL DIMENSIONS ± 5mm

AMENDMENT DETAILS

SCALE	NTS
ISSUED	13/01/2015
DRAWN BY	W.GATLEY
CHECKED BY	W.GATLEY

AUTHORISED BY

Graeme Barnewall

PRINCIPAL ENGINEER UNDERGROUND CONSTRUCTION STANDARDS

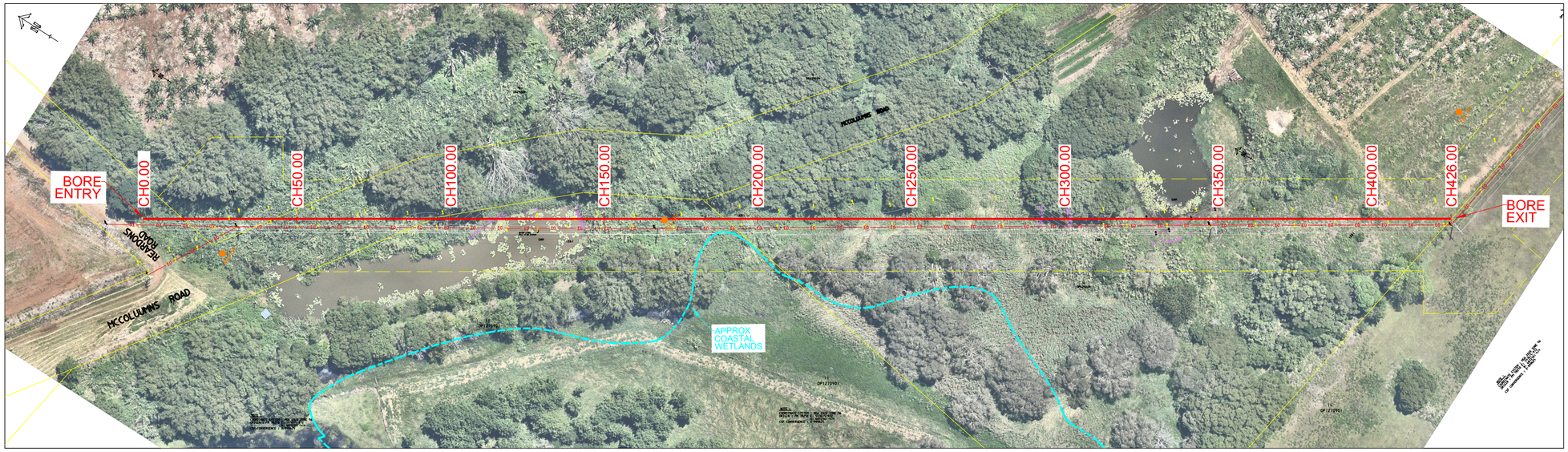
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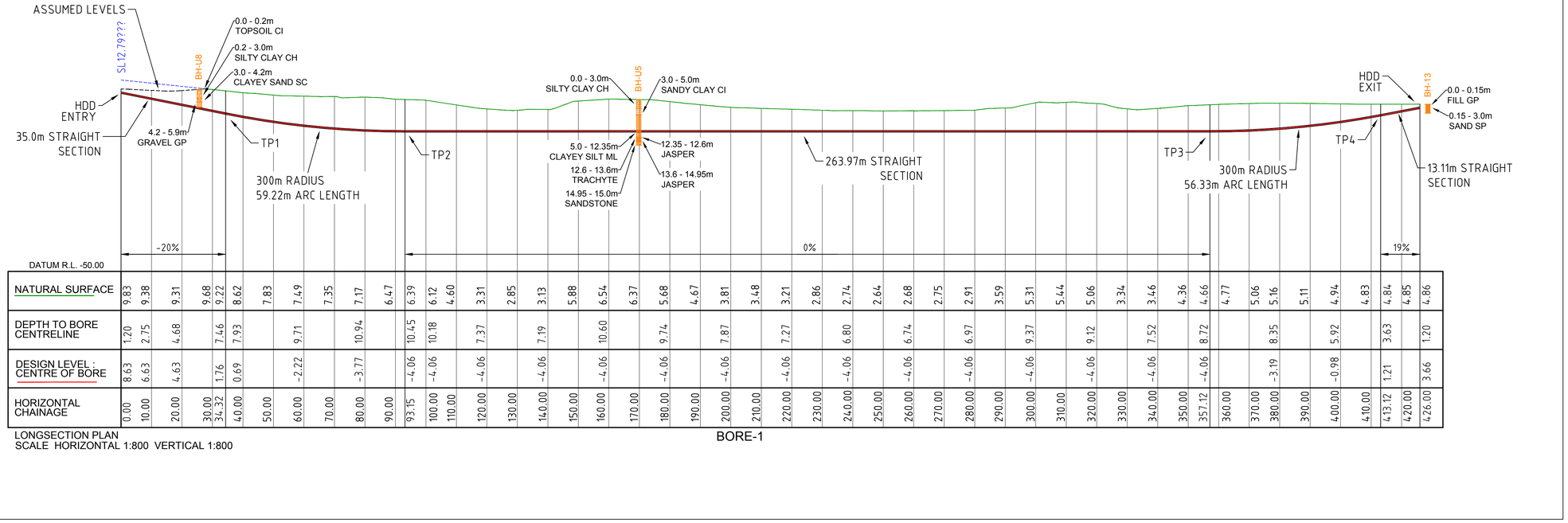
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SUBTRANSMISSION
LINK BOX
PIT
66 & 132kV

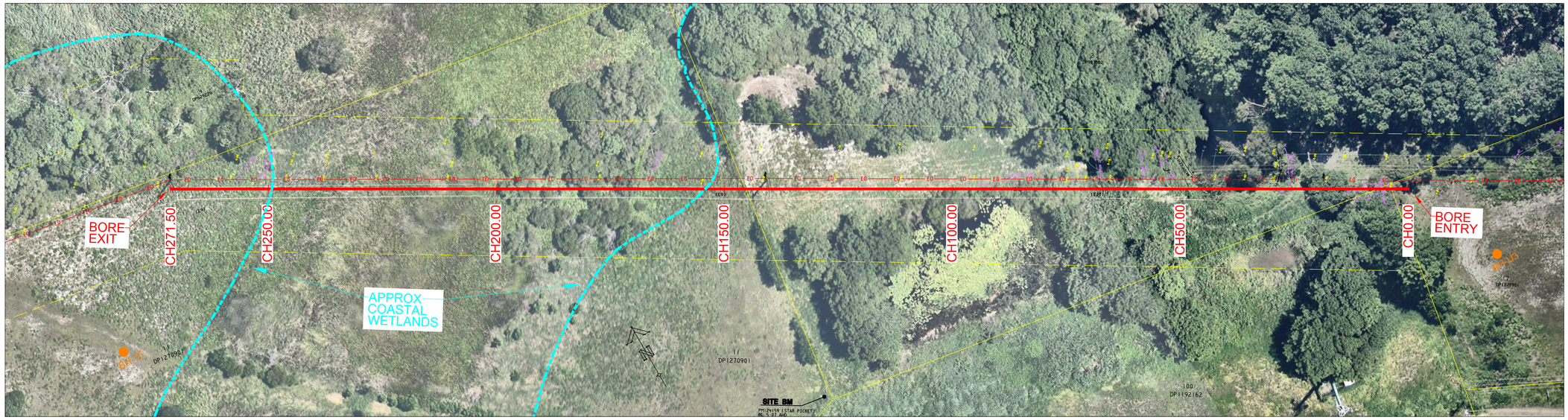
Appendix B: Horizontal Directional Drilling Plans (Underbore Solutions, 2024)



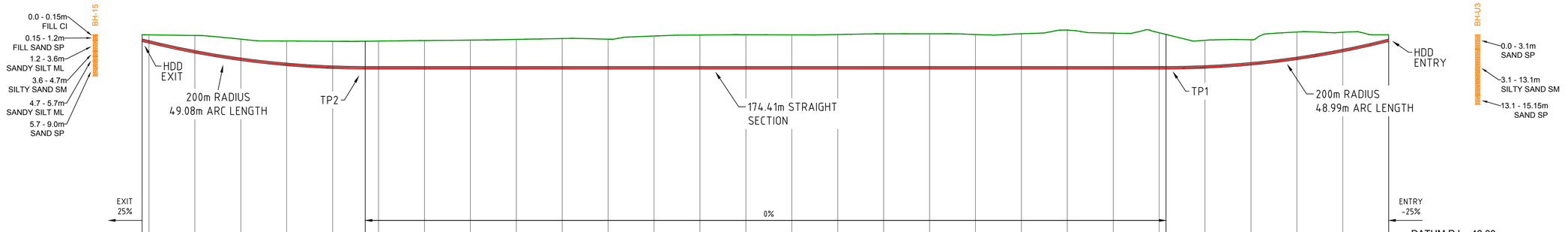
ALIGNMENT PLAN
SCALE 1:800



| | | |



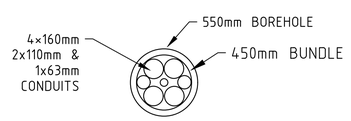
ALIGNMENT PLAN
SCALE 1:500



4.84	4.82	4.66	3.87	3.48	3.41	3.42	3.46	3.59	3.67	3.82	4.00	3.87	4.55	4.78	4.85	4.81	4.89	5.04	5.04	4.88	5.05	5.85	5.18	5.26	4.90	3.62		3.75	5.43	5.37	4.82	NATURAL SURFACE
1.20		3.54		5.10		5.77	5.81		6.02		6.35		6.90		7.20		7.24		7.39		7.40		7.53		7.25				5.74		1.20	DEPTH TO BORE CENTRE
3.64		1.12		1.62		-2.35	-2.35		-2.35		-2.35		-2.35		-2.35		-2.35		-2.35		-2.35		-2.35		-2.35				-0.31		3.62	DESIGN LEVEL : CENTRE OF BORE
271.5	270.00	260.00	250.00	240.00	230.00	222.91	220.00	210.00	200.00	190.00	180.00	170.00	160.00	150.00	140.00	130.00	120.00	110.00	100.00	90.00	80.00	70.00	60.00	50.00	48.50	40.00		30.00	20.00	10.00	0.00	HORIZONTAL CHAINAGE

BORE-2

LONGSECTION PLAN
SCALE HORIZONTAL 1:500 VERTICAL 1:500



BORE SECTION
NOT TO SCALE

10m 0 10m 20m 30m
SCALE - 1:500

CLIENT:

BEFORE YOU DIG www.byda.com.au Zero Damage - Zero Harm

REV.	DESCRIPTION	DRAWN	DESIGN	APPR.	DATE
B	BORE PROFILE AMENDED DEEPER, APPROX COASTAL WETLANDS ADDED	G.B.	DG	--	13/05/24
A	PRELIMINARY	G.B.	DG	--	28/03/24

DESIGNED BY D. GUNNELL
DRAFTED BY G. BAKER
DESIGN CHECKED BY
APPROVED BY

UNDERBORE SOLUTIONS

UNDERBORE SOLUTIONS PTY LTD
108 KINGSWOOD ROAD
ENGADINE NSW 2233
Mobile : 0434 317767

DATE: 28.03.2024
SHEET SIZE A1
HORIZ DATUM:
LEVEL DATUM:

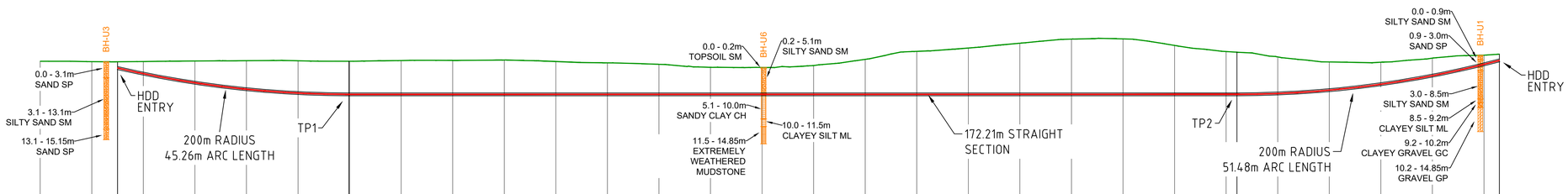
PROJECT: ESSENTIAL ENERGY - KINGS FOREST CUDGEN FEEDER

TITLE
ESSENTIAL ENERGY - KINGS FOREST CUDGEN FEEDER
HDD BORE-2
ALIGNMENT AND LONGSECTION PLAN

PROJECT No. XX
SCALE: 1: 500
SHEET 1 OF 1 REV B
DRAWING No. 101144-02



ALIGNMENT PLAN
SCALE 1:500

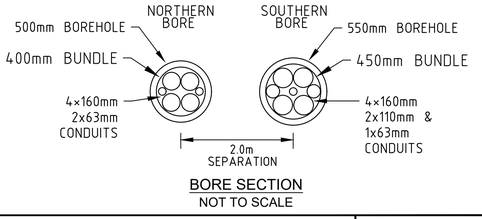


DATUM R.L. -40.00

NATURAL SURFACE	4.82	4.74	4.72	4.77	4.87	4.94	4.92	4.82	4.82	4.95	4.99	5.06	4.78	4.51	4.23	3.64	3.63	3.98	5.19	6.75	7.40	8.32	9.13	9.17	7.90	6.70	6.57	5.68	4.69	4.64	5.43	6.01	6.19
DEPTH TO BORE CENTRE			1.22	2.35		5.55		6.42			6.59		6.37		5.83		5.23		6.79		9.00		10.73		9.50		8.17	7.12			4.28	3.40		1.20
DESIGN LEVEL : CENTRE OF BORE			3.50	2.42		-0.61		-1.60			-1.60		-1.60		-1.60		-1.60		-1.60		-1.60		-1.60		-1.60		-1.60	-1.44			0.36	2.03		4.99
HORIZONTAL CHAINAGE	0.00	10.00	15.00	20.00	30.00	40.00	50.00	0.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	200.00	210.00	220.00	230.00	0.00	240.00	250.00	260.00	270.00	280.00	283.00

LONGSECTION PLAN
SCALE HORIZONTAL 1:500 VERTICAL 1:500

BORE-3



BORE SECTION
NOT TO SCALE

10m 0 10m 20m 30m
SCALE - 1:500

CLIENT:

BEFORE YOU DIG www.byda.com.au Zero Damage - Zero Harm

REV.	DESCRIPTION	DRAWN	DESIGN	APPR.	DATE
B	BORE PROFILE AMENDED DEEPER	G.B.	DG	--	13/05/24
A	PRELIMINARY	G.B.	DG	--	28/03/24

DESIGNED BY D. GUNNELL
DRAFTED BY G. BAKER
DESIGN CHECKED BY
APPROVED BY

UNDER BORE SOLUTIONS

UNDERBORE SOLUTIONS PTY LTD
108 KINGSWOOD ROAD
ENGADINE NSW 2233
Mobile : 0434 317767

DATE: 28.03.2024
SHEET SIZE A1
HORIZ DATUM:
LEVEL DATUM:

PROJECT: ESSENTIAL ENERGY - KINGS FOREST CUDGEN FEEDER

TITLE
ESSENTIAL ENERGY - KINGS FOREST CUDGEN FEEDER
HDD BORE-3
ALIGNMENT AND LONGSECTION PLAN

PROJECT No. XX
SCALE: 1: 500
SHEET 1 OF 1 REV B
DRAWING No. 101144-03

Appendix C: Geotechnical Investigation (Regional Geotechnical Solutions, 2023)

Essential Energy

Proposed Kings Forest Development Transmission Network Upgrade

Cudgen NSW

Geotechnical Report

Report No. RGS33650.1 – AB

24 October 2023

REGIONAL GEOTECHNICAL SOLUTIONS

REGIONAL GEOTECHNICAL SOLUTIONS

Manning-Great Lakes
Port Macquarie
Coffs Harbour

RGS33650.1 – AB

24 October 2023

Essential Energy
PO BOX 5730
PORT MACQUARIE NSW 2444

Attention: Julia Clearwater

Dear Julia,

RE: Proposed Kings Forest Development Transmission Network Upgrade – Cudgen NSW
Geotechnical Report

Regional Geotechnical Solutions Pty Ltd (RGS) has completed geotechnical investigations and assessment for the proposed Kings Forrest Development Transmission Network Upgrade, Cudgen NSW.

The upgrade works will include:

- The installation of high voltage underground feeder cables from the existing Cudgen zone substation to the proposed Kings Forest zone substation. The cabling will be installed via open trenching and trenchless methods.
- Construction of the Kings Forest zone substation.

The report provides comments and recommendations on the subsurface profiles encountered along the proposed cable route and within the proposed substation site to assist with planning, design and construction.

If you have any questions regarding this report or require any further assistance, please do not hesitate to contact the undersigned.

Regional Geotechnical Solutions Pty Ltd
ABN 51141848820

14 / 25-27 Hurley Drive
Coffs Harbour 2450
Ph. (02) 6650 0010

Email adam.h@regionalgeotech.com.au
Web: www.regionalgeotech.com.au

For and on behalf of

Regional Geotechnical Solutions Pty Ltd

Prepared by



Adam Holzhauser
Principal Geotechnical Engineer

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Figure 1 Open Trenching Section - Borehole Locations

Figure 2 Underbore Section – Borehole Locations

Figure 3 Substation Site – Borehole Locations

Figure 4 Interpreted Geotechnical Section – Underbore No. 1 and No. 2

Figure 5 Interpreted Geotechnical Section – Underbore No. 3

Appendices

Appendix A Results of Field Investigations

Appendix B Laboratory Test Results

1 INTRODUCTION

This report presents the findings of the geotechnical investigations and assessment undertaken by Regional Geotechnical Solutions Pty Ltd (RGS) completed for the proposed Kings Forest Development Transmission Network Upgrade, Cudgen NSW.

The work was undertaken in general accordance with proposal number RGS33650.1-AA Rev. 2 dated 22 June 2023. The purpose of the geotechnical investigations and assessment as presented herein was to provide information on the geotechnical conditions to inform planning, design and construction.

The report provides comments and recommendations on the following:

- Subsurface profile, including the presence of fill, soil and rock properties and depth and groundwater.
- Earthworks including:
    - Site preparation
    - Excavation conditions
    - Excavation plant
    - Trench support and backfilling
    - Fill placement and compaction control
    - Material reuse, disposal and importation
- Underboring.
- Retention, including batter slope geometry, retaining wall options and design parameters.
- Site classification and estimate of characteristic ground surface movements for structures within the propped zone substation.
- Foundation options, design levels and design parameters, including data to allow assessment of potential settlements.
- Soil aggressivity.
- Pavement design values (subgrade CBR) for the zone substation site.
- Acid sulfate soil.

2 PROPOSED DEVELOPMENT

The Kings Forest Development is a large residential housing subdivision located in Kings Forest to the west of Tweed Valley Road as illustrated in Diagram 1. Upgrades to the power transmission network are required to service the residential development.

The network upgrades will include:

- A sub-transmission 33kV or 66kV high voltage underground feeder from the existing Cudgen Zone Substation on Cudgen Road to the proposed Kings Forest Zone Substation on Depot Road. This route generally follows an existing 33kV overhead feeder. Trenching to approximately 3m is anticipated along this alignment.
- A section below the wetland area between Reardons Road and Depot Road will require a series of three underbores to reduce the potential impacts to the wetland.

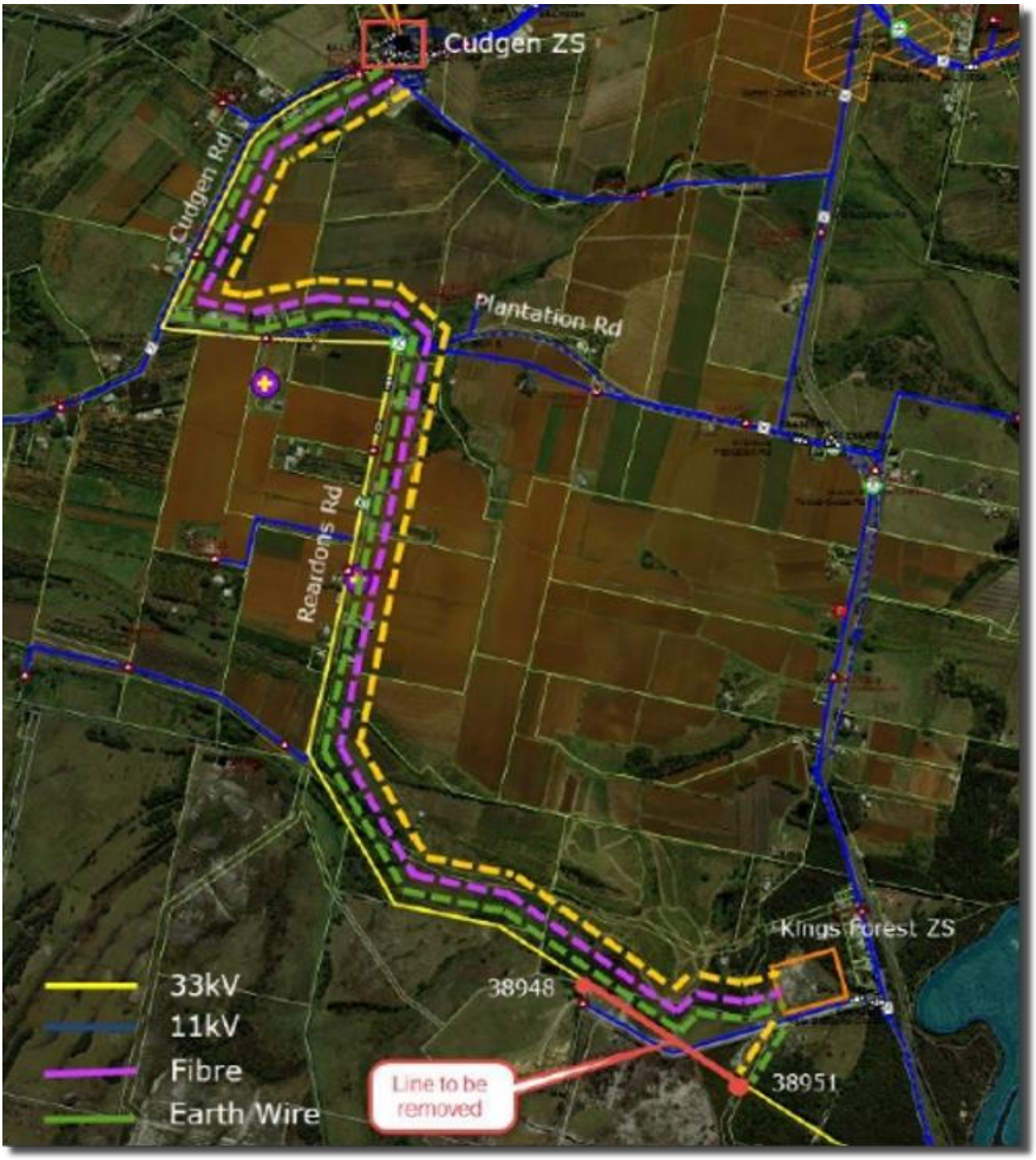
- Construction of the proposed Kings Forest Zone Substation near the intersection of Depot Road and Secret Lane.

Diagram 1: Site Location



Diagram 2 illustrates the proposed transmission line alignment and location of the proposed Kings Forest zone substation.

Diagram 2: Transmission Line Alignment and Kings Forest Zone Substation



3 SCOPE OF WORK

3.1 Fieldwork

Fieldwork for the assessment was undertaken by Geotechnical Engineers and Engineering Geologists from RGS over a period of several months due to drill rig availability and variations to the scope of work. In general, the site investigations included:

- Observation of surface features and exposures along the alignment relevant to the geotechnical conditions of the site.
- Drilling of twelve (12) boreholes (BH1 to BH12) between the Cudgen zone substation and the southern end of Reardons road where open trenching is proposed. The boreholes were drilled to depth of up to 3m with a ute mounted drill rig and auger drilling methods.
- Drilling of three (3) boreholes (BH13 to BH15) within the wetland area to depths of up to 9m with a ute mounted drill rig and auger drilling methods.
- Drilling of five (5) boreholes (BH-U1, BH-U3, BH-U5, BH-U6 and BH-U8) with a Geoprobe drill rig to depths of up to about 15m. The drilling included auger, wash bore and NMLC diamond core drilling methods.
- Drilling of five (5) boreholes (BH-S1 to BH-S5) within the proposed Kings Forest zone substation. The boreholes were drilled to depths of up to 4.5m with a ute mounted drill rig and auger drilling methods.
- Dynamic Cone Penetrometer (DCP) testing adjacent to some of the boreholes as considered appropriate for the conditions encountered.
- Hand Penetrometer Testing was undertaken on recovered samples through the subsurface profile.
- Collection of samples for subsequent laboratory testing.

3.2 Laboratory Testing

Samples obtained during the field work were returned to NATA registered laboratories for analysis. A summary of the testing undertaken is provided below.

- Two (2) Aggressivity tests to assess durability requirements.
- Eight (8) acid sulfate soil screening tests.
- Four (4) acid sulfate soil CRS test suits.

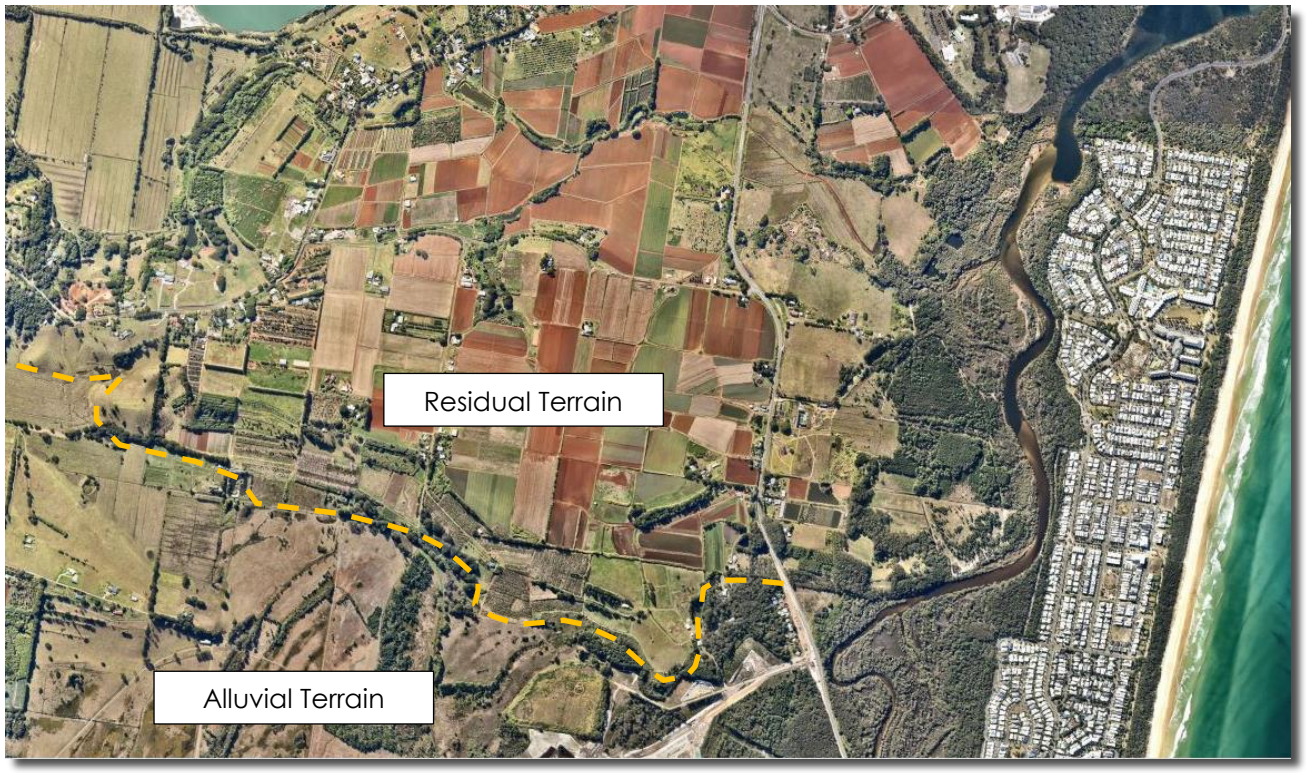
The results of the testing are presented and discussed in the relevant sections of this report. A copy of the laboratory test results sheets is provided in Appendix B.

4 SITE CONDITIONS

4.1 Surface Conditions

The site can be separated into two distinct terrain types comprising undulating residual hills over the northern portion and low-lying undulating aeolian and alluvial profiles over the southern portion. The boundary between the two terrain types is clearly defined by the plunging south facing slopes that terminate at the coastal wetlands associated with the aeolian and alluvial profiles. Diagram 3 illustrates the two terrain areas.

Diagram 3: Terrain Types



Residual Terrain

The open trenching section of the transmission lines will be within residual terrain. The western end of Underbore 1 will be within the residual terrain and traverse the contact or convergence of the residual and alluvial terrain.

The northern portion of the broader 'site' comprises undulating residual slopes of basaltic origins. Surface slopes are typically in the order of 2 to 5° with localised steeper slopes.

Surface exposures indicate a profile comprising residual clay soils with basalt cobbles and boulders. An exposure at the southern end of Reardons Road exhibits a matrix of stiff to hard residual clays with extremely weathered to fresh basalt core stones, cobbles and boulders. The exposure illustrates the variability within the profile over short distances.

Alluvial Terrain

Underbore 2 and Underbore 3 will likely be within the alluvial terrain. The zone substation will also be within aeolian and alluvial terrain.

The southern portion of the site consists of a low-lying wetland area comprising alluvial and aeolian sand deposits. The surface is flat to undulating. An intermittent creek meanders from west to east through a series of billabongs and man-made dams.

Landforms modifications have been undertaken in the general area and continued during the various stages of the site investigations.

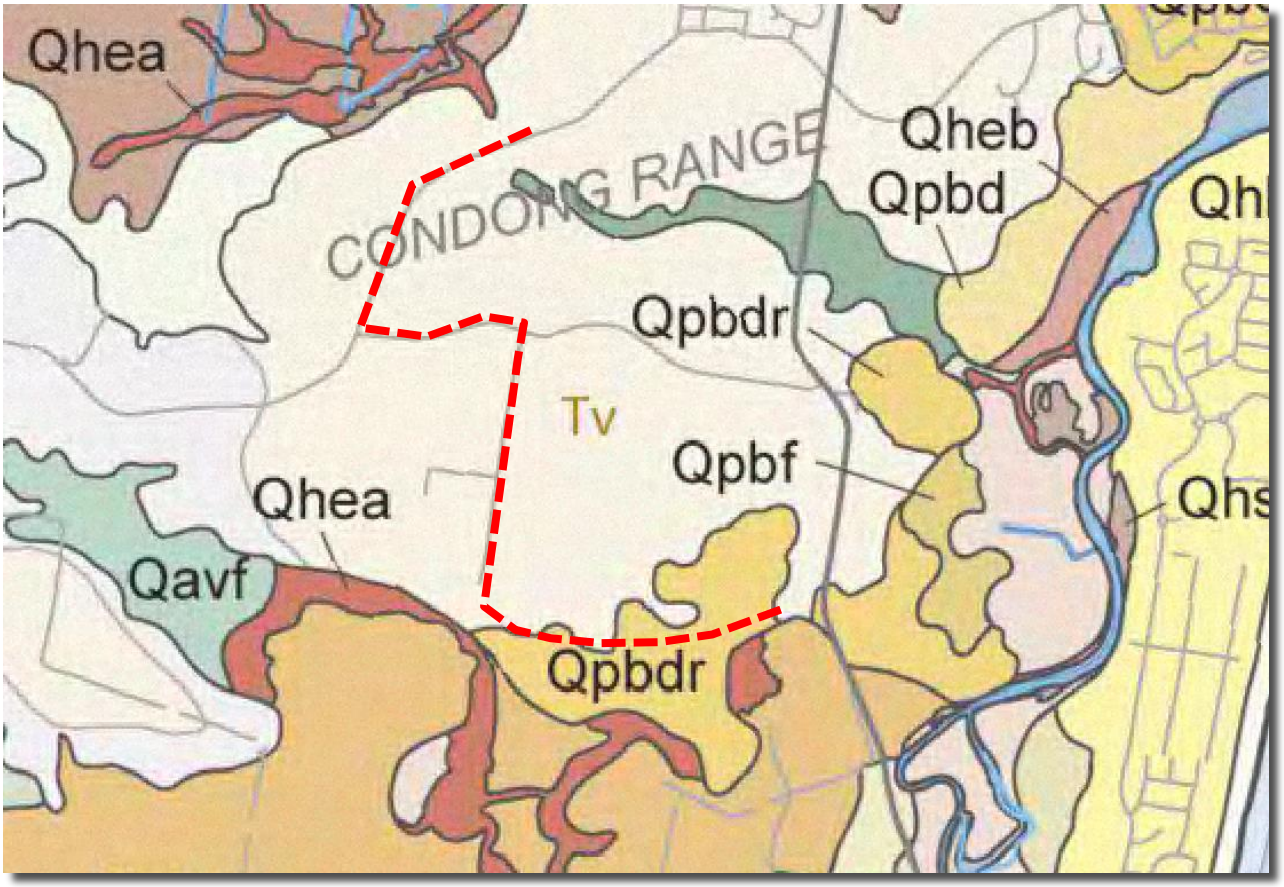
Of note are changes that were observed to the zone substation site between the initial investigations and subsequent visits to the site. The surface level of the zone substations appears to have been cut by approximately 1m since the initial investigations were completed in May 2023.

4.2 Subsurface Conditions

4.2.1 Local Geology

The Tweed Heads Area Coastal Quaternary Geology map indicates the northern elevated residual areas of the site are underlain by tertiary volcanic rocks, including basalt, rhyolite, trachyte, gabbro and syenite (Tv). The southern low lying alluvial areas are underlain by Holocene estuarine paleochannel fill: organic mud, peat, clay, silt, marine sand (Qhea) and Pleistocene bedrock-mantling dune: marine sand, indurated sand. An extract from the Tweed Heads Area Coastal Quaternary Geology map is presented in Diagram 4.

Diagram 4: Coastal Quaternary Geology Map.



A summary of the subsurface profiles encountered within each section of the site is provided below.

4.2.2 Open Trenching Sections (BH1 to BH15)

Open trenching will be undertaken between the existing Cudgen Zone Substation and the southern end of Reardons Road. Areas of open trenching may also be undertaken between underbore sections and within the proposed zone substation site. These sections of open trenching will be

within a combination of residual clays soils, possible weathered basalt and alluvial and aeolian sands. The profile encountered within the open trenching sections are summaries below.

Cudgen Zone Substation to End Reardons Road (BH1 to BH12)

Fill: Sandy gravel pavement material, dense. Typically, between 0.3 to 0.5m deep.

Topsoil: Silty clay, low to medium plasticity, with gravel and rootlets to typically 0.2m

Residual: Silty clay, medium to high plasticity, very stiff to hard and friable extending up to 3m. The residual clay contains varying amounts of basalt gravel, cobbles and small boulders. The boulders are typically rounded and high strength.

Extremely Weathered Basalt. Recovered as gravelly clay, medium plasticity, hard and friable was encountered in some of the boreholes, typically over the southern portion of the residual terrain. The weathered basalt is variable within the profile as evidenced in the cutting exposure adjacent to Reardons Road. The exposure indicates the basalt has weathered to residual soil with the more resistant material remaining as high strength rounded basalt cobbles and boulders or core stones within the residual clay soil matrix.

Open Trenching Sections between Underbore location (BH13, BH14 and BH15)

Fill: Sandy gravel pavement material, dense. To 0.15m at BH13. Gravelly clay and sand to 1.2m at BH 15.

Aeolian / Alluvial: sand, loose to medium dense to depths up to 9.0m. The alluvial soils contained layers / lenses of sandy silt and peat.

4.2.3 Underbore Sections (BH-U1, BH-U3, BH-U5, BH-U6 and BH-U8)

BH – U8 and BH-U5 were drilled within the residual terrain while BH-U1, BH-U3, BH-U6 and BH15 were drilled within the alluvial terrain.

The residual terrain comprises silty clay soils overlying weathered rock. Core stones of medium to high strength rock were encountered within the residual and upper weathered rock profile that extended to depths up to 15.15m in BH-U8B. In BH-U5 bands of high strength rock were encountered from 12.35 to 15.0m. The rock is variable and includes Jasper and Trachyte overlying sandstone from 13.35m.

Interpreted geotechnical long sections are provided in the Figures.

4.2.4 Zone Substation Site (BH-S1 to BH-S5)

Five boreholes were drilled within the zone substation site. At the time of the investigations the site was used as a laydown area containing numerous stockpiles, construction materials and waste. Site coverage was restricted as a result. It is also noted that site regrading has been undertaken since the boreholes were drilled. The ground surface level appears to have been lowered by approximately 1m.

A summary of the conditions encountered at the proposed zone substation site are provided in Table 1.

Table 1: Subsurface conditions at Zone Substation Site

Material Unit	Material Type / Description	Depth to Base of Material Unit (m)				
		BHS1	BHS2	BHS3	BHS4	BHS5
1	Sand – Fine, pale grey, very loose	0.15	0.15	0.15	0.15	0.1
2	Silty Sand – Fine, dark grey, loose	0.7	0.4	0.3	0.4	0.5
3	Silty Sand / Sand – fine, grey, brown and pale grey, medium dense	≥3.0	≥3.0	≥3.0	≥3.0	≥3.0
Groundwater		N/E	N/E	N/E	N/E	2.6m

Note:

≥ Base not encountered.
N/E Not Encountered.

Detailed descriptions of the subsurface conditions encountered are provided in the logs presented in Appendix A.

4.3 Laboratory Analysis

Laboratory analysis included:

- Two (2) Aggressivity tests to assess durability requirements.
- Eight (8) acid sulfate soil screening tests.
- Four (4) acid sulfate soil CRS test suites.

The results of the testing are presented and discussed in the relevant sections of this report. A copy of the laboratory test results sheets is provided in Appendix B.

5 GEOTECHNICAL CONSIDERATIONS

The site encompasses two distinctly different terrain types, with varying soil and rock profiles. The northern portion, where the transmission line is likely to be installed by open trenching is within residual clays soils that contain cobbles and boulders of varying size and quantities. The presence of cobbles and boulders should be considered and will impact the methods of construction adopted. Excavation should be achievable by conventional bucket excavation methods but may be problematic for chain trenching plant. Trench overbreak should also be expected.

Excavations within sand will also be problematic with trench overbreak likely. Trench support will be required where seepage is encountered within sand soils.

The underbores will be within a combination of residual clay soils with cobbles and boulders, weathered rock, including high strength and fractured rock, sand and gravel. Horizontal directional drilling is a feasible option but should be decided by experienced underbore contractors. Contractors should be provided with a copy of this geotechnical report including borehole logs to enable them to make an informed decision.

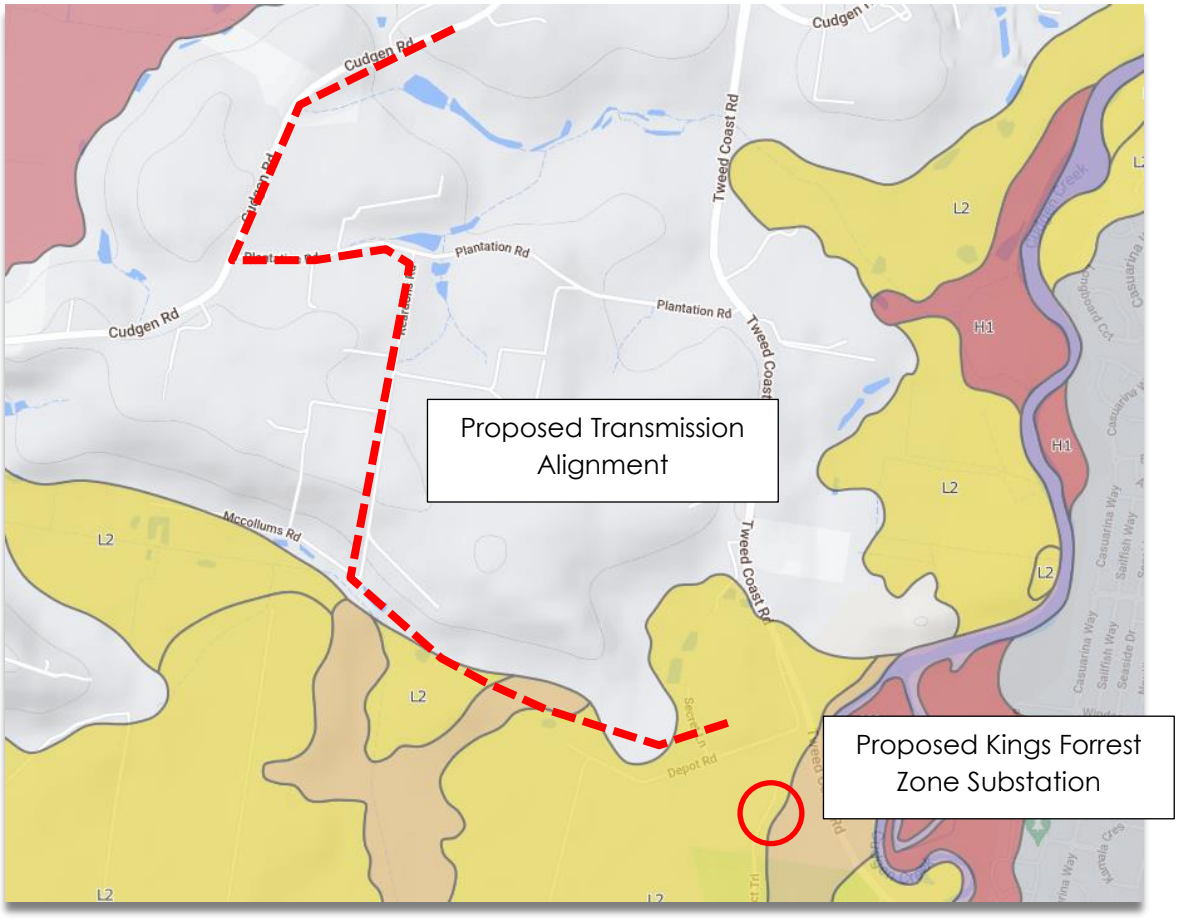
Some of the soils encountered within the alluvial profiles are potential acid sulfate soil. Of note are the alluvial soils below about 1m near BH15 where open excavation may be undertaken. If these soils are expected to be exposed during construction, they should be treated in accordance with a project specific acid sulfate soil management plan. The management plan should be prepared once details of the proposed works are known.

Further details on the above and other pertinent geotechnical information are provided in the following sections.

6 ACID SULFATE SOILS

An extract of the acid sulfate soils risk map for the area is presented below. The map indicates the southern alluvial terrain is within an area of low probability at depths greater than 1m below ground level.

Diagram 5: Acid Sulfate Soil Risk Map



Sourced from the NSW Government Environment and Heritage eSPADE website.

6.1 Sampling and Analysis

Eight samples were collected from the alluvial soil profiles within the area mapped low risk. This included six from within the proposed zone substation site and two on the alignment. The samples were submitted to a NATA registered contract laboratory for ASS screening. The results are summarised below:

Zone Substation Site

- The samples revealed pHF values between 5.31 and 6.32 in distilled water. pHF less than 4 is an indicator of Actual ASS.
- The samples revealed pHFOX values between 2.22 and 2.66 in hydrogen peroxide. Values less than 3 can be an indicator of Potential ASS but can also be the result of high organic content in the soil.

Transmission Line Alignment

- The samples revealed pHF values between 5.04 and 5.93 in distilled water.
- The samples revealed pHFOX values between 1.94 and 4.08 in hydrogen peroxide.

To provide a more comprehensive assessment, four samples were submitted for Chromium Reducible Sulfur (S_{Cr}) and net acidity analysis. A summary of the test results is presented in Table 2.

Table 2: Summary of ASS Net Acidity Test Results

Test location	Depth (m)	Texture	Action Criteria[1] (mol H^+ / t)	Actual Acidity – TAA (mol H^+ / t)	Potential Sulfidic Acidity – CRS (mol H^+ / t)	Net Acidity (mol H^+ / t)
BH-S1	1.0 to 1.5	Coarse	≥18	8	0	8
BH-S3	1.5 to 1.6	Coarse	≥18	9	0	9
BH-S5	0.1 to 0.6	Coarse	≥18	**38**	0	**38**
BH15	1.2 to 1.5	Fine	≥62	**63**	49	**117**

NOTE:

1. *Action criteria is based on less than 1000 tonnes of soil being disturbed.*
2. *Values in Bold exceed the adopted action criteria.*
3. *BH13 and BH15 mislabel as BHS13 and BHS15 on the test results sheets.*

6.2 Results

The results of the analysis were compared against the action criteria as presented in Table 5.4 of the Water Quality Australia *National Acid Sulfate Soils Guidance National acid sulfate soils sampling and identification methods manual, June 2018.*

Zone Substation Site

The testing indicates Titratable Actual Acidity (TAA) concentrations of between 8 and 38 mol H/*t, therefore the soils are acidic. The testing indicates chromium reducible sulphur (S_{Cr}) below laboratory detection limits in all three samples tested and therefore below the adopted action criteria. The net acidity values are below the adopted action criteria for two of these three

samples. The results indicate the soils are naturally acidic but are not actual or potential acid sulfate soils.

Transmission Line Alignment

Most of the transmission line alignment will be within residual soils outside of mapped ASS areas. As such acid sulfate soils will not be an issue. Testing undertaken within the alluvial terrain where some open excavation and soil disturbance through underbore drilling will occur indicates the following.

- A Titratable Actual Acidity (TAA) concentration of 63 mol H/*t was recorded for BH15, therefore the soils are acidic.
- The testing indicates chromium reducible sulphur (SCr) of 49 mol H/*t, indicating potential sulfidic acidity. The net acidy is 117 mol H/*t, which exceeds the adopted action criteria of 62 mol H/*t. The results therefore indicate the soils are naturally acidic and are actual and/ or potential acid sulfate soils.

Based on the results of the assessment an ASS Management Plan should be prepared where soil disturbance is expected to occur within the alluvial terrain along the transmission line alignment. The results indicate that a management plan is not required for works within the proposed zone substation site.

A project specific acid sulfate soil management plan should be prepared once details of the proposed method of construction, areas of disturbance etc are known.

7 EXCAVATIONS

7.1 Open Trenching

All excavation work should be undertaken in accordance with the Safe Work Australia '*Excavation Code of Practice (January 2020)*.

Open trenching will be undertaken between the existing Cudgen Zone Substation and the southern end of Reardons Road. Areas of open trenching may also be undertaken between underbore sections and within the proposed zone substation site. These areas of open trenching will be within a combination of materials including residual clays soils, possible weathered basalt and alluvial and aeolian sands.

The trench excavations are expected to up to depths of approximately 3m. Excavation to these depths could be achievable using conventional bucket excavation methods with medium to large excavators. Excavation within the residual terrain is likely to encounter cobbles and boulders of varying size and quantity. These conditions are likely to be problematic for chain trenching plant. Trench overbreak should also be expected where cobbles and boulders are encountered which will result in trenches being larger and wider than required. This should be considered when excavations are proposed close to other infrastructure including other buried services.

Excavations cut vertically in residual soils should be self-supporting for several hours while the cable is laid and backfilled. Lengths of open excavation should be limited to the extent of cable that can be laid and backfilled within several hours. Large lengths of open unsupported trenching should be avoided.

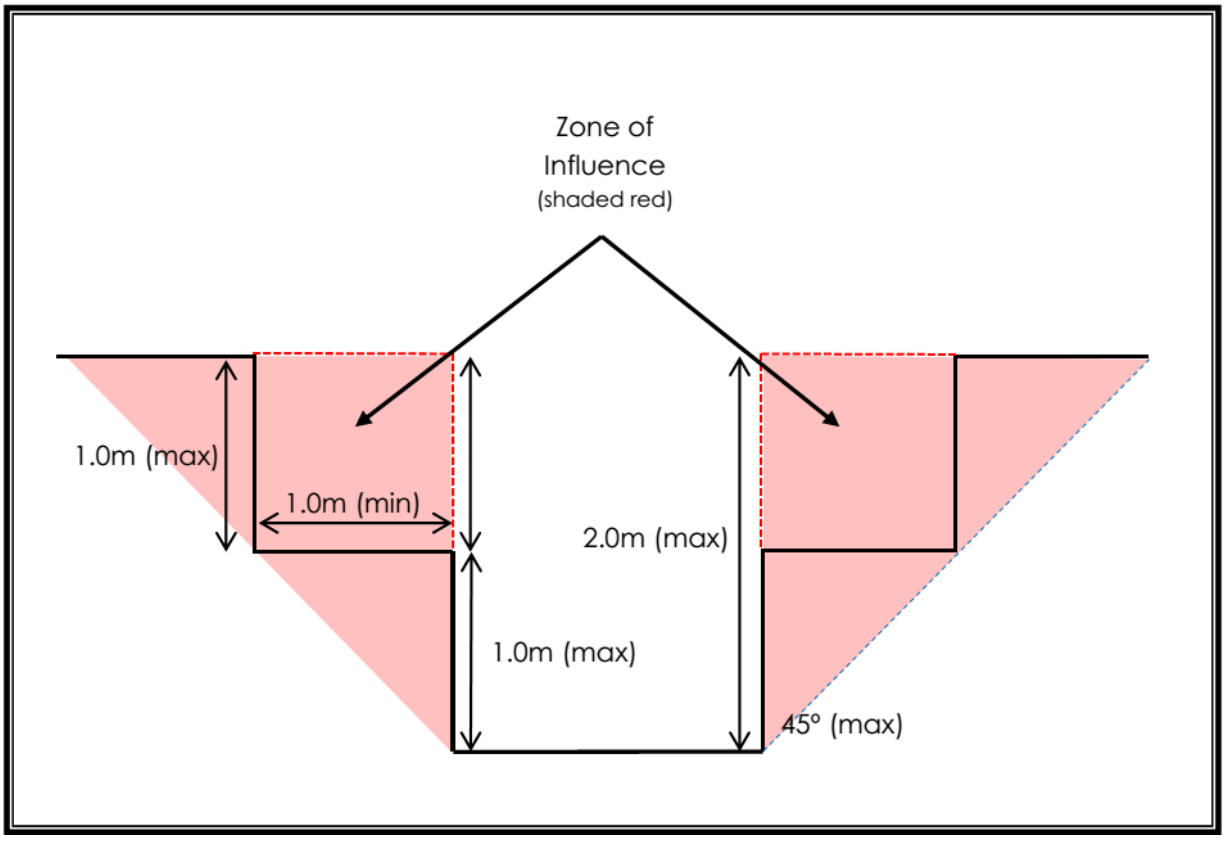
Vertical excavations will not be achievable in sands, particularly if groundwater seepage is encountered. The excavation should be laid back at no steeper than 1V:1H (45°) or trench shields adopted if vertical excavations are required, or seepage is encountered. Excavations below groundwater should be avoided, but, if necessary, will require the implementation of a dewatering system. If a dewatering system is proposed additional geotechnical investigations and guidance will be required along with specialist design from a dewatering contractor. Dewatering and lowering of the water table can have significant impacts on the surrounding environment and should not be undertaken without careful consideration, assessment, and design.

Excavations should not be undertaken where loads are located within the zone of influence of the excavation toe (area within a line drawn up at 45° (max) of the toe of the excavation – see Sketch 1). This includes adjoining traffic loads, construction loads and loads imposed by nearby structures. The trench should be fully supported in situations where the minimum load setback distances cannot be achieved.

It is noted that additional setbacks will be required for excavations within sand where the zone of influence should be drawn up at 30° instead of 45°.

Entry into unsupported trenches should be avoided and appropriate signage and barricading should be installed around all open excavations to prevent entry. Where entry into the trench is required appropriate shoring, such as a trench shield or similar should be used. Alternatively, where space permits the sides of the trenches can be battered at no steeper than 1V:1H (45°) or benched as shown in Sketch 1 below.

Sketch 1: Typical Trench Benching Detail and Zone of Influence



7.2 Underboring

Underbores could be constructed using various methods including micro tunnelling, horizontal directional drilling (HDD) or Pipe Jacking methods. Micro tunnelling and Pipe Jacking methods can generally only be undertaken on a horizontal or slightly inclined plane with only very minor direction alterations achievable during installation.

HDD allows for more directional control but can also result in irregularities and low points along the alignment which may not be desirable when a consistent grade is required. This is not likely to be a significant concern for a power transmission line. HDD methods also reduce the requirement for entry and exit pit excavations.

The method of construction adopted should be decided by prospective underbore contractors in consideration of the soil and rock profile. It is noted that the proposed Underbore 1 alignment will be within variable materials, including residual clays soils with cobbles and boulders, weathered rock, including high strength and fractured rock, sand and gravel. Horizontal directional drilling is likely to be feasible within these materials.

Point load strength index testing on the rock indicates rock strengths ion the order of 150MPa based on a point load to UCS multiplication factor of 20.

Gravel and sand lenses may be encountered within the alluvial soils. Additionally, the upper rock profile is fractured. Collapse of unsupported bores can be an issue in fractured rock.

The drill hole may require support within gravel, sand and fractured rock profiles. Casing is recommended to reduce the potential for drill hole collapse. Drilling fluid pressures should be reduced to prevent the potential for frac out.

8 TRENCH BACKFILLING

8.1 General Guide

The backfill of trenches should be undertaken in accordance with local Council and Essential Energy requirements. The following information is provided as a general guide to the construction and backfilling of the trenches.

- The base of trench excavations should be consistent with no abrupt changes of grade or surface irregularities.
- The cable should be laid in an appropriate bedding material.
- Consideration must be given to location when selecting appropriate backfill materials and compaction requirements (i.e. backfill material below roads will require a higher level of material quality and compaction control).
- Only small compaction plant should be used for compaction around cabling to reduce potential damage. Reference should be made to the suppliers specifications.
- The trench backfill should be placed in layers not exceeding 200mm loose thickness. Compaction requirements are provided in Table 3.

8.2 Backfill Material

Bedding and haunch material should comprise a clean sand or quarried product, free of rocks and other deleterious materials. The material should extend 150mm above the top of the cable. The material should meet the material requirements presented in Table 3.

Table 3: Bedding and Haunch Material Requirements

	Sieve Size (mm)	Percentage Passing
Grading	4.75	100
	2.36	95 – 100
	0.075	0 - 5
PI	3% (max)	

Backfill material above the haunch material could include the excavated material provided it is free of oversized material including cobbles and boulders and free of deleterious and contaminated materials. Any over wet material should also be excluded or appropriately moisture conditioned prior to use.

Backfill in non-trafficable areas can be undertaken up to approximately 200mm of the finished surface using the excavated materials were appropriate and then topsoiled. In trafficable areas the upper 500mm of backfill below the pavement formation should comprise well graded granular select fill with a minimum CBR of 12% and PI of less than 15%. The pavement above should be constructed in accordance with the pavement design.

Trench backfill should be placed in accordance with Council requirements or as specified in Table 4.

Table 4: Trench Backfill Material and Compaction Requirements

Location	Material Type	Moisture Content	Compaction Requirement (%)	
			Non Trafficable	Trafficable
Bedding and Haunch	Non-cohesive (sand)	±2%OMC	60% Density Index	60% Density Index
Backfill	Cohesive (including excavated materials)	±2%OMC	95% SMDD	95% SMDD
Underside of Pavement profile	Select Material (Min CBR12%, PI 12% max)	±2%OMC	- -	100% SMDD (upper 500mm below pavement profile)
Testing Frequency	- -	- -	1 test per layer per 100m interval	1 test per layer per 50m interval (within 500mm of underside of pavement profile)

9 AGGRESSIVITY TO BURIED STRUCTURAL ELEMENTS

The aggressivity test results presented in Table 5 were compared to the exposure classifications provided in Australian Standard AS2159-2009, *Piling Design and Installation*.

Table 5: Results of Soil Aggressivity Testing

Sample Location	pH	Soluble Sulfate (mg/kg)	Chloride (mg/kg)	Resistivity (ohm.cm)	Concrete	Steel
BH6	5.83	50.4	49.7	20,000	Mild	Non-Aggressive
BH12	5.52	63.3	22.6	20,000	Mild	Non-Aggressive

10 MATERIAL DISPOSAL REQUIREMENTS

Most of the material excavated during construction will be reused for backfill and therefore there is not likely to be a requirement of offsite disposal.

If, however, offsite disposal is required the material will require a waste classification assessment in accordance with the NSW EPA Waste Classification Guidelines (2014). Based on the assessment undertaken much of the material will likely classify as either:

- Virgin excavated natural material (VENM), or
- Excavated natural material (ENM).

The natural residual soils and rock that will be excavated could be classified as VENM. It is noted that most of the residual terrain is within farming areas. It may therefore be prudent to carry out some testing to assess the potential presence of contaminants associated with these farming activities.

It is further noted that the alluvial terrain is in mapped acid sulfate soil risk areas and testing has shown some areas to contain acid sulfate soils. This will impact offsite disposal of alluvial soils. Treated soils cannot be classified as ENM or VENM, as such it would be preferable for the soil to remain on site post treatment and validation.

11 ZONE SUBSTSTION CONSTRUCTION

Details of the zone substation are unknown, and the following geotechnical comments and recommendations are provided as preliminary guide to assist with planning, design, and construction. Once details of the proposed zone substation are known RGS should be consulted regarding any additional work required or changes to the provided design recommendations.

11.1 Footings and Foundations

11.1.1 Site Classification

AS2870-2011, '*Residential Slabs and Footings*', sets out criteria for the classification of a site and the design and construction of a footing system for a single dwelling house, townhouse, or similar structure. The site classification presented herein is provided on the basis that the performance expectations of AS2870-2011 are acceptable for the proposed substation and associated infrastructure.

Due to the presence of very loose to loose sands in the upper profile and hence low bearing capacity, in accordance with AS2870-2011 'Residential slabs and footings' the site is classified as **Class 'P'**. It is noted that the upper 1m or so has been removed post investigation which may have resulted in the removal of the upper loose material.

While the site is classified as Class P due to low bearing capacity within the upper sand profile, footings can be designed on engineering principles based on a non-reactive soil profile. Shrink swell movements within the sand will be negligible and footings can therefore be designed based on shrink swell surface movements equivalent to that of a Class A site.

This classification is based on site conditions at the time of the assessment. Trees and changes to the existing profile including additional cut or fill earthworks can have significant impacts on shrink-swell related ground surface movements and subsequently the site classification. Any fill should comprise of non-reactive materials such as sands and gravel. The use of clay soils will result in higher shrink-swell related movements. If site regrading or tree planting in addition to that discussed above are to be undertaken, reclassification will be required.

Site maintenance must comply with the recommendations and advice provided in CSIRO Sheet BTF18 "*Foundation Maintenance and Footing Performance: A Homeowners Guide*" a copy of which can be obtained from www.csiro.au.

11.1.2 Foundation Options and Design Parameters

Shallow Footings

Shallow footings comprising of pad and/or strip footings, raft slabs, or waffle pod, would be feasible. Shallow footings should be founded and designed based on the following:

- All footings including slab thickenings should be founded in the natural sands exposed at the base of the excavation.
- Shallow footings founded within sand of at least loose density can be designed based on an allowable bearing pressure (ABP) of 100kPa.
- Young's Modulus (E) of 15MPa.
- All footings should be entirely founded on similar material and outside or below all zones of influence resulting from existing or future service trenches.

The base of the footings should be wetted down and compacted with a vibrating plate immediately prior to the placement of reinforcement and concrete to increase near surface compaction.

Piles

Screw piles, cased bored piles or CFA piles could be adopted to found within the medium dense sand at a depth of approximately 2m below ground surface level. Piles can be designed based on the parameters provided in Table 6.

Table 6: Summary of Pile Design Parameters

Material	Ultimate End Bearing Capacity (kPa)	Ultimate Shaft Adhesion[1] (kPa)	Effective Vertical Young's Modulus, E'v (MPa)	Effective Horizontal Young's Modulus, E'h (MPa)
Sand	900	25(1)	15	10

NOTES:

1. *Should be taken as zero for screw piles.*

In accordance with AS2159-2009, when assessing the geotechnical reduction factor (Φ_g) an assignment of an Average Risk Rating (ARR) is required which considers the redundancy of the pile system and the quantity and type of pile testing. This process necessarily requires the consideration of several factors which are beyond the direct control of a geotechnical consultant during the site investigation stage. For a recommendation to be provided the assumptions listed below have

been made. If these assumptions change, the geotechnical reduction factor would need to be modified in accordance with the requirements of AS2159-2009 Clause 4.3.

- Design of piles and pile groups will be undertaken in accordance with the recommendations presented in this report.
- Neither static, rapid or dynamic load testing is undertaken on any of the piles.
- Limited degree of professional geotechnical involvement in the supervision of the installation of the piles; and
- No performance monitoring of the supported structure during or after construction.

Based on the above and in accordance with AS2159-2009 a risk rating of 2.72 is estimated. Therefore, assuming the pile configuration will have low redundancy a Geotechnical Strength Reduction Factor of Φ_g=0.52 would be appropriate for the site.

11.2 Site Preparation and Earthworks

The site has been modified since the site investigations where undertaken. This appears to have included the removal of approximately 1m of the upper profile. Therefore, site preparation works for the zone substation are likely to be minimal. The profile should however be assessed to ensure that no uncontrolled fill or other deleterious material exist over the site. The profile should also be proof rolled to identify any potential soft or loose areas.

11.3 Excavation and Excavation Support

Excavations are likely to be less than about 1m for the installation of services and footings. Excavations will encounter sand and will be readily achievable with small to medium plant.

Temporary batters and / or benching may be feasible for the temporary support of excavations where setback distances are sufficient. A minimum set back of at least 2 times the excavation depth should be maintained from the hinge point or crest of the excavation (i.e. 2m setback for a 1m deep excavation).

Batters should be constructed in accordance with the recommendations in Table 7.

Table 7: Temporary Batter Geometry

Maximum Vertical Batter Height (m)	Material Type	Temporary Batters
1	Loose Sand	2H:1V

Seepage is not anticipated but if encountered flatter batters will be required as the sand will tend to 'flow'. The batters should be protected from rain by covering with an impermeable or low permeability material such as light weight geofabric.

Where required for permanent support retaining walls can be designed based on a triangular lateral earth pressure distribution using the following characteristic earth pressure coefficients and subsoil parameters:

- Retaining walls should be uniformly founded within the natural sands of at least loose density.
- For cantilever walls where movement is of little concern, an active earth pressure coefficient (k_a) of 0.33 can be adopted for the soil profile, assuming a horizontal backfill surface.
- Where the top of the retaining wall is to be restrained, such as by floor slabs, or if the walls are retaining areas which are sensitive to movement, an 'at rest' earth pressure coefficient (k_o) of 0.5 should be adopted.
- The following soil parameters should be adopted for the soil profile for the design of retaining walls:
    - Angle of internal friction (ϕ) – 30 deg.
    - Effective cohesion (c') – 0 kPa
    - Bulk Unit Weight (γ) - 18 kN/m^3
- To provide lateral restraint at the wall toe, the toe of the walls must be embedded below the base of the excavations and below the zone of influence of any nearby service trenches etc. A passive earth pressure coefficient (k_p) of 3.0 can be adopted for the soils at the toe of the wall. The excavation should be assessed during construction to assess appropriate passive resistance values.
- Any surcharge affecting the walls (e.g. building footings, traffic loading, adjacent retaining walls and their backfill, etc.) should be allowed for in the design. If inclined backfill surfaces are proposed, then the lateral earth pressure coefficient would have to be appropriately increased, or the inclined surface treated as a surcharge.

The retaining walls should be designed as drained and measures taken to induce complete and permanent drainage of the ground behind the wall. The wall backfill should comprise free draining granular material such as a 20mm drainage gravel. Crusher dust should not be used as a drainage medium. Subsoil drains should comprise a geocomposite drain or geotextile (Bidim A34 or similar) wrapped gravel drain at the toe of the back of the wall. The drains should be connected to the site drainage system and discharged to the stormwater system. Flushing points should be incorporated into the design. These measures should reduce the potential for pore water pressures to build up behind the walls, however the design of the walls should include an allowance of potential water pressure build-up equivalent to the full retained height.

11.4 Pavements

Pavement subgrades will likely comprise sand which are presently exposed. Pavements constructed over the sand can be designed based on a CBR value of 10%.

Once details are known such as pavement location, pavement type, subgrade level and traffic loadings are known pavement thickness deigns can be provided.

12 LIMITATIONS

This report comprises the results of an investigation carried out for a specific purpose and client as defined in the document. The report should not be used by other parties or for purposes or projects other than those assumed and stated within the report, as it may not contain adequate or appropriate information for applications other than those assumed or advised at the time of its preparation. The contents of the report are for the sole use of the client and no responsibility or

liability will be accepted to any third party. The report should not be reproduced either in part or in full, without the express permission of Regional Geotechnical Solutions Pty Ltd.

Geotechnical site investigation is based on data collection, judgment, experience, and opinion. By its nature, it is less exact than other engineering disciplines. The findings presented in this report and used as the basis for the recommendations presented herein were obtained using normal, industry accepted geotechnical design practises and standards. To our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points.

The recommended depth and properties of any soil, rock, groundwater, or other material referred to in this report is an engineering estimate based on the information available at the time of its writing. The estimate is influenced and limited by the fieldwork method and testing carried out in the site investigation, and other relevant information as has been made available. In cases where information has been provided to Regional Geotechnical Solutions for the purposes of preparing this report it has been assumed that the information is accurate and appropriate for such use. No responsibility is accepted by Regional Geotechnical Solutions for inaccuracies within any data supplied by others.

If site conditions encountered during construction vary significantly from those discussed in this report, Regional Geotechnical Solutions Pty Ltd should be contacted for further advice.

This report alone should not be used by contractors as the basis for preparation of tender documents or project estimates. Contractors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

If you have any questions regarding this report, please contact the undersigned.

For and on behalf of

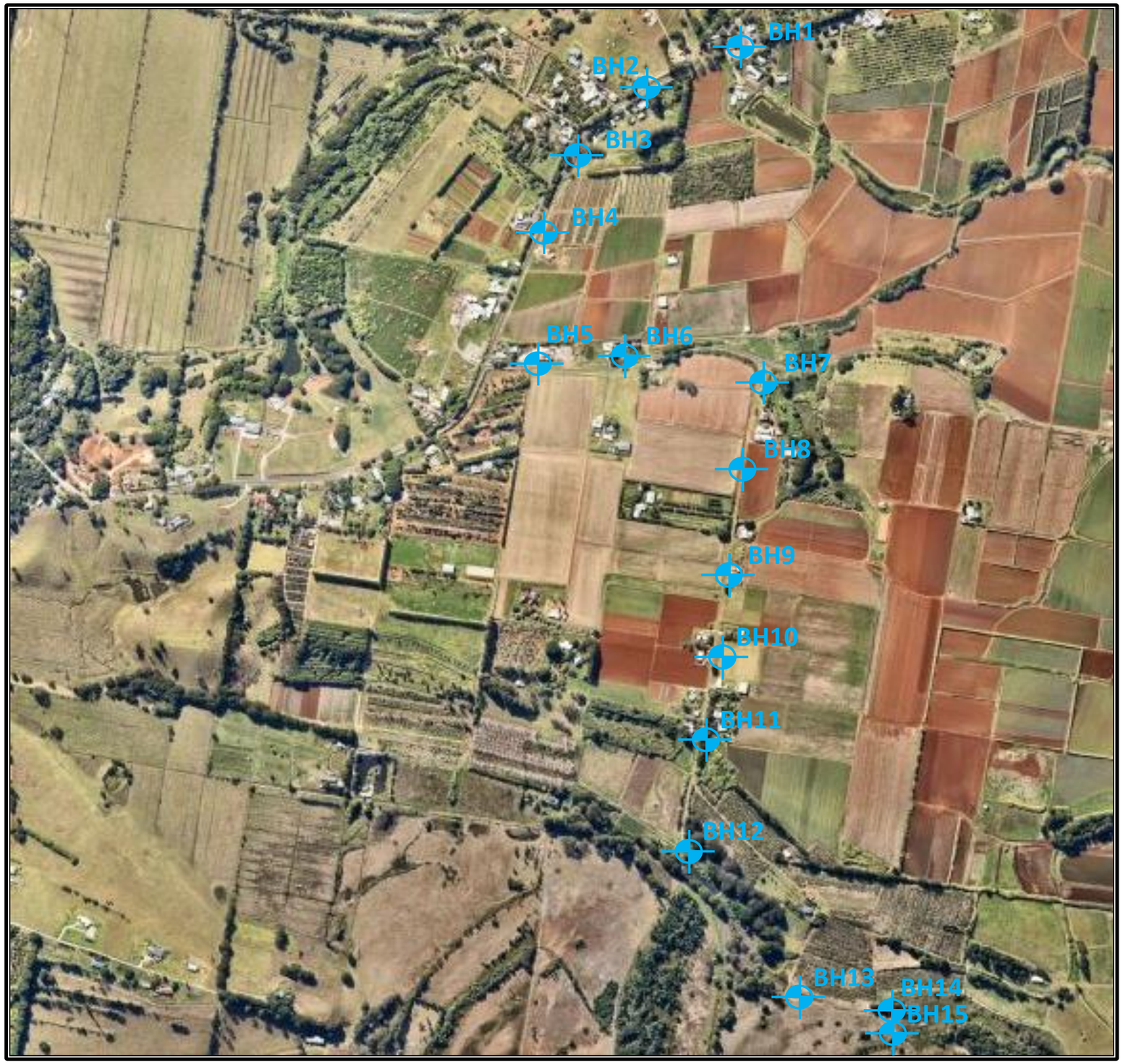
Regional Geotechnical Solutions Pty Ltd

Prepared by

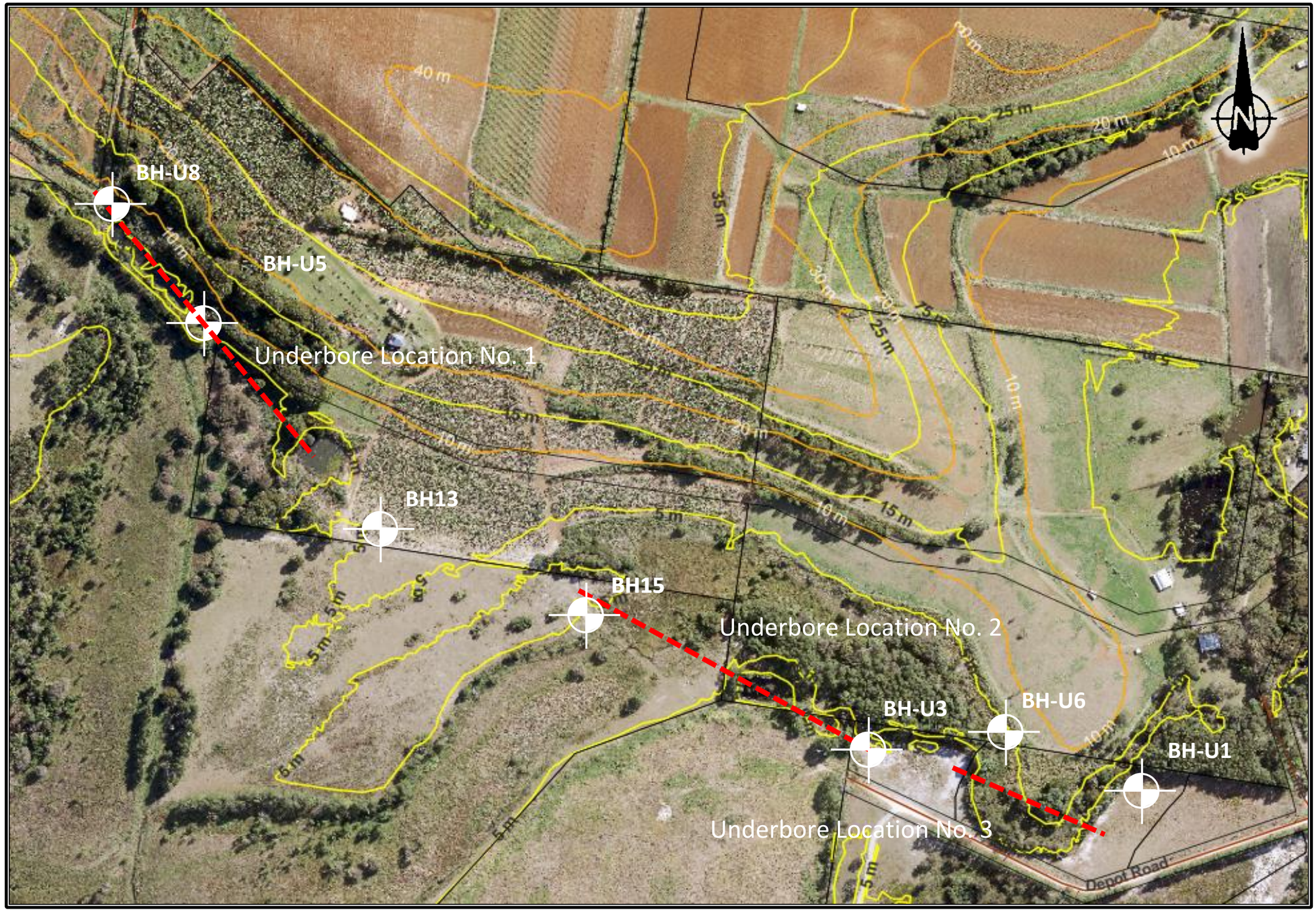


Adam Holzhauser
Principal Geotechnical Engineer

Figures

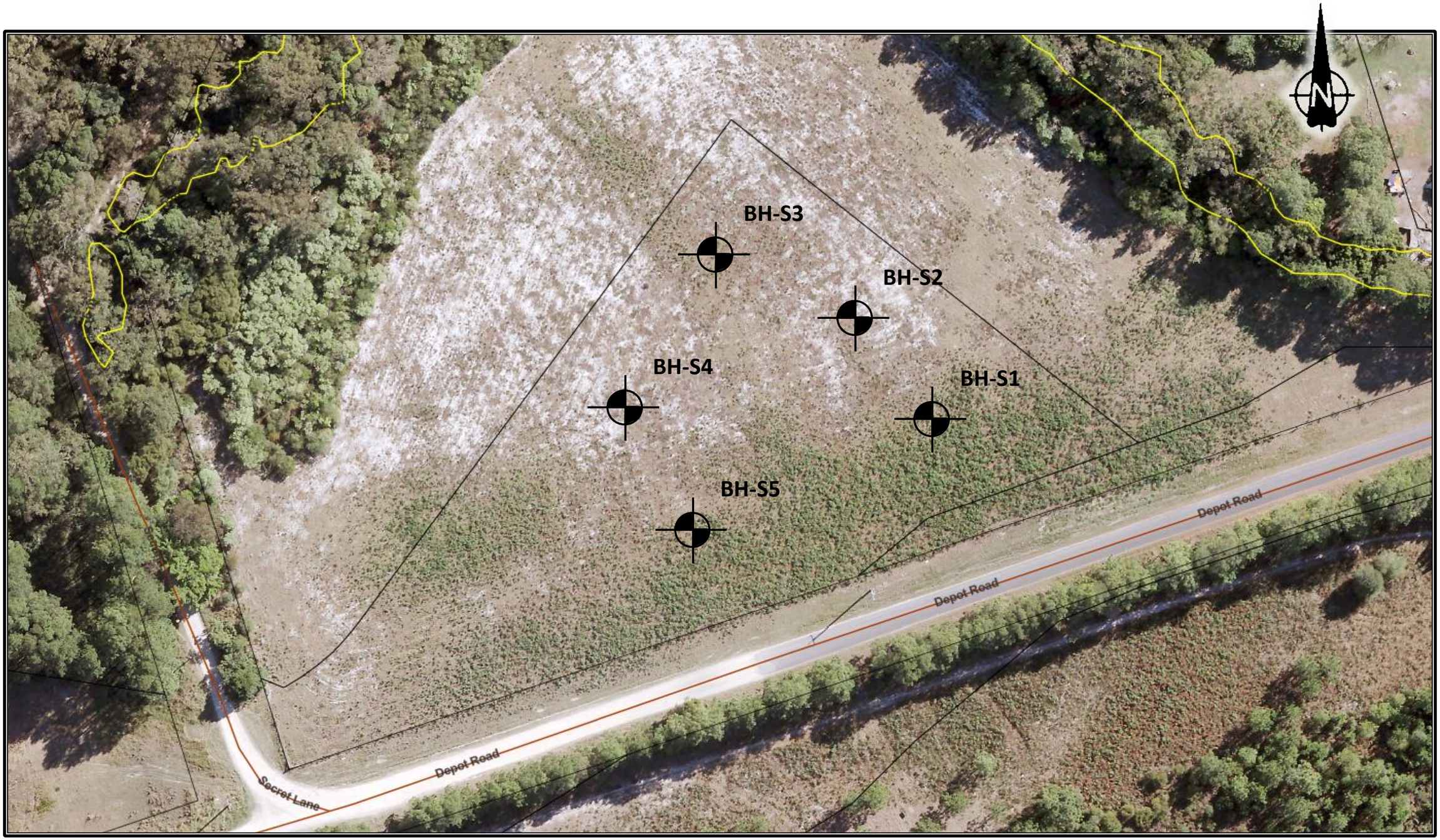


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	Project:	Kings Forest Development	Drawn By:	AH
			Scale:	NTS
		Kings Forest	Date:	26-Sep-23
	Title:	Open Trenching Section - Borehole Locations	Drawing No.	**Figure 1**

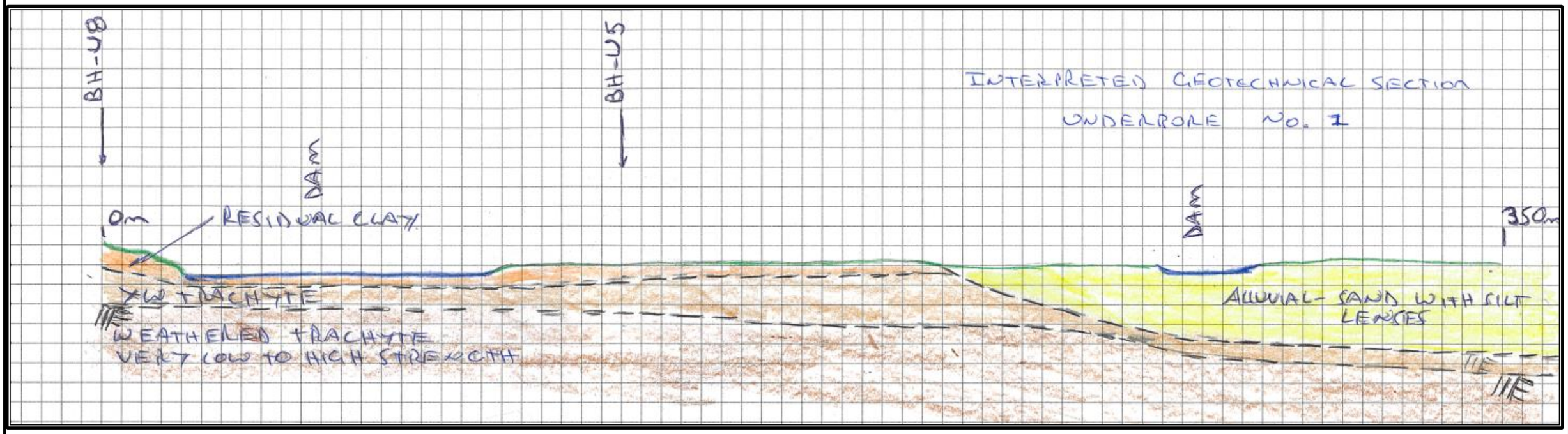


REGIONAL GEOTECHNICAL SOLUTIONS

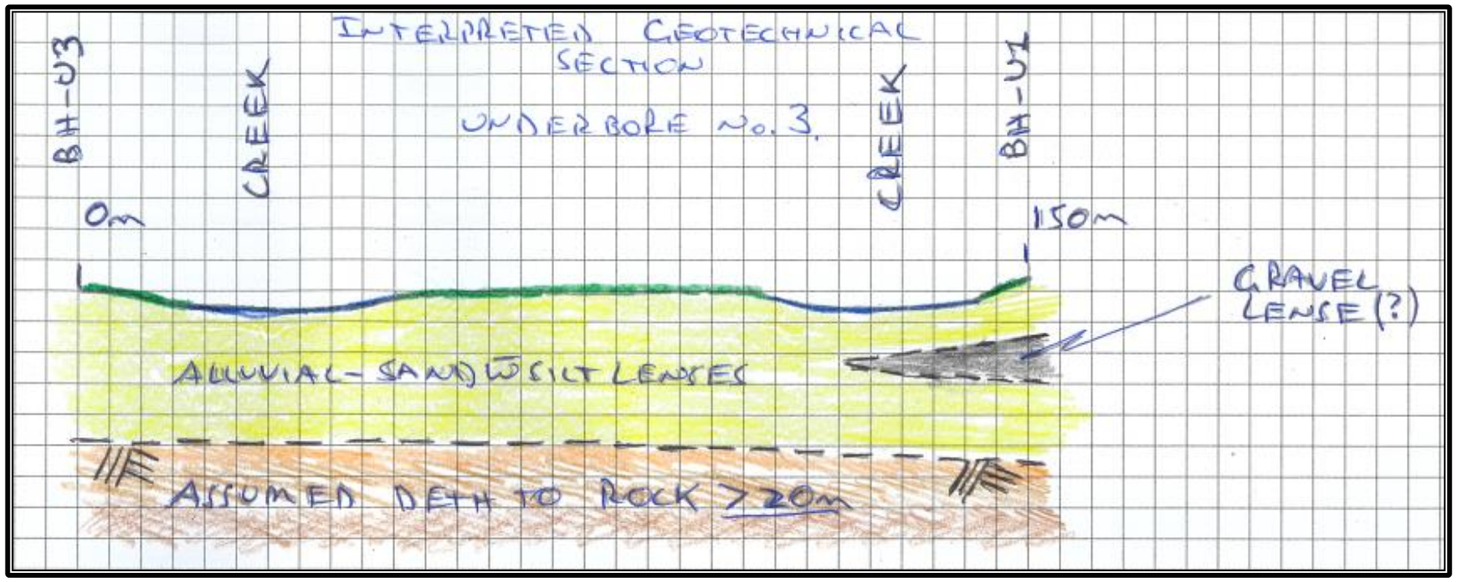
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Project:	Kings Forest Development	Drawn By:	AH
		Scale:	NTS
	Kings Forest	Date:	22-Jun-20
Title:	Underbore Section - Borehole Locations	Drawing No.	**Figure 2**

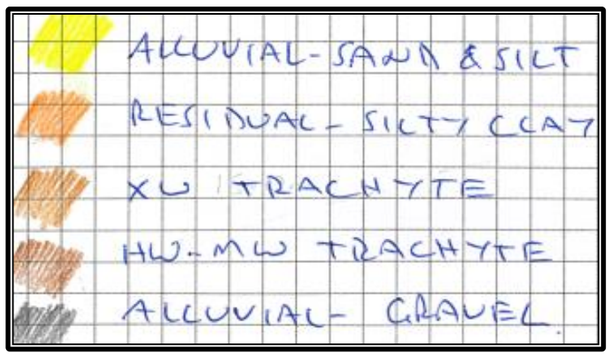


REGIONAL GEOTECHNICAL SOLUTIONS	**Client:**	Essential Energy	Job No.	RGS33650.1
	Project:	Kings Forest Development	Drawn By:	AH
			Scale:	NTS
		Kings Forest	Date:	26-Sep-23
	Title:	Substation Site - Borehole Locations	Drawing No.	**Figure 3**



REGIONAL GEOTECHNICAL SOLUTIONS	**Client:**	Essential Energy	Job No.	RGS33650.1
	Project:	Kings Forest Development	Drawn By:	AH
			Scale:	1:100 @ A3
		Kings Forest	Date:	26-Sep-23
	Title:	Interpreted Geotechnical Section - Underbore No. 1 and No. 2	Drawing No.	**Figure 4**





REGIONAL GEOTECHNICAL SOLUTIONS	**Client:**	Essential Energy	Job No.	RGS33650.1
	Project:	Kings Forest Development	Drawn By:	AH
			Scale:	1:100 @ A3
		Kings Forest	Date:	22-Jun-20
	Title:	Interpreted Geotechnical Section - Underbore No. 3	Drawing No.	**Figure 5**

Appendix A

Results of Field Investigations

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH1

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 23/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING: 553925 m
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING: 6873029 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered			0.5		GP	**FILL:** Sandy GRAVEL, fine to coarse grained, pale brown/brown, sand, fine to medium grained, with some silt fines	M				FILL
							0.25m					
						Cl	**Silty CLAY:** Medium plasticity, pale brown/brown, trace of sand and gravel, fine to medium grained	M < w_P	VSt	HP	220	RESIDUAL
				1.0				M > w_P		HP	280	
							1.20m					
				1.5		Cl	**Silty CLAY:** Medium plasticity, pale brown/pale orange-brown, trace of sand and gravel, fine to medium grained			HP	300	
								M < w_P				
				2.0						HP	300	
							2.30m					
				2.5		Cl	**Silty CLAY:** Medium plasticity, pale brown/pale orange-brown with pale grey mottling, trace of sand and gravel, fine to medium grained					
										HP	250	
				3.0			3.00m					
							Hole Terminated at 3.00 m					
				3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:47 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH2

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 23/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING: 553689 m
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING: 6872933 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered			0.5		CL CI	0.15m **TOPSOIL:** Silty CLAY, low to medium plasticity, brown/dark brown, trace of sand and gravel, fine to medium grained, trace of grass roots **Silty CLAY:** Medium plasticity, brown, trace of sand and gravel, fine to medium grained, trace of cobbles	$M < w_P$ $M > w_P$	St	HP	180	TOPSOIL RESIDUAL
				1.0			Becoming more brown/pale brown from 1.0m			HP	150	
				1.5						HP	150	Cobbles/boulders encountered from 1.2m Some highly weathered basalt gravel
				2.0			1.60m Hole Terminated at 1.60 m Refusal on Basalt boulder					
				2.5								
				3.0								
				3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:47 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH3

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 23/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING: 553567 m
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING: 6872819 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered			0		CI	**FILL:** Silty CLAY, medium plasticity, brown, trace of sand and gravel, fine to medium grained	M < w_P	St - VSt	HP	180	FILL
							0.30m			HP	230	
						CI	**Silty CLAY:** Medium plasticity, brown/red-brown, trace of sand and gravel, fine to medium grained		VSt			RESIDUAL
				0.5						HP	300	
				1.0				M > w_P		HP	250	
							1.30m					
				1.5		CI	**Silty CLAY:** Medium plasticity, brown, pale brown, trace to some sand and gravel, fine to medium grained	M < w_P	VSt - H	HP	350	
				2.0						HP	370	
				2.5						HP	370	
				3.0			3.00m			HP	420	
							Hole Terminated at 3.00 m					
				3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:48 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH4

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 23/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING: 553482 m
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING: 6872618 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered			0		CL	**TOPSOIL:** Silty CLAY, low to medium plasticity, brown/red-brown, trace of sand and gravel, fine to medium grained, trace of grass roots	M < w_P				TOPSOIL
				0.20m		CI	**Silty CLAY:** Medium plasticity, brown/red-brown, trace of sand and gravel, fine to medium grained	M > w_P	St - VSt			RESIDUAL
				0.5						HP	180	
				1.0						HP	210	
				1.5						HP	280	
				1.50m		CI	**Silty CLAY:** Medium plasticity, brown, trace of sand and gravel, fine to medium grained	M < w_P	VSt - H			
				2.0						HP	380	
				2.5						HP	420	
				3.0						HP	500	
				3.00m			Hole Terminated at 3.00 m					
				3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:48 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH5

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 23/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING: 553458 m
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING: 6872316 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered			0.5		CL	**TOPSOIL:** Silty CLAY, low to medium plasticity, brown/red-brown, trace of sand and gravel, fine to medium grained, trace of grass roots and cobbles	M < w_P				TOPSOIL
							0.20m					
						CI	**Silty CLAY:** Medium plasticity, brown/red-brown, trace of sand and gravel, fine to medium grained		VSt	HP	350	RESIDUAL
				1.0						HP	150	
									St			
										HP	150	
							1.20m					
				1.5		CI	**Silty CLAY:** Medium plasticity, brown/pale brown, trace to some sand and gravel, fine to medium grained, trace of cobbles and boulders	M > w_P		HP	120	
				2.0						HP	110	
							2.40m					
				2.5			Hole Terminated at 2.40 m Refusal on Basalt boulder					
				3.0								
				3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:48 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH6

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 23/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING: 553659 m
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING: 6872331 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	▶					GM	**TOPSOIL:** Silty GRAVEL, fine to medium grained, brown, trace of sand, fine to medium grained					FILL
							0.15m					
				0.5		CL	**Silty CLAY:** Low to medium plasticity, red-brown/brown, trace of sand and gravel, fine to medium grained, trace of cobbles and boulders					RESIDUAL
				1.0						HP	70	
				1.5			1.50m					
						GM	**Silty GRAVEL:** Fine to coarse grained, brown/pale brown					EXTREMELY TO HIGHLY WEATHERED BASALT
		2.00m		2.0								
		D										
		2.50m		2.5			2.50m					
							Hole Terminated at 2.50 m Refusal on Basalt boulder					
				3.0								
				3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:48 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH7

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 23/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING: 553958 m
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING: 6872283 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered					CI	**FILL:** Silty CLAY, medium plasticity, brown/red-brown, trace of sand and gravel, fine to medium grained	M < w_P	St			FILL
							0.35m					
				0.5		SP	**FILL:** Gravelly SAND, fine to coarse grained, grey, brown, gravel, fine to coarse grained	M				FILL-ALLUVIAL SANDY GRAVEL
							0.60m					
							Hole Terminated at 0.60 m due to possible services					
				1.0								
				1.5								
				2.0								
				2.5								
				3.0								
				3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:48 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

ENGINEERING LOG - BOREHOLE

REGIONAL GEOTECHNICAL SOLUTIONS

BOREHOLE NO: BH8
CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 23/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING: 553922 m
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING: 6872087 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered			0		CL	**FILL:** Silty CLAY, low to medium plasticity, brown/red-brown, with some sand and gravel, fine to medium grained	M < w_P	VSt	HP	220	FILL
							0.30m					
				0.5		CL	**Silty CLAY:** Low to medium plasticity, brown/red-brown, trace to some sand and gravel, fine to medium grained	M > w_P	St	HP	150	RESIDUAL
				1.0						HP	110	
							1.20m					
				1.5		CL	**Silty CLAY:** Low to medium plasticity, brown, trace to some sand and gravel, fine to medium grained			HP	100	
				2.0			2.00m			HP	120	EXTREMELY WEATHERED BASALT
						CL	**Gravelly Silty CLAY:** Low to medium plasticity, brown/pale brown, gravel, fine to medium grained, trace sand, fine to medium grained	M < w_P				
				2.5						HP	150	Becoming harder to drill from 2.5m
				3.0			3.00m					
							Hole Terminated at 3.00 m					
				3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:49 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH9

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 23/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING: 553882 m
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING: 6871838 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered			0		CL	**FILL:** Silty CLAY, low plasticity, brown/red-brown, trace of sand and gravel, fine to medium grained, trace of grass roots	M < w_P				TOPSOIL
				0.20m		CL	**Silty CLAY:** Low to medium plasticity, brown/pale brown, trace to some sand and gravel, fine to medium grained, trace of cobbles	M > w_P	St	HP	100	RESIDUAL
				0.5								
				1.0						HP	110	
				1.5								Hard drilling from 1.5m
				1.65m			Hole Terminated at 1.65 m Practical refusal on Basalt boulder					
				2.0								
				2.5								
				3.0								
				3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:49 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH10

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 23/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING: 553857 m
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING: 6871669 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered			0		CL	**FILL:** Silty CLAY, low to medium plasticity, brown, trace to some sand and gravel, fine to medium grained	M < w_P				FILL
							0.25m					
				0.5		Cl	**Silty CLAY:** Medium plasticity, brown/red-brown, trace of sand and gravel, fine to medium grained	M > w_P	St	HP	180	RESIDUAL
				1.0						HP	120	
				1.5						HP	140	
							1.80m					
				2.0		CL	**Silty CLAY:** Low to medium plasticity, brown/pale brown, trace to some sand and gravel, fine to medium grained			HP	160	
				2.5						HP	100	
							2.70m					
				3.0		CL	**Gravelly Silty CLAY:** Low to medium plasticity, pale brown/grey-brown, gravel, fine to medium grained, trace sand, fine to medium grained	M < w_P	H / Fr			EXTREMELY WEATHERED BASALT Harder drilling
							3.00m					
							Hole Terminated at 3.00 m					
				3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:49 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH11

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 23/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING: 553817 m
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING: 6871455 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered					GP	**FILL:** Sandy GRAVEL, fine to coarse grained, pale brown/pale orange-brown, with some clay fines					FILL
				0.5			0.40m					
						Cl	**Silty CLAY:** Medium plasticity, brown/red-brown, trace of sand and gravel, fine to medium grained	M > w_P	St			RESIDUAL
				1.0			0.90m					
						GC	1.00m **Clayey GRAVEL:** Fine to coarse grained, grey/dark grey/brown, clay, medium plasticity, trace of sand, fine to medium grained					EXTREMELY TO HIGHLY WEATHERED BASALT
							Hole Terminated at 1.00 m Refusal on Basalt boulder					Very hard drilling from 0.9m
				1.5								
				2.0								
				2.5								
				3.0								
				3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:49 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH11A

CLIENT: Essential Energy
PROJECT NAME: Kings Forest Development
SITE LOCATION: Cudgen
TEST LOCATION: Refer to Figure 1

PAGE: 1 of 1
JOB NO: RGS33650.1
LOGGED BY: AH
DATE: 23/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
EASTING:
NORTHING:
SURFACE RL:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered			0.5		GP	**FILL:** Silty GRAVEL, fine to coarse grained angular basalt	D				FILL
						CH	**Silty CLAY:** Medium to high plasticity, brown, trace fine to coarse grained basalt gravel	M < w_P	H			RESIDUAL
				1.0			Hole Terminated at 0.70 m Refusal on Basalt boulder					
				1.5								
				2.0								
				2.5								
				3.0								
				3.5								

0.50m
0.70m

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:50 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH12

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: AH
TEST LOCATION: Refer to Figure 1
DATE: 24/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered	0.50m D 1.00m		0.5 1.0 1.5 2.0 2.5 3.0 3.5		CI	**FILL:** Gravelly CLAY, medium plasticity, orange-brown, gravel, fine to coarse grained subangular basalt					FILL
						CI	**Silty CLAY:** Medium plasticity, orange-brown, with fine to medium grained basalt gravel	M > w_P	VSt / Fr H / Fr	HP	500	RESIDUAL
						CI	**Silty CLAY:** Medium plasticity, orange-brown mottled grey-brown, with fine to medium grained basalt gravel					
						CI	**Sandy CLAY:** Medium plasticity, orange-brown mottled grey-brown, sand, fine to medium grained					EXTREMELY WEATHERED BASALT
						SC	**Clayey SAND:** Fine to medium grained, pale grey mottled orange-brown	M	VD			
							Hole Terminated at 3.00 m					

0.25m
1.00m
1.50m
2.40m
3.00m

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:50 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH13

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 24/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	24/5/2023	0.50m D 0.60m		0.5		GP	0.15m **FILL:** Sandy GRAVEL, fine to coarse grained, pale brown, sand, fine to medium grained, trace silt fines	M		DCP (0.00-2.00m)	17	FILL
						SP	**SAMPLE:** Fine to medium grained, dark brown/dark grey, with some silt fines		MD		4	AEOLIAN
		0.80m D 1.00m		1.0		SP	0.50m **SAND:** Fine to medium grained, pale brown/pale orange-brown with grey mottling				3	
						SP	0.80m **SAND:** Fine to medium grained, dark brown/dark grey, trace of silt fines				5	
				1.5		SP	1.10m **SAND:** Fine to medium grained, grey-brown	W			5	
						SP	1.70m **SAND:** Fine to medium grained, pale brown				5	
				2.0		SP	2.10m **SAND:** Fine to medium grained, pale grey/white				5	
				2.5			3.00m					
				3.0			Hole Terminated at 3.00 m					
				3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:51 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH14

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 24/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	▽ 24/5/2023			0.5 1.0 1.5 2.0 2.5 3.0 3.5		SP SP	0.10m **SAND:** Fine to medium grained, grey/pale brown, trace grass roots **SAND:** Fine to medium grained, pale grey/grey 3.00m Hole Terminated at 3.00 m	M W		DCP (0.00-2.00m)	1 1 1 2 2 1 2 2 2 2 3 3 3 2 2 2 3 3 3 4	AEOLIAN

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:51 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH15

CLIENT: Essential Energy
PAGE: 1 of 3
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 24/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	24/5/2023			0.5 1.0 1.5 2.0 2.5 3.0 3.5		CI	**FILL:** Gravelly CLAY, medium plasticity, pale brown/pale orange-brown/grey, gravel, fine to coarse grained	< w_P	St			FILL
						SP	0.15m **FILL:** SAND, fine to medium grained, grey/dark grey	M				
							1.20m	W				
						ML	**Sandy SILT:** Low plasticity, dark brown, with organic matter		S - VSt	HP	50	ORGANIC PEAT
										HP	30	
										HP	20	
						SM	3.60m **Silty SAND:** Fine to medium grained, dark brown					ALLUVIUM

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:51 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

ENGINEERING LOG - BOREHOLE

REGIONAL GEOTECHNICAL SOLUTIONS

BOREHOLE NO: BH15

CLIENT: Essential Energy
PAGE: 2 of 3
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 24/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T				4.5		SM	**Silty SAND:** Fine to medium grained, dark brown *(continued)*	W	S - VSt			
							4.70m					
				5.0		ML	**Sandy SILT:** Low plasticity, dark brown, sand, fine to medium grained, trace of organic matter		VS	HP	10	
				5.5								
							5.70m					
				6.0		SP	**SAND:** Fine to medium grained, grey, dark grey, trace to some silt fines					
				6.5								
				7.0								
				7.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:51 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH15

CLIENT: Essential Energy
PAGE: 3 of 3
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 24/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T				8.5		SP	**SAND:** Fine to medium grained, grey, dark grey, trace to some silt fines *(continued)*	W	VS			
				9.0			9.00m Hole Terminated at 9.00 m					
				9.5								
				10.0								
				10.5								
				11.0								
				11.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH LOGS 1-15.GPJ <<DrawingFile>> 27/9/2023 10:51 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U1

CLIENT:	Essential Energy	**PAGE:**	1 of 3
PROJECT NAME:	Kings Forest Development	**JOB NO:**	RGS33650.1
SITE LOCATION:	Kings Forest	**LOGGED BY:**	AH
TEST LOCATION:	Refer to Figure 1	**DATE:**	12/7/23

DRILL TYPE: **EASTING:** **SURFACE RL:**

BOREHOLE DIAMETER: 100 mm **INCLINATION:** 90° **NORTHING:** **DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T						SM	**Silty SAND:** Fine grained, dark brown, rootlets in upper 100mm	M	VL			ALLUVIAL
		1.00m		1.0		SP	0.90m **SAND:** Fine grained, pale grey					
		SPT 1,1,1 N=2										
		1.45m										
				2.0				W	MD			Slight sulfuric odour
		2.50m										
		SPT 8,12,10 N=22										
WB		2.95m		3.0		SM	3.00m **Silty SAND:** Dark brown, with indurated bands, weakly cemented		MD - D			
	90-100% RETURN			4.0					D - VD			
		4.20m										Sulfuric odour
		SPT 15,32,35/100mm N=R										
		4.60m		5.0								
		5.70m										
		SPT 18,18,18 N=36										

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 11:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U1

CLIENT: Essential Energy
PROJECT NAME: Kings Forest Development
SITE LOCATION: Kings Forest
TEST LOCATION: Refer to Figure 1

PAGE: 2 of 3
JOB NO: RGS33650.1
LOGGED BY: AH
DATE: 12/7/23

DRILL TYPE:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
EASTING:
NORTHING:
SURFACE RL:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
WB		6.15m				SM	**Silty SAND:** Dark brown, with indurated bands, weakly cemented *(continued)*	W	D - VD			
							6.50m					
						SM	**Silty SAND:** Fine grained, pale grey, with a trace of medium plasticity clay fines		MD			
				7.0								
		7.20m SPT 6,10,12 N=22										
		7.65m										
				8.0								
							8.50m					
WB	90-100% RETURN	8.70m SPT 3,5,6 N=11				ML	**Clayey SILT:** Low plasticity, pale grey, with a trace of fine grained angular gravel bands/lenses	M > w_P	H	HP HP	>600 500	
		9.15m		9.0								
							9.20m					
						GC	**Clayey GRAVEL:** Medium to coarse grained, subrounded to subangular gravel, dark grey, pale grey, clay, medium plasticity, pale grey		MD			
				10.0								
		10.20m SPT 5,10,15 N=25					10.20m					
						GP	**GRAVEL:** Fine to medium grained, grey, dark grey, pale grey, subrounded to subangular, with bands of silt and gravelly silt		D			
		10.65m										
				11.0								
		11.70m SPT 25 N=R										No sample recovery

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 11:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U1

CLIENT: Essential Energy
PAGE: 3 of 3
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Kings Forest
LOGGED BY: AH
TEST LOCATION: Refer to Figure 1
DATE: 12/7/23

DRILL TYPE:
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
WB	90-100% RETURN	11.85m				GP	**GRAVEL:** Fine to medium grained, grey, dark grey, pale grey, subrounded to subangular, with bands of silt and gravelly silt *(continued)*		D			
		13.20m SPT 20 N=R 13.35m		13.0								No sample recovery
		14.70m SPT 30 N=R 14.85m		14.0			14.85m					
				15.0			Hole Terminated at 14.85 m					
				16.0								
				17.0								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 11:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U3

CLIENT: Essential Energy
PAGE: 1 of 3
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Kings Forest
LOGGED BY: AH
TEST LOCATION: Refer to Figure 1
DATE: 12/7/23

DRILL TYPE:
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T						SP	**SAND:** Fine grained, pale grey	M	VL			ALLUVIAL
	▶							W	L			
		1.00m		1.0								
		SPT 5,5,6 N=11										
		1.45m										
		2.50m		2.0								
		SPT 3,2,2 N=4										
		2.95m		3.0								
							3.10m					
						SM	**Silty SAND:** Fine grained, dark brown, with indurated bands, weakly cemented					
				4.0					D			
		4.20m										
		SPT 25/75mm N=R										
		4.28m										
				5.0								
		5.70m										
		SPT 18,26,30 N=56										

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 11:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U3

CLIENT: Essential Energy
PAGE: 2 of 3
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Kings Forest
LOGGED BY: AH
TEST LOCATION: Refer to Figure 1
DATE: 12/7/23

DRILL TYPE:
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T		6.15m				SM	**Silty SAND:** Fine grained, dark brown, with indurated bands, weakly cemented *(continued)*	W	D			
		7.20m		7.0								
		SPT 16,18,30 N=48										
		7.65m										
		8.70m		8.0								
		SPT 9,4,20 N=24										
		9.15m		9.0								
		10.00m		10.0			10.00m					
		SPT 2,2,1 N=3				SM	**Silty SAND:** Fine grained, grey		L			
		10.45m										
		11.70m		11.0								
		SPT 2,2,2 N=4										

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 11:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U3

CLIENT: Essential Energy
PAGE: 3 of 3
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Kings Forest
LOGGED BY: AH
TEST LOCATION: Refer to Figure 1
DATE: 12/7/23

DRILL TYPE:
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T		12.15m				SM	**Silty SAND:** Fine grained, grey *(continued)*	W	L			
				13.0			Small clay band					
		13.20m					13.10m					
		SPT 4,4,8 N=12				SP	**SAND:** Fine to medium grained, pale grey		MD			
		13.65m										
				14.0								
		14.70m										
		SPT 6,6,8 N=14		15.0			15.15m Fine grained					
		15.15m					Hole Terminated at 15.15 m					
				16.0								
				17.0								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 11:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U5

CLIENT: Essential Energy
PAGE: 1 of 4
PROJECT NAME: Kings Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Kings Forest
LOGGED BY: AH
TEST LOCATION: Refer to Figure 1
DATE: 5/9/23

DRILL TYPE:
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/V	Not Encountered					CH	**Silty CLAY:** Medium to high plasticity, red-brown, with a trace to some fine grained basalt gravel and cobbles	M > w_P	St			RESIDUAL
									H			
		1.00m		1.0						HP	>600	
		SPT 4,5,7 N=12								HP	550	
		1.45m										
				2.0			2.00m			HP	550	
						CH	**Silty CLAY:** Medium to high plasticity, pale grey mottled red-brown, trace sand					
		2.50m								HP	>600	
		SPT 5,6,8 N=14										
				3.0			3.00m					
		2.95m				Cl	**Sandy CLAY:** Medium plasticity, pale grey mottled red-brown, with fine to medium grained angular gravel, bands of medium to high strength rock		H / Fr			EXTREMELY WEATHERED TRACHYTE
		4.00m		4.0								
		SPT 20,20,18 N=38										
WB		4.45m										
				5.0			5.00m					
						ML	**Clayey SILT:** Low to medium plasticity, pale grey and grey-brown, with bands of medium to high strength rock, sand and medium to coarse grained gravel clasts		St - VSt			
		5.50m								HP	250	
		SPT 3,9,15 N=24										
RR										HP	350	

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 11:59 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U5

CLIENT: Essential Energy
PROJECT NAME: Kings Forest Development
SITE LOCATION: Kings Forest
TEST LOCATION: Refer to Figure 1

PAGE: 2 of 4
JOB NO: RGS33650.1
LOGGED BY: AH
DATE: 5/9/23

DRILL TYPE:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
EASTING:
NORTHING:
SURFACE RL:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
RR	Not Encountered	5.95m				ML	**Clayey SILT:** Low to medium plasticity, pale grey and grey-brown, with bands of medium to high strength rock, sand and medium to coarse grained gravel clasts *(continued)*	M > w_P	St - VSt			
		7.00m SPT 15/16mm,30 N=R 7.17m		7.0								
		8.70m SPT 17/50mm N=R 8.75m		8.0						HP	450	
				9.0						HP	350	
		10.10m SPT 32 N=R 10.25m		10.0						HP	350	
				11.0						HP	200	
		11.80m SPT								HP	450	

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 11:59 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U5

CLIENT: Essential Energy
PROJECT NAME: Kings Forest Development
SITE LOCATION: Kings Forest
TEST LOCATION: Refer to Figure 1

PAGE: 3 of 4
JOB NO: RGS33650.1
LOGGED BY: AH
DATE: 5/9/23

DRILL TYPE:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
EASTING:
NORTHING:
SURFACE RL:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
RR		14,20/80mm N=R 12.03m				ML	12.35m	M > w_P	St - VSt			Rock Roller refusal on Jasper band
							Continued as Cored Drill Hole					
				13.0								
				14.0								
				15.0								
				16.0								
				17.0								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 11:59 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

ENGINEERING LOG - CORED BOREHOLE

REGIONAL GEOTECHNICAL SOLUTIONS

BOREHOLE NO: BH-U5

CLIENT: Essential Energy
PROJECT NAME: Kings Forest Development
SITE LOCATION: Kings Forest
TEST LOCATION: Refer to Figure 1

PAGE: Page 4 of 4
JOB NO: RGS33650.1
LOGGED BY: AH
DATE: 5/9/23

DRILL TYPE:
BOREHOLE DIAMETER: 100 mm **INCLINATION:** 90°

EASTING:
NORTHING:

SURFACE RL:
DATUM: AHD

Drilling and Sampling				Material description and profile information				Testing	Rock Mass Defects		
METHOD	WATER	RL Not measured	DEPTH (m)	GRAPHIC LOG	Material Description: Rock type, particle characteristics, colour, minor components, structure	WEATHERING	ESTIMATED STRENGTH	$I_{s(50)}D/A$	RQD %	Defect Spacing mm	Defect Description: Type, inclination, planarity, roughness, coating, thickness
					START CORING AT 12.35m						
NMLC					**JASPER:** Moderately to slightly weathered, fine to medium grained, grey, high strength, silicious	MW - SW	V H	6.18			Hard band of silica rich rock, Rock Roller refused, than punched through
			13.0		**TRACHYTE:** Extremely weathered, fine to medium grained, pale grey with brown bands and occasional fine to coarse grained lithified clasts, very low strength, weathered to soil strength in ??	XW	VL		11.6		All defects drillers breaks
					JASPER: Moderately to slightly weathered, grey, high strength, lithic clasts and hairline calcite infilling, silicious	MW	V H	7.61			
			14.0		**SANDSTONE:** Fine grained, brown-grey, very highly fractured, very low strength	XW	VL		17.7		Highly fractured into 10-60mm fragments
					CORE LOSS				0		
			15.0		**SANDSTONE:** Fine grained, brown-grey, very highly fractured, very low strength	XW	VL				JT 0-5° PL SO
					Hole Terminated at 15.00 m						
			16.0								
			17.0								

LEGEND:

Method

WB	Wash Bore
RR	Rock Roller
CB	Claw or Blad Bit
NMLC	NMLC Core
NQ,HQ,PQ	Wireline Coring

Bedding

Laminated	<20mm
Thinnly Bedded	20-200mm
Medium Bedded	200-600mm
Thickly Bedded	600-2000mm
Very Thickly Bedded	2000mm
Massive	No Visible Bedding

Degree of Fracturing

Fragmented	<20mm
Highly Fractured	20mm to 40mm
Fractured	40mm to 200mm
Slightly Fractured	200mm to 1000mm

Weathering

EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
FR	Fresh

Strength

		$I_{s(50)}$
VL	Very Low	<0.1
L	Low	0.1 - 0.3
M	Medium	0.3 - 1
H	High	1 - 3
VH	Very High	3 - 10
EH	Extremely High	>10

Defect Type

JT	Joint
PT	Parting
SM	Seam
SZ	Shear Zone
CS	Crushed Seam

Roughness

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slickensided

Coating

CN	Clean
SN	Stained
VN	Veneer(<1mm)
CO	Coating(1-5mm)

Planarity

PL	Planar
CU	Curved
ST	Stepped
IR	Irregular

RG 2.00.3 LIB.GLB Log RG CORED BOREHOLE RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 12:01 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U6

CLIENT: Essential Energy
PROJECT NAME: Kings Forest Development
SITE LOCATION: Kings Forest
TEST LOCATION: Refer to Figure 1

PAGE: 1 of 3
JOB NO: RGS33650.1
LOGGED BY: DR
DATE: 5/9/23

DRILL TYPE:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
EASTING:
NORTHING:
SURFACE RL:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered					SM	**TOPSOIL:** Silty SAND, fine to medium grained, grey, organics					TOPSOIL
						SM	0.20m **Silty SAND:** Fine to medium grained, grey, trace to some fines	M	L			ALLUVIAL
		1.00m		1.0		SM	1.00m **Silty SAND:** FIne to medium grained, dark brown, organics	W				
		SPT 1,0,0 N=0										
		1.45m										
				2.0								
		2.50m							MD			
RR		SPT 1,7,8 N=15										
		2.95m		3.0			Gravel band from 3.1m-3.3m Some parts weathered to clay					
		4.00m		4.0								
		SPT 0,0,0 N=0										
		4.45m										
				5.0			5.10m					
		5.50m				CH	**Sandy CLAY:** Medium to high plasticity, pale grey, sand, fine to medium grained, predominantly quartz and ??	M < w_P	St			
WB		SPT 1,3,4 N=7								HP	120	

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 11:59 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

ENGINEERING LOG - BOREHOLE

REGIONAL GEOTECHNICAL SOLUTIONS

BOREHOLE NO: BH-U6

CLIENT: Essential Energy
PROJECT NAME: Kings Forest Development
SITE LOCATION: Kings Forest
TEST LOCATION: Refer to Figure 1

PAGE: 2 of 3
JOB NO: RGS33650.1
LOGGED BY: DR
DATE: 5/9/23

DRILL TYPE:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
EASTING:
NORTHING:
SURFACE RL:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
WB	Not Encountered	5.95m				CH	**Sandy CLAY:** Medium to high plasticity, pale grey, sand, fine to medium grained, predominantly quartz and ?? *(continued)*	M < w_P	St			
							Gravel band, cobbles, drill rig bouncing					
		7.00m		7.0								
RR		SPT 4,8,10 N=18					Angular gravel, 10-50mm, in clay matrix, gravel is dark grey siltstone and quartz	M ~ w_P		HP	120	
		7.45m										
				8.0								
		8.50m					Pale brown gravel			HP	150	
		SPT 9,4,3 N=7										
		8.95m		9.0			Gravel/cobbles					
		10.00m		10.0			10.00m					
		SPT 10,18,23/140mm N=R				CH	**CLAY:** Medium to high plasticity, grey	M < w_P	H	HP	550	
		10.44m										
				11.0								
		11.50m					11.50m					
		SPT 12,25,30					**EXTREMELY WEATHERED MUDSTONE:** Very fine grained, grey/blue, laminated		H / Fr			EXTREMELY WEATHERED MUDSTONE

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 11:59 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U6

CLIENT: Essential Energy
PROJECT NAME: Kings Forest Development
SITE LOCATION: Kings Forest
TEST LOCATION: Refer to Figure 1

PAGE: 3 of 3
JOB NO: RGS33650.1
LOGGED BY: DR
DATE: 5/9/23

DRILL TYPE:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
EASTING:
NORTHING:
SURFACE RL:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
RR	Not Encountered	11.96m					**EXTREMELY WEATHERED MUDSTONE:** Very fine grained, grey/blue, laminated *(continued)*	$M < w_P$	H / Fr			
		13.00m SPT 18,25/140mm N=R 13.29m		13.0						HP	300	
		14.50m SPT 25/80mm N=R 14.58m		14.0			14.58m					
				15.0			Hole Terminated at 15.00 m					
				16.0								
				17.0								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 11:59 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U8

CLIENT:	Essential Energy	**PAGE:**	1 of 1
PROJECT NAME:	Kings Forest Development	**JOB NO:**	RGS33650.1
SITE LOCATION:	Kings Forest	**LOGGED BY:**	DR
TEST LOCATION:	Refer to Figure 1	**DATE:**	13/7/23

DRILL TYPE: **EASTING:** **SURFACE RL:**

BOREHOLE DIAMETER: 100 mm **INCLINATION:** 90° **NORTHING:** **DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered					CI	**TOPSOIL:** SIlty CLAY, medium plasticity, dark brown, organics					TOPSOIL
							0.20m					
						CH	**Silty CLAY:** Medium to high plasticity, red-brown, trace to some basalt gravel	M < w_P	VSt - H			RESIDUAL
				1.0								
		1.50m										
		SPT 6,12,20 N=32										
		1.95m										
				2.0			Gravel and cobbles					
		3.00m		3.0			3.00m					
		SPT 4,4,5 N=9				SC	**Clayey SAND:** Fine to medium grained, pale brown, orange	M	MD			COLLUVIAL
		3.45m										
				4.0								
		4.20m					4.20m					
		SPT 6,19,30/100mm N=R				GP	**GRAVEL:** Medium to coarse grained, pale brown, gravel is angular quartz, trace to some subrounded gravel, fine to medium grained, some bands of brecciated ironstone		D / VD			QUARTZ BAND
NMLC		4.60m		5.0								
							5.90m					
							Hole Terminated at 5.90 m					

LEGEND:

Water

- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes

- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 12:00 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U8B

CLIENT:	Essential Energy	**PAGE:**	1 of 3
PROJECT NAME:	Kings Forest Development	**JOB NO:**	RGS33650.1
SITE LOCATION:	Kings Forest	**LOGGED BY:**	DR
TEST LOCATION:	Refer to Figure 1	**DATE:**	14/7/23

DRILL TYPE: **EASTING:** **SURFACE RL:**

BOREHOLE DIAMETER: 100 mm **INCLINATION:** 90° **NORTHING:** **DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered					CI	0.15m **TOPSOIL:** Silty CLAY, medium plasticity, dark brown, organics	M				TOPSOIL
						CH	**Silty CLAY:** Medium to high plasticity, brown-red, trace fine to medium grained gravel	M < w_P	St			RESIDUAL
				1.0								
RR				2.0			Gravel and cobbles					
				3.0			More gravel and cobbles, possible quartz vein					
				4.0								Multiple colour changes, variable soil zone fault?
				5.0			White silty layer					
		5.70m SPT 5,12,12 N=24					5.70m **EXTREMELY WEATHERED BASALT:** Returned as Silty CLAY, with subrounded basalt gravel, pale brown	W	VD			EXTREMELY WEATHERED BASALT BOULDER

LEGEND:

Water

- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes

- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 12:00 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U8B

CLIENT: Essential Energy
PROJECT NAME: Kings Forest Development
SITE LOCATION: Kings Forest
TEST LOCATION: Refer to Figure 1

PAGE: 2 of 3
JOB NO: RGS33650.1
LOGGED BY: DR
DATE: 14/7/23

DRILL TYPE:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
EASTING:
NORTHING:
SURFACE RL:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
RR	Not Encountered	6.15m					**EXTREMELY WEATHERED BASALT:** Returned as Silty CLAY, with subrounded basalt gravel, pale brown *(continued)*	W	VD			
				7.0								
		7.20m SPT 12,16,30/45mm N=R					Grey/brown, returned as Silty GRAVEL, with basalt gravel throughout					
		7.55m		8.0		8.00m						
						CL	**SILT:** Low to medium plasticity, grey, blue, some subrounded gravel, trace to some very fine sand, pale grey/blue, Sandy SILT, some gravel and quartz	M < w_P	H			
		8.70m SPT 5,17,28 N=45		9.0								
		9.15m										
				10.0								
		10.20m SPT 11,17,25 N=42										
		10.65m		11.0								
		11.70m SPT 28,23,23 N=46										

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 12:00 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH-U8B

CLIENT: Essential Energy
PROJECT NAME: Kings Forest Development
SITE LOCATION: Kings Forest
TEST LOCATION: Refer to Figure 1

PAGE: 3 of 3
JOB NO: RGS33650.1
LOGGED BY: DR
DATE: 14/7/23

DRILL TYPE:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
EASTING:
NORTHING:
SURFACE RL:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
RR	Not Encountered	12.15m				CL	**SILT:** Low to medium plasticity, grey, blue, some subrounded gravel, trace to some very fine sand, pale grey/blue, Sandy SILT, some gravel and quartz *(continued)* Hard band	M < w_P	H			Harder drilling from 13.6m
		14.70m SPT 14,30/70mm N=R 14.92m		13.0 14.0 15.0			Less sandy and gravelly 15.15m					
				16.0 17.0			Hole Terminated at 15.15 m					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH SERIES U LOGS.GPJ <<DrawingFile>> 27/9/2023 12:00 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BHS1

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Creek Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: AH
TEST LOCATION: Refer to Figure 1
DATE: 24/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered	0.50m 0.60m D 1.00m D 1.50m 1.80m D 2.00m		0.5 1.0 1.5 2.0 2.5 3.0		SP SM SP SP SP	0.15m **SAND:** Fine grained, pale grey **Silty SAND:** Fine grained, dark grey 0.80m **SAND:** Fine grained, grey 1.50m **SAND:** Fine grained, brown 2.00m **SAND:** Fine grained, pale grey 3.00m	D M	VL - L L MD	DCP (0.00-3.00m)	3 3 4 4 4 4 3 6 7 8 10 9 10 9 9 9 9 8 11 8 10 9 7 6 6 6 4 6 6 6	AEOLIAN
				3.5 4.0 4.5			Hole Terminated at 3.00 m					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH 51-55 LOGS.GPJ <<DrawingFile>> 27/9/2023 12:33 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BHS2

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Creek Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: AH
TEST LOCATION: Refer to Figure 1
DATE: 24/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered	0.50m 0.60m D 1.00m 1.10m D 1.50m 1.60m D 2.00m 2.10m D		0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5		SM 0.15m SM 1.80m SM 3.00m	**Silty SAND:** Fine grained, pale grey **Silty SAND:** Fine grained, brown **Silty SAND:** Fine grained, pale grey Hole Terminated at 3.00 m	D M	VL L MD	DCP (0.00-3.30m)	2 2 4 4 5 6 7 8 8 8 10 9 9 8 9 7 8 8 9 10 10 9 10 10 8 8 8 8 8 9 8 8 9	AEOLIAN

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH 51-55 LOGS.GPJ <<DrawingFile>> 27/9/2023 12:33 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BHS3

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Creek Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: AH
TEST LOCATION: Refer to Figure 1
DATE: 24/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered	0.50m 0.60m D 1.00m 1.10m D 1.50m 1.60m D 2.00m 2.10m D		0.5 1.0 1.5 2.0 2.5 3.0		SM SM SP SP	0.15m **Silty SAND:** Fine grained, pale grey **Silty SAND:** Fine grained, dark grey 0.60m **SAND:** Fie grained, pale grey 1.00m **SAND:** Fie grained, pale brown 3.00m	D M	VL L MD	DCP (0.00-2.30m)	3 3 3 5 6 6 7 6 7 6 5 6 5 6 5 6 5 4 7 5 5 4 4	AEOLIAN
				3.0 3.5 4.0 4.5			Hole Terminated at 3.00 m					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH 51-55 LOGS.GPJ <<DrawingFile>> 27/9/2023 12:33 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BHS4

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Creek Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: AH
TEST LOCATION: Refer to Figure 1
DATE: 24/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered	0.50m 0.60m D 1.00m 1.10m D 1.50m 1.60m D 2.00m 2.10m D		0.5 1.0 1.5 2.0 2.5 3.0		SM SM SP SP	**Silty SAND:** Fine grained, pale grey (0.15m) **Silty SAND:** Fine grained, dark grey (0.40m) **SAND:** Fine grained, brown (1.00m) **SAND:** Fine grained, grey-brown (3.00m)	D M	VL L MD	DCP (0.00-2.10m)	2 2 4 4 5 6 5 6 8 8 9 6 15 10 12 11 12 12 13 13 14	AEOLIAN
				3.5 4.0 4.5			Hole Terminated at 3.00 m					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH 51-55 LOGS.GPJ <<DrawingFile>> 27/9/2023 12:34 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BHS5

CLIENT: Essential Energy
PAGE: 1 of 1
PROJECT NAME: Kings Creek Forest Development
JOB NO: RGS33650.1
SITE LOCATION: Cudgen
LOGGED BY: AH
TEST LOCATION: Refer to Figure 1
DATE: 24/5/23

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING:
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING:
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T						SP	**SAND:** Fine grained, pale grey	D	VL	DCP (0.00-2.80m)	2	AEOLIAN
							0.15m				3	
						SM	**Silty SAND:** Fine grained, dark grey		L		3	
		0.50m									3	
		0.60m D		0.5					MD		4	
							0.70m				5	
						SP	**SAND:** Fine grained, pale grey				7	
											7	
		1.00m		1.0							8	
		1.10m D									8	
							1.20m				6	
						SP	**SAND:** Fine grained, pale grey-brown				8	
											7	
		1.50m									7	
		1.60m D		1.5							7	
											5	
											5	
											5	
		2.00m		2.0							6	
	24/5/2023	2.10m D									5	
											6	
											5	
											4	
								W			7	
				2.5							4	
							2.60m				6	
						SM	**Silty SAND:** Fine grained, dark brown				10	
											20	Slight sulfuric odour
		2.90m										
		3.00m D		3.0								
				3.5								
		4.00m		4.0								
		4.10m D										
				4.5			4.50m					
							Hole Terminated at 4.50 m					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

RG 2.00.3 LIB.GLB Log RG NON-CORED BOREHOLE - TEST PIT RGS33650.1 BH 51-55 LOGS.GPJ <<DrawingFile>> 27/9/2023 12:34 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: RG 2.00.3 2022-03-03 Prj: RG 2.00.0 2021-06-30

Appendix B

Laboratory Test results

RESULTS OF ACID SULFATE SOIL ANALYSIS

8 samples supplied by Regional Geotechnical Solutions Pty Ltd on 30/05/2023. Lab Job No. P1304.
Analysis requested by Adam Holzhauser. Your Job: RGS33650.1 Essential Energy Cudgen.

1/21 Cook Drive COFFS HARBOUR NSW 2450

Sample Identification	EAL Lab Code	Texture	Moisture Content		pH_F and pH_{FOX}			
			(% moisture of total wet weight)	(g moisture / g of oven dry soil)	pH_F	pH_{FOX}	pH change	Reaction
Method Info.		**	**		*(In-house method S21)*			
BHS1, 1-1.5	*P1304/1*	Coarse	5.6	0.06	6.14	2.66	-3.48	Low
BHS2, 1.5-1.6	*P1304/2*	Coarse	5.2	0.06	5.94	2.45	-3.49	Low
BHS3,2-2.1	*P1304/3*	Coarse	6.5	0.07	6.13	2.45	-3.68	Low
BHS4, 1.5-1.6	*P1304/4*	Coarse	5.7	0.06	6.32	2.44	-3.88	Low
BHS5, 4-4.5	*P1304/5*	Coarse	18.9	0.23	5.62	2.43	-3.19	Low
BHS5, 0.1-0.6	*P1304/6*	Coarse	7.2	0.08	5.31	2.22	-3.09	Low
BHS13, 0.8-1	*P1304/7*	Coarse	11.6	0.13	5.93	4.08	-1.85	Low
BHS15, 1.2-1.5	*P1304/8*	Fine	77.2	3.39	5.04	1.94	-3.10	Volcanic

NOTES:

1. All analysis is reported on a dry weight (DW) basis, unless wet weight (WW) is specified.
2. Samples are dried and ground immediately upon arrival (unless supplied dried and ground).
3. Analytical procedures are sourced from Sullivan L, Ward N, Toppler N and Lancaster G. 2018. National acid sulfate soils guidance: national acid sulfate soils identification and laboratory methods manual, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.
4. The Acid Base Accounting Equation, where Acid Neutralising Capacity has not been corroborated by other data, is Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity (Eq. 3.2; Sullivan et al. 2018 - full reference above).
5. The Acid Base Accounting Equation for post-limed soil materials is Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity - (post treatment Acid Neutralising Capacity - initial Acid Neutralising Capacity) (Eq. 3.3; Sullivan et al. 2018 - full reference above).
   While the Acid Neutralising Capacity of a soil material may not be included in the Net Acidity calculation (Note 4), it must be measured to give an Initial Acid Neutralising Capacity if verification testing is planned post-liming.
   The Inital Acid Neutralising Capacity must be provided by the client to enable EAL to produce Verification Net Acidity and Liming calculations for post-limed soil materials.
6. The Acid Base Accounting Equation, where Acid Neutralising Capacity has been corroborated by other data, is Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity - Acid Neutralising Capacity (Eq. 3.1; Sullivan et al. 2018 - full reference above).
7. The lime calculation includes a Safety Factor of 1.5 as a safety margin for acid neutralisation (Sullivan et al. 2018). This is only applied to positive values. An increased Safety Factor may be required in some cases.
8. Retained Acidity is required when the pHKCl < 4.5 or where jarosite has been visually observed.
9. A negative Net Acidity result indicates an excess acid neutralising capacity.
10. If insufficient mixing occurs during intial sampling, or during post-liming, or both: the Potential Sulfidic Acidity may be greater in the post-limed sample than in the intial sample; the post-liming Acid Neutralising Capacity may be lower in the post-limed sample than in the intial sample.
11. **An acid sulfate soil management plan is triggered by Net Acidity results greater than the texture dependent criterion: coarse texture ⩾ 0.03% S or 18 mol H+/t; medium texture ⩾ 0.06% S or 36 mol H+/t; fine texture ⩾ 0.1% S or 62 mol H+/t) (Table 1.1; Sullivan et al. 201**
12. For projects that disturb > 1000 t of soil material, the coarse trigger of ≥ 0.03% S or ≥ 18 mol H+/t must be applied in accordance with Sullivan et al. (2018) (full reference above).
13. Acid sulfate soil texture triggers can be related to NCST (2009) textures: coarse and peats = sands to loamy sands; medium = clayey sand to light clays; fine = light medium to heavy clays (Sullivan et al. 2018 - full reference above).
14. Bulk density is required to convert liming rates to soil volume based results. Field bulk density rings can be submitted to EAL for bulk density determination.
15. A negative Net Acidity result indicates an excess acid neutralising capacity.
16. '..' is reported where a test is either not requested or not required. Where pHKCl is < 4.5 or > 6.5, zero is reported for SNAS and ANC in Net Acidity calculations, respectively.
17. Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.
18. ** NATA accreditation does not cover the performance of this service.
19. Analysis conducted between sample arrival date and reporting date.
20. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer SCU.edu.au/eal/t&cs or on request).
21. Results relate to the samples tested.
22. This report was issued on 1/06/2023.

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checked: .....
Graham Lancaster
Laboratory Manager

RESULTS OF ACID SULFATE SOIL ANALYSIS

8 samples supplied by Regional Geotechnical Solutions Pty Ltd on 30/05/2023. Lab Job No. P1304.
Analysis requested by Adam Holzhauser. Your Job: RGS33650.1 Essential Energy Cudgen.

1/21 Cook Drive COFFS HARBOUR NSW 2450

Sample Identification	EAL Lab Code	Texture	Moisture Content		pH_F and pH_{FOX}				KCl-extractable sulfur (S_{KCl})		Potential Sulfidic Acidity (Chromium Reducible Sulfur - CRS)			Actual Acidity (Titratable Actual Acidity - TAA)	Retained Acidity		Non-treated soil: Acid Neutralising Capacity (ANC_{BT})		Non-treated soil: Net Acidity	Non-treated soil: Lime Calculation
			(% moisture of total wet weight)	(g moisture / g of oven dry soil)	pH_F	pH_{FOX}	pH change	Reaction	(% S_{KCl})	(equiv. mol H^+/t)	(% S_{cr})	(mol H^+/t)	pH_{KCl}	(mol H^+/t)	(%S_{NAS})	(mol H^+/t)	(% $CaCO_3$)	(mol H^+/t)	(mol H^+/t)	(kg $CaCO_3$/t DW)
Method Info.		**	**		*(In-house method S21)*				**		*(In-house method S20)*		*(In-house method 16b)*		**		*(In-house method S14)*		**	**
BHS1, 1-1.5	*P1304/1*	Coarse	5.6	0.06	6.14	2.66	-3.48	Low	0.003	2	< 0.005	0	5.57	8	..	..	..	..	8	1
BHS2, 1.5-1.6	*P1304/2*	Coarse	5.2	0.06	5.94	2.45	-3.49	Low	..	..	..	..	..	..	..	..	..	..	..	..
BHS3,2-2.1	*P1304/3*	Coarse	6.5	0.07	6.13	2.45	-3.68	Low	0.003	2	< 0.005	0	5.53	9	..	..	..	..	9	1
BHS4, 1.5-1.6	*P1304/4*	Coarse	5.7	0.06	6.32	2.44	-3.88	Low	..	..	..	..	..	..	..	..	..	..	..	..
BHS5, 4-4.5	*P1304/5*	Coarse	18.9	0.23	5.62	2.43	-3.19	Low	..	..	..	..	..	..	..	..	..	..	..	..
BHS5, 0.1-0.6	*P1304/6*	Coarse	7.2	0.08	5.31	2.22	-3.09	Low	0.002	1	< 0.005	0	4.87	38	..	..	..	..	38	3
BHS13, 0.8-1	*P1304/7*	Coarse	11.6	0.13	5.93	4.08	-1.85	Low	..	..	..	..	..	..	..	..	..	..	..	..
BHS15, 1.2-1.5	*P1304/8*	Fine	77.2	3.39	5.04	1.94	-3.10	Volcanic	0.021	13	0.079	49	4.17	63	0.011	5	..	..	117	9

NOTES:

1. All analysis is reported on a dry weight (DW) basis, unless wet weight (WW) is specified.
2. Samples are dried and ground immediately upon arrival (unless supplied dried and ground).
3. Analytical procedures are sourced from Sullivan L, Ward N, Toppler N and Lancaster G. 2018. National acid sulfate soils guidance: national acid sulfate soils identification and laboratory methods manual, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.
4. The Acid Base Accounting Equation, where Acid Neutralising Capacity has not been corroborated by other data, is Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity (Eq. 3.2; Sullivan et al. 2018 - full reference above).
5. The Acid Base Accounting Equation for post-limed soil materials is Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity - (post treatment Acid Neutralising Capacity - initial Acid Neutralising Capacity) (Eq. 3.3; Sullivan et al. 2018 - full reference above).
   While the Acid Neutralising Capacity of a soil material may not be included in the Net Acidity calculation (Note 4), it must be measured to give an Initial Acid Neutralising Capacity if verification testing is planned post-liming.
   The Inital Acid Neutralising Capacity must be provided by the client to enable EAL to produce Verification Net Acidity and Liming calculations for post-limed soil materials.
6. The Acid Base Accounting Equation, where Acid Neutralising Capacity has been corroborated by other data, is Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity - Acid Neutralising Capacity (Eq. 3.1; Sullivan et al. 2018 - full reference above).
7. The lime calculation includes a Safety Factor of 1.5 as a safety margin for acid neutralisation (Sullivan et al. 2018). This is only applied to positive values. An increased Safety Factor may be required in some cases.
8. Retained Acidity is required when the pHKCl < 4.5 or where jarosite has been visually observed.
9. A negative Net Acidity result indicates an excess acid neutralising capacity.
10. If insufficient mixing occurs during intial sampling, or during post-liming, or both: the Potential Sulfidic Acidity may be greater in the post-limed sample than in the intial sample; the post-liming Acid Neutralising Capacity may be lower in the post-limed sample than in the intial sample.
11. An acid sulfate soil management plan is triggered by Net Acidity results greater than the texture dependent criterion: coarse texture ⩾ 0.03% S or 18 mol H+/t; medium texture ⩾ 0.06% S or 36 mol H+/t; fine texture ⩾ 0.1% S or 62 mol H+/t) (Table 1.1; Sullivan et al. 2018 - full r
12. For projects that disturb > 1000 t of soil material, the coarse trigger of ≥ 0.03% S or ≥ 18 mol H+/t must be applied in accordance with Sullivan et al. (2018) (full reference above).
13. Acid sulfate soil texture triggers can be related to NCST (2009) textures: coarse and peats = sands to loamy sands; medium = clayey sand to light clays; fine = light medium to heavy clays (Sullivan et al. 2018 - full reference above).
14. Bulk density is required to convert liming rates to soil volume based results. Field bulk density rings can be submitted to EAL for bulk density determination.
15. A negative Net Acidity result indicates an excess acid neutralising capacity.
16. '..' is reported where a test is either not requested or not required. Where pHKCl is < 4.5 or > 6.5, zero is reported for SNAS and ANC in Net Acidity calculations, respectively.
17. Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.
18. ** NATA accreditation does not cover the performance of this service.
19. Analysis conducted between sample arrival date and reporting date.
20. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer SCU.edu.au/eal/t&cs or on request).
21. Results relate to the samples tested.
22. This final report was issued on 01/07/2023 and replaces the previous report issued on 01/06/2023. Net acidity data is now included.

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checked: .....
Graham Lancaster
Laboratory Manager

RESULTS OF SOIL ANALYSIS

2 samples supplied by Regional Geotechnical Solutions Pty Ltd on 30/05/2023 - Lab Job No. P1305
Analysis requested by Adam Holzhauser. - **Your Project: RGS33650.1**
1/21 Cook Drive COFFS HARBOUR NSW 2450

	Method	Sample 1 BH6	Sample 2 BH12
	EAL job No.	***P1305/1***	***P1305/2***
Moisture (%)	*inhouse*	28	25
Texture	*See note 2 below.*	Medium	Medium
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.83	5.52
Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.050	0.050
Resistivity (ohm.mm)	** Calculation	200,000	200,000
Resistivity (ohm.cm)	** Calculation (ohm.mm / 10)	20,000	20,000
Chloride (mg/kg)	** Water Extract - Colorimetric (1:5 Water)	49.7	22.6
Chloride **(as %)**	** Calculation	0.005	0.002
Sulfate (mg/kg)	** Water Extract-APHA 3120 ICPOES	50.4	63.3
Sulfate **(as % SO_4)**	** Calculation	0.0050	0.0063
Chloride / Sulfate Ratio	** Calculation	1.0	0.4

Notes:

1. ppm = mg/kg dried soil
2. For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays
3. All results as dry weight DW - soils were dried at 60°C for 48hrs prior to crushing and analysis.
4. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm
5. Methods from Rayment and Lyons, 2011. Soil Chemical Methods - Australasia.CSIRO Publishing: Collingwood.
6. Based on Australian Standard AS: 2159-2009
7. Methods from Ahern, CR, McElnea AE , Sullivan LA (2004). *Acid Sulfate Soils Laboratory Methods Guidelines* . QLD DNRME.
8. Analysis conducted between sample arrival date and reporting date.
9. ** NATA accreditation does not cover the performance of this service.
10. .. Denotes not requested.
11. This report is not to be reproduced except in full.
12. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal or on request).
13. Results relate only to the samples tested.
14. This report was issued on 23/06/2023.

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Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

checked: .....
Graham Lancaster
Laboratory Manager

Appendix D: Acid Sulfate Soil Management Plan (Regional Geotechnical Solutions, 2025)

REGIONAL GEOTECHNICAL SOLUTIONS

Manning-Great Lakes
Port Macquarie
Coffs Harbour

RGS33650.2 – AA Rev. 3

20 February 2025

Across Environmental
PO BOX 2236
DANGAR NSW 2309

Attention: Leanne Cross

Dear Leanne,

RE: Kings Forrest Development Transmission Network Upgrade – Cudgen NSW

Acid Sulfate Soil Management Plan

1 INTRODUCTION

This Acid Sulfate Soil Management Plan (ASSMP) has been prepared for sections of underbore associated with the Kings Forrest development transmission network upgrade, Cudgen, NSW.

The management plan is based on the findings of the acid sulfate soil assessment undertaken by Regional Geotechnical Solutions in 2023 for Essential Energy for the development (Ref: RGS33650.1 – AB dated 24 October 2024).

2 PROPOSED DEVELOPMENT

The Kings Forest Development is a large residential housing subdivision located in Kings Forest to the west of Tweed Valley Road as illustrated in Diagram 1. Upgrades to the power transmission network are required to service the residential development.

The network upgrades will include:

- A sub-transmission 33kV or 66kV high voltage underground cable from the existing Cudgen Zone Substation on Cudgen Road to the proposed Kings Forest Zone Substation on Depot Road. This route generally follows an existing 33kV overhead feeder. Trenching to approximately 3m is anticipated along this alignment.
- Three primary underbores located within the southern section of the alignment, below sensitive environmental features including coastal wetlands, and are proposed to minimise environmental impact.

Diagram 2 illustrates the proposed transmission line alignment and location of the underbore subject of this ASSMP.

Diagram 1: Site Location

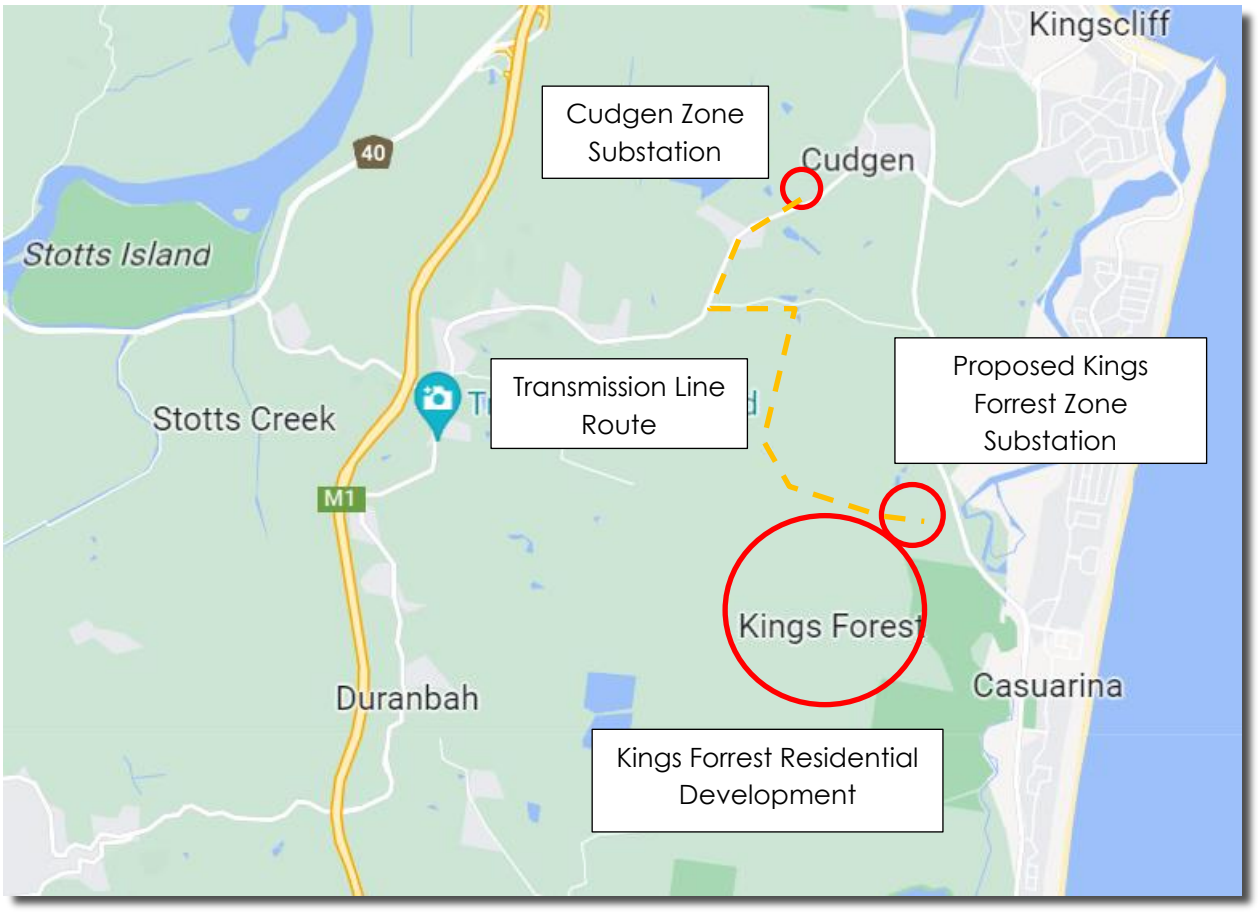
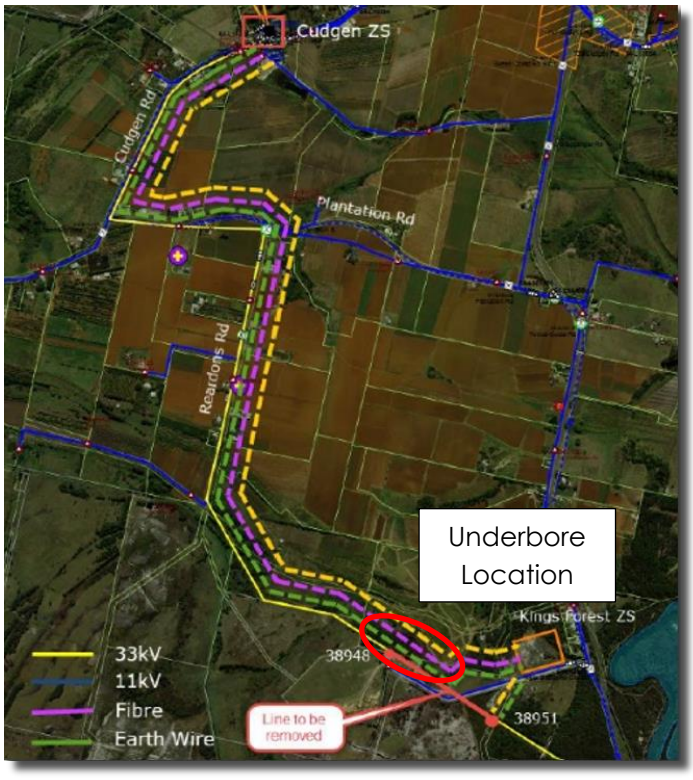
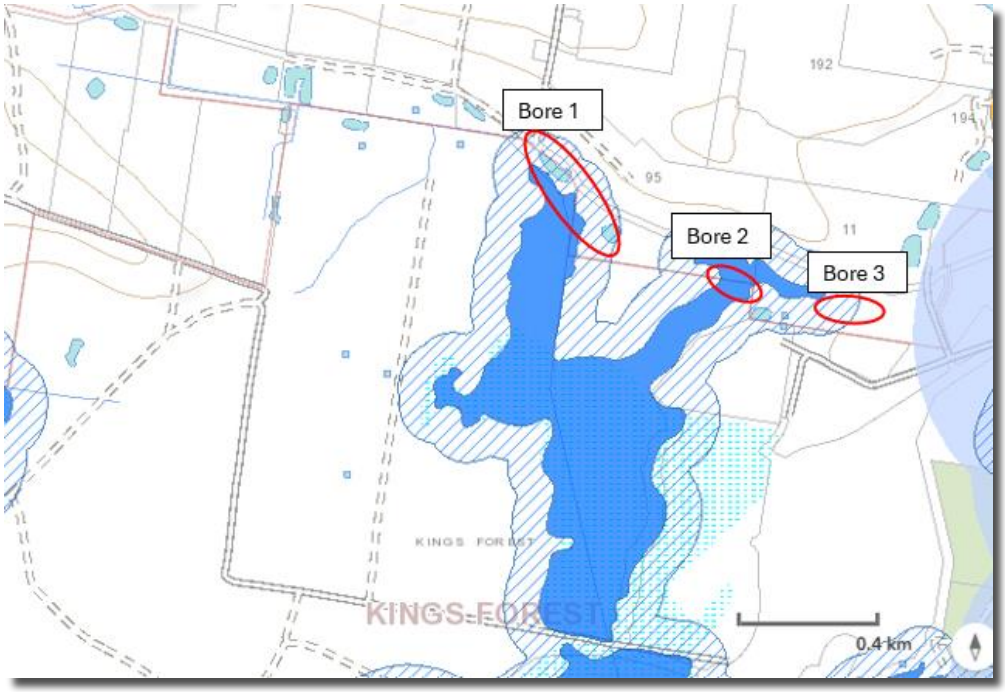


Diagram 2: Transmission Line Alignment and Underbore Location



In the southern section of the alignment, three underbores will be undertaken using horizontal directional drilling (HDD) methods with a wireless steering methodology (see Diagram 3 for indicative locations). Underbore 1 is approximately 350m long, beneath a farm dam that is adjacent to a mapped coastal wetland. Underbore 2 is approximately 270m long beneath a mapped coastal wetland and nearby a farm dam. Underbore 3 is approximately 140m long and is beneath koala habitat.

Diagram 3: Indicative Underbore Locations



Details regarding the underbore construction procedures are outlined in the document prepared by Underbore Solutions dated 17 June 2023.

Based on above the following was considered in the preparation of this ASSMP.

- Minor excavations for entry and exit pits as such soil disturbance through excavation at the entry and exit points will be minor.
- Drill fluid recirculation will be used; therefore, soil cuttings will be contained within fluid recirculation tanks.
- Soil disturbance will be less than 1,000tonnes.
- Drilling fluids will be disposed off site in accordance with regulatory requirements.

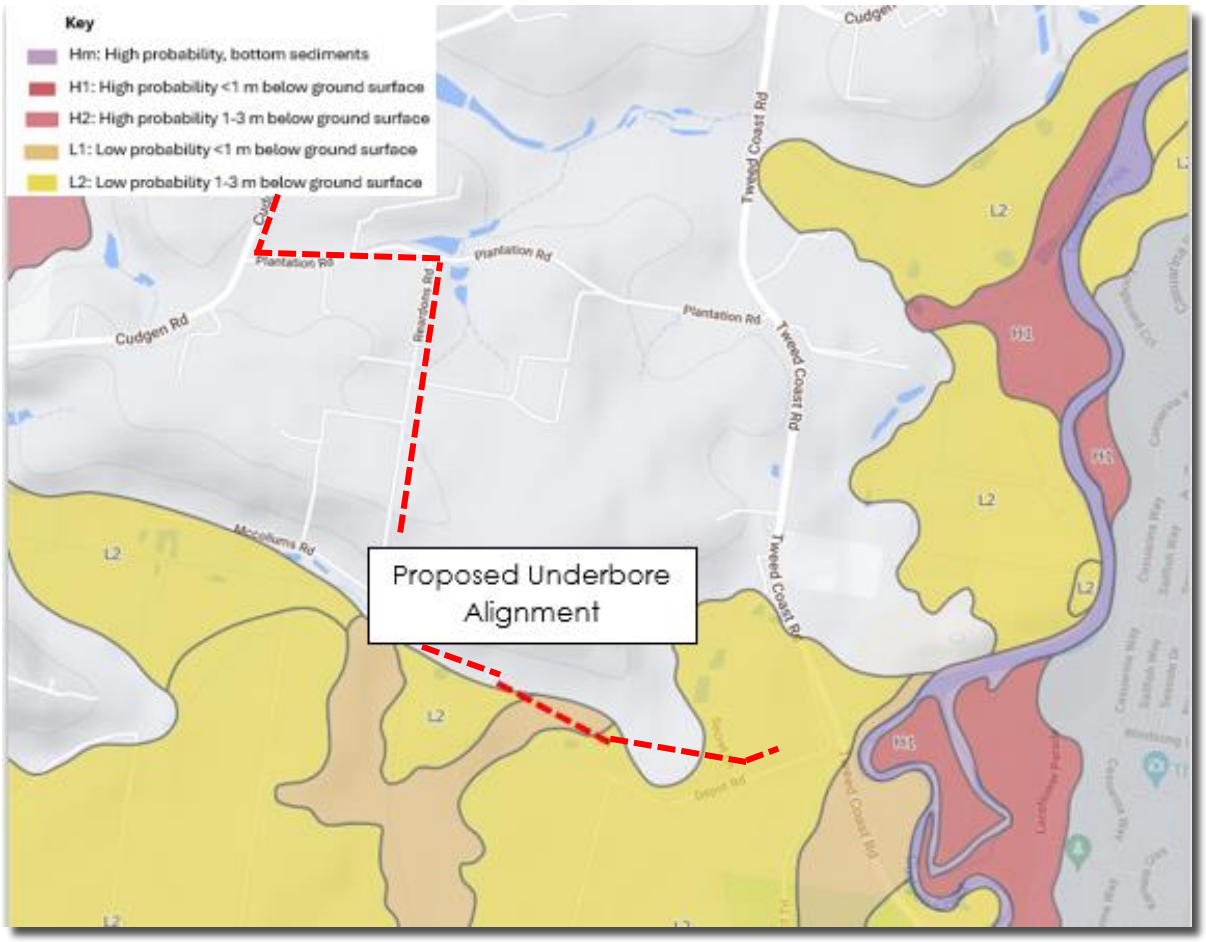
3 ACID SULFATE SOILS

An acid sulfate soils (ASS) assessment was undertaken as part of the geotechnical investigations for the development. the results are reproduced in this Section.

3.1 Risk Mapping

An extract of the ASS risk map for the area is presented below. The map indicates the southern alluvial terrain is within an area of low probability of ASS at depths greater than 1m below ground level.

Diagram 4: Acid Sulfate Soil Risk Map



Sourced from the NSW Government Environment and Heritage eSPADE website.

3.2 Sampling and Analysis

Eight samples were collected from the alluvial soil profiles within the area mapped as low risk. This included six from within the proposed zone substation site and two on the alignment. The samples were submitted to a NATA registered contract laboratory for ASS screening. The results are summarised below:

<u>Underground Cable Alignment</u>

- The samples revealed pHF values between 5.04 and 5.93 in distilled water.
- The samples revealed pHFOX values between 1.94 and 4.08 in hydrogen peroxide.

To provide a more comprehensive assessment, samples were submitted for Chromium Reducible Sulfur (S_{Cr}) and net acidity analysis. A summary of the test results is presented in Table 1.

Table 1: Summary of ASS Net Acidity Test Results

Test location	Depth (m)	Texture	Action Criteria[1] (mol H^+ / t)	Actual Acidity – TAA (mol H^+ / t)	Potential Sulfidic Acidity – CRS (mol H^+ / t)	Net Acidity (mol H^+ / t)
BH15	1.2 to 1.5	Fine	≥62	**63**	49	**117**

NOTE:

1. *Action criteria is based on less than 1000 tonnes of soil being disturbed.*
2. *Values in Bold exceed the adopted action criteria.*
3. *BH13 and BH15 mislabel as BHS13 and BHS15 on the test results sheets.*

3.3 Results

The results of the analysis were compared against the action criteria as presented in Table 5.4 of the Water Quality Australia *National Acid Sulfate Soils Guidance National acid sulfate soils sampling and identification methods manual, June 2018.*

Underground Cable Alignment

Most of the transmission line alignment will be within residual soils outside of mapped ASS areas. As such acid sulfate soils will not be an issue. Testing undertaken within the alluvial terrain where some open excavation and soil disturbance through underbore drilling will occur indicates the following.

- A Titratable Actual Acidity (TAA) concentration of 63 mol H/*t was recorded for BH15, therefore the soils are acidic.
- The testing indicates chromium reducible sulphur (SCr) of 49 mol H/*t, indicating potential sulfidic acidity. The net acidy is 117 mol H/*t, which exceeds the adopted action criteria of 62 mol H/*t. The results therefore indicate the soils are naturally acidic and are actual and/ or potential acid sulfate soils.

Based on the results of the assessment an ASS Management Plan should be prepared where soil disturbance is expected to occur within the alluvial terrain along the transmission line alignment. The results indicate that a management plan is not required for works within the proposed zone substation site.

4 POSIBLE AREAS OF IMPACT

Based on the results of the ASS assessment the underbores are likely to intercept ASS. It will not be feasible to delineate the different soil units during the drilling operations, as such all soils impacted during underboring should be considered as ASS.

The drill spoil recovered during most of the underboring operations will be in suspension within the drilling fluids. It is expected that bentonite will be used in the drilling fluid, which will have a buffering effect on the soils, possibly neutralising any potential acid generation through oxidisation of ASS. Oxidisation of soils within suspension will likely occur at a slower rate and to a lesser extent than what will occur in a dry soil state. Due to these factors the potential for acid generation within the drilling fluids is considered low, however there is a potential for acid generation due to oxidisation of acid sulfate soils and is therefore addressed in this ASSMP.

5 POSIBLE ASS INDICATORS

Possible indicators of ASS include:

- Peaty soils.
- Sulfurous smell – rotten egg gas.
- Iron oxide mottling.
- Soil pH less than 4.
- Oily appearance on water surface.

If any of the above indicators are encountered during construction regional Geotechnical Solutions should be contacted immediately to carry out sampling and testing.

6 RESPONSIBILITIES

The project Supervisor / drilling foreman is responsible for implementing the ASS management protocols detailed within this ASSMP. Only a suitably experienced ASS consultant may vary the procedures detailed herein.

The Supervisor / Foreman should:

- Record a daily log showing the volume of material that has been excavated and treated.
- Ensure that validation testing is undertaken by an independent monitoring consultant on a regular basis.

The requirements of the ASSMP are in addition to, but do not override any other standard procedures such as safety considerations. Where conflict results, or may result from, the implementation of the ASS management as against other performance criteria, the project Supervisor / Foreman shall obtain directives from the project manager or the ASS consultant as appropriate.

7 NEUTRALISING MATERIALS

Fine Agricultural Lime (ag-lime) must be used for liming of excavated materials. Hydrated lime, Dolomatic ag-lime, or magnesium blend ag-lime, should not be used. The ag-lime grind shall have:

- At least 85% by weight passing 1mm, and 100% passing 2.5mm. In general, a finer grind is better; and
- Ag-lime shall have a Neutralising Value (NV) of 90% or better (i.e. NV>90).

Based on the laboratory test results a liming rate of **10 kg/ tonne** dry weight of soil should be adopted.

8 MANAGEMENT AND TREATMENT

8.1 Options

The management and treatment of the ASS will be dependent on where the material is treated. On site treatment is the preferred method and should be feasible based on the site.

NSW EPA requirements (Waste Classification Part 5 – ASS) note ASS is to be treated on site prior to removal off site to a licenced waste disposal facility. Transport of ASS off site for treatment and then

potential reuse of the material as a general fill will require a Site-Specific Exemption application to NSW EPA for disposal at a nominated site that has a Development Approval for filling works.

Spoil generated though excavation not requiring the use of drilling fluids can be treated in a preprepared treatment area as described in Section 8.2.

The spoil generated from the underboring operations will be mostly in a liquid state – essentially comprising over 90% water. As discussed in Section 4 the potential for acid generation from oxidisation of ASS in the drilling fluids is likely to be low, due to low oxidisation and buffering from bentonite within the drilling fluid. Treatment of drilling fluids may not be required, pending assessment as detailed in Section 8. Where treatment is required preferably it will be done in an enclosed containment vessel or alternatively in an appropriately constructed, sized and suitably lined 'turkeys nest'.

8.2 Treatment

Drilling Fluids

The drilling fluids may not require treatment for the reasons discussed in Section 4. The need for treatment should be assessed by adopting the following management strategy.

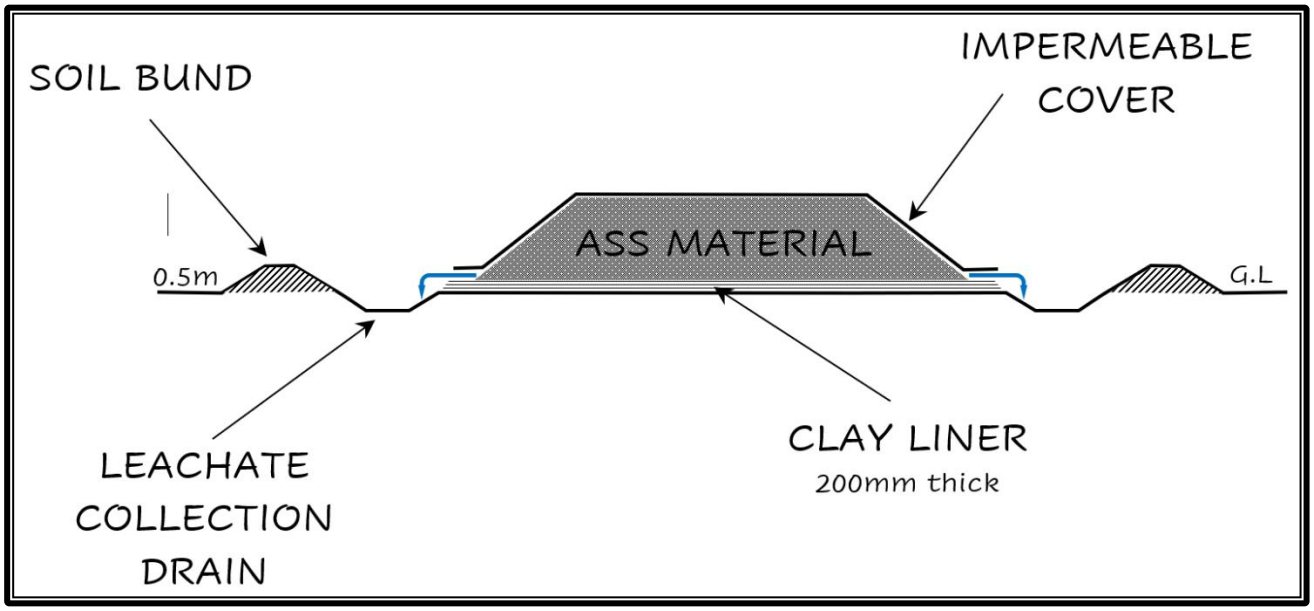
- Monitor the pH of the drilling fluid during the drilling works to assess any pH drop that would indicate oxidization of ASS. It is noted that in a suspended solids state it could take some time for oxidisation and subsequently acid generation to occur. Monitoring should be undertaken for at least 24hrs after the commencement of drilling.
- If no pH drop is recorded – i.e pH of the drilling fluid remains within the range of 6.5 to 8.5 as specified in Section 9.1, then dispose of the drilling fluids in accordance with regulatory requirements at a licenced waste facility.
- If a pH drop is measured – indicating oxidization of ASS has occurred, then treat with lime in accordance with the recommendations in Section 9.1 of this report and dispose in accordance with regulatory requirements at a licenced waste facility.

Spoil contained within drilling fluids should be treated within an enclosed vessel. Lime should be added at the specified rate and agitated / mixed to ensure even distribution of lime throughout.

Dry Soil Cuttings

The treatment area shall be fully enclosed by a bund wall to prevent runoff to other areas of the site. The bund must have a height of at least 0.5m that comprises of soils that are not ASS or are treated ASS. The size of the treatment area should be of sufficient size to treat the excavated materials at the proposed excavation rate and to store material for the period required to undertake the verification testing (approximately two (2) weeks). The treatment area should be lined with at a layer of compacted clay at least 200mm thick. The clay lining should be repaired / toped up periodically as required, where it is damaged during the treatment process. Alternatively, the material may be placed in large metal skip bins for treatment. It is noted that this may not be efficient for treatment of large volumes of material. Sketch 1 provides a schematic of a suitable treatment area.

Sketch 1: Proposed Treatment Area



The treatment area should always be covered with heavy duty plastic to prevent runoff, particularly when inclement weather is forecast.

The stockpile pad should grade to a low point where potential leachate can be captured within the bunded area for further treatment if required.

8.3 Treatment

The ASS shall be placed in the treatment area. For dry materials it should be spread in a layer of not more than 200mm thickness.

Approved ag-lime should be applied at a rate of approximately **10kg / tonne dry weight of soil**. In calculating the quantity of lime required the 95% upper confidence limit of the arithmetic average liming rate has been adopted, and the theoretical requirement has been multiplied by a factor of safety of 1.5 to account for the rate of lime reactivity and the possibility of non-homogenous mixing.

The following liming procedures (or equivalent) should be undertaken for dry soils:

- Spreading of soil in thin (<200mm) layers at the prepared treatment pad.
- Addition of lime by a spreader or pug.
- Cultivate the lime thoroughly into the soil using a disc plough or cultivator before placement of next layer.
- Placement of second layer onto stockpile and addition of lime, repeating the process until the maximum height of the stockpile is achieved.
- Removal of the material and disposal (Refer Section 8.6).

The soil undergoing treatment should always be kept moist but not wet.

For the treatment of drilling fluids lime should be added to the containment unit at a rate of **10kg/m^3 of drilling fluid.** The fluid should be mixed / agitated to ensure thorough distribution through the material.

The material should be stored on site for validation sampling and testing.

8.4 Validation Testing

Validation testing shall be undertaken by an independent ASS consultant at the initial rate of one sample per 250m^3 or part thereof. The samples shall be submitted to a NATA accredited laboratory for validation testing using the Chromium Reducible Sulfur suite.

All records applicable to acid sulfate testing and treatment shall be collated to substantiate treatment.

It is noted that validation testing takes about 7 to 10 days, therefore this should be allowed in the earthworks management plan to reduce the potential for delays during construction.

Any leachate accumulation in the bunded area or drilling fluids not contained within the drilling recirculation unit, should be pH tested daily. Neutralisation may be required should the leachate pH fall below background levels.

8.5 Monitoring

The following monitoring regime is recommended:

- Prior to commencement of works a round of water quality monitoring from adjacent surface waters and drains should be undertaken to determine natural background levels.
- Treated ASS should be assessed using validation techniques to ensure net acidity is less than the Action Criteria (18 moles H+/ tonne):
    - *Action – Where net acidity > 18 moles H+/ tonne further lime treatment will be required*.
- Water quality monitoring should be undertaken on any leachate captured within the bunded areas. Representative background values are to be confirmed:
    - *Action – Where leachate water has a pH < background value it will require neutralisation which can be undertaken using a neutralising agent such as calcined magnesia or hydrated lime. Further pH monitoring of the treated water will be required to ensure neutralisation has occurred. Treated water should be discharged overland, away from surface water bodies, to allow infiltration into the soil.*
- Record details of all monitoring results.

8.6 Post Treatment

Once the ASS materials have been treated in accordance with this ASSMP, the materials may be reused onsite or disposed of in accordance with the relevant regulatory requirements. To comply with the NSW EPA Waste Classification Guidelines (2014) any material to be disposed of off-site requires waste classification. As the material will be treated acid sulfate soil it cannot be classified as virgin excavated natural material (VENM) or excavated natural material (ENM). Therefore, the material will need to be disposed of at a licenced waste facility. It is noted that only limited waste facilities are licenced to accept drilling fluids.

9 MANAGEMENT OF ONSITE DEWATERING

Dewatering is not expected to be required. If onsite water is however encountered the following measures must be implemented.

9.1 Treatment of Water

Groundwater and surface water collected from within the site during excavation should be assessed prior to disposal. The following procedures will be required depending on the contamination status of the water.

- The water should be assessed for pH. If pH is below 6.5, the water will require treatment prior to discharge or disposal.
- pH change can take some time to occur, therefore, a suitable holding tank and a water pump should be installed to store collected water. The tank may fulfil a dual purpose and provide suspended solids removal prior to discharge.
- Hydrated lime in a pre-mixed slurry should be added and the water thoroughly agitated. The pH of the water should be measured for one day to confirm stabilisation of water conditions, until pH is within the optimum level of 6.5 to 8.5 pH Units. The application of hydrated lime should continue until the water quality objectives are met.

Alternatively, the acidic waters can be disposed of to a licensed treatment facility in accordance with the NSW EPA Waste Classification Guidelines.

It is noted that background pH levels should be assessed prior to any site works commencing to assess the suitability of the above pH level recommendations. If the pH of the receiving waters is not within the range of 6.5 to 8.5 alternative criteria may be required. This would require a more detailed assessment of what is an appropriate discharge pH value.

10 LIMITATIONS

This report comprises the results of an investigation carried out for a specific purpose and client as defined in the document. The report should not be used by other parties or for purposes or projects other than those assumed and stated within the report, as it may not contain adequate or appropriate information for applications other than those assumed or advised at the time of its preparation. The contents of the report are for the sole use of the client and no responsibility or liability will be accepted to any third party. The report should not be reproduced either in part or in full, without the express permission of Regional Geotechnical Solutions Pty Ltd.

Geotechnical site investigation is based on data collection, judgment, experience, and opinion. By its nature, it is less exact than other engineering disciplines. The findings presented in this report and used as the basis for the recommendations presented herein were obtained using normal, industry accepted geotechnical design practises and standards. To our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points.

The recommended depth and properties of any soil, rock, groundwater, or other material referred to in this report is an engineering estimate based on the information available at the time of its writing. The estimate is influenced and limited by the fieldwork method and testing carried out in the site investigation, and other relevant information as has been made available. In cases where information has been provided to Regional Geotechnical Solutions for the purposes of preparing this report it has been assumed that the information is accurate and appropriate for such use. No responsibility is accepted by Regional Geotechnical Solutions for inaccuracies within any data supplied by others.

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This report alone should not be used by contractors as the basis for preparation of tender documents or project estimates. Contractors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

If you have any questions regarding this project, or require any additional consultations, please contact the undersigned.

If you have any questions regarding this acid sulfate soil management plan, or require any additional consultations, please contact the undersigned.

For and on behalf of

Regional Geotechnical Solutions Pty Ltd

Prepared by



Adam Holzhauser

Principal Geotechnical Engineer

Appendix E: Ecological Impact Assessment (AREA Environment & Heritage, 2024)

AREA Environmental & Heritage Consultants ABN: 29 616 529 867

- ✓ Environmental impact assessments and approvals
- ✓ Ecology, Aboriginal and historic heritage assessments
- ✓ Biodiversity assessment method (BAM) assessments (BDAR) and offsetting (BSSAR)
- ✓ Commercial external landscape designs and architecture for built or natural environments
- ✓ Vegetation Management Plans
- ✓ Compliance specialist and Expert witness
- ✓ Plans of management
- ✓ Aboriginal community engagement
- ✓ Stakeholder and community engagement
- ✓ Peer review / project briefs / budgeting assistance / expert witness

Prepared for Essential Energy

Proposed installation of underground 33kV cables: Kings Forest

Ecological Impact Assessment

Tweed Shire Council Local Government Area, NSW

December 2024



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AREA Environmental & Heritage Consultants acknowledges

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Executive summary

Essential Energy proposes to install approximately four kilometres of new underground 33 kilovolt electricity cables. The cables will be installed between Essential Energy's existing Cudgen ZS, located at 571 Cudgen Road, Cudgen, and the termination of underground 33 kilovolt cables installed previously on Leda owned land (Lot 1 DP781633).

The proposal includes installation of new fibre optic communication cables and earthing cable alongside the 33 kilovolt underground electricity cables and installation of two new underground-overhead (UGOH) poles. The UGOH poles will be installed within the existing overhead 33 kilovolt powerline corridor, and Leda owned land at the southern extent of the proposal site.

Approximately 460 metres of existing overhead 33 kilovolt powerline between the new UGOH poles referred to above will be decommissioned and removed.

AREA Environmental & Heritage Consultants (AREA) has been engaged by Essential Energy (the client) to assess the proposal's potential impact to biodiversity.

Part 5, Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) provides for a public authority assessing the environmental impact of certain activities that they are either carrying out themselves or approving. The proponent must fulfil their duties under section 5.5 of the EP&A Act to consider, to the fullest extent possible, all matters affecting or likely to affect the environment, including impacts to biodiversity. This ecological impact assessment seeks to inform both the Review of Environmental Factors (REF) being prepared under Part 5, Division 5.1. This report also aims to address relevant requirements under the *Biosecurity Act 2015* (NSW) and *Local Land Services Act 2013* (LLS Act) (NSW).

This proposal does not require assessment under the Biodiversity Offset Scheme. The proposal does not occur in an area of Outstanding Biodiversity Value and would not result in a significant impact to threatened species, populations or communities.

This purpose of this report is to determine if the development will potentially have a significant impact to the environment by documenting the potential impact to threatened species, populations and ecological communities protected under the BC Act and FM Act as well as nationally listed threatened species, ecological communities, and migratory species protected under the EPBC Act.

One threatened species (Wallum Froglet - *Crinia tinnula*) was recorded during the field assessment, calling from a waterbody outside of the subject land. A test of significance confirmed that the proposal would not be a significant impact to this species.

Two threatened ecological communities, both listed as Endangered under the BC Act were confirmed to occur within the subject land, largely in poor condition. A test of significance confirmed that the proposal would not be a significant impact to these communities:

- Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions – 0.03 hectares
- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions – 0.40 hectares

The assessment determined the proposal will not result in a significant impact to matters protected under the NSW *Biodiversity Conservation Act 2016* (BC Act), NSW *Fisheries Management Act 1994* (FM Act) nor the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Safeguards are required to mitigate the direct and potential indirect harm of this proposal.

Safeguards and mitigation measures are provided in this report to ensure harm to the environment is minimised. If implemented, it is unlikely the proposal will have a significant impact to listed species, populations and communities under the BC Act, EPBC Act or FM Act.

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1 Introduction

Essential Energy proposes to install approximately four kilometres of new underground 33 kilovolt electricity cables. The cables will be installed between Essential Energy's existing Cudgen ZS, located at 571 Cudgen Road, Cudgen, and the termination of underground 33kV cables installed previously on Leda owned land (Lot 1 DP781633).

The proposal includes installation of new fibre optic communication cables and earthing cable alongside the 33kV underground electricity cables and installation of two new underground-overhead (UGOH) poles. The UGOH poles will be installed within the existing overhead 33kV powerline corridor, and Leda owned land at the southern extent of the proposal site.

Approximately 460 metres of existing overhead 33 kilovolt powerline between the new UGOH poles referred to above will be decommissioned and removed.

AREA Environmental & Heritage Consultants (AREA) has been engaged by Essential Energy (the client) to assess the proposal's potential impact to biodiversity.

1.1 Key results and actions

This proposal has been designed to avoid impact to important local biodiversity values by using direct drilling/ under boring construction method where the proposal intersects waterbodies/ wetland areas.

No significant ecological constraints were identified for the proposal.

1.1.1 Weeds

Weeds recorded in the subject land are locally relatively abundant.

1.1.2 Environmental conservation zones

The nearest conservation zone is Cudgen Nature Reserve, which would not be impacted by this proposal.

1.1.3 Threatened Ecological Communities

Two Threatened Ecological Communities were identified during the field survey. Impact to these communities would not be significant. No further assessment or action is required.

1.1.4 Threatened Species

No significant impact to threatened species, populations or communities is likely to occur as a result of this proposal. No further assessment or action is required.

Implementation of mitigation measures are provided in section 6.3.

1.2 Objectives

Essential Energy is the determining authority for this proposal under Part 5, Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This Ecological Impact Assessment addresses requirements under s.7.3 of the *Biodiversity Conservation Act 2016* (BC Act) and considers matters protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *NSW Fisheries Management Act 1994* (FM Act).

This ecological impact assessment seeks to inform a Review of Environmental Factors (REF) being prepared under Part 5, Division 5.1 of the EP&A Act

This proposal does not require assessment under the Biodiversity Offset Scheme. The proposal does not occur in an area of Outstanding Biodiversity Value and would not result in a significant impact to threatened species, populations or communities.

This report also aims to address relevant requirements under the:

- *Biosecurity Act 2015* (NSW),
- *Fisheries Management Act 1994* (FM Act) (NSW); and,
- *Local Land Services Act 2013* (LLS Act) (NSW).

International agreements:

- Japan-Australia Migratory Bird Agreement (JAMBA)
- China-Australia Migratory Bird Agreement (CAMBA)
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)
- Ramsar Convention on Wetlands (Ramsar).

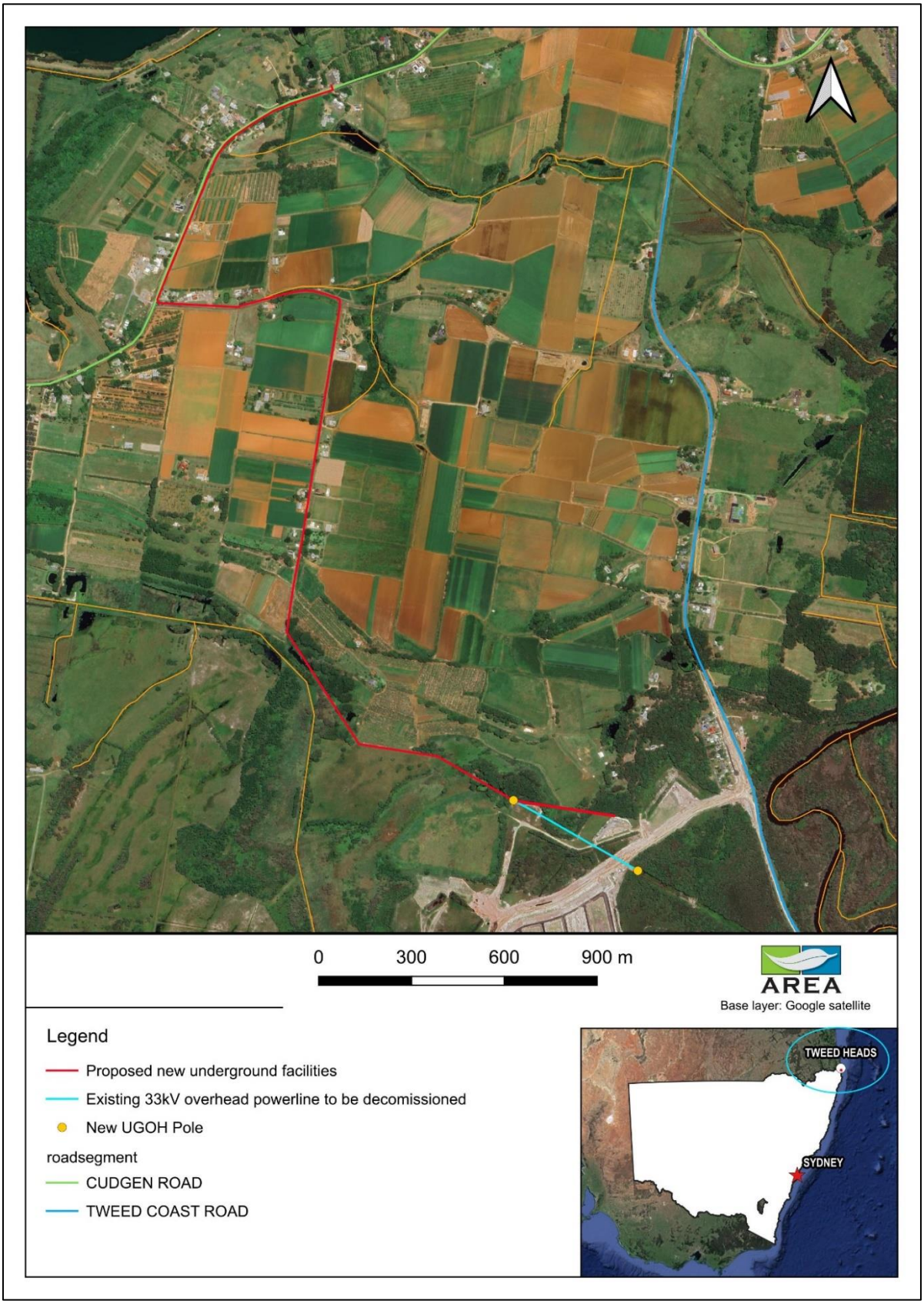
The objectives of this biodiversity assessment report are to accurately:

- describe the ecological communities within the assessment area,
- identify habitat for threatened species,
- assess the proposed impact to threatened species, populations, ecological communities, and their habitats; and,
- detail the measures to avoid and mitigate potential impacts.

The objectives of this ecological assessment are to provide:

- accurate predictions and mapping of any vegetation clearing on site
- detailed assessment of the potential impact to any threatened species, populations, endangered ecological communities or their habitats; groundwater dependent ecosystems; and any potential for offset requirements,
- descriptions of measures to avoid, minimise, and offset impacts to biodiversity.

Figure 1-1: Proposal location



1.3 Definitions

Two terms are used in this report to describe the proposal:

- **Subject land** – land directly affected by the proposal, including where the ground surface would be disturbed during construction of the new infrastructure, and land associated with the existing power line to be decommissioned and removed.
- **Assessment area** – land in and around the subject land, defined by a 500-metre buffer around the proposed alignment.

Additional terms and abbreviations used in this report are provided in Appendix A.

1.4 Project description

Essential Energy proposes to install approximately four kilometres of new underground 33 kilovolt electricity cables between Essential Energy's existing Cudgen ZS, located at 571 Cudgen Road, Cudgen, and the termination of underground 33kV cables installed previously on Leda owned land (Lot 1 DP781633).

The proposal includes installation of new fibre optic communication cables and earthing cable alongside the 33kV underground electricity cables and installation of two new underground-overhead (UGOH) poles within the existing overhead 33kV powerline corridor, and Leda owned land at the southern extent of the proposal site Figure 1-2.

Decommissioning and removal of approximately 460 metres of existing overhead 33kV powerline between the new UGOH poles referred to above Figure 1-2.

In more detail, the proposal includes:

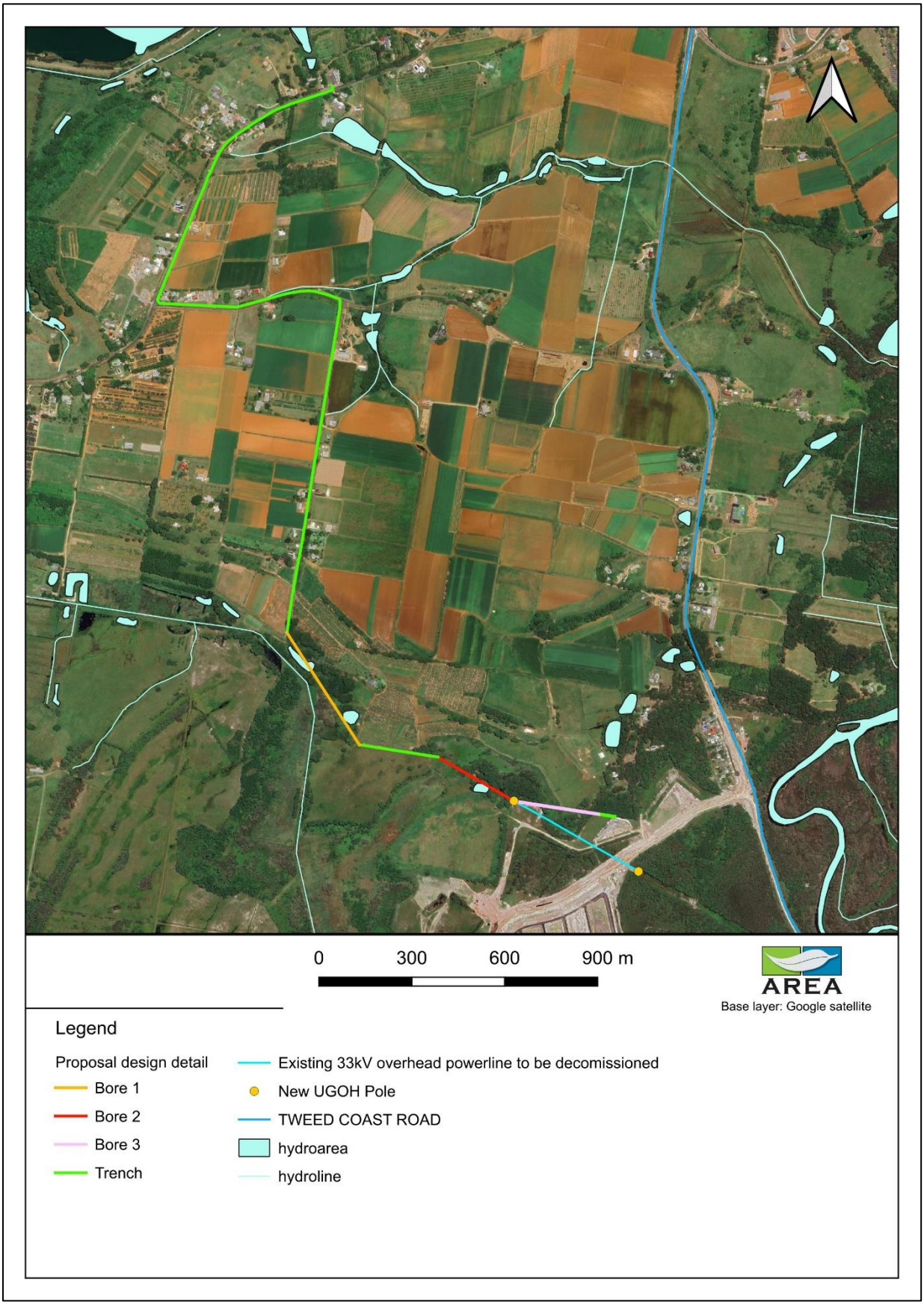
- Installation of approximately four kilometres of new underground 33 kilovolt cables within the road reserves of Cudgen Road, Plantation Road and Reardons Road, and across low lying land from approximately the end of Reardons Road to the connection point with previously installed underground 33 kilovolt cables.
- Construction methodology will be primarily by open trenching along the road reserves, although several short, shallow (i.e., approximately one to three metres depth) underbores via horizontal directional drilling (HDD) will likely be used where required to avoid and minimise impacts to roads, driveways and planted ornamental vegetation. The exact location and length of the short, shallow underbores is yet to be finalised.
- Trench dimensions will be approximately 0.7 metres wide by 1.35 metres deep. Trenches will likely be excavated using a small to medium sized excavator (i.e. eight to 16 tonne), although this will be confirmed by the successful civil contractor.
- Several cable jointing pits and associated earth link boxes will be installed along the proposal route. These will be permanent structures installed below ground level with trafficable lids to allow access for inspection and maintenance from the surface when required. The approximate dimensions of the joining pits are 6.3 metres long by 2.7 metres wide by 2.0 metres deep. The earth link boxes will be approximately 1.6 metres long by 0.9 metres wide by 0.75 metres deep.

- Three longer, deeper underbores via HDD will be required in the southern portion of the proposal to avoid and minimise impacts to remnant vegetation, farms dams, and wetland environments, comprising the following:
  - Underbore 1: entry from approximately the end of Reardons Road, progressing in a southeasterly direction through Lot 1 DP12737 and Lot 4 DP629229, to an exit point in a cleared paddock on Leda owned land (Lot 1 DP781633), a total of approximately 426 metres.
  - Underbore 2: entry from Leda owned land (Lot 1 DP781633), off Depot Road, progressing in a north westerly direction across the corner of Lot 2 DP597802 and back to Leda owned land (Lot 1 DP781633) on the western side of the mapped coastal wetland, with the exit point near the proximity of an existing power pole 38946, a total of approximately 271 metres
  - Underbore 3: entry will be from approximately the same entry point as Underbore 2 (i.e., the eastern extent of underbore 2), progressing in an easterly direction to the connection point with the previously installed underground 33kV cables all on Leda owned land (Lot 1 DP781633), a total of approximately 280 metres. Underbore 3 will require two separate bores spaced approximately two metres apart. Two separate bores are required at Underbore 3 to facilitate a second set of cables installed to a new UGOH pole.

Table 1-1: Approximate surface disturbance areas associated with underbores

Underbore surface disturbance areas	Disturbance Type	Approximate total disturbance area
Underbore 1 - Entry	Excavation of entry pit (approximately 2.0m long by x 1.5m wide by 1.0m deep) within broader disturbed area of approximately 20m by 50m). Requires access for excavator, vacuum trucks, light vehicles and room for semi-trailers to enter and exit and parking of equipment and machinery. May require hardstand (i.e., imported rock) if ground soft at time of drilling.	1250m^2 (20m x 50m)
Underbore 1 - Exit	Excavation of entry pit (approximately 2.0m long by x 1.5m wide by 1.0m deep) within broader disturbed area of approximately 20m by 10m. Requires access for excavator, vacuum trucks, and light vehicles.	200m^2 (20m 10m)
Underbore 2 and 3 - Entry (combined)	Excavation of entry pit (approximately 2.0m long by x 1.5m wide by 1.0m deep) within broader disturbed area of approximately 40m by 30m. Requires access for excavator, vacuum trucks, and room for semi-trailers to enter and exit, parking of equipment and machinery and Site shed, facilities and tools/spares. May require hardstand (i.e., imported rock) if ground soft at time of drilling.	1200m^2 (40m x 30m)
Underbore 2 - Exit	Excavation of entry pit (approximately 2.0m long by x 1.5m wide by 1.0m deep) within broader disturbed area of approximately 20m by 10m. Requires access for excavator, vacuum trucks, and light vehicles.	200m^2 (20m x 10m)
Underbore 3 - Exit	Excavation of entry pit (approximately 2.0m long by x 1.5m wide by 1.0m deep) within broader disturbed area of approximately 20m by 10m. Requires access for excavator, vacuum trucks, and light vehicles.	200m^2 (20m x 10m)
Turkeys Nest (if required at Underbore 2 and 3)	Approximately 20m x 10m with 0.5m high bund, lined with geofabric or similar. Requires access for excavator, vacuum trucks and light vehicles	200m^2 (20m x 10m)
Conduit Stringing Laydown Area for Underbore 1 and 2	Requires access for excavator and light vehicles. No excavation required	1200m^2 (240m x 5m)
Conduit Stringing Area for Underbore 3	Requires access for excavator and light vehicles. No excavation required.	500m^2 (130m x 5m)

Figure 1-2: Proposal detail



1.5 Construction types

Bore construction is proposed to negotiate and minimise the impact on ecologically sensitive landscapes and impact on infrastructure. Trenching construction method is proposed elsewhere.

1.6 Subject land

The regional context of the proposed alignment is shown in Table 1-2. Proximity to environmentally sensitive areas is shown in Table 1-3.

Table 1-2: Regional context of the assessment area

Criteria	Assessment area
Interim Biogeographic Regionalisation for Australia (IBRA Region)	IBRA Regions: South Eastern Queensland bioregion IBRA Subregion: Burringbar-Conondale Ranges subregion
Local Government Area	Tweed Shire Local Government Area
Land use / disturbance	The local landscape has largely been subject to historic land clearing and urbanisation. Some areas within the subject land have been allowed to revegetate somewhat, however very few trees, and no large trees, occur in the subject land.
Nearest waterways	The nearest named waterway to the subject land is Cudgen Creek (within 500m). The proposed alignment does not intersect any mapped waterways, and impact to low lying wetland areas would be under bored.
Spot point Australian Height Datum (AHD)	Elevation along the alignment varies from 6-8m in the south to approximately 40m ADH in the north.

Table 1-3 Proximity of environmentally sensitive areas to the assessment area

Environmental Considerations	In the assessment area?
Reserved or a dedicated National Park	Cudgen Nature Reserve
National Heritage Places	No
World Heritage Area	No
Category 2 – Sensitive Regulated Land on Native Vegetation Regulatory (NVR) Map	Yes – however does not occur within the subject land.
Mapped on Biodiversity Values (BV) Map	Occurs within the assessment area but now within the subject land
Land identified in an Act as wilderness (*Wilderness Act 1987*)	No
State or national critical habitat	No
Key Fish Habitat (KFH)	KFH habitat is mapped within the assessment area associated with Blacks Creek and Cudgen Creek, waterbodies, and unnamed hydrolines.

Environmental Considerations	In the assessment area?
Regional Forest Agreement	The North East NSW RFA was identified in the EBPC Act Protected Matters Report. It is unlikely to apply to land within the subject land.
Wetland areas dedicated under the Ramsar Wetlands Convention?	No, however the Cudgen Nature Reserve is identified as a Nationally Important Wetland in the EBPC Act Protected Matters Report. It is unlikely to apply to land within the subject land.

2 Methods

The following methods were used for this assessment:

- desktop review of ecological databases and literature sources as direct references for the field survey,
- field survey of the assessment area.

The assessment rationale was to evaluate the type and quality of habitat to be impacted by the proposal, apply professional judgement, and then complete targeted assessment of potential habitat to detect the region's listed species, populations or communities.

This assessment was completed by suitably qualified AREA staff (Table 2-1).

Table 2-1: AREA staff qualifications

Name	Position	CV Details
Addy Watson	Manager | Senior Consultant	• Grad. Dip. Captive Vertebrate Management, Charles Sturt University • Grad. Cert. Social Impact, University of NSW • B. Env. Sc. University of New England. • NSW Biodiversity Assessment Method Accredited Assessor (BAAS19066) • Diploma Project Management • NSW Biodiversity Assessment Method • Lean Six Sigma Certificate (Sydney Uni) • WHS White Card • Apply First Aid. Certificate number: 07328
Phil Cameron	Managing Director	• BSc. Major in Biology. Macquarie University • Ass Dip App Sci. University of Queensland • Dip Landscape Design (in-prep) • Cert III (Captive vertebrate management) • Certified Environmental Practitioner (EIANZ) and practicing member • NSW OEH BioBanking and Bio-certification Assessor: accreditation number 0117 • NSW Biodiversity Assessment Method Accredited Assessor (BAAS17082) • AHCPCM201- Recognising grasses • Practicing member of the NSW Ecological Consulting Association
Dave Sturman	Manager | Senior Consultant	• B. Env. Sc. Land and Water Specialisation Charles Sturt University • Cert III (Horticulture) • White card – general construction induction card. • RMS-worker on foot training. • Senior First Aid • Chainsaw operator ticket • Confined Space worker and atmospheric monitoring. • Risk assessment training. • AHCPM201-Recognising grasses • NSW Biodiversity Assessment Method Accredited Assessor (BAAS22015)
Gabrielle Green	Environmental Consultant	• B. Env. Sc. University of New England • AHCPCM201 – Recognising grasses • WHS White Card - general construction induction card (CGI1667253SEQ01) • RMS-worker on foot training • First Aid Certificate (Cert No. 6995717) • WIRES volunteer

2.1 Desktop review

2.1.1 Information sources

Preliminary assessment drew on local experience, previous reporting and information held on government databases and archives (Table 2-2 and Appendix B).

Database searches were used to inform the field assessment and applied to determine the likelihood for a protected matter and Plant Community Type (PCT) to be recorded within the assessment area, and what targeted searches would be needed for detection.

Published information showing predicted threatened and non-native species were used during the field assessment. Where a potentially threatened flora or fauna or ecological community was identified, such resources were used to confirm occurrence.

Table 2-2: Resources used for this assessment

Title	Web address
Legislation	
Telecommunications Act 1997	https://www.legislation.gov.au/C2004A05145/latest/text
Telecommunications (Low-impact Facilities) Determination 2018	https://www.legislation.gov.au/F2018L00170/latest/text
Biodiversity Conservation Act 2016	https://www.legislation.nsw.gov.au/view/html/inforce/current/act-2016-063
Commonwealth Environment Protection & Biodiversity Conservation Act 1999	http://www.austlii.edu.au/au/legis/cth/consol_act/epabca1999588/
Environmental Planning and Assessment Act 1979	https://www.legislation.nsw.gov.au/view/html/inforce/current/act-1979-203
Fisheries Management Act 1994	https://www.legislation.nsw.gov.au/view/html/inforce/current/act-1994-038
National Parks and Wildlife Act 1974	https://www.legislation.nsw.gov.au/view/html/inforce/current/act-1974-080
Water Management Act 2000	https://www.legislation.nsw.gov.au/view/html/inforce/current/act-2000-092
Biodiversity	
DPIE Threatened Species website	https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species
Surveying threatened plants and their habitats (DPIE 2020)	https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Biodiversity/surveying-threatened-plants-and-habitats-nsw-survey-guide-biodiversity-assessment-method-200146.pdf
NSW Biodiversity Values Map and Threshold Tool	https://www.lmbc.nsw.gov.au/Maps/index.html?viewer=BOSETMap
NSW Native Vegetation Regulatory Map	https://www.lmbc.nsw.gov.au/Maps/index.html?viewer=NVRMap
NSW Planning Portal	https://www.planningportal.nsw.gov.au/spatialviewer/#/find-a-property/address
PlantNET	http://plantnet.rbgsyd.nsw.gov.au/
Significant Impact Guidelines 1.1 - Matters of National Environmental Significance	http://www.environment.gov.au/epbc/publications/significant-impact-guidelines-11-matters-national-environmental-significance
Threatened Biodiversity Survey and Assessment: Guidelines for	https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/draft-

Title	Web address
Developments and Activities – Working Draft (DEC, 2004)	threatened-biodiversity-survey-guide.pdf
Threatened Species Test of Significance Guidelines (OEH 2018)	https://www2.environment.nsw.gov.au/sites/default/files/2024-02/threatened-species-test-significance-guidelines-170634_0.pdf
Management plans developed for the adjacent Kings Forest residential development	
Kings Forest Koala Plan of Management	Prepared by JWA Pty Ltd Ecological Consultants, December 2019
Kings Forest Wallum Sedge Frog Management Plan,	Prepared by JWA Pty Ltd Ecological Consultants, April 2020
King Forest Vegetation Management Plan	Prepared by JWA Pty Ltd Ecological Consultants, Amended September 2011
Kings Forest Threatened Species Management Plan (two documents)	Prepared by JWA Pty Ltd Ecological Consultants, June 2011

2.2 Field survey

AREA Environmental & Heritage Consultants (AREA) conducted the field survey on 10 July 2024, with representatives from Essential Energy present during the assessment.

The objectives of the field assessment were to:

- describe the nature and extent of native vegetation in accordance with the NSW BioNet Vegetation Classification Tool
- determine the presence of not native vegetation and planted native vegetation which was not consistent with a local Plant Community Type.
- determine the presence of habitat values which would be likely to be used by listed species and populations.
- record any threatened species, populations or communities (having specific regard to wetlands) present at the time of the assessment.
- determine if groundwater dependent communities would be, or have potential to be, affected by the proposal and
- consider the location of bore entry and exit points to ensure adequate avoidance of mapped Coastal Wetlands.

The subject land was assessed on foot, except where the alignment intersected with mown residential lawns or ploughed paddocks.

All areas of surface impact (the subject land) which would occur on sandy low-lying areas were assessed on foot. This survey confirmed the presence/ absence of listed flora species as far as they would have been visible at the time of the field assessment.

Habitat values were noted within the subject land, and areas adjacent to the subject land.

Results of the field assessment are presented in Section 4.

2.2.1 Threatened Ecological Communities

TECs were predicted based on database searches, and the PCTs associated with a TEC. Data collected during the field assessment and the NSW and Commonwealth descriptions of TECs were used to confirm presence or absence of TECs in the alignment.

2.2.2 Habitat assessment

Habitat in the alignment was assessed for its potential to provide resources for listed species predicted or known to occur. Database searches were used to inform the field assessment. Professional judgement was applied on site to determine a likelihood for each protected matter to be recorded and which targeted searches would be needed to detect and consider the magnitude of the potential impact.

In the field, any indirect evidence of fauna (i.e., scats, tracks, calls, fur, feathers, sloughed skins etc.) was investigated. Mature trees in the alignment, where present, were recorded, inspected for hollows and signs of use by listed fauna species, and assessed to determine if they were used as fauna breeding sites. Ground habitat such as rocks and logs which may be potential habitat for listed reptiles were inspected to determine if they were significant habitat.

The assessment area was assessed with a mix of pedestrian and vehicular survey methods. Areas where impacts to native vegetation had potential to occur, changes in vegetation type were evident, and/or where vegetation had potential to support threatened species was sampled. Threatened species profiles were used to assist in threatened species identification in the field. Each vehicle carried hard copy resources (identification books, scientific papers, etc) to assist in threatened species and community identification.

Areas where the construction type did not result in impact to native vegetation (where under boring applied or where land dominated by exotic species *i.e.* crops / pasture improved paddocks), were not assessed in detail, unless an opportunity for a threatened species to be recorded there was determined.

2.2.3 Threatened fauna

Opportunistic sightings of mammals, birds, reptiles, and frogs were recorded during assessment of the assessment area. Attention was given to identifying the presence of suitable habitat (e.g., tree hollows, nests, logs, waterways) and signs of activity (e.g., feeding scars, scats).

2.2.4 Limitations

Not all animals and plants can be fully accounted for within a given assessment area. The presence of threatened species is not static, and it changes over time, often in response to longer term natural forces which can at any time be dramatically influenced by man-made disturbance or weather. A ‘precautionary approach’ for species occurrence has been adopted where required. Database searches were used to identify threatened species known or predicted to occur in the assessment area. All these species were considered for their potential to occur in the subject land and likelihood of impact, therefore, the use of specific fauna survey methods such as trapping, ultrasonic call capture and nocturnal assessments was not considered necessary.

The above-mentioned constraints are not considered to compromise the findings or results of the field assessment.

2.3 Significance of potential impact

EPBC Act, BC Act and FM Act listed species, populations, communities and migratory species, identified in the desktop review and field survey were assessed for likelihood of occurrence in the subject land, and likelihood of impact from the development.

The following three terms of likelihood were used in this process:

- **"Unlikely"** = There is a very low to low probability a species uses the subject land. Species unlikely to occur are also therefore, unlikely to be impacted. A test of significance under the EPBC or BC Act is not required for this species.
- **"Potential"** = There is a medium to high probability a species uses the subject land. If the development may impact this species a test of significance under the EPBC or BC Act is required for this species. If the development will not impact the species, a test of significance is not required.
- **"Yes"** = The species was or has been observed in or near the subject land and/or will be impacted by the development. A test of significance under the EPBC and / or BC Act is required for this species. If the development will not impact the species, a test of significance is not required.

If a species scored 'Potential' or 'Yes' for likelihood of occurrence AND had potential to be impacted by the development, a test of significance was completed as per the required BC Act test questions and EPBC Act significant impact criteria. See the following sections for details.

Completed tests of significance required for this proposal, relative to the species conservation listing status and requirements, are included in Appendix D.

2.3.1 Plant Community Types

Plant community types are the finest level in the NSW vegetation classification hierarchy and area described in the NSW BioNet Vegetation Classification System[1]. They identify and describe recurring patterns of native plant species assemblages in relation to environmental conditions such as soil, temperature, moisture and other factors. Their floristic composition is characterised by frequently co-occurring species, including combinations of trees, shrubs and/or ground cover plants[2]. This classification includes identification of vegetation formation and vegetation class.

Plant Community Types were identified in the field using State Vegetation Type Map sourced from the NSW SEED website and used as a baseline for the assessment area and region.

The assessment aimed to confirm mapped PCTs and update those incorrectly mapped to the correct vegetation class, PCT and / or TEC. PCT IDs and boundaries between the mapped PCTs were adjusted after ground-truthing.

[1] https://vegetation.bionet.nsw.gov.au/LoginPR.aspx?ReturnUrl=%2f

[2] https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity/nsw-bionet/nsw-plant-community-type-classification

Areas of non-native vegetation were also identified including areas where the vegetation consisted of exotic species or where there was no vegetation such as along tracks and roads.

Formal vegetation plots were not used for this assessment.

2.3.2 NSW legislation – BC Act

To determine whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats, within Section 7.3 of the BC ACT, the following questions are asked in a BC Act Threatened Species Test of Significance:

Adverse effects on the life cycle of a species:

(i) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Adverse effects on ecological communities:

(ii) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
b) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Adverse effects on habitats:

(iii) in relation to the habitat of a threatened species or ecological community:

a) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and
b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and
c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.

Adverse effects on areas of outstanding biodiversity value:

(iv) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).

Key threatening processes:

(v) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

2.3.3 Commonwealth legislation - EPBC Act

Under the EPBC Act an action requires approval from the Australian Government Environment Minister (the minister) if the action has, or will have, or is likely to have, a significant impact on a matter of national environmental significance (MNES). The EPBC Act protects nationally and

internationally important flora, fauna, ecological communities, and heritage places as defined in the EPBC Act as MNES.

The criteria which apply to EPBC listed species, populations or communities to determine if a significant impact on any MNES is likely, are outlined below:

Critically endangered or endangered species

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

(i) lead to a long-term decrease in the size of a population,
(ii) reduce the area of occupancy of the species,
(iii) fragment an existing population into two or more populations,
(iv) adversely affect habitat critical to the survival of a species,
(v) disrupt the breeding cycle of a population,
(vi) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline,
(vii) result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat,
(viii) introduce disease that may cause the species to decline, or
(ix) interfere with the recovery of the species.

Vulnerable Species

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

(i) lead to a long-term decrease in the size of an important population of a species,
(ii) reduce the area of occupancy of an important population,
(iii) fragment an existing important population into two or more populations,
(iv) adversely affect habitat critical to the survival of a species,
(v) disrupt the breeding cycle of an important population,
(vi) modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline,
(vii) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat,
(viii) introduce disease that may cause the species to decline, or
(ix) interfere substantially with the recovery of the species.

Endangered or Critically Endangered Ecological Community

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

(i) reduce the extent of an ecological community,
(ii) fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines,
(iii) adversely affect habitat critical to the survival of an ecological community,

(iv) modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns,

(v) cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning, or flora or fauna harvesting,

(vi) cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to assisting invasive species, that are harmful to the listed ecological community, to become established or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological or

(vii) interfere with the recovery of an ecological community.

Definitions: A 'population of a species' as determined by the *Environment Protection and Biodiversity Conservation Act 1999* is an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations, or
- a population, or collection of local populations, that occurs within a particular bioregion.

Important Population as determined by the *Environment Protection and Biodiversity Conservation Act 1999*, is one that for a vulnerable species:

- is likely to be key source populations either for breeding or dispersal,
- is likely to be necessary for maintaining genetic diversity, and/or
- is at or near the limit of the species range.

2.3.4 NSW legislation – FM Act

The Department of Primary Industries and Regional Development administers the key pieces of legislation that identify and protect threatened fish and marine vegetation in NSW: the *Fisheries Management Act 1994* and the Fisheries Management (General) Regulation 2010.

If a planned development or activity is likely to have any impact on a threatened species listed under the Fisheries Management Act 1994 (FM Act), a preliminary assessment of the potential impacts must be made (the 'Assessment of Significance' or '7 part test'). If the impacts are likely to be significant, or if critical habitat is affected, a species impact statement must be prepared. In these cases, the Director-General of the Department of Primary Industries must agree to the development approval and the Minister for Primary Industries may also need to be consulted.

The factors of assessment

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

(d) In relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and Threatened Species Assessment Guidelines, February 2008

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

(g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatened process.

3 Desktop review results

3.1 Landscape context

The landscape lies amongst urban development, large lot hobby farms and small patches of various coastal forest/vegetation types.

Cleared areas are dominated by exotic plant species of tree, shrub and grass.

The proposal would under bore to avoid impact to mapped environmental values including areas mapped as Vegetation Class - Coastal Freshwater Lagoons.

Cudgen Nature Reserve lies within 500 metres of the subject land, and would not be directly, or indirectly impacted by this proposal.

3.1.1 IBRA bioregion and subregions

Bioregions are relatively large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems. They capture the large-scale geophysical patterns across Australia. These patterns in the landscape are linked to fauna and flora assemblages and processes at the ecosystem scale, thus providing a useful means for simplifying and reporting on more complex patterns of biodiversity. Subregions, as described by Morgan and Terrey (1992), are 'based on finer differences in geology, vegetation and other biophysical attributes and are the basis for determining the major regional ecosystems'.

The Interim Biogeographic Regionalisation of Australia (IBRA), and IBRA subregion inform the identification of PCTs and habitat suitability for threatened species. Biodiversity does not recognise administrative boundaries, which is another reason to use a bioregional approach to assess all land across the region.

The subject land is located within the Burringbar-Conondale Ranges IBRA subregion of the South Eastern Queensland bioregion.

3.1.2 NSW Landscapes (Mitchell Landscapes)

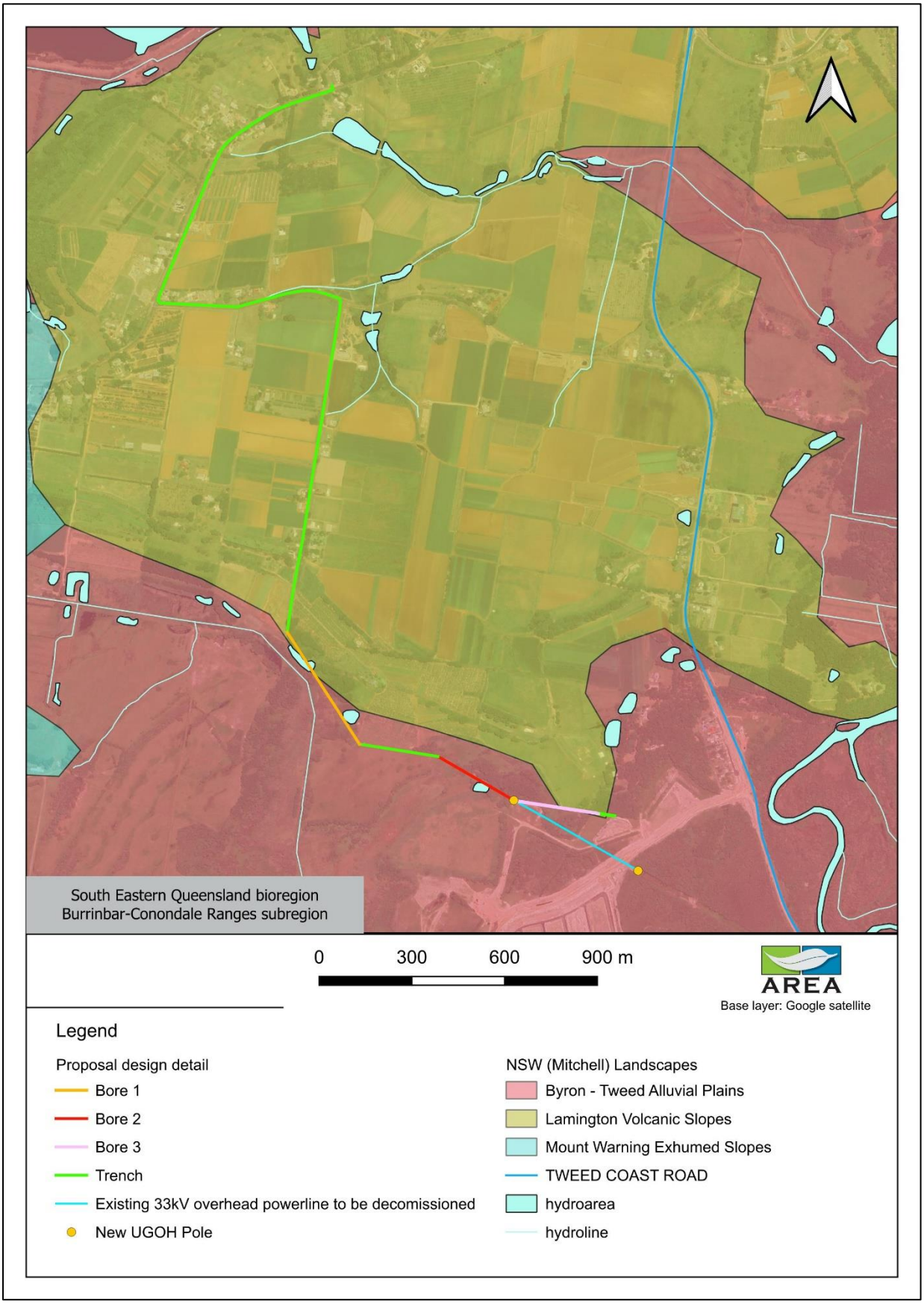
NSW (Mitchell) Landscapes were developed for conservation planning and reserve establishment purposes to provide consistent state-wide ecological units finer than the existing bioregions and sub-regions. These landscapes have relatively homogeneous geomorphology, soils and broad vegetation types, and help to provide site context for the assessment area.

The alignment traverses two different Michell Landscapes as described in Table 3-1 and shown in Figure 3-1 (Mitchell, 2008).

Table 3-1: NSW Landscapes descriptions

Name	Description	Percent cleared
Lamington Volcanic Slopes	Very extensive hills and ridges forming a broadly circular pattern 50km in diameter with radial drainage centred on Mt Warning. The Tertiary Lamington volcanics complex of multiple layers of flows of basalt, rhyolite and trachyte and pyroclastics including; tuff and agglomerate. General elevation 50 to 1120m, local relief varies considerably and is greatest in the higher landscape where it is up to 500m. Soils are mostly red and brown gradational structured loams with high organic content and high fertility. On lower slopes adjacent to valleys red, brown and grey-brown texture-contrast soils occur. Most of the landscape is covered in subtropical closed forest with stands of cool temperate Antarctic beech above 1000m. Typical subtropical species include; white booyong (*Argyrodendron trifoliolatum*), red carabeen (*Geissois benthamii*), rose marara (*Pseudoweinmannia lanchnocarpa*), pigeonberry ash (*Cryptocarya erythroxylon*), myrtle ebony (*Diospyros pentamera*), incense cedar (*Anthocarapa sp.)* and emergent Moreton Bay fig (Ficus macrophylla), strangling fig (*Ficus watkinsiana*), giant stinging tree (*Dendrocnide excelsa*) and yellow carabeen (*Sloanea woollsii*). Drier sites and less fertile soils support forests of; Sydney blue gum (*Eucalyptus saligna*), brush box (*Lophostemon confertus*), broad-leaved apple (*Angophora subvelutina*), flooded gum (*Eucalyptus grandis*), turpentine (*Syncarpia glomulifera*), blackbutt (*Eucalyptus pilularis*) and coachwood (*Ceratopetalum apetalum*). On lower slopes; tallow wood (*Eucalyptys microcorys*) grey gum (*Eucalyptus punctata*), white mahogany (*Eucalyptus acmenoides*), manna gum (*Eucalyptus viminalis*) and forest oak (Allocasuarina torulosa).	57
Byron - Tweed Alluvial Plains	Channels, floodplain, terraces and estuary of the Tweed River and other coastal streams on Quaternary alluvium, general elevation 0 to 50m, local relief 15m. Uniform brown earths and structured brown clays on floodplains. Brown texture-contrast soil with high organic content on terrace remnants. Most of the valley is cleared but contained subtropical closed forest with; white booyong (*Argyrodendron trifoliolatum*), red cedar (*Toona australis*), and retains many rare species such as; heart-leaved bosistoa (*Bosistoa selwynii*), velvet laurel (*Endiandra hayesii*), red-fruited ebony (*Diospyros mabacea*) and southern fontainea (*Fontainea australis*). Dry coastal hardwood forest on the terraces and slopes including; cabbage gum *(Eucalyptus amplifolia*), forest red gum *(Eucalyptus tereticornis*), broad-leaved apple (*Angophora subvelutina*), river oak (*Casuarina cunninghamiana*), silky oak (*Grevillea robusta*), rough-barked apple (*Angophora floribunda*), native teak (*Flindersia australis*), coastal grey box *(Eucalyptus bosistoana*), pink bloodwood (*Corymbia intermedia*), spotted gum *(Corymbia maculata*), grey ironbark *(Eucalyptus paniculata*), broad-leaved paperbark (*Melaleuca quinquenervia*), blackwood (*Acacia melanoxylon*) and black she-oak (*Casuarina litoralis*).	81

Figure 3-1: Mitchell Landscapes



3.1.3 Waterways

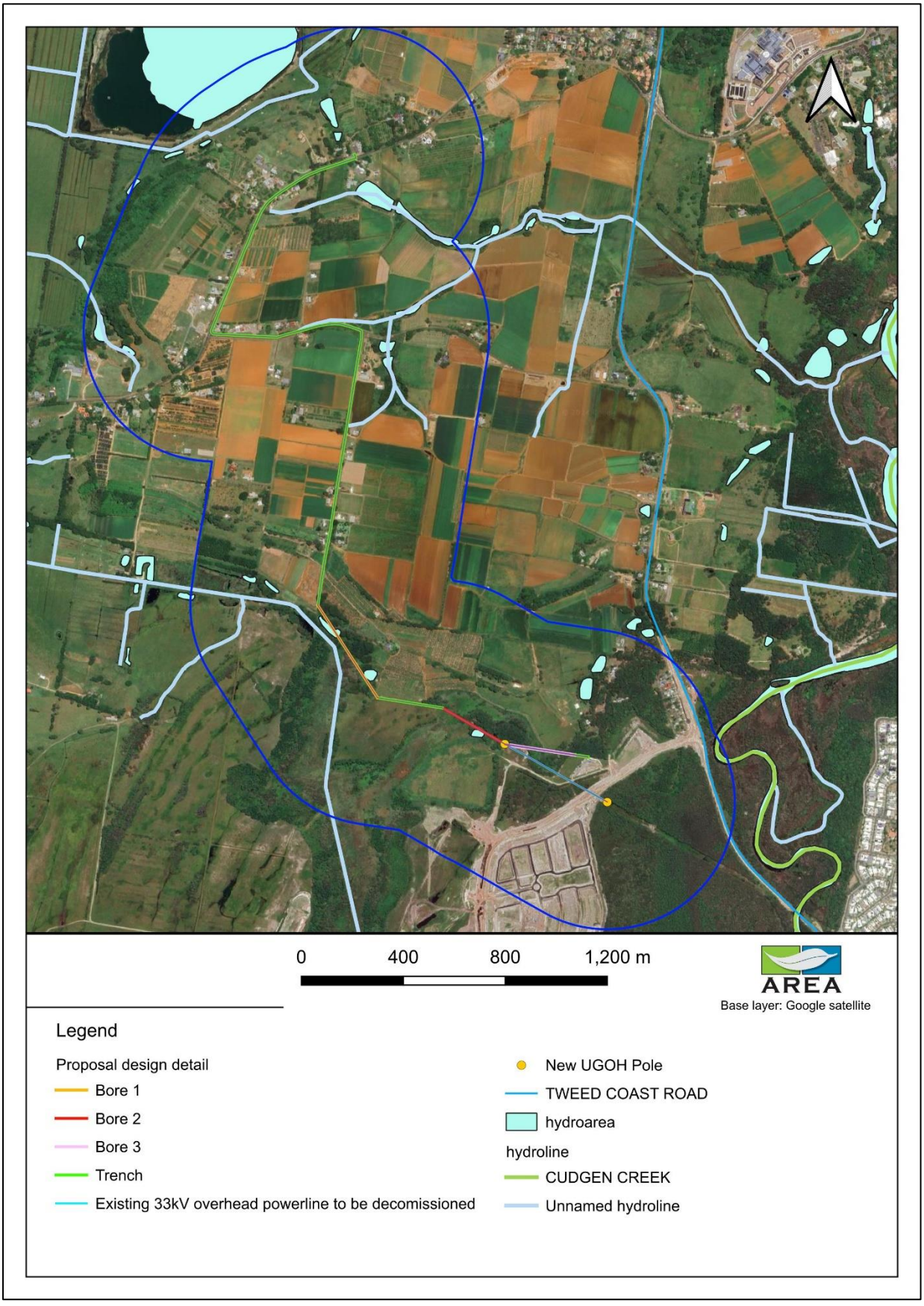
Landscape features such as distance to water and land-use can greatly influence the ecology of an area and consequently the likelihood that protected matters are present.

No waterways in the assessment area were mapped in the Directory of Important Wetlands or as part of a Ramsar site.

The proposed alignment crosses no mapped hydrolines, however several unnamed hydrolines and Cudgen Creek occurs within 500 metres (Figure 3-2).

Waterbodies identified on the hydroarea spatial layer would be underbored.

Figure 3-2: Waterways within 500m of the proposed alignment



3.1.4 Land use

The NSW Landuse 2017 map captures how land in the state is utilised across various sectors such as residential, commercial, agricultural, industrial, and conservation. The NSW State Land use maps the following land uses that are intersected by the alignment:

- Nature conservation
- Grazing native vegetation
- Plantation forests
- Grazing modified pastures
- Cropping
- Perennial horticulture
- Seasonal horticulture
- Land in transition
- Residential and farm infrastructure
- Transport and communication
- River
- Other minimal use

Generally, land mapped with 500 metres of the subject land associated with low lying wetland areas are not shown on the land use spatial layer.

3.1.5 Climate

The climate of the far north coast region of NSW is relatively mild, changing slightly with the seasons. The following long-term climate statistics were collected from Bureau of Meteorology - Coolangatta[3].

Table 3-2: Climate statistics for Coolangatta

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean Max (°C)	28.5	28.4	27.4	25.6	23.2	21.1	20.7	21.7	23.4	24.7	26.1	27.5	24.9
Mean Min (°C)	21.0	20.9	19.9	17.0	13.9	11.3	10.1	10.6	13.4	16.0	18.0	19.8	16.0
Mean Rain (mm)	161.6	195.0	199.4	155.4	130.8	125.8	73.7	56.1	42.6	93.0	115.3	155.9	1503.1
Mean Rain Days	10.8	12.3	13.3	11.2	10.2	7.8	6.0	5.0	4.8	7.5	8.8	10.2	107.9

Recent rainfall data collected at Kingscliff (Woram Place) in the months and days prior to the field assessment shows average rainfall during April and May with 237.0 millimetres and 248.2 millimetres consecutively. June received below average rainfall with only 19.1 millimetres recorded. In the nine days prior to the field assessment, 144.6 millimetres of rain fell[4]. Areas which hold water and therefore would provide frog breeding habitat during times of rainfall would have been inundated at the time of the assessment. No such areas occur within the subject land.

[3] http://www.bom.gov.au/climate/averages/tables/cw_040717.shtml

[4] http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_stn_num=058137&p_startYear=

3.2 Ecological context

The ecological context of the landscape assessment area was assessed at desktop to inform the field survey.

3.2.1 Predicted species

A review of the Burringbar-Conondale subregion predicted matters search found a total of 93 listed species were predicted to occur in the subregion. A combined list of IBRA and EPBC listed threatened species is found in Appendix C.

3.2.2 BioNet species records

BioNet is a biodiversity database and mapping system used in NSW. It serves as a comprehensive repository of biodiversity information, including data on species occurrence, habitats, ecosystems, and conservation status.

Seventeen threatened species have previously been recorded within 500 metres of the proposed alignment (Table 3-3, Figure 3-3) More substantial populations of Mitchell's Rainforest Snail and Wallum Froglet occur within 1500 metres, and beyond (Figure 3-4). Records within 1500 metres include one amphibian species, eight bird species, two plant species and six mammal species.

Table 3-3: BioNet records within 1500-meter buffer

Class	Scientific	Common name	NSW Status	Commonwealth Status	Records within 500m
Amphibia	*Crinia tinnula*	Wallum Froglet	Vulnerable	Not listed	11
Aves	*Ardenna tenuirostris*	Short-tailed Shearwater	Not listed	C, J, R*	2
Aves	*Burhinus grallarius*	Bush Stone-curlew	Endangered	Not listed	7
Aves	*Calyptorhynchus lathami lathami*	South-eastern Glossy Black-Cockatoo	Vulnerable	Vulnerable	6
Aves	*Circus assimilis*	Spotted Harrier	Vulnerable	Not listed	1
Aves	*Hirundapus caudacutus*	White-throated Needletail	Vulnerable	Vulnerable C, J, R*	1
Aves	*Hydroprogne caspia*	Caspian Tern	Not listed	JAMBA	1
Aves	*Pandion cristatus*	Eastern Osprey	Vulnerable	Not listed	1
Aves	*Tyto longimembris*	Eastern Grass Owl	Vulnerable	Not listed	2
Flora	*Desmodium acanthocladum*	Thorny Pea	Vulnerable	Vulnerable	9
Flora	*Lindsaea fraseri*	Fraser's Screw Fern	Endangered	Not listed	1
Mammalia	*Cercartetus nanus*	Eastern Pygmy-possum	Vulnerable	Not listed	9
Mammalia	*Miniopterus australis*	Little Bent-winged Bat	Vulnerable	Not listed	2
Mammalia	*Petaurus norfolcensis*	Squirrel Glider	Vulnerable	Not listed	6
Mammalia	*Phascolarctos cinereus*	Koala	Endangered	Endangered	6
Mammalia	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	Vulnerable	Not listed	1
Mammalia	*Scoteanax rueppellii*	Greater Broad-nosed Bat	Vulnerable	Not listed	3

*C=CAMBA; J=JAMBA; R=ROKAMBA

Figure 3-3: BioNet records within 500m

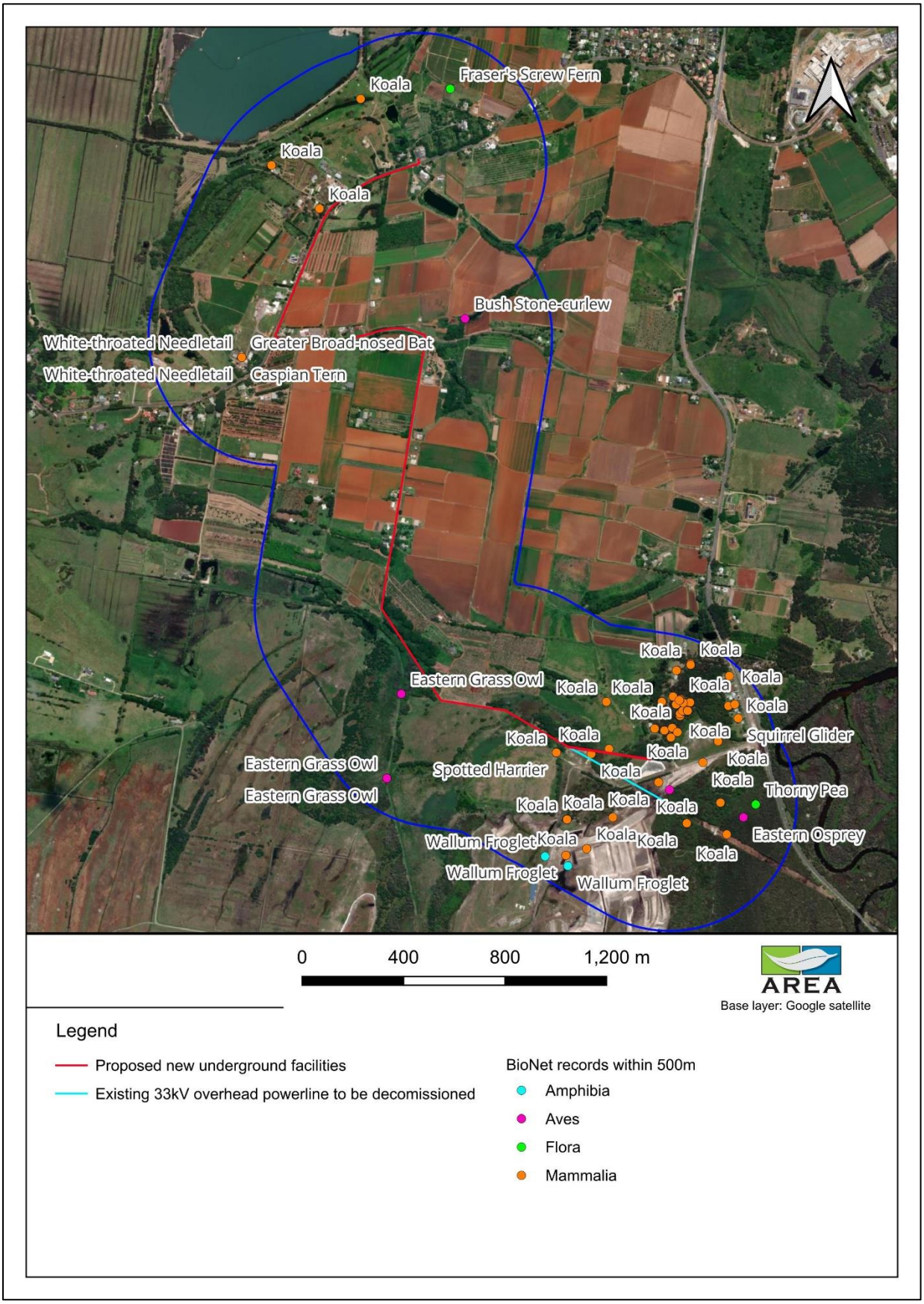
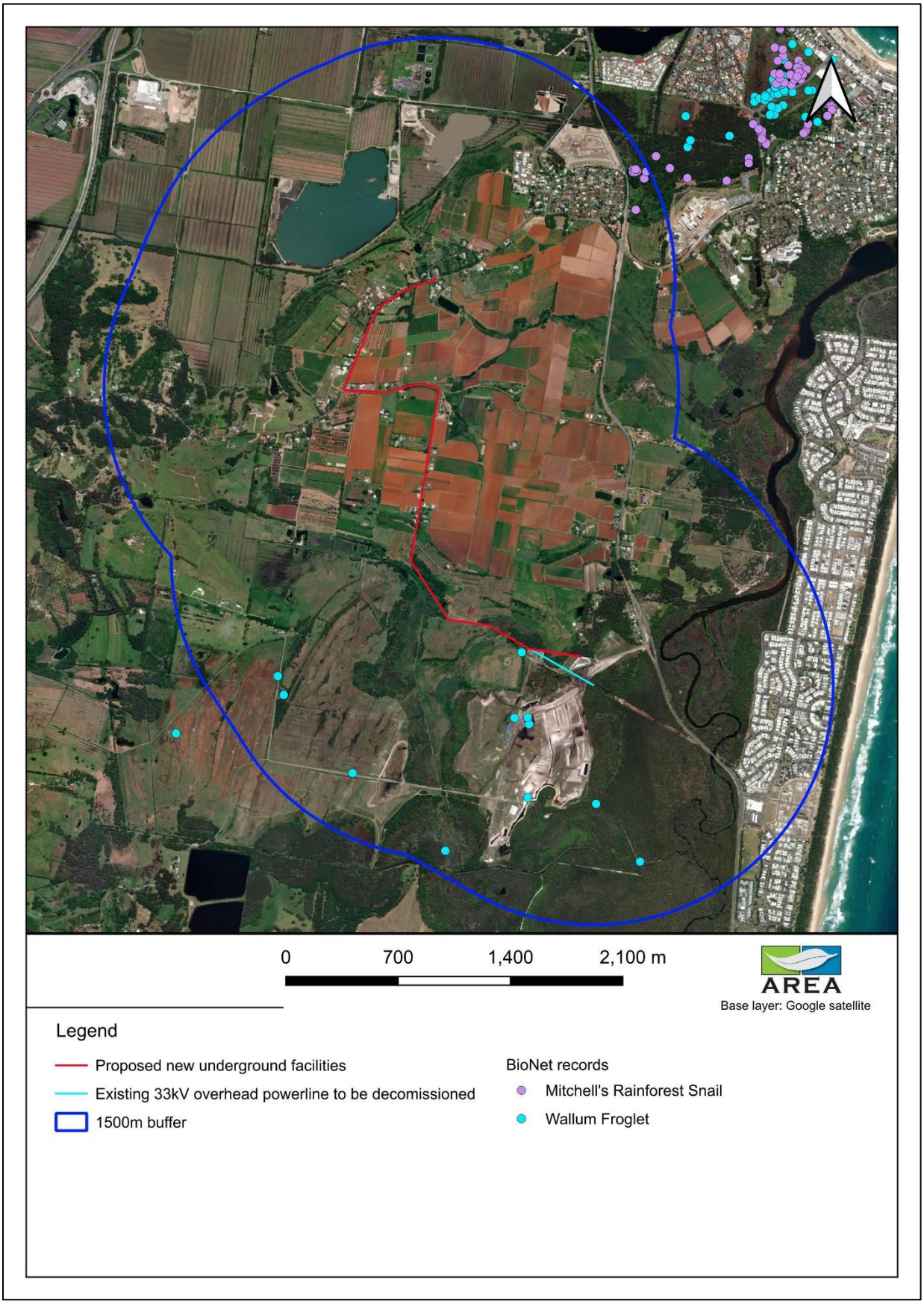


Figure 3-4: BioNet records Mitchell's Rainforest Snail and Wallum Froglet records



3.2.3 Plant Community Types

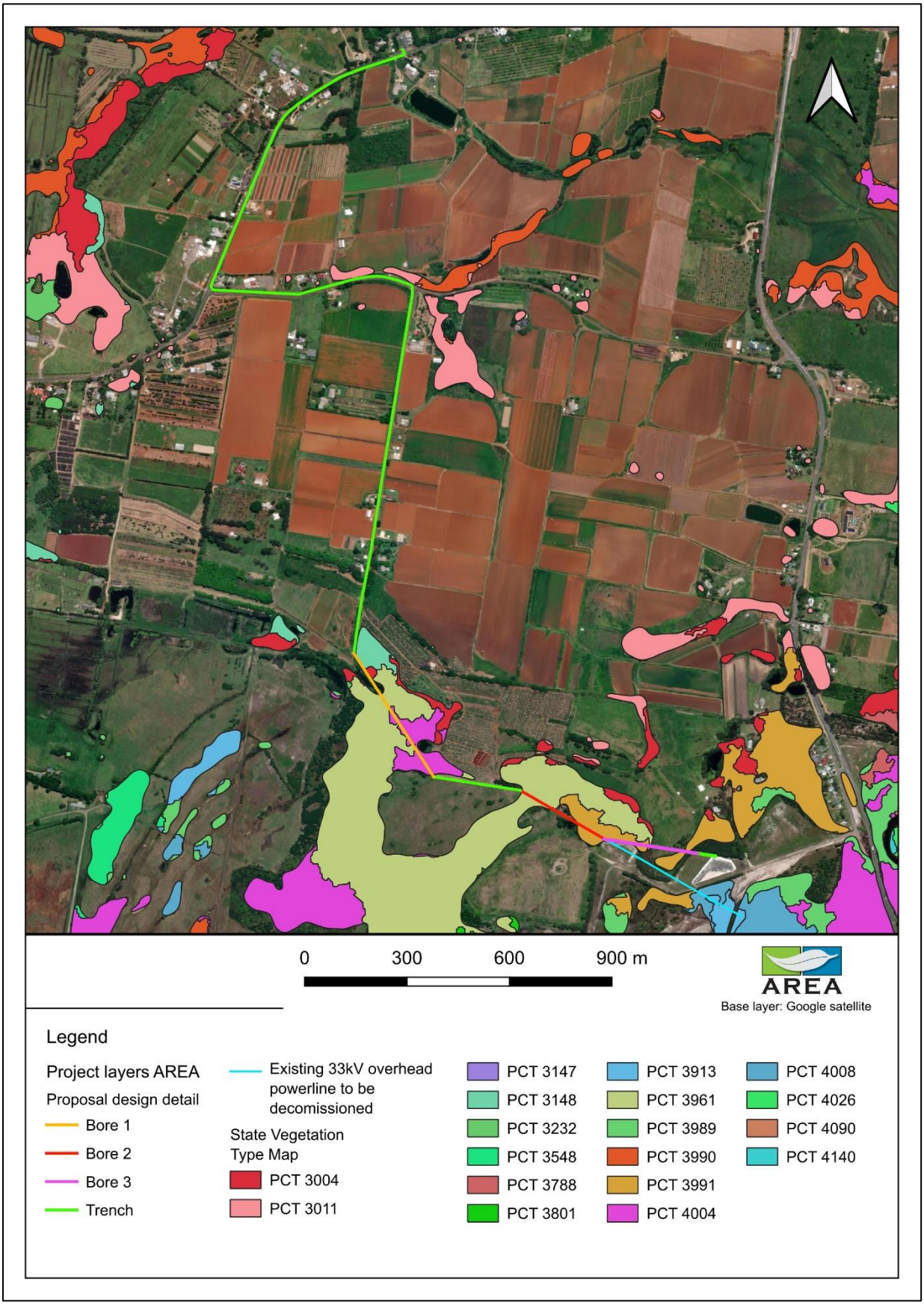
Plant Community Types taken from the State Vegetation Type Map (STVM)[5] with a 500-metre buffer applied, were used during the desktop assessment to understand the range of PCTs with potential to occur within the subject land. Seventeen PCTs, excluding not native vegetation (identified as 'Not classified'), are mapped within 500 metres of the alignment (Figure 3-5).

Table 3-4: PCTS within 500m of the alignment on the STVM

PCTID	PCT Name	Vegetation Form	Vegetation Class
0	Not classified	Not classified	Not classified
3004	Far North Bangalow Palm Swamp Forest	Rainforests	Subtropical Rainforests
3011	Far North Lowland Subtropical Rainforest	Rainforests	Subtropical Rainforests
3147	Far North Brush Box-Bloodwood Wet Forest	Wet Sclerophyll Forests (Shrubby sub-formation)	North Coast Wet Sclerophyll Forests
3148	Far North Brush Box-Walnut Wet Forest	Wet Sclerophyll Forests (Shrubby sub-formation)	North Coast Wet Sclerophyll Forests
3232	Far North Coastal Hills Blackbutt-Ironbark Forest	Wet Sclerophyll Forests (Grassy sub-formation)	Northern Hinterland Wet Sclerophyll Forests
3548	Far North Sands Scribbly Gum Heathy Forest	Dry Sclerophyll Forests (Shrubby sub-formation)	Coastal Dune Dry Sclerophyll Forests
3788	Coastal Foredune Wattle Scrub	Heathlands	Coastal Headland Heaths
3801	Far North Sandplain Wallum Heath	Heathlands	Wallum Sand Heaths
3913	Northern Sandplain Wet Heath	Freshwater Wetlands	Coastal Heath Swamps
3961	Coast Sands Lepironia Sedgeland	Freshwater Wetlands	Coastal Freshwater Lagoons
3989	Far North Paperbark Fern Swamp Forest	Forested Wetlands	Coastal Swamp Forests
3990	Far North Paperbark Gahnia Swamp Forest	Forested Wetlands	Coastal Swamp Forests
3991	Far North Sands Swamp Turpentine-Paperbark Forest	Forested Wetlands	Coastal Swamp Forests
4004	Northern Melaleuca quinquenervia Swamp Forest	Forested Wetlands	Coastal Swamp Forests
4008	Northern Sands Swamp Mahogany Shrubby Rush Forest	Forested Wetlands	Coastal Swamp Forests
4026	Estuarine Sea Rush Swamp Oak Forest	Forested Wetlands	Coastal Floodplain Wetlands
4140	Far North Mangrove Forest	Saline Wetlands	Mangrove Swamps

[5] https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity/nsw-bionet/state-vegetation-type-map

Figure 3-5: State Vegetation Type Map



3.2.4 Threatened Ecological Communities

An ecological community is a naturally occurring group of plants, animals and other organisms that constitute a unique habitat. Its structure, composition and distribution are determined by environmental factors such as soil type, position in the landscape (e.g. altitude), climate and water availability (Department of Climate Change, Energy, the Environment and Water, 2021).

IBRA and MNES database searches identified 11 Threatened Ecological Communities (NSW listed) and Ecological Communities (Commonwealth listed) as potentially occurring in the subject land.

NSW database searches predicted eleven Threatened Ecological Communities (TECs), all listed as Endangered under the *Biodiversity Conservation Act 2016*, likely to occur in the NSW South Eastern Queensland Bioregion – Burringbar – Conondale Ranges IBRA subregion (Appendix B):

- Byron Bay Dwarf Graminoid Clay Heath Community
- Coastal Cypress Pine Forest in the New South Wales North Coast Bioregion
- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions
- Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion
- Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- *Themeda* grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner bioregions

Five Ecological Communities (EC) listed under the *Environmental Protection and Biodiversity Conservation Act 1999* were predicted in the EPBC Act Protected Matters Report (Appendix A):

- Threatened Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community - Endangered
- Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland - Endangered
- Lowland Rainforest of Subtropical Australia - Critically Endangered
- Subtropical and Temperate Coastal Saltmarsh - Vulnerable
- Subtropical eucalypt floodplain forest and woodland of the New South Wales North Coast and South East Queensland bioregions - Endangered

The presence of these predicted TECs/ECs is considered further considering data collected during the field survey in section 3.2.2.

3.2.5 Areas of Outstanding Biodiversity Value

The NSW Government describes an Area of Outstanding Biodiversity Value (AOBV) as special areas with irreplaceable biodiversity values that are important to the whole of New South Wales, Australia or globally[6].

An AOBV associated with the Mitchell's Rainforest Snail occurs approximately 3.5 kilometres west of the subject land in the Stotts Island Nature Reserve. While this AOBV would not be impacted by this proposal, the associated species (Mitchell's Rainforest Snail) has also been recorded within 1500 metres of the subject land to the northeast in remnant forest. Impact to Mitchell's Rainforest Snail has been considered under a test of significance later in this report (section 5.1.4 and Appendix D).

3.2.6 Biodiversity Values Map

The Biodiversity Values (BV) Map and Threshold Tool identifies land with high biodiversity value, particularly land sensitive to impacts from development and clearing. This database is not relevant for assessments under Part 5 of the EP&A Act, however for such assessments it can provide guidance to the assessor about the importance of habitat and the likelihood of presence of protected matters.

A small section of the proposed alignment intersects with land mapped on the NSW Biodiversity Values Map[7]. The BVM at this point reflects the presence of the coastal wetlands, which are similarly mapped on the State Vegetation Type Map (Figure 3-6).

In this section, the construction methodology is underboring. This construction method seeks to avoid direct and indirect impact on the water quality and hydrological processes associated with wetland values, particularly those seen and experienced at the surface by threated species and ecological communities (Figure 3-6).

Standard and project specific safeguards would be employed during construction to ensure inadvertent impact to water quality, water bodies and hydrological processes does not occur, and any incidents are managed effectively and swiftly.

Potential of impact to wetland areas, hydrological processes and aquatic values are discussed further in sections 5.1.6 and 5.17.

3.2.7 Key Fish Habitat

Key Fish Habitat (KFH) in NSW refers to critical aquatic environments that support the lifecycle of fish species, including spawning, nursery, feeding, and migration habitats. These habitats are essential for maintaining healthy fish populations and the overall integrity of aquatic ecosystems.

[6] https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity/areas-of-outstanding-biodiversity-value

[7] https://www.lmbc.nsw.gov.au/Maps/index.html?viewer=BOSETMap

Areas marked as KFH on the NSW Key Fish Habitat map intersects the alignment by a very small margin where it runs close to a tributary to Cudgen Creek (Figure 3-6).

3.2.8 Environmental Conservation Zones

In NSW, Environmental Conservation Zones[8] are designated areas aimed at protecting and conserving significant environmental values, biodiversity, and ecosystems. These zones are established through Local Environmental Plans (LEPs), to manage land use and development in accordance with conservation objectives.

This proposal does not intersect with any conservation zones mapped in the subject land as per the NSW planning Portal Spatial Viewer, although the Cudgen Nature Reserve lies within 1500 metres of the subject land and is mapped as C1 - National Parks and Nature Reserves.

3.2.9 Groundwater dependant ecosystems

Groundwater Dependent Ecosystems (GDEs) in NSW refer to ecosystems that rely on groundwater to support their structure, function, or ecological processes. These ecosystems can include various habitats such as wetlands, springs, streams, and riparian zones.

The Bureau of Meteorology (BoM 2019) Atlas of Groundwater Dependant Ecosystems mapping was checked for Groundwater Dependent Ecosystems (GDEs)[9]. Desktop results are provided in Appendix B.

The proposed work does not intersect with any areas mapped as having potential aquatic or terrestrial GDEs.

3.2.10 Native Vegetation Regulatory (NVR) mapping

The Draft Native Vegetation Regulatory Map NSW is a spatial dataset that shows where regulations related to native vegetation management under the Local Land Services Act applies[10].

This proposal would largely result in impact to areas mapped as Category 2 – regulated land surrounded by land mapped as Category 1 – Exempt land. The proposal avoids impact to land mapped as Category 2 Sensitive Regulated Land associated with low lying wetland areas.

[8] https://www.planningportal.nsw.gov.au/spatialviewer/#/find-a-property/address
[9] http://www.bom.gov.au/water/groundwater/gde/index.shtml
[10] https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity/native-vegetation-regulatory-map

Figure 3-6: Biodiversity Values Map and Key Fish Habitat

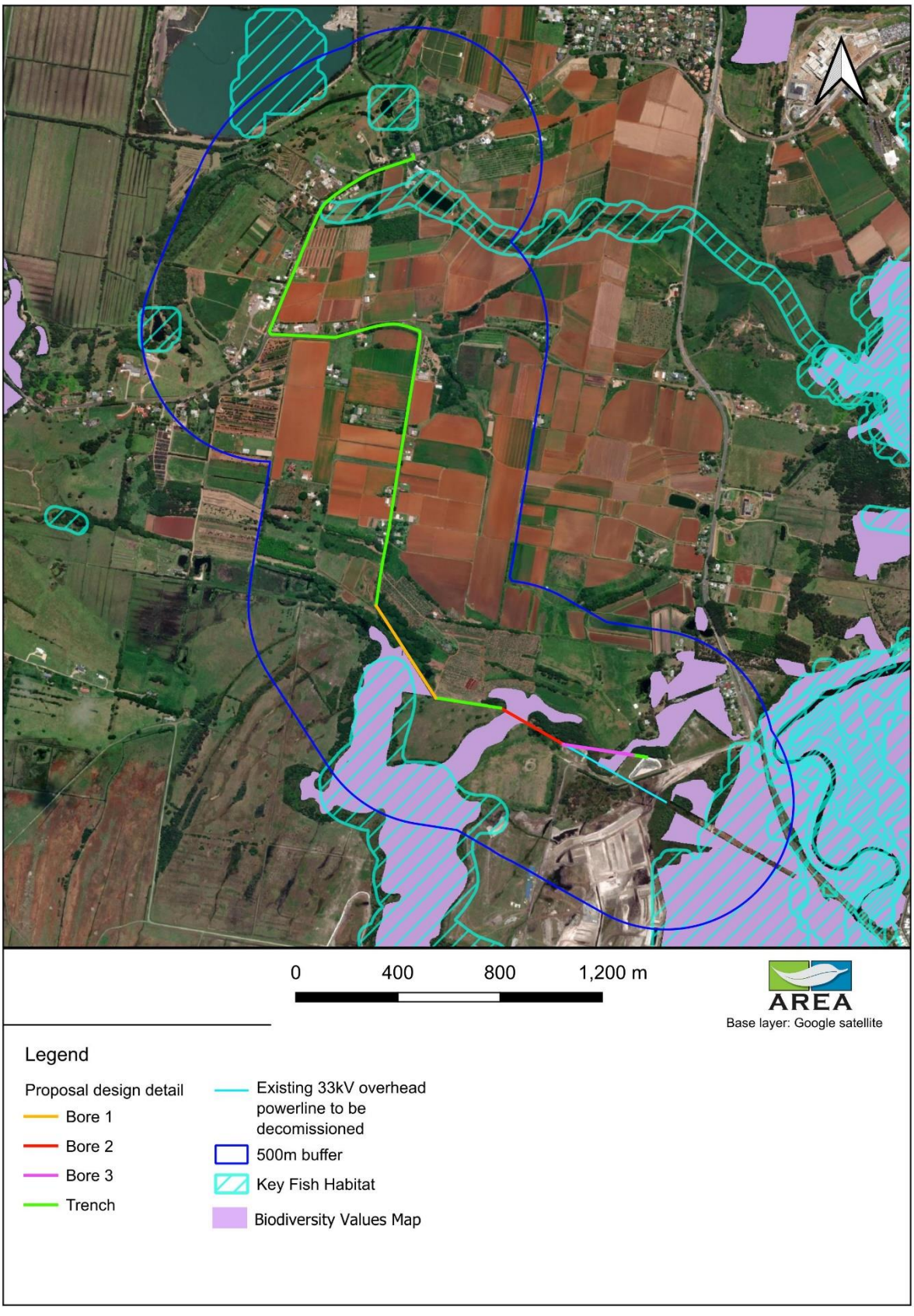
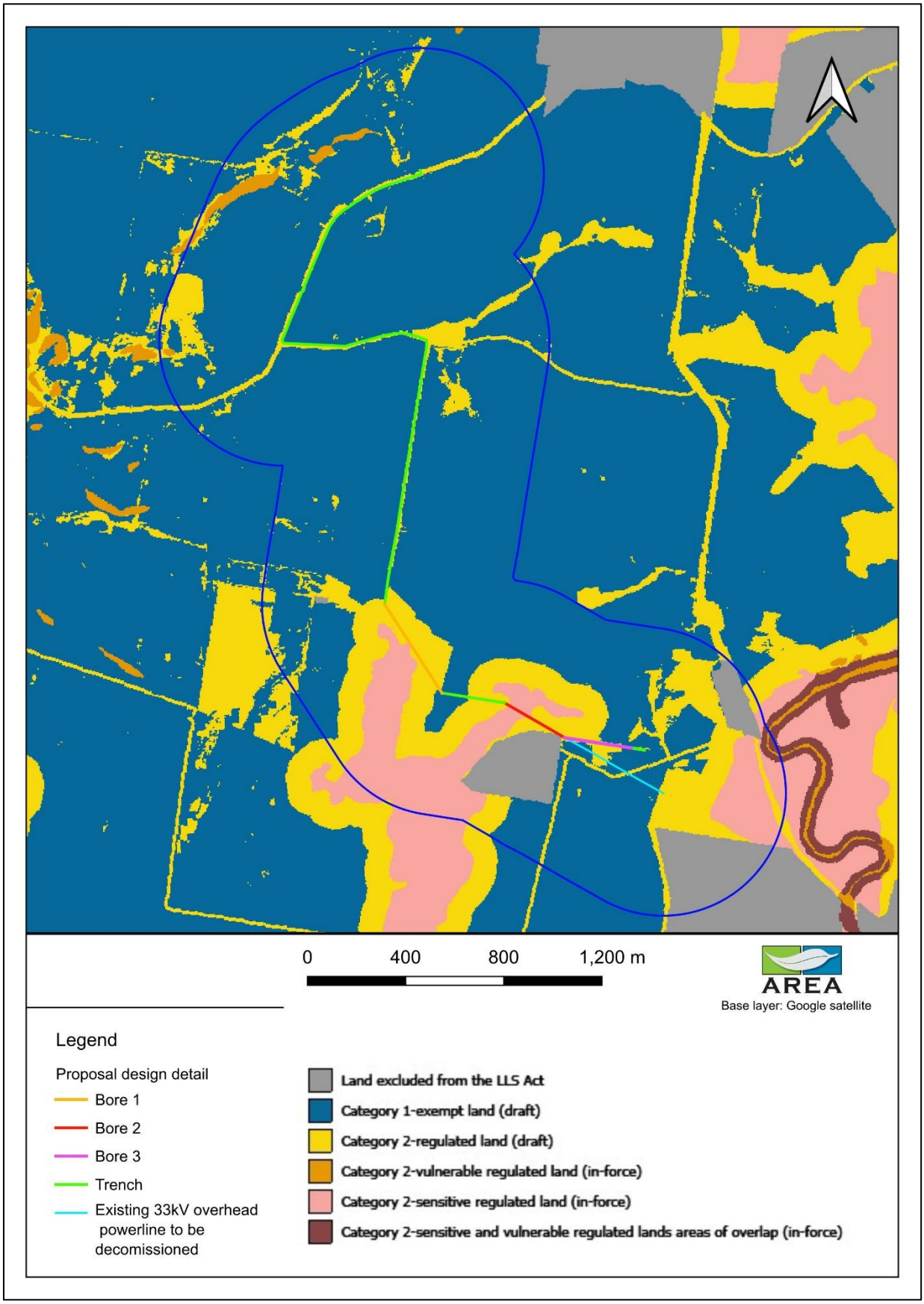


Figure 3-7: NSW Draft Native Vegetation Regulatory map



3.2.11 EPBC Protected Matters

An EPBC Protected Matter Report generated for this proposal considered environmental matters within a 500-metre buffer of the proposal alignment. This report is provided in Appendix B and summarised in Table 3-5.

Potential impacts to species and communities highlighted are considered in the following sections of this report.

Table 3-5: EPBC Protected Matters Report summary

MNES	Result	Relevance to this assessment
World Heritage Properties	None	None
National Heritage Places	None	None
Wetlands of International Importance	None	None
Great Barrier Reef Marine Park	None	None
Commonwealth Marine Area	None	None
Listed Threatened Ecological Communities	5	Section 3.2.11 and Section 5.1.3
Listed Threatened Species	103	Section 4.4 and Section 5.1.4
Listed Migratory Species	60	Section 5.1.5
Commonwealth Land	None	None
Commonwealth Heritage Places	None	None
Listed Marine Species	91	All birds, considered as Migratory Species, Section 5.1.5
Whales and Other Cetaceans	12	None
Critical Habitats	None	None
Commonwealth Reserves Terrestrial	None	None
Australian Marine Parks	None	None
Habitat Critical to the survival of Marine Turtles	None	None
State and Territory Reserves	1	Cudgen Nature Reserve – not within the subject land, however, is within 500m to the southeast of the subject land.
Regional Forest Agreements	1	None - North East NSW REF – subject land is mapped as freehold land.
Nationally Important Wetlands	1	Cudgen Nature Reserve – not within the subject land, however, is within 500m to the southeast of the subject land.
EPBC Act Referrals	10	All either post-approval or completed. Includes the nearby Kings Forest Residential Development Kingscliff, NSW (EPBC 2012/6328).
Key Ecological Features (Marine)	None	None
Biologically Important Areas	5	None – all are whale, shark, turtle and dolphin habitat which does not occur in or within 500m of the subject land.
Bioregional Assessments	None	None
Geological and Bioregional Assessments	None	None

EPBC Referral 2012/6328

On 21 May 2015 the Commonwealth Department of Environment approved (with conditions) the Kings Forest residential development (EPBC 2012/6328). The conditions to the approval were last varied on 25 May 2021. The Commonwealth approval is confined to the mitigation of impacts of the proposed development on the Koala and Wallum Sedge Frog, both of which are listed under the EPBC Act.

3.2.12 Previous Reports / Management Plans

This assessment is prepared with consideration of the management plans for Koala and Wallum Sedge Frog prepared for the Kings Forest residential development. These management plans and the consistency of this proposal with those plans are discussed below.

Kings Forest Koala Plan of Management (KPoM) (JWA 2019)

The Kings Forest KPoM was prepared as two volumes. Volume 1 is most relevant for consideration in this report as it presents the specific threatening processes, management actions and reporting protocol as the pertain to the Kings Forest residential development.

Many of the threats and actions within Volume 1 of the KPoM are not applicable to this proposal as they are targeting management of impact to large areas of vegetation withing which Koalas are known to occur, where Koala food/ use trees would be impacted or where revegetation of Koala habitat is proposed.

This report and this proposal seek to be consistent with the directions within the KPoM as they relevant to this proposal. These directions include:

- Field assessment for this proposal confirmed no Koala use trees listed in the *Koala (Phascolarctos cinereus) Biodiversity Assessment Method Survey Guide*[11] or the NSW Government document *A review of koala tree use across New South Wales*[12] would be impacted by this proposal. It should be noted that these species do occur in vegetation adjacent to the subject land, and hence the presence of Koalas resting or moving through vegetation in the subject land should be considered during implementation of this proposal.
- Reporting any sighting of, or incident involving a Koala, in or around the proposal work area to the Biodiversity Conservation and Science Directorate, the Tweed Shire Council and Friends of the Koala
- Contact Friends of the Koala in the even of injury to wildlife other than Koala.
- Ensuring vehicle movements do not exceed 50 kilometres per hour to minimise the risk of vehicle strike.
- No domestic dogs are to be brought onto the site during pre-construction and construction activities.

[11] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/koala-phascolarctos-cinereus-biodiversity-assessment-method-survey-guide-220249.pdf

[12] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Native-animals/review-of-koala-tree-use-across-nsw-180385.pdf

Kings Forest Wallum Sedge Frog Management Plan (WSFMP) (JWA 2020)

The WSFMP was developed to meet State and Commonwealth conditions of consent for the Kings Forest residential development. For this species, it supersedes the Threatened Species Management Plan which was prepared at an earlier stage of the approval process. Broadly, the WSFMP directs actions which minimise impact to the habitat values for this species and treats to the species and its habitat.

Records of the Wallum Sedge Frog were identified within the boundary of the Kings Forest residential development area. This proposal runs approximately along the northern edge of the boundary of the Kings Forest residential development area, and further north across basalt derived soils which do not provide habitat for this species.

The WSFMP maps areas of potential habitat (Figure 12 in the WSFMP). The closest mapped habitat to this proposal includes:

- Breeding habitat mapping in small pool areas south of this proposal, and which would not be directly or indirectly impacted by this proposal.
- Foraging habitat mapping intersects with the proposal alignment only in the section which involves removal of existing powerlines. This activity would not include ground disturbance activities and would not change any hydrological processes on this land, or adjacent land.
- Potential habitat mapping. The very edge of this mapped area would be under bored by this proposal.

Kings Forest Threatened Species Management Plans (JWA 2011)

The Kings Forest Threatened Species Management Plans (KFTSMPs) provide specific management action of specific species.

All species considered in the KFTSMPs were also considered in this report. Table 3-6 indicates which species were considered not likely to occur in the subject land for this proposal, and which were considered to have potential to use the habitat values in the subject land and where therefore assessed with a test of significance under the relevant Act/s.

Table 3-6: Species considered in Kings Forest Threatened Species Management Plans

Considered not likely to occur in the subject		Considered under tests of significance under the relevant Acts
BIRDS		BIRDS
Black Bittern		Grass Owl
Glossy Black Cockatoo		Masked Owl
Black-neck Stork		Bush Stone Curlew
Rose-crowned Fruit Dove		MAMMALS
Pale-vented Bush Hen		Grey-headed Flying Fox
PLANT		Koala
Square-stemmed Spike Rush		Yellow-bellied Sheath-tailed Bat
Green-leaved Rose Walnut		Common Planigale
Southern Swamp Orchid		Microchiroptera Bats
Stinking Cryptocharia		AMPHIBIAN
White Lace Flower		Wallum Froglet
White Yiel Yiel		Wallum Sedge Frog

4 Field survey results

4.1 Survey effort

AREA Environmental & Heritage Consultants (Phil Cameron and Addy Watson) conducted the field survey on 10 July 2024.

4.2 Vegetation communities

Field survey confirmed the subject land occurs across two broad soil types which influences the vegetation community which occur, and the species which occupy them. This soil type change generally occurs around an elevation of 10 metres. This change occurs where the alignment meets the southern end of Reardons Road. The higher elevations in the northern section of the alignment are loam soils derived from basalt, while the lower elevations in the southern section are sandy soils. This change in landscape is also reflected in the NSW (Mitchell) landscape mapping (section 3.1.2).

4.2.1 Plant Community Types

Very little wooded vegetation occurs in the subject land. Where Plant Community Types (PCTs) are described in the subject land in the following sections of this report, it is largely previously cleared land supporting groundcover species only, or with bracken fern and small shrub regrowth. This distinction is most important in the southern sections of the proposed alignment, where the only substantial impact to wooded vegetation would occur where edge vegetation would be cleared to allow manoeuvring of the direct drilling machinery, or where access is required to install a new UGOH pole or removal of existing infrastructure.

Plant Community Type (PCT) mapping from the desktop search was corrected by a field survey in the subject land based on observations of mid, upper and ground stratum species, and landform and soils.

Three PCTs excluding PCT 0 (not native vegetation) and small patches of planted garden vegetation were determined to occur along the subject land (Figure 4-1 and Table 4-1). Planted vegetation was not consistent with a PCT. The three PCTs are:

- PCT 3004 - Far North Bangalow Palm Swamp Forest – 0.03 hectares
- PCT 3988 - Far North Mesophyll Paperbark Swamp Forest – 0.03 hectares
- PCT 4004 - Northern *Melaleuca quinquenervia* Swamp Forest – 0.17 hectares

Planted vegetation occupies 0.03 hectares and the not native vegetation occupies 1.39 hectares. Example photos of each PCT are provided in Table 4-1. These example photos show the best conditions of each PCT identified.

The tree recorded PCTs are described on the NSW BioNet Vegetation Classification Tool as provided below.

PCT 3004: Far North Bangalow Palm Swamp Forest

Tall to very tall dense palm forest or rainforest, or rarely, extremely tall sclerophyll open forest with a dense sub-canopy, restricted to poorly-drained sites along a narrow strip of coastal

lowlands north from Woodburn, north coast. The palm *Archontophoenix cunninghamiana* is almost always present and has the highest foliage cover, very frequently accompanied by *Ficus coronata* and *Melaleuca quinquenervia*, with *Ficus obliqua* occasionally present. Other tree species such as *Araucaria cunninghamii* or *Syzygium francisii* may be locally common and the vine *Flagellaria indica* is very frequent. The mid-stratum and ground layer are commonly highly diverse, although it may have low species richness where the palm canopy cover is very high. This PCT occurs only at very warm, very wet locations receiving 1710-1830 mm mean annual rainfall, in poorly-drained and seasonally swampy gullies and depressions, usually on alluvium, at low elevations of up to 40 metres asl, within 15 km of the coast. It occurs as part of a complex, small-scale mosaic involving a range of other lowland PCTs. For example, it may be replaced by PCT 3993 on adjacent estuarine deposits or by PCTs 3016 or 3148 on adjacent slopes.

PCT 3988: Far North Mesophyll Paperbark Swamp Forest

Tall mid-dense to dense forest, or occasionally sparse to mid-dense eucalypt canopy or emergents with a dense sub-canopy, which occurs on alluvial flats or coastal sand deposits on coastal lowlands between Cudgen and Woodburn, north coast. The most frequent eucalypts in the tree canopy, each of which occurs rarely, are *Eucalyptus grandis* and *Eucalyptus robusta*. The canopy or sub-canopy very frequently includes *Melicope elleryana, Melaleuca quinquenervia* and *Archontophoenix cunninghamiana*, commonly with *Glochidion sumatranum, Lophostemon suaveolens* and *Livistona australis*. The fern *Hypolepis muelleri* is almost always present in the ground layer and commonly has high foliage cover. This PCT mainly occurs in very warm, very wet locations receiving 1520-1800 mm mean annual rainfall, at low elevations of 0-10 metres asl. It occurs as part of a mosaic with other coastal lowland PCTs, depending on topographic variations and drainage. For example, it frequently grades into PCT 3989 or PCT 4004 in low-lying depressions with more impeded drainage. In undulating landscapes on metasediments, it may grade into PCT 3148 on better-drained upslope sites.

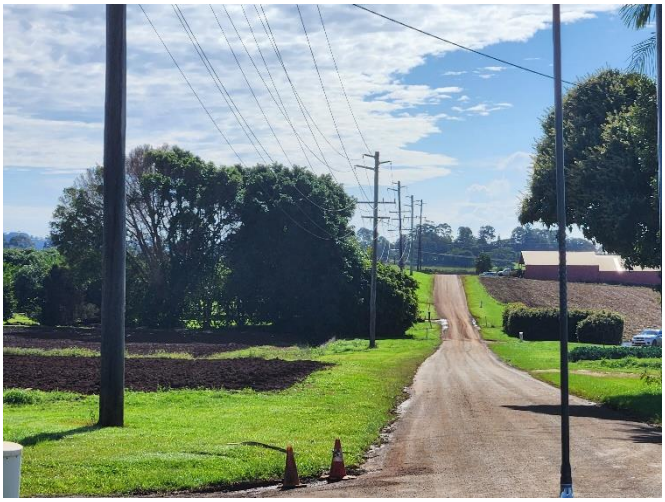
PCT 4004: Northern *Melaleuca quinquenervia* Swamp Forest

A tall to very tall, or rarely low to mid-high, mid-dense to dense forest of *Melaleuca quinquenervia*, occasionally with eucalypts, which occurs in coastal lowland swamps on seasonally inundated alluvium or in drainage depressions. The canopy almost always includes *Melaleuca quinquenervia*, commonly with *Casuarina glauca* which sometimes has a high foliage cover. Eucalypts are occasionally present as part of the canopy or as emergents, by far the most frequent species being *Eucalyptus robusta*. The vine *Parsonsia straminea* is commonly present in the canopy however rarely with high cover. There is a mid-dense to dense ground layer of ferns, sedges and grasses that very frequently includes *Telmatoblechnum indicum*, commonly *Gahnia clarkei* and *Machaerina articulata*, occasionally with *Machaerina rubiginosa* and *Phragmites australis*, the latter forming dense stands in local depressions which are inundated for a longer duration. This PCT has a wide latitudinal range and occupies a range of warm, mostly wet climates at locations receiving 1070-1570 mm mean annual rainfall at low elevations of up to 10 metres asl within 20 km of the coast. It forms

a mosaic with a range of other wetland PCTs, such as PCT 4000, with which it shares similar environments, and grades into as the influence of salinity increases.

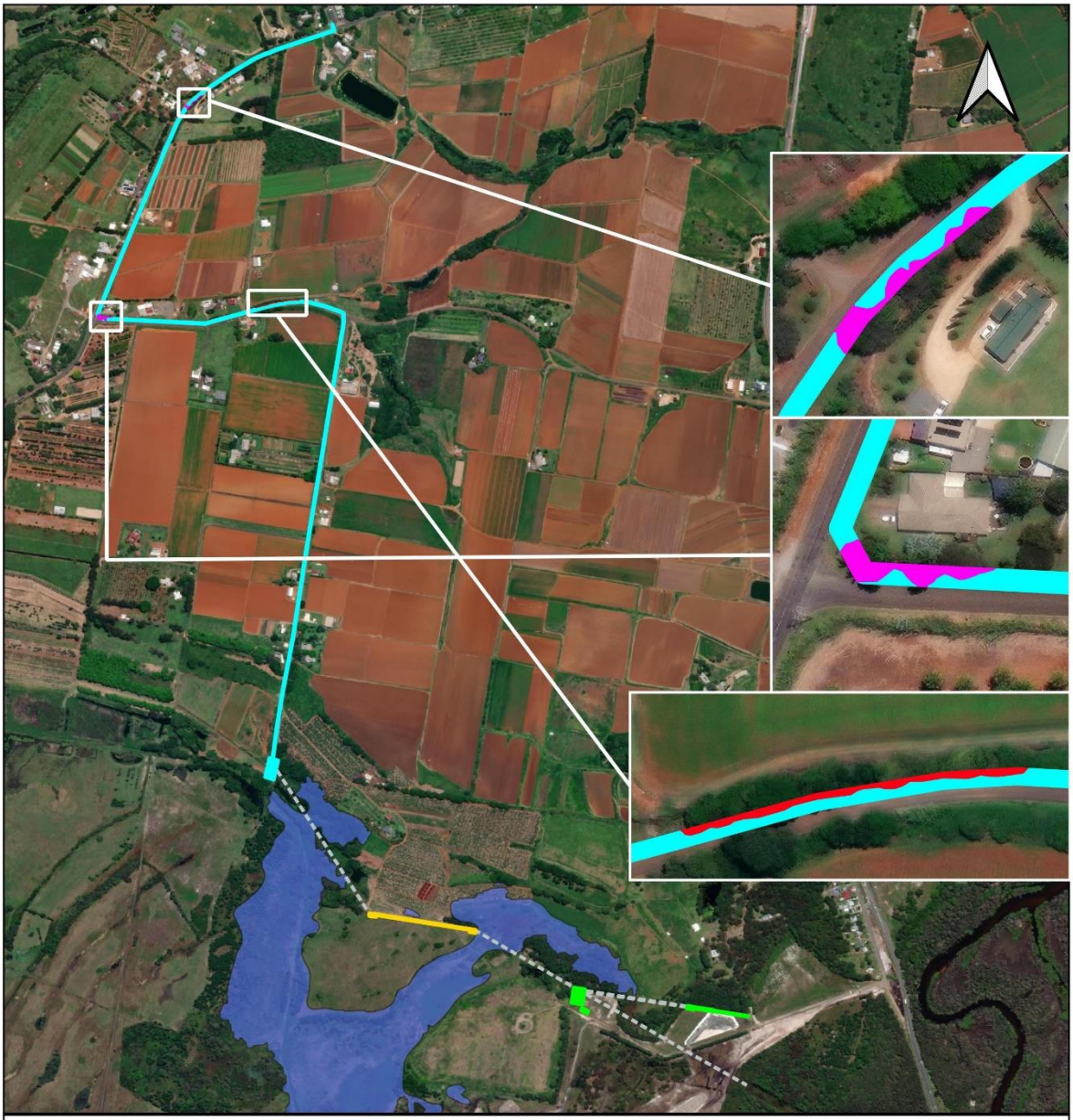
Table 4-1: Plant Community Types recorded in the assessment area

PCT ID and name	Representative photo	Comment
3004 Far North Bangalow Palm Swamp Forest		This PCT patch was in moderate condition, with much of the canopy dominated by *Camphor Laurel* Some native understory species were present, with *Macaranga tanarius*.
3988 Far North Mesophyll Paperbark Swamp Forest		This PCT is in a historically cleared area, with some impact occurring in areas of shrubby/ young regrowth.
4004 Northern *Melaleuca quinquenervia* Swamp Forest		This PCT is mapped in an area which has been historically cleared and is in two condition states. (see photo on the following page)

PCT ID and name	Representative photo	Comment
		
Planted vegetation		Planted vegetation is associated with private house gardens
Not native vegetation		Not native vegetation includes manicured lawns and patches of weeds.

PCT ID and name	Representative photo	Comment
		
Vegetation beneath existing cable to be decommissioned and removed.	 	Mostly weedy under the existing powerline. Impact to vegetation would be minimal or avoided, and no additional ground disturbance would occur.

Figure 4-1: Groundtruted Vegetation map



4.2.2 Threatened Ecological Communities

Of the TECs highlighted by database searches (section 3.2.4), five are associated with the PCTs determined to be present in the assessment area. The remaining TECs were determined not to be present on this basis, but were also unlikely to be present as key species were not recorded, or soil and landscape features were inconsistent within the subject land.

Two TECs were determined to be present based on TEC descriptions (including community composition and condition).

Table 4-2 provides an assessment of each associated TEC and whether they are present in the subject land.

Note the three BC Act listed communities refer to being present in the NSW North Coast bioregion, however, do not identify the South Eastern Queensland bioregion in which this proposal would occur. Review of the supporting documents for each of these communities confirms that the scientific determination for these communities does intend to include the section of the NSW north coast area which occurs in the South Eastern Queensland bioregion, and extends to the border.

TECs confirmed to be present within the subject land have been considered under the relevant test of significance in Appendix D.

Table 4-2: Threatened Ecological Community assessment table

Scientific Name	NSW Status	Commonwealth Status	Associated PCT within subject land	Present/not present justification
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	Endangered	Not listed	3004	**Likely to be present. Condition of the community is not considered a reason to discount the community. Species listed as characteristic species of this community are present in or adjacent sections of the gully to the east. Location, soil and landscape requirements for this TEC are present in the subject land.**
Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion	Endangered	Not listed	3004	Not present – the small patch of PCT3004 is not located on a floodplain, and, at an elevation of 30m AHD is out of the Design Flood Depth areas of the Tween Shire Council[13].
Lowland Rainforest of Subtropical Australia	Not listed	Critically Endangered	3004	Not present – the small patch of PCT3004 in the subject land does not meet the Commonwealth condition requirements. Namely: The canopy and total vegetation cover is dominated by Camphor Laurel, the patch size is less than 1ha, and the diversity of native woody species is likely to be less than 30[14]

[13] https://experience.arcgis.com/experience/f997fac07a2c45ac9f7f2b89f038be8b

[14] https://www.environment.gov.au/biodiversity/threatened/communities/pubs/101-listing-advice.pdf

Scientific Name	NSW Status	Commonwealth Status	Associated PCT within subject land	Present/not present justification
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	Not listed	3988 4004	**Likely to be present. Condition of the community is not considered a reason to discount the community. Species listed as characteristic species of this community are present in or adjacent to the subject land. Location, soil and landscape requirements for this TEC are present in the subject land.**
Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland	Not listed	Endangered	4004	Unlikely While the vegetation within the area mapped as PCT4004 meets many of the condition requirements, especially where the ground stratum is dominated by bracken as opposed to exotic grasses such as *setaria sp*., it is lacking a canopy layer due to historic clearing. Key diagnostics for this TEC include a requirement for a minimum crown cover of 10%.

4.3 Terrestrial habitat

Ecologists assessed habitat suitability, concentrating on the extent to which endangered species habitat requirements occur within the subject land. The study identified the following key habitat characteristics in the subject land:

- Native vegetation within the subject land is predominantly historically cleared land, which is now occupied by maintained urban lawns/ roadsides or young re-growing forest communities.
- Weeds are prevalent within and surrounding the subject land. These provide minor habitat value within the subject land.
- Planted vegetation occurs within the subject land associated with domestic maintained gardens and shrubby property boundary planting. This vegetation is native and exotic and may contribute to shelter and nesting habitat for some bird species.
- No notable rocky habitat, caves, or cliffs occur within the subject land.
- No tree hollows occur in the subject land.
- No significant log/ coarse woody habitat is present in the subject land; however, it is likely to occur in adjacent patches of vegetation
- Leaf litter occurs in small patches within the subject land. Most notably associated with a patch of PCT 3004 - Far North Bangalow Palm Swamp Forest. Leaf litter elsewhere is of low density, meaning it does not provide a moist leaf litter forest floor within the subject land.

4.4 Aquatic habitat

Aquatic habitats can be described in many ways including:

- the natural materials that comprise the habitat (e.g. rocks, coral, gravel, sand and mud),
- the type of vegetation present (e.g. macrophytes, snags, seaweeds, seagrasses, mangroves and saltmarsh),
- the shape and nature of the habitat (e.g. pools and riffles, billabongs, reefs), or
- the overall ecosystem (e.g. wetlands, floodplains, streams, estuaries, lakes, beaches)[15]

The proposed alignment intersects areas of mapped aquatic habitat, including as wetland habitat. The proposal has been designed to avoid impact to waterways and aquatic habitat values by electing to use under boring construction techniques where wetlands, or aquatic habitat values occur.

No waterways or aquatic communities occur within the subject land (where surface ground disturbance would occur) (Figure 3-6).

No habitat suitable for FM Act listed species occurs in the subject land.

Ecological survey of land within the mapped wetland areas did not occur as part of this assessment, however these areas were assumed to provide suitable habitat for predicted listed species.

4.5 Threatened fauna and flora

One species of threatened fauna was noted during the field assessment. Wallum Froglet was heard calling from outside the subject land. Approximate location is shown in Figure 4-2.

Note that the location of this call is also approximately the closest area where the Wallum Sedge Frog Management Plan maps breeding habitat for that species. This area would not be directly or indirectly impacted by this proposal.

Suitable habitat areas for Wallum Sedge Frog as identified in the Kings Forest Wallum Sedge Frog Management Plan and how they relate to the location of this proposal are discussed in section 3.2.12. No core Wallum Sedge Frog habitat was identified within the subject land (area of surface earth disturbance).

No other threatened species were identified during the field assessment.

[15] https://www.dpi.nsw.gov.au/fishing/habitat/aquatic-habitats/about-aquatic-habitats

Figure 4-2: Wallum Froglet call heard during the field assessment



4.6 Pests, weeds and disease

No notable feral fauna species were observed during the field assessment.

No sign of disease was observed during the field assessment. However, the Chytridiomycosis fungus may occur in the local landscape. No dead or diseased frogs were recorded during the field assessment on the subject land. The subject land includes land where surface disturbance may occur and includes only land away from wetland areas or areas of pooled water. This fungus is a waterborne fungus and no interaction with surface water is expected during construction of this proposal.

Weeds dominated the landscape, particularly in the northern section of the alignment.

Priority weeds observed included:

- Camphor Laurel (*Cinnamomum camphora*)
- Lantana (*Lantana camara*)
- Slash pine (Pinus elliottii)
- Elephant Grass (*Pennisetum purpureum*)
- Kikuyu (*Pennisetum clandestinum*)
- *Setaria sp*
- Fireweed (*Senecio madagascariensis*)

5 Impact analysis

5.1 Direct impact

Direct impacts are a direct result of construction activities. Direct impacts predicted to be caused by the development are considered in the following sections. Safeguards and mitigation measures to reduce potential impacts are outlined in Section 6.

5.1.1 Impact to habitat values

All native vegetation mapped in the assessment area has some role in habitat connectivity, however the proposal will not fragment habitat nor prevent movement of fauna or exclude any fauna from suitable habitat during construction or operation.

Some obstacles to wildlife movement may exist during the construction phase of the development as created by machinery and construction activities. These will be temporary and if an individual's movement is disrupted this will not exclude the animal from habitat or its ability to more through the alignment during or post construction.

Habitat features

The alignment is designed to avoid impact to habitat as much as reasonably practicable, however impact is unavoidable.

- Waterways/wetlands occur within the assessment area (500 metres) however the proposal has been designed to avoid impact to waterways and aquatic habitat values by electing to use under boring and trenching construction techniques.
- Native vegetation within the subject land is predominantly historically cleared land, which is now occupied by maintained urban lawns/ roadsides or young re-growing forest communities. The proposal would not substantially alter the habitat values provided by native vegetation. Areas disturbed during construction would be allowed to naturally revegetate.
- Weeds are prevalent within and surrounding the subject land. These provide minor habitat value withing the subject land.
- Planted vegetation occurs within the subject land associated with domestic maintained gardens and shrubby property boundary planting. This vegetation is native and exotic and may contribute to shelter and nesting habitat for some bird species.
- Leaf litter occurs in small patches within the subject land. Most notably associated with a patch of PCT 3004 - Far North Bangalow Palm Swamp Forest. Leaf litter elsewhere is of low density, meaning it does not provide a moist leaf litter forest floor within the subject land.

Fragmentation of habitat

Habitat fragmentation refers to the process by which a large, continuous habitat is divided into smaller, isolated patches, often as a result of human activities such as urbanisation, agriculture, and infrastructure development.

The proposal is unlikely to result in a significant increase in fragmentation nor prevent the movement of fauna or restrict flora species from colonising other areas, for the following reasons:

- the nature and scale of impact will not prevent movement of fauna,
- the impacted area will be allowed to fully rehabilitate after construction,
- no fauna species will be excluded from suitable habitat at any time and
- the proposed alignment largely follows existing cleared landscapes with all impacted areas expected to regenerate. Where native vegetation would be impacted, it would not increase the fragmentation of the landscape.

5.1.2 Native vegetation

The alignment passes through areas with varying levels of disturbance including road corridors, agricultural land, historically cleared land and areas associated with existing powerline infrastructure.

Proposed construction types include trenching with a four-metre-wide impact footprint and under boring which impacts surface land at either end of the bore, and associated construction and laydown areas.

The impact to the PCTs recorded in the subject land is described in Table 5-1.

Table 5-1: Native vegetation impacted by the proposal

PCT ID	PCT Name	Vegetation Class	Impact (ha)
0	Not native vegetation	N/A	1.39
X	Planted non-indigenous and exotic vegetation	N/A	0.03
3004	Far North Bangalow Palm Swamp Forest	Subtropical Rainforests	0.03
3988	Far North Mesophyll Paperbark Swamp Forest	Coastal Swamp Forests	0.23
4004	Northern *Melaleuca quinquenervia* Swamp Forest	Coastal Swamp Forests	0.17
		Total area impacted	1.85
		Total impact to native vegetation	**0.43**

No vegetation will be impacted by the proposal within the section of the route that intersects with the mapped coastal wetland.

5.1.3 Threatened Ecological Communities

Two TECs (refer Table 5-2) were determined to be present in the subject land, albeit in a historically disturbed and weedy state. A test of significance has been completed for these two TECs, which determined the impact is unlikely to be significant.

Table 5-2: TECs present in the subject land

Scientific Name	NSW Status	C'wealth Status	Associated PCT within subject land	Hectares within the subject land.
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	Endangered	Not listed	3004	0.03
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	Not listed	3988 4004	0.40

5.1.4 Threatened species

Forty-nine threatened species were identified as potentially being directly impacted by the proposal based on survey and desktop results and the threatened species assessment (Appendix C and Table 5-3).

Tests of significance undertaken (Appendix D) show a significant impact to threatened species from the proposal is considered unlikely.

Wetland habitat, including mapped coastal wetlands communities, other un-mapped low-lying wet areas which would constitute suitable habitat for species including Wallum Froglet, Wallum Sedge Frog would be under bored. Under boring seeks to avoid disturbance of wetland habitat values, hydrological processes and threatened species occupying the wetland areas. Wet areas suitable for breeding for Wallum Froglet, Wallum Sedge Frog were not recorded in the subject land, noting that wet areas would have contained water at the time of the assessment given recent rainfall events (daily rain in the nine days leading up to the assessment totalling 144.6 millimetres).

Table 5-3: Test of significance for threatened species potentially impacted

Scientific name	Common name	NSW Status	EPBC Status	Significant impact
Amphibian				
Crinia tinnula	Wallum Froglet	Vulnerable	Not listed	No
Litoria aurea	Green and Golden Bell Frog	Endangered	Not listed	No
Litoria brevipalmata	Green-thighed Frog	Vulnerable	Not listed	No
Litoria olongburensis	Wallum Sedge Frog	Vulnerable	Vulnerable	No
Mixophyes iteratus	Giant Barred Frog	Vulnerable	Vulnerable	No
Invertebrate				
Argynnis hyperbius	Australian Fritillary	Endangered	Critically Endangered	No
Birds				
Anseranas semipalmata	Magpie Goose	Vulnerable	Not listed	No
Artamus cyanopterus cyanopterus	Dusky Woodswallow	Vulnerable	Not listed	No
Burhinus grallarius	Bush Stone-curlew	Endangered	Not listed	No
Circus assimilis	Spotted Harrier	Vulnerable	Not listed	No
Coracina lineata	Barred Cuckoo-shrike	Vulnerable	Not listed	No
Erythrotriorchis radiatus	Red Goshawk	Endangered	Endangered	No
Falco subniger	Black Falcon	Vulnerable	Not listed	No
Hieraaetus morphnoides	Little Eagle	Vulnerable	Not listed	No
Lophoictinia isura	Square-tailed Kite	Vulnerable	Not listed	No
Ninox connivens	Barking Owl	Vulnerable	Not listed	No
Tyto longimembris	Eastern Grass Owl	Vulnerable	Not listed	No
Tyto novaehollandiae	Masked Owl	Vulnerable	Not listed	No
Reptiles				
Cacophis harriettae	White-crowned Snake	Vulnerable	Not listed	No
Coeranoscincus reticulatus	Three-toed Snake-tooth Skink	Vulnerable	Vulnerable	No
Mammals – bats				
Chalinolobus dwyeri	Large-eared Pied Bat	Vulnerable	Endangered	No

Scientific name	Common name	NSW Status	EPBC Status	Significant impact
Chalinolobus nigrogriseus	Hoary Wattled Bat	Vulnerable	Not listed	No
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Vulnerable	Not listed	No
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	Vulnerable	Not listed	No
Miniopterus australis	Little Bent-winged Bat	Vulnerable	Not listed	No
Miniopterus orianae oceanensis	Large Bent-winged Bat	Vulnerable	Not listed	No
Myotis macropus	Southern Myotis	Vulnerable	Not listed	No
Nyctimene robinsoni	Eastern Tube-nosed Bat	Vulnerable	Not listed	No
Nyctophilus bifax	Eastern Long-eared Bat	Vulnerable	Not listed	No
Ozimops lumsdenae	Northern Free-tailed Bat	Vulnerable	Not listed	No
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable	Vulnerable	No
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Vulnerable	Not listed	No
Scoteanax rueppellii	Greater Broad-nosed Bat	Vulnerable	Not listed	No
Syconycteris australis	Common Blossom-bat	Vulnerable	Not listed	No
Mammals – other than bats				
Aepyprymnus rufescens	Rufous Bettong	Vulnerable	Not listed	No
Cercartetus nanus	Eastern Pygmy-possum	Vulnerable	Not listed	No
Dasyurus maculatus	Spotted-tailed Quoll	Vulnerable	Endangered	No
Petaurus norfolcensis	Squirrel Glider	Vulnerable	Not listed	No
Phascogale tapoatafa	Brush-tailed Phascogale	Vulnerable	Not listed	No
Phascolarctos cinereus	Koala	Endangered	Endangered	No
Planigale maculata	Common Planigale	Vulnerable	Not listed	No
Potorous tridactylus	Long-nosed Potoroo	Vulnerable	Vulnerable	No
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	Vulnerable	Not listed	No
Pseudomys novaehollandiae	New Holland Mouse	Not listed	Vulnerable	No
Plants				
Cryptostylis hunteriana	Leafless Tongue Orchid	Vulnerable	Vulnerable	No
Cynanchum elegans	White-flowered Wax Plant	Endangered	Endangered	No
Elionurus citreus	Lemon-scented Grass	Endangered	Not listed	No
Geodorum densiflorum	Pink Nodding Orchid	Endangered	Not listed	No
Oldenlandia galioides	Sweet False Galium	Endangered	Not listed	No

5.1.5 Migratory species

A significant impact to migratory (birds, reptiles, mammals, sharks) species under the EPBC Act is considered unlikely.

Sixty EPBC listed migratory species were identified on as potentially occurring in the subject land (Appendix B) and have been considered against the significance criteria in Table 5-4.

Table 5-4: Assessment of Significance, listed migratory birds

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	
Criteria	**Response**
I. substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	There is little evidence to suggest that the subject land supports 'important habitat' for migratory species, it would at most likely provide seasonal breeding and feeding grounds. Given their migratory habits, the nature of food and habitat resources and the extent of habitat across their range, it is likely that the existing resources within the subject land would be utilised infrequently and on a transitory basis only. Migratory birds are extremely mobile in nature and have a large feeding area that would not be solely reliant on the habitat provided in the subject land. The lack of proximity of wetlands and marine area to the subject land reduces the likelihood that habitat in the subject land is 'important habitat' for those migratory species dependants on wetlands or marine area. Terrestrial migratory species are unlikely to be impacted.
II. result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or	The local area has a history of habitat modification for rural and urban development, which has benefited a number of feral and invasive flora and fauna species. The proponent will ensure the spread of weeds and feral fauna is not enhanced by the development which will contribute to the overall enhancement of habitat for migratory species.
III. seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	As noted above, the subject land is not considered to be an area of 'important habitat' for migratory birds, whether they are wetland or terrestrial species. It is unlikely migratory birds would rely on habitat in the subject land.

5.1.6 Impact to waterways

The proposal would not result in impact to waterways, or wetland areas. Where these features occur locally, they would be underbored to avoid impact.

5.1.7 Hydrological process and aquatic values

The assessment area contains native vegetation with a potential for groundwater interaction, however, the development is not expected to place any component of groundwater-dependent communities at risk of local extinction. This is due to the following features of this proposal:

- Impact to areas with aquatic habitat values from surface disturbance activities would be avoided by underboring.
- Cross sectional impact of the underbore and subsequent installation of the cable occurs in a closed system, meaning it would not result in interaction between inert drilling materials and the surface water or groundwater systems
- Cross sectional impact of the underbore and subsequent installation of the cable would not obstruct any surface or groundwater movement or alter hydrological processes by stopping or slowing the movement of water, or biological process associated with that water.

- Limited vegetation would be impacted by this proposal (all outside mapped wetland environments) and land disturbed by this proposal would be allowed to naturally revegetate meaning alteration of the hydrological processes is unlikely to occur.
- The proposal would not directly impact any mapped areas of terrestrial or aquatic GDEs. The proposal would not result in changes to groundwater systems.
- Underboring of waterways would be conducted such that vegetation is not disturbed and groundwater processes are not compromised. Standard and project specific safeguards would be employed during construction to ensure inadvertent impact to water quality, water bodies and hydrological processes does not occur, and any incidents such as frac-outs are managed effectively and swiftly.

5.1.8 Soils and drainage

Soils will be disturbed where vegetation removal occurs or on bare earth and in drainage lines from ploughing and / or trenching. Disturbed soils have the potential to move off the alignment and impact waterways if not appropriately managed.

Soil disturbance will be managed using standard processes to avoid long term impacts (Section 6).

Overall, the proposal is not anticipated to impact drainage at the landscape scale.

5.2 Indirect impact

Indirect impacts are those which are not a direct result of the proposal, often produced away from, or as a result of, a complex impact pathway. They can be hard to predict and difficult to manage. Indirect impacts are considered in the following sections and mitigation measures outlined in Section 6.

5.2.1 Erosion and sediment

Erosion and sediment control measures would be implemented as required to prevent movement of sediment off site, and particularly to local waterways. Earth displaced during trenching would be returned to position and restabilised as soon as practicable following installation. Material removed during the under boring process would be disposed of as required.

5.2.2 Acid Sulfate Soils

Presence of Acid Sulfate Soils is possible only in the southern low lying areas of the subject land. It is unlikely to be associated with the basalt derived soils in the northern section of the alignment from the western end of Underbore 1.

Acid sulfate soils would be managed in accordance with an acid sulfate soil management plan developed for the proposal.

5.2.3 Frac-out

Under boring of waterways would be conducted such that vegetation is not disturbed and groundwater processes are not compromised. Standard and project specific safeguards would

be employed during construction to ensure inadvertent impact to water quality, water bodies and hydrological processes does not occur, and any incidents such as frac-outs are managed effectively and swiftly.

Safeguards against and response to frac-out are detailed in the REF.

5.2.4 Key Fish Habitat

The proposed alignment intersects with a small area of Key Fish Habitat (KFH) where it runs close the start of an unnamed tributary of Cudgen Creek.

Earth work proposed within mapped KFH is limited to approximately 0.02 hectares adjacent to Cudgen Road, where the KFH values are very minor, and limited to roadside drain values.

Standard controls and reinstatement of the land following construction would ensure the value of this area to fish habitat is unchanged during and following construction.

5.2.5 Injury to wildlife

Injury to wildlife is unlikely, but possible, during the construction phase of this proposal. Contact with wildlife and suitable habitat will be avoided wherever possible. Local wildlife rescue organisations should be contacted in the event that wildlife requires rescue or removal. Management and mitigation measures have been provided in Chapter 6 to minimise the chance that the proposal will cause injury to threatened species.

5.2.6 Spread of pests, weeds and disease

To minimise the spread of the disease chytridiomycosis to and between habitats, all contractors should not access wetland areas. If they are required to work in wetland areas, they must follow the protocol set out within the publication *Hygiene protocol for the control of disease in frogs* (DECCW & NPWS 2008).

Standard safeguard measures are described in Table 6-1. Section 5.2.6 addresses weed risks and responsibilities further.

5.2.7 Changes to hydrology and groundwater dependent ecosystems

Given the temporary, low impact nature and small area of ground surface disturbance of the development, as well as the small number of shrubs and trees to be removed (outside of wetland areas), it is unlikely this proposal will disturb function of groundwater dependent ecosystems.

The impact footprint will be allowed to naturally regenerate and is likely to do so as demonstrated along existing adjacent infrastructure corridors.

The assessment area contains native vegetation with a potential for groundwater interaction, however, the development is not expected to place any component of groundwater-dependent communities at risk of local extinction. As such, no long-term obstruction or change to surface water flow will occur because of this development.

5.2.8 Noise, light and vibration

Construction noise, light and vibration during construction may disturb fauna or prevent them using habitat in the assessment area. This impact would be short term. Safeguards and mitigation measures have been provided in Section 6.

5.2.9 Operational noise

The construction phase of the proposal will generate moderate levels of noise and vibration, temporarily. Sensitive fauna can remove themselves from the local landscape during the construction phase of the proposal. This impact would be short term. Safeguards and mitigation measures have been provided in Section 6.

5.2.10 Weeds

Inappropriate management of weed control can lead to the dissemination of weeds across the environment and may result in fines for both individuals and organizations engaged in the proposal. Processes such as clearing vegetation, removing and transporting topsoil, importing and exporting soil and mulch, as well as the movement of vehicles, are all activities that could contribute to the spread of weeds.

Below are key pieces of legislation and regulations relevant to weed management in NSW:

Biosecurity Act 2015[16]:

- **Objective:** To provide for the prevention, elimination, minimisation, and management of biosecurity risks.
- **Requirements:** any person who deals with plants has a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. This includes occupiers and/or users of land having a duty to control weeds.
- **Enforcement:** Local control authorities, usually local councils, implement and enforce this Act. Biosecurity Directions and fees can be issued for non-compliance.

Regional Strategic Weed Management Plan: South East Regional Strategic Weed Management Plan[17]

- **Objective** The Plans provide guidance on the outcomes required to discharge the duty for managing weeds under the Biosecurity Act.

Australian Weeds Strategy[18]

- **Objective:** Identifies Weeds of National Significance (WONS) and National Environmental Alert Weeds, focusing on their invasiveness, potential for spread, and impacts.

Biodiversity Conservation Act 2016 (BC Act)

[16] https://www.legislation.gov.au/C2015A00061/2020-03-25/text
[17] https://www.lls.nsw.gov.au/__data/assets/pdf_file/0006/722706/South-East-Regional-Strategic-Weed-Management-Plan-2023-2027.pdf
[18] https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/pests-diseases-weeds/consultation/aws-final.pdf

- **Objective:** Identifies certain weeds as Key Threatening Processes (KTPs), highlighting their impact on biodiversity.

NSW Invasive Species Plan 2023-2028

- The plan adopts four goals for managing invasive species (including weeds):

  a) Exclude – prevent the establishment of new invasive species.

  b) Eradicate or contain – eliminate or prevent the spread of new invasive species.

  c) Effectively manage – reduce the impacts of widespread invasive species.

  d) Capacity building – ensure NSW has the ability and commitment to manage invasive species.

Implications for Project Management

For infrastructure projects in NSW, it is essential to:

- **Comply with Legislation:** Understand and follow the specific requirements of each piece of legislation relevant to weed management.
- **Ensure Qualified Personnel:** Ensure that those applying pesticides are properly trained and qualified, in compliance with the *Pesticides Regulation 2017*.

5.3 Impact on Key Threatening Processes

Key Threatening Processes (KTPs) listed under the BC Act, EPBC Act and FM Act were reviewed in Table 5-5. Six KTPs will be negligibly or possibly exacerbated by the proposal:

- Anthropogenic Climate Change – BC Act
- Clearing of native vegetation – BC Act
- Invasion of native plant communities by exotic perennial grasses – BC Act
- Invasion, establishment and spread of Lantana camara – BC Act
- Land clearance – EPBC Act
- Novel biota and their impact on biodiversity – EPBC Act

Table 5-5: Review of proposed impacts to Key Threatening Processes

KTP	Implication for development
BC Act KTPs	
Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands.	**Unlikely.** The proposal is unlikely to result in a change of landform capable of altering natural flow regimes. Construction methods will avoid major waterways and under bore low lying wetland areas.
Aggressive exclusion of birds from woodland and forest habitat by abundant Noisy Miners *Manorina melanocephala*	**Neutral.** The proposal is unlikely to influence Noisy Miner abundance
Alteration of habitat following subsidence due to longwall mining	**Not applicable**
Anthropogenic Climate Change	**Negligible increase**. The development would result in the negligible loss of a carbon sink consisting of native vegetation. The proposal would generate CO_2 emissions from construction machinery.

KTP	Implication for development
Bushrock Removal	**Neutral.** Bush rock would be left in the immediate vicinity of the subject land if disturbed. Minimal bushrock is present along the proposed alignment.
Clearing of native vegetation	**Minor increase.** The development site would be allowed to fully revegetate post construction.
Competition and grazing by the feral European Rabbit, *Oryctolagus cuniculus* (L.)	**Neutral.** The development is unlikely to influence feral rabbit numbers.
Competition and habitat degradation by Feral Goats, *Capra hircus* Linnaeus 1758	**Neutral.** The development is unlikely to influence feral goat numbers.
Competition from feral honeybees, *Apis mellifera* L.	**Neutral.** The development is unlikely to influence feral bee numbers.
Death or injury to marine species following capture in shark control programs on ocean beaches	**Not applicable**
Entanglement in, or injection of anthropogenic debris in marine and estuarine environments	**Not applicable**
Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners	**Not applicable**
Habitat degradation and loss by Feral Horses (brumbies, wild horses), *Equus caballus* Linnaeus 1758	**Neutral.** The development is unlikely to influence feral horses.
Herbivory and environmental degradation caused by feral deer	**Neutral.** The development is unlikely to influence feral deer numbers.
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	**Neutral.** The development is low impact and is unlikely to result in accidental fire and associated disruption to native vegetation.
Importation of Red Imported Fire Ants *Solenopsis invicta* Buren 1972	**Neutral.** The development is unlikely to increase the abundance of Red Imported Fire Ants.
Infection by Psittacine circoviral (beak and feather) disease affecting endangered psittacine species	**Neutral.** The development is unlikely to influence any part of the beak and feather disease life cycle.
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	**Unlikely but possible.** To minimise the spread of the disease chytridiomycosis to and between habitats, all contractors should not access wetland areas, and if they are required to work in wetland areas they must follow the protocol set out within the publication *Hygiene protocol for the control of disease in frogs* (DECCW & NPWS 2008).
Infection of native plants by *Phytophthora cinnamomi*	**Neutral.** The development is unlikely to result in the introduction or spread of *Phytophthora cinnamomic*. It is not known to occur in the assessment area.
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family *Myrtaceae*	**Neutral.** The development is unlikely to result in the spread of Exotic Rust Fungi. Clearing of native vegetation will be minor. No evidence of rust was noted during the field assessment. Ensuring machinery conducting the work is cleared before and after completing the work will assist with management of this KTP.
Introduction of the Large Earth Bumblebee *Bombus terrestris* (L.)	**Neutral.** The development is unlikely to result in the spread of *Bombus terrestris* as this species is not known to occur in NSW.
Invasion and establishment of exotic vines and scramblers	**Neutral:** The development is unlikely to result in invasion and establishment of exotic vines and scramblers.
Invasion and establishment of Scotch Broom (*Cytisus scoparius*)	**Neutral.** The development is unlikely to result in the invasion and establishment of Scotch Broom.
Invasion and establishment of the Cane Toad	**Neutral.** The development us unlikely to contribute to a change in the invasion and establishment of the Cane Toad.

KTP	Implication for development
Invasion of native plant communities by African Olive *Olea europaea subsp. cuspidata* (Wall. ex G. Don) Cif.	**Neutral.** The proposal is unlikely to result in the invasion and establishment of African Olive as it is not observed during field assessment. Recommended mitigation measures would further minimise the risk
Invasion of native plant communities by *Chrysanthemoides monilifera*	**Neutral.** The proposal is unlikely to result in the importation of Boneseed or Bitou Bush and these species are not known to occur in the assessment area. Recommended mitigation measures would further minimise the risk
Invasion of native plant communities by exotic perennial grasses	**Possible but low risk**. The proposal could enable the invasion and establishment of exotic perennial grasses in disturbed areas. Recommended mitigation measures would further minimise the risk
Invasion of the Yellow Crazy Ant, *Anoplolepis gracilipes* (Fr. Smith) into NSW	**Neutral.** The Yellow Crazy Ant is not known to occur in the assessment area, as they are more likely to occur in Northern Australia.
Invasion, establishment and spread of *Lantana camara*	**Possible but low risk.** The proposal is unlikely to result in the increased likelihood of invasion and establishment of *Lantana camara*. This species was recorded in the study area, under the existing powerline to be decommissioned. This species is spread by birds and given the limited ground disturbance from this proposal, there would not be a notable increase in opportunity for this weed.
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	**Neutral**. The proposal is unlikely to lead to loss of habitat by invasion of escaped garden plants.
Loss and/or degradation of sites used for hill-topping by butterflies	**Not relevant**
Loss of Hollow-bearing Trees	**Neutral** No hollow bearing trees are expected to be impacted by the proposal,
Predation and hybridisation by Feral Dogs, *Canis lupus familiaris*	**Neutra.** The proposal is unlikely to contribute to predation and hybridisation by feral dogs.
Predation by the European Red Fox	**Neutral.** The development is unlikely to influence European red fox numbers.
Predation by the Plague Minnow (*Gambusia holbrooki*)	**Neutral.** The development is unlikely to influence Plague Minnow numbers.
Predation by the Ship Rat (*Rattus rattus*) on Lord Howe Island	**Not relevant**
Predation by feral cats	**Neutral.** The development is unlikely to influence feral cat numbers.
Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* Linnaeus 1758	**Neutral.** The development is unlikely to influence feral pig numbers.
Removal of dead wood and dead trees	**Possible (negligible).** Dead wood and trees disturbed by the proposal are unlikely to be removed from the immediate environment. Recommended mitigation measures further reduce the risk.
FM Act KTPs	
Alteration to the Natural Flow Regimes of Rivers and Streams	**Neutral.** The development is unlikely to influence flow regimes of rivers and streams. Control measures would be followed to prevent alternation of waterways.
Alteration to the Natural Temperature of Rivers and Streams	**Neutral.** The development is unlikely to influence the temperature of rivers and streams.

KTP	Implication for development
Increased Sediment Input to Rivers and Streams Due to Human Activities	**Neutral.** Soil disturbance as a result of the development would be managed to prevent movement of sediment, and the likelihood of active erosion establishing.
Introduction of Live Fish into Waters Outside their Natural Range after 1770	**Neutral.** The development is unlikely to influence introduction of Live Fish into Waters Outside their Natural Range after 1770.
Removal of Large Woody Debris from Rivers and Streams	**Neutral.** The development will not result in removal of large woody debris from rivers and streams.
The Prevention of Passage of Aquatic Biota as a Result of the Presence of Instream Structures	**Neutral.** The development is unlikely to prevent aquatic biota passage.
EPBC Act KTPs	
Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners (*Manorina melanocephala*)	**Neutral.** The development is unlikely to increase exclusion by Noisy Miners.
Competition and land degradation by rabbits	**Neutral.** The development is unlikely to influence feral rabbit numbers.
Competition and land degradation by unmanaged goats	**Neutral.** The development is unlikely to influence feral goat numbers.
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)	**Neutral.** The proposal is unlikely to exacerbate this KTP if mitigation measures are followed.
Fire regimes that cause declines in biodiversity	**Neutral**
Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South	**Not applicable**
Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations	**Not applicable**
Infection of amphibians with chytrid fungus resulting in chytridiomycosis	**Neutral.** The development is unlikely to result in transmission of this fungus.
Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris	**Not applicable**
Invasion of northern Australia by Gamba Grass and other introduced grasses	**Not applicable**
Land clearance	**Negligible increase/Increased temporarily.** The proposal would result in a minor amount of land clearance. The subject land would be allowed to fully revegetate where vegetation currently exists.
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	**Neutral**. The proposal is unlikely to lead to loss of habitat by invasion of escaped garden plants.
Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean	**Not applicable**
Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases	**Neutral.** The proposal is unlikely to result in changes of climatic habitat
Novel biota and their impact on biodiversity	**Potential**. The development is unlikely to influence novel biota numbers. All relevant weeds, invasive species, pathogens will not be exacerbated if mitigation is implemented.
Predation by European red fox	**Neutral.** The development is unlikely to influence European red fox numbers.

KTP	Implication for development
Predation by exotic rats on Australian offshore islands of less than 1000 km2 (100,000 ha)	**Not applicable**
Predation by feral cats	**Neutral.** The development is unlikely to influence feral cat numbers.
Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs	**Neutral.** The development is unlikely to influence feral pig numbers.
Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species	**Neutral.** The development is unlikely to influence any part of the beak and feather disease life cycle.
The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*)	**Neutral. The proposal is unlikely to influence this KTP**
The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, *Solenopsis invicta* (fire ant)	**Neutral.** Fire ants are not known to occur in the assessment area and the development is unlikely to result in the importation of Fire Ants. Control measures would be followed to prevent importation.

5.4 Cumulative impact

While this proposal occurs in a landscape of urbanisation and historic clearing, a range of measures will be taken to avoid, minimise and mitigate potential impacts, and where vegetation would be disturbed, it would be allowed to re-establish. In considering the impacts of the proposal against know of potential future development, cumulative impacts would be low to negligible given the construction methods employed and approach to the powerline installation (i.e., undergrounding).

6 Environmental safeguards and mitigation measures

The proposal has followed the principles of 'avoid, minimise, mitigate' to reduce the impact on local biodiversity values.

6.1 Avoid impact

The following avoidance measures have been made:

- The alignment has been largely located within land previously cleared for agricultural activities and/ or urbanisation.
- Portions of the alignment will be installed by underboring, thereby avoiding impact to vegetation and wetland elements along these sections.
- The proposed alignment has been designed to minimised impact to stands of wooded vegetation.
- Removal of trees and shrubs has been minimised.

6.2 Minimise impact

The following measures have been made to minimise impact to the environment:

- Underboring will be implemented to avoid impact to native vegetation and waterways,
- The alignment follows fire trails and road corridors where possible.

The environmental safeguards in Table 6-1 are proposed to minimise the impact of the development.

Table 6-1: Environmental safeguards

Impact	Environmental safeguards	Responsibility	Timing
General	• Any change in design affecting land outside the subject land assessed in this report will require further ecological survey - notwithstanding minor changes where the ecological values have been assessed for this proposal. • Provide site construction personnel with an induction which includes information about the Wallum Sedge Frog and its habitat, and associated precautions.	Proponent	Pre-construction, construction, operation
Clearing and prevention of over-clearing	• All personnel would be inducted to be aware any stand of native vegetation outside the subject land has legislative consequences if deliberately or accidentally impacted without approval. The extent of the clearing footprint is to be confined to the assessed areas. • No clearing is permitted outside these areas without further assessment • Note the requirements of the Kings Forest Vegetation Management Plan, particularly protocols for vegetation clearing and measures to protect all native vegetation to be retained.	Contractor	Pre-construction
Damage to native vegetation outside of impact zone	• Stockpile and compound sites would be located using the following criteria: ○ At least 40 m away from the nearest waterway ○ In areas of low ecological conservation significance (i.e., previously disturbed land) ○ On relatively level ground	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	○ Outside the one in 10-year Average Recurrence Interval (ARI) floodplain if possible • Stockpiling materials and equipment and parking vehicles would be avoided within the dripline (extent of foliage cover) of any tree.		
Water pollution - fuel, chemical spills and hazardous materials	• Store fuels, chemical and hazardous materials in secure, bunded areas • Control measures will be implemented to manage risks associated with the handling of fuel through using spill trays when undertaking in field re-fuelling	Contractor	Pre-construction and during construction
Introduction and spread of noxious weeds and pathogens	• Essential Energy has a general biosecurity duty under the *Biosecurity Act 2015* to prevent, eliminate or minimise biosecurity risk so far as is reasonably practicable. • Field crews shall follow procedures as outlined in Essential Energy's Operational Guideline: Biosecurity Risk Management (CERM1000.96) to prevent, eliminate or minimise biosecurity risk so far as is reasonably practicable, with particular reference to vehicle and equipment hygiene practises • To minimise the spread of the disease chytridiomycosis to and between habitats, all contractors should not access wetland areas, and if they are required to work in wetland areas they must follow the protocol set out within the publication *Hygiene protocol for the control of disease in frogs* (DECCW & NPWS 2008).	Contractor	Construction
Disturbance to waterways	• Avoid impact to non-perennial waterways if there is flowing water. • Access the waterway in a way that minimises harm to banks or native vegetation. • Keep machinery away from banks of the waterway (where possible). • Do not refuel, store or decant chemicals within 50m of a waterway.	Proponent, contractor	Pre-construction and construction
Fauna management	• No Koala use trees would be impacted by this proposal. All other wooded vegetation should be checked for the presence of Koalas prior to clearing. • Contact a nominated animal rescue agency / wildlife care group (i.e., Friends of the Koala) or veterinarian if an animal is injured. Friends of the Koala may be contacted for fauna other than Koalas. • Report any Koala sightings or incidents to BCSD and TSC. • Report any Wallum Sedge Frog sightings or incidents to BCSD and TSC. • No domestic dogs are to be allowed on the site during pre-construction or construction. • Impacts to Wallum Sedge Frog breeding habitat will be avoided through use of HDD methodology.	Contractor	Construction
Vehicle operation	• Vehicles shall be restricted to a maximum speed of 50kph and shall operate only in daylight hours for the duration of the construction phase.	Contractor	Construction

6.3 Offset impact

No offsetting requirement is triggered by this proposal.

7 Conclusion

The proposal will not result in a significant impact to the ecological values present in the subject land. The impact to listed threatened species, populations or communities recorded or presumed to occur in the subject land was assessed as not significant.

Safeguards and mitigation measures have been provided to minimise harm to the environment. If these are implemented then the proposal is unlikely to have a significant impact to species populations and communities listed under the EPBC, FM, or BC Acts.

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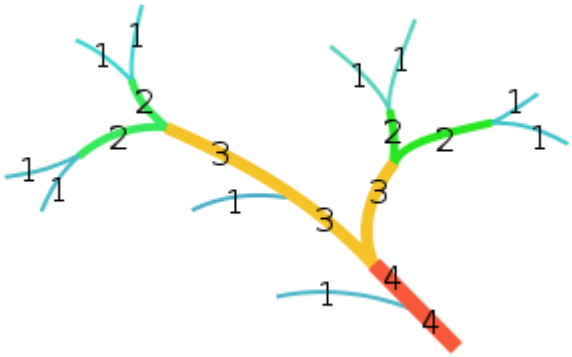
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8 Appendix A: Terms and abbreviations used in this report

Terms and abbreviations used in this report

Abbreviation	Terminology	Description
	Assessment or test of significance	The Assessment of Significance refers to the factors that must be considered by decision makers to assess whether a Proposal is likely to have a significant effect on threatened biodiversity. These mechanisms are contained in s5A of the EP&A Act and s94 of the BC Act.
	Biosecurity	The management of risks to the economy, the environment, and the community of pests and diseases entering, emerging, establishing or spreading
BoM	Australian Bureau of Meteorology	The Bureau of Meteorology is Australia's national weather, climate and water agency.
	Critical habitat	Critical habitat is defined as an area crucial to the survival of an endangered species, population or ecological community. The declaration of critical habitat provides greater protection and stricter controls over activities in the area.
	Cumulative impacts	Impacts, when considered together, lead to a stronger impact than any impact in isolation.
Subject land		Encompasses all land which the Development Consent will apply to. This is the area to be impacted by the development and is the focus of this report.
	Direct impacts	Directly affect the habitat and individuals. They include, but are not limited to, death through predation, trampling, poisoning of the animal/plant itself and the removal of suitable habitat. When applying each factor, consideration must be given to all of the likely direct impacts of the proposed activity or development.
DCCEEW	Department of Climate Change, Energy, and the Environment	The DCCEE protects Australia's natural environment and heritage sites as well as help Australia respond to climate change and carefully manage our water and energy resources.
EEC	Endangered Ecological Community	An ecological community identified by relevant legislation likely to become extinct or is in immediate danger of extinction.
	Environment	The environment includes all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings.
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).	Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process.
GDA	Geocentric Datum of Australia	The Geocentric Datum of Australia (GDA) is the latest Australian coordinate system, replacing the Australian Geodetic Datum (AGD). The GDA is a part of a global coordinate reference frame and is directly compatible with the Global Navigation Satellite Systems.
GDE	Groundwater Dependent Ecosystems	Six types of groundwater dependent ecosystems are conventionally recognised in Australia: Terrestrial vegetation relies on the availability of shallow groundwater. Wetlands such as paperbark swamp forests and mound springs ecosystems. River base flow systems where a groundwater discharge provides a base flow component to the river's discharge. Aquifer and cave ecosystems where life exists independent of sunlight Terrestrial fauna, both native and introduced, dependant on groundwater as a source of drinking water. Estuarine and near shore marine systems, such as some coastal mangroves, salt marshes and sea grass beds, which rely on the submarine discharge of groundwater.
	Habitat	The area occupied, or periodically or occasionally occupied, by any threatened species, population or ecological community and includes all

Abbreviation	Terminology	Description
		the different aspects (both biotic and abiotic) used by species during the different stages of their life cycles.
IBRA	Interim Biogeographic Regionalisation of Australia	The Interim Biogeographic Regionalisation for Australia (IBRA) is a biogeographic regionalisation of Australia developed by the Australian Government's Department of the Environment. Each region is a land area made up of a group of interacting ecosystems repeated in similar form across the landscape.
	Indirect impacts	Occur when project-related activities affect species, populations or ecological communities in a manner other than direct loss. Indirect impacts can include loss of individuals through starvation, exposure, predation by domestic and/or feral animals, loss of breeding opportunities, loss of shade/shelter, deleterious hydrological changes, increased soil salinity, erosion, inhibition of nitrogen fixation, weed invasion, fertiliser drift, or increased human activity within or directly adjacent to sensitive habitat areas. As with direct impacts, consideration must be given, when applying each factor, to all of the likely indirect impacts of the proposed activity or development.
KTP	Key Threatening Process	A key threatening process is defined as a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. A requirement of their listing on the Act is that the process adversely affects two or more threatened species, populations or ecological communities, or may cause species, populations or ecological communities not threatened to become threatened.
LGA	Local Government Area	The relevant LGA is Governed by Council who are the determining authority for this development application.
	Local population	The population occurs in the assessment area. The assessment of the local population may be extended to include individuals beyond the assessment area if it can be clearly demonstrated contiguous or interconnecting parts of the population continue beyond the assessment area. The local population of a threatened plant species comprises those individuals occurring in the assessment area, or the cluster of individuals extend into habitat adjoining and contiguous with the assessment area could reasonably be expected to be cross-pollinating with those in the assessment area. The local population of resident fauna species comprises those individuals known or likely to occur in the assessment area, as well as any individuals occurring in adjoining areas (contiguous or otherwise) are known or likely to utilise habitats in the assessment area. The local population of migratory or nomadic fauna species comprises those individuals likely to occur in the assessment area from time to time.
	Local population (EEC)	The ecological community present within the assessment area. However, the local occurrence may include adjacent areas if the ecological community on the assessment area forms part of a larger contiguous area of the ecological community and the movement of individuals and exchange of genetic material across the boundary of the assessment area can be clearly demonstrated.
MNES	Matters of national environmental significance.	Refers to the seven matters of national environmental significance outlined under the EPBC Act.
RAMSAR	Convention on Wetlands of International Importance	The Ramsar Convention's broad aims are to halt the worldwide loss of wetlands and to conserve, through wise use and management, those remaining. This requires international cooperation, policy making, capacity building and technology transfer.
	Significant impact	A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity.
	Assessment area	Assessment area means the subject land and any additional areas which are likely to be affected by the Proposal, either directly or indirectly. The assessment area should extend as far as is necessary to take all potential impacts into account.

Abbreviation	Terminology	Description
	Strahler stream order	Strahler stream order and are used to define stream size based on a hierarchy of tributaries. 
WoNS	Weeds of National Significance	A weed that has been identified as nationally significant based on its impact, feasibility of management and for which there is a clear rationale for why management would benefit from national coordination.

9 Appendix B: Database search results

IBRA subregion predicted threatened species and communities search in the Burringbar-Conondale Ranges IBRA subregion.

Scientific Name	Common Name	Type Of Species	NSW Status
Assa darlingtoni	Pouched Frog	Animal>Amphibians	Vulnerable
Crinia tinnula	Wallum Froglet	Animal>Amphibians	Vulnerable
Litoria aurea	Green and Golden Bell Frog	Animal>Amphibians	Endangered
Litoria brevipalmata	Green-thighed Frog	Animal>Amphibians	Vulnerable
Litoria olongburensis	Wallum Sedge (Olongburra) Frog	Animal>Amphibians	Vulnerable
Mixophyes fleayi	Fleay's Barred Frog	Animal>Amphibians	Endangered
Mixophyes iteratus	Giant Barred Frog	Animal>Amphibians	Vulnerable
Chalinolobus dwyeri	Large-eared Pied Bat	Animal>Bats	Endangered
Chalinolobus nigrogriseus	Hoary Wattled Bat	Animal>Bats	Vulnerable
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Animal>Bats	Vulnerable
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	Animal>Bats	Vulnerable
Miniopterus australis	Little Bent-winged Bat	Animal>Bats	Vulnerable
Miniopterus orianae oceanensis	Large Bent-winged Bat	Animal>Bats	Vulnerable
Myotis macropus	Southern Myotis	Animal>Bats	Vulnerable
Nyctimene robinsoni	Eastern Tube-nosed Bat	Animal>Bats	Vulnerable
Nyctophilus bifax	Eastern Long-eared Bat	Animal>Bats	Vulnerable
Ozimops lumsdenae	Northern Free-tailed Bat	Animal>Bats	Vulnerable
Pteropus poliocephalus	Grey-headed Flying-fox	Animal>Bats	Vulnerable
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Animal>Bats	Vulnerable
Scoteanax rueppellii	Greater Broad-nosed Bat	Animal>Bats	Vulnerable
Syconycteris australis	Common Blossom-bat	Animal>Bats	Vulnerable
Amaurornis moluccana	Pale-vented Bush-hen	Animal>Birds	Vulnerable
Anseranas semipalmata	Magpie Goose	Animal>Birds	Vulnerable
Anthochaera phrygia	Regent Honeyeater	Animal>Birds	Critically Endangered
Ardenna carneipes	Flesh-footed Shearwater	Animal>Birds	Vulnerable
Artamus cyanopterus cyanopterus	Dusky Woodswallow	Animal>Birds	Vulnerable
Botaurus poiciloptilus	Australasian Bittern	Animal>Birds	Endangered
Burhinus grallarius	Bush Stone-curlew	Animal>Birds	Endangered
Calidris alba	Sanderling	Animal>Birds	Vulnerable
Calidris ferruginea	Curlew Sandpiper	Animal>Birds	Critically Endangered
Calidris tenuirostris	Great Knot	Animal>Birds	Vulnerable
Calyptorhynchus banksii banksii	Red-tailed Black-Cockatoo (coastal subspecies)	Animal>Birds	Critically Endangered
Calyptorhynchus lathami lathami	South-eastern Glossy Black-Cockatoo	Animal>Birds	Vulnerable
Carterornis leucotis	White-eared Monarch	Animal>Birds	Vulnerable
Charadrius leschenaultii	Greater Sand-plover	Animal>Birds	Vulnerable
Charadrius mongolus	Lesser Sand-plover	Animal>Birds	Vulnerable
Chthonicola sagittata	Speckled Warbler	Animal>Birds	Vulnerable
Circus assimilis	Spotted Harrier	Animal>Birds	Vulnerable
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	Animal>Birds	Vulnerable

Scientific Name	Common Name	Type Of Species	NSW Status
Coracina lineata	Barred Cuckoo-shrike	Animal>Birds	Vulnerable
Cyclopsitta diophthalma coxeni	Coxen's Fig-Parrot	Animal>Birds	Critically Endangered
Daphoenositta chrysoptera	Varied Sittella	Animal>Birds	Vulnerable
Dromaius novaehollandiae - endangered population	Emu population in the New South Wales North Coast Bioregion and Port Stephens local government area	Animal>Birds	Endangered Population
Ephippiorhynchus asiaticus	Black-necked Stork	Animal>Birds	Endangered
Erythrotriorchis radiatus	Red Goshawk	Animal>Birds	Endangered
Esacus magnirostris	Beach Stone-curlew	Animal>Birds	Critically Endangered
Falco subniger	Black Falcon	Animal>Birds	Vulnerable
Gallinago hardwickii	Latham's Snipe	Animal>Birds	Vulnerable
Glossopsitta pusilla	Little Lorikeet	Animal>Birds	Vulnerable
Grus rubicunda	Brolga	Animal>Birds	Vulnerable
Gygis alba	White Tern	Animal>Birds	Vulnerable
Haematopus fuliginosus	Sooty Oystercatcher	Animal>Birds	Vulnerable
Haematopus longirostris	Pied Oystercatcher	Animal>Birds	Endangered
Haliaeetus leucogaster	White-bellied Sea-Eagle	Animal>Birds	Vulnerable
Hieraaetus morphnoides	Little Eagle	Animal>Birds	Vulnerable
Hirundapus caudacutus	White-throated Needletail	Animal>Birds	Vulnerable
Irediparra gallinacea	Comb-crested Jacana	Animal>Birds	Vulnerable
Ixobrychus flavicollis	Black Bittern	Animal>Birds	Vulnerable
Lathamus discolor	Swift Parrot	Animal>Birds	Endangered
Lichenostomus fasciogularis	Mangrove Honeyeater	Animal>Birds	Vulnerable
Limicola falcinellus	Broad-billed Sandpiper	Animal>Birds	Vulnerable
Limosa limosa	Black-tailed Godwit	Animal>Birds	Vulnerable
Lophoictinia isura	Square-tailed Kite	Animal>Birds	Vulnerable
Macronectes giganteus	Southern Giant Petrel	Animal>Birds	Endangered
Macronectes halli	Northern Giant-Petrel	Animal>Birds	Vulnerable
Menura alberti	Albert's Lyrebird	Animal>Birds	Vulnerable
Ninox connivens	Barking Owl	Animal>Birds	Vulnerable
Ninox strenua	Powerful Owl	Animal>Birds	Vulnerable
Onychoprion fuscata	Sooty Tern	Animal>Birds	Vulnerable
Oxyura australis	Blue-billed Duck	Animal>Birds	Vulnerable
Pachycephala olivacea	Olive Whistler	Animal>Birds	Vulnerable
Pandion cristatus	Eastern Osprey	Animal>Birds	Vulnerable
Petroica boodang	Scarlet Robin	Animal>Birds	Vulnerable
Petroica phoenicea	Flame Robin	Animal>Birds	Vulnerable
Phaethon rubricauda	Red-tailed Tropicbird	Animal>Birds	Vulnerable
Podargus ocellatus	Marbled Frogmouth	Animal>Birds	Vulnerable
Pterodroma leucoptera leucoptera	Gould's Petrel	Animal>Birds	Vulnerable
Pterodroma neglecta neglecta	Kermadec Petrel (west Pacific subspecies)	Animal>Birds	Vulnerable
Pterodroma nigripennis	Black-winged Petrel	Animal>Birds	Vulnerable
Ptilinopus magnificus	Wompoo Fruit-Dove	Animal>Birds	Vulnerable
Ptilinopus regina	Rose-crowned Fruit-Dove	Animal>Birds	Vulnerable
Ptilinopus superbus	Superb Fruit-Dove	Animal>Birds	Vulnerable

Scientific Name	Common Name	Type Of Species	NSW Status
Rostratula australis	Australian Painted Snipe	Animal>Birds	Endangered
Sternula albifrons	Little Tern	Animal>Birds	Endangered
Stictonetta naevosa	Freckled Duck	Animal>Birds	Vulnerable
Todiramphus chloris	Collared Kingfisher	Animal>Birds	Vulnerable
Tyto longimembris	Eastern Grass Owl	Animal>Birds	Vulnerable
Tyto novaehollandiae	Masked Owl	Animal>Birds	Vulnerable
Tyto tenebricosa	Sooty Owl	Animal>Birds	Vulnerable
Xenus cinereus	Terek Sandpiper	Animal>Birds	Vulnerable
Argynnis hyperbius	Australian Fritillary	Animal>Invertebrates	Endangered
Petalura litorea	Coastal Petaltail	Animal>Invertebrates	Endangered
Phyllodes imperialis southern subspecies	Southern Pink Underwing Moth	Animal>Invertebrates	Endangered
Thersites mitchellae	Mitchell's Rainforest Snail	Animal>Invertebrates	Endangered
Arctocephalus forsteri	New Zealand Fur-seal	Animal>Marine Mammals	Vulnerable
Arctocephalus pusillus doriferus	Australian Fur-seal	Animal>Marine Mammals	Vulnerable
Dugong dugon	Dugong	Animal>Marine Mammals	Endangered
Aepyprymnus rufescens	Rufous Bettong	Animal>Marsupials	Vulnerable
Cercartetus nanus	Eastern Pygmy-possum	Animal>Marsupials	Vulnerable
Dasyurus maculatus	Spotted-tailed Quoll	Animal>Marsupials	Vulnerable
Petauroides volans	Southern Greater Glider	Animal>Marsupials	Endangered
Petaurus australis	Yellow-bellied Glider	Animal>Marsupials	Vulnerable
Petaurus norfolcensis	Squirrel Glider	Animal>Marsupials	Vulnerable
Phascogale tapoatafa	Brush-tailed Phascogale	Animal>Marsupials	Vulnerable
Phascolarctos cinereus	Koala	Animal>Marsupials	Endangered
Planigale maculata	Common Planigale	Animal>Marsupials	Vulnerable
Potorous tridactylus	Long-nosed Potoroo	Animal>Marsupials	Vulnerable
Potorous tridactylus - endangered population	Long-nosed Potoroo, Cobaki Lakes and Tweed Heads West population	Animal>Marsupials	Endangered Population
Thylogale stigmatica	Red-legged Pademelon	Animal>Marsupials	Vulnerable
Cacophis harriettae	White-crowned Snake	Animal>Reptiles	Vulnerable
Caretta caretta	Loggerhead Turtle	Animal>Reptiles	Endangered
Chelonia mydas	Green Turtle	Animal>Reptiles	Vulnerable
Coeranoscincus reticulatus	Three-toed Snake-tooth Skink	Animal>Reptiles	Vulnerable
Dermochelys coriacea	Leatherback Turtle	Animal>Reptiles	Endangered
Hoplocephalus bitorquatus	Pale-headed Snake	Animal>Reptiles	Vulnerable
Hoplocephalus stephensii	Stephens' Banded Snake	Animal>Reptiles	Vulnerable
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	Animal>Rodents	Vulnerable
Byron Bay Dwarf Graminoid Clay Heath Community		Community>Threatened Ecological Communities	Endangered Ecological Community
Coastal Cypress Pine Forest in the New South Wales North Coast Bioregion		Community>Threatened Ecological Communities	Endangered Ecological Community
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		Community>Threatened Ecological Communities	Endangered Ecological Community
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		Community>Threatened Ecological Communities	Endangered Ecological Community

Scientific Name	Common Name	Type Of Species	NSW Status
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		Community>Threatened Ecological Communities	Endangered Ecological Community
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions		Community>Threatened Ecological Communities	Endangered Ecological Community
Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion		Community>Threatened Ecological Communities	Endangered Ecological Community
Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion		Community>Threatened Ecological Communities	Endangered Ecological Community
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		Community>Threatened Ecological Communities	Endangered Ecological Community
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		Community>Threatened Ecological Communities	Endangered Ecological Community
Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions		Community>Threatened Ecological Communities	Endangered Ecological Community
Hygrocybe rubronivea	Hygrocybe rubronivea	Fungi>Fungi	Vulnerable
Cynanchum elegans	White-flowered Wax Plant	Plant>Epiphytes and Climbers	Endangered
Marsdenia longiloba	Slender Marsdenia	Plant>Epiphytes and Climbers	Endangered
Tinospora tinosporoides	Arrow-head Vine	Plant>Epiphytes and Climbers	Vulnerable
Tylophora woollsii	Cryptic Forest Twiner	Plant>Epiphytes and Climbers	Endangered
Angiopteris evecta	Giant Fern	Plant>Ferns and Cycads	Endangered
Belvisia mucronata	Needle-leaf Fern	Plant>Ferns and Cycads	Endangered
Drynaria rigidula	Basket Fern	Plant>Ferns and Cycads	Endangered
Lindsaea brachypoda	Short-footed Screw Fern	Plant>Ferns and Cycads	Endangered
Lindsaea fraseri	Fraser's Screw Fern	Plant>Ferns and Cycads	Endangered
Arthraxon hispidus	Hairy Jointgrass	Plant>Herbs and Forbs	Vulnerable
Centranthera cochinchinensis	Swamp Foxglove	Plant>Herbs and Forbs	Endangered
Chamaesyce psammogeton	Sand Spurge	Plant>Herbs and Forbs	Endangered
Cyperus aquatilis	Water Nutgrass	Plant>Herbs and Forbs	Endangered
Cyperus semifertilis	Missionary Nutgrass	Plant>Herbs and Forbs	Endangered
Doryanthes palmeri	Giant Spear Lily	Plant>Herbs and Forbs	Vulnerable
Eleocharis tetraquetra	Square-stemmed Spike-rush	Plant>Herbs and Forbs	Endangered
Elionurus citreus	Lemon-scented Grass	Plant>Herbs and Forbs	Endangered
Harnieria hygrophiloides	Native Justicia	Plant>Herbs and Forbs	Endangered
Isoglossa eranthemoides	Isoglossa	Plant>Herbs and Forbs	Endangered
Maundia triglochinoides	Maundia triglochinoides	Plant>Herbs and Forbs	Vulnerable
Oldenlandia galioides	Sweet False Galium	Plant>Herbs and Forbs	Endangered
Rhynchosia acuminatissima	Pointed Trefoil	Plant>Herbs and Forbs	Vulnerable
Rotala tripartita	Rotala tripartita	Plant>Herbs and Forbs	Endangered
Thesium australe	Austral Toadflax	Plant>Herbs and Forbs	Vulnerable
Wahlenbergia scopulicola	Rock-face Bluebell	Plant>Herbs and Forbs	Endangered
Dendrobium melaleucaphilum	Spider orchid	Plant>Orchids	Endangered
Diuris byronensis	Byron Bay Diuris	Plant>Orchids	Endangered

Scientific Name	Common Name	Type Of Species	NSW Status
Geodorum densiflorum	Pink Nodding Orchid	Plant>Orchids	Endangered
Oberonia complanata	Yellow-flowered King of the Fairies	Plant>Orchids	Endangered
Oberonia titania	Red-flowered King of the Fairies	Plant>Orchids	Vulnerable
Peristeranthus hillii	Brown Fairy-chain Orchid	Plant>Orchids	Vulnerable
Phaius australis	Southern Swamp Orchid	Plant>Orchids	Endangered
Pterostylis nigricans	Dark Greenhood	Plant>Orchids	Vulnerable
Sarcochilus fitzgeraldii	Ravine Orchid	Plant>Orchids	Vulnerable
Sarcochilus hartmannii	Hartman's Sarcochilus	Plant>Orchids	Vulnerable
Sarcochilus weinthalii	Blotched Sarcochilus	Plant>Orchids	Vulnerable
Acalypha eremorum	Acalypha	Plant>Shrubs	Endangered
Allocasuarina defungens	Dwarf Heath Casuarina	Plant>Shrubs	Endangered
Caesalpinia bonduc	Knicker Nut	Plant>Shrubs	Endangered
Corokia whiteana	Corokia	Plant>Shrubs	Endangered
Dendrocnide moroides	Gympie Stinger	Plant>Shrubs	Endangered
Desmodium acanthocladum	Thorny Pea	Plant>Shrubs	Vulnerable
Fontainea australis	Southern Fontainea	Plant>Shrubs	Vulnerable
Gossia fragrantissima	Sweet Myrtle	Plant>Shrubs	Endangered
Myrsine richmondensis	Ripple-leaf Muttonwood	Plant>Shrubs	Endangered
Ozothamnus vagans	Wallumbin Dogwood	Plant>Shrubs	Endangered
Phyllanthus microcladus	Brush Sauropus	Plant>Shrubs	Endangered
Pomaderris notata	McPherson Range Pomaderris	Plant>Shrubs	Vulnerable
Pultenaea maritima	Coast Headland Pea	Plant>Shrubs	Vulnerable
Randia moorei	Spiny Gardenia	Plant>Shrubs	Endangered
Rhodamnia maideniana	Smooth Scrub Turpentine	Plant>Shrubs	Critically Endangered
Rhodamnia rubescens	Scrub Turpentine	Plant>Shrubs	Critically Endangered
Rhodomyrtus psidioides	Native Guava	Plant>Shrubs	Critically Endangered
Senna acclinis	Rainforest Cassia	Plant>Shrubs	Endangered
Sophora fraseri	Brush Sophora	Plant>Shrubs	Vulnerable
Sophora tomentosa	Silverbush	Plant>Shrubs	Endangered
Symplocos baeuerlenii	Small-leaved Hazelwood	Plant>Shrubs	Vulnerable
Xylosma terrae-reginae	Queensland Xylosma	Plant>Shrubs	Endangered
Acacia bakeri	Marblewood	Plant>Trees	Vulnerable
Acronychia littoralis	Scented Acronychia	Plant>Trees	Endangered
Archidendron hendersonii	White Lace Flower	Plant>Trees	Vulnerable
Backhousia subargentea	Giant Ironwood	Plant>Trees	Endangered
Bosistoa transversa	Yellow Satinheart	Plant>Trees	Vulnerable
Cassia marksiana	Cassia marksiana	Plant>Trees	Endangered
Coatesia paniculata	Axe-Breaker	Plant>Trees	Endangered
Cryptocarya foetida	Stinking Cryptocarya	Plant>Trees	Vulnerable
Cupaniopsis serrata	Smooth Tuckeroo	Plant>Trees	Endangered
Davidsonia jerseyana	Davidson's Plum	Plant>Trees	Endangered
Davidsonia johnsonii	Smooth Davidson's Plum	Plant>Trees	Endangered
Diospyros mabacea	Red-fruited Ebony	Plant>Trees	Endangered
Diospyros yandina	Shiny-leaved Ebony	Plant>Trees	Endangered
Diploglottis campbellii	Small-leaved Tamarind	Plant>Trees	Endangered

Scientific Name	Common Name	Type Of Species	NSW Status
Eidothea hardeniana	Nightcap Oak	Plant>Trees	Endangered
Elaeocarpus sedentarius	Minyon Quandong	Plant>Trees	Endangered
Elaeocarpus williamsianus	Hairy Quandong	Plant>Trees	Endangered
Endiandra floydii	Crystal Creek Walnut	Plant>Trees	Endangered
Endiandra hayesii	Rusty Rose Walnut	Plant>Trees	Vulnerable
Endiandra muelleri subsp. bracteata	Green-leaved Rose Walnut	Plant>Trees	Endangered
Floydia praealta	Ball Nut	Plant>Trees	Vulnerable
Grevillea hilliana	White Yiel Yiel	Plant>Trees	Endangered
Hicksbeachia pinnatifolia	Red Boppel Nut	Plant>Trees	Vulnerable
Lepiderema pulchella	Fine-leaved Tuckeroo	Plant>Trees	Vulnerable
Macadamia tetraphylla	Rough-shelled Bush Nut	Plant>Trees	Vulnerable
Melicope vitiflora	Coast Euodia	Plant>Trees	Endangered
Niemeyera chartacea	Smooth-leaved Plum	Plant>Trees	Endangered
Niemeyera whitei	Rusty Plum, Plum Boxwood	Plant>Trees	Vulnerable
Ochrosia moorei	Southern Ochrosia	Plant>Trees	Endangered
Owenia cepiodora	Onion Cedar	Plant>Trees	Vulnerable
Syzygium hodgkinsoniae	Red Lilly Pilly	Plant>Trees	Vulnerable
Syzygium moorei	Durobby	Plant>Trees	Vulnerable
Triflorensia cameronii	Cameron's Tarenna	Plant>Trees	Endangered
Uromyrtus australis	Peach Myrtle	Plant>Trees	Endangered

Australian Government
Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 28-Jun-2024

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	103
Listed Migratory Species:	60

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	91
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	1
Regional Forest Agreements:	1
Nationally Important Wetlands:	1
EPBC Act Referrals:	10
Key Ecological Features (Marine):	None
Biologically Important Areas:	5
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community likely to occur within area
Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland	Endangered	Community likely to occur within area
Lowland Rainforest of Subtropical Australia	Critically Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Subtropical eucalypt floodplain forest and woodland of the New South Wales North Coast and South East Queensland bioregions	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calyptorhynchus lathami lathami South-eastern Glossy Black-Cockatoo [67036]	Vulnerable	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Climacteris picumnus victoriae Brown Treecreeper (south-eastern) [67062]	Vulnerable	Species or species habitat may occur within area
Cyclopsitta diophthalma coxeni Coxen's Fig-Parrot [59714]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Species or species habitat may occur within area
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat may occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western) [64450]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Stagonopleura guttata Diamond Firetail [59398]	Vulnerable	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area
Turnix melanogaster Black-breasted Button-quail [923]	Vulnerable	Species or species habitat may occur within area
FISH		
Epinephelus daemelii Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat may occur within area
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]	Endangered	Species or species habitat likely to occur within area
Seriolella brama Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
Thunnus maccoyii Southern Bluefin Tuna [69402]	Conservation Dependent	Species or species habitat known to occur within area
FROG		
Litoria olongburensis Wallum Sedge Frog [1821]	Vulnerable	Species or species habitat known to occur within area
Mixophyes fleayi Fleay's Frog [25960]	Endangered	Species or species habitat likely to occur within area
INSECT		
Argynnis hyperbius inconstans Australian Fritillary [88056]	Critically Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Phyllodes imperialis smithersi		
Pink Underwing Moth [86084]	Endangered	Species or species habitat may occur within area
MAMMAL		
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat may occur within area
Chalinolobus dwyeri		
Large-eared Pied Bat, Large Pied Bat [183]	Endangered	Species or species habitat may occur within area
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat likely to occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Petauroides volans		
Greater Glider (southern and central) [254]	Endangered	Species or species habitat known to occur within area
Petaurus australis australis		
Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat known to occur within area
Potorous tridactylus tridactylus		
Long-nosed Potoroo (northern) [66645]	Vulnerable	Species or species habitat known to occur within area
Pseudomys novaehollandiae		
New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Xeromys myoides		
Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat may occur within area
PLANT		
Acronychia littoralis		
Scented Acronychia [8582]	Endangered	Species or species habitat known to occur within area
Arthraxon hispidus		
Hairy-joint Grass [9338]	Vulnerable	Species or species habitat likely to occur within area
Baloghia marmorata		
Marbled Balogia, Jointed Baloghia [8463]	Vulnerable	Species or species habitat likely to occur within area
Bosistoa transversa		
Three-leaved Bosistoa, Yellow Satinheart [16091]	Vulnerable	Species or species habitat likely to occur within area
Cryptocarya foetida		
Stinking Cryptocarya, Stinking Laurel [11976]	Vulnerable	Species or species habitat known to occur within area
Cryptostylis hunteriana		
Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat may occur within area
Cynanchum elegans		
White-flowered Wax Plant [12533]	Endangered	Species or species habitat may occur within area
Davidsonia johnsonii		
Smooth Davidsonia, Smooth Davidson's Plum, Small-leaved Davidson's Plum [67178]	Endangered	Species or species habitat may occur within area
Diospyros mabacea		
Red-fruited Ebony, Silky Persimmon, Ebony [18548]	Endangered	Species or species habitat likely to occur within area
Diploglottis campbellii		
Small-leaved Tamarind [21484]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Endiandra floydii Floyd's Walnut, Crystal Creek Walnut [52955]	Endangered	Species or species habitat likely to occur within area
Endiandra hayesii Rusty Rose Walnut, Velvet Laurel [13866]	Vulnerable	Species or species habitat likely to occur within area
Fontainea australis Southern Fontainea [24037]	Vulnerable	Species or species habitat may occur within area
Gossia fragrantissima Sweet Myrtle, Small-leaved Myrtle [78867]	Endangered	Species or species habitat may occur within area
Hicksbeachia pinnatifolia Monkey Nut, Bopple Nut, Red Bopple, Red Bopple Nut, Red Nut, Beef Nut, Red Apple Nut, Red Boppel Nut, Ivory Silky Oak [21189]	Vulnerable	Species or species habitat may occur within area
Leichhardtia longiloba listed as Marsdenia longiloba Clear Milkvine [91911]	Vulnerable	Species or species habitat likely to occur within area
Macadamia integrifolia Macadamia Nut, Queensland Nut Tree, Smooth-shelled Macadamia, Bush Nut, Nut Oak [7326]	Vulnerable	Species or species habitat may occur within area
Macadamia tetraphylla Rough-shelled Bush Nut, Macadamia Nut, Rough-shelled Macadamia, Rough-leaved Queensland Nut [6581]	Vulnerable	Species or species habitat likely to occur within area
Ochrosia moorei Southern Ochrosia [11350]	Endangered	Species or species habitat likely to occur within area
Owenia cepiodora Onionwood, Bog Onion, Onion Cedar [11344]	Vulnerable	Species or species habitat may occur within area
Pedleya acanthoclada listed as Desmodium acanthocladum Thorny Pea [93275]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Phaius australis Lesser Swamp-orchid [5872]	Endangered	Species or species habitat known to occur within area
Randia moorei Spiny Gardenia [10577]	Endangered	Species or species habitat likely to occur within area
Rhodamnia maideniana Smooth Scrub Turpentine [20665]	Critically Endangered	Species or species habitat known to occur within area
Rhodamnia rubescens Scrub Turpentine, Brown Malletwood [15763]	Critically Endangered	Species or species habitat likely to occur within area
Rhodomyrtus psidioides Native Guava [19162]	Critically Endangered	Species or species habitat likely to occur within area
Sophora fraseri [8836]	Vulnerable	Species or species habitat may occur within area
Syzygium hodgkinsoniae Smooth-bark Rose Apple, Red Lilly Pilly [3539]	Vulnerable	Species or species habitat likely to occur within area
Syzygium moorei Rose Apple, Coolamon, Robby, Durobby, Watermelon Tree, Coolamon Rose Apple [12284]	Vulnerable	Species or species habitat known to occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat likely to occur within area
Vincetoxicum woollsii listed as Tylophora woollsii [40080]	Endangered	Species or species habitat may occur within area
REPTILE		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Delma torquata		
Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Furina dunmalli		
Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
SHARK		
Carcharias taurus (east coast population)		
Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Galeorhinus galeus		
School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Sphyrna lewini		
Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area
SNAIL		
Thersites mitchellae		
Mitchell's Rainforest Snail [66774]	Critically Endangered	Species or species habitat known to occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea		
Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat known to occur within area
Diomedea antipodensis		
Antipodean Albatross [64458]	Vulnerable	Species or species habitat may occur within area
Diomedea epomophora		
Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans		
Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche salvini		
Salvin's Albatross [64463]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		
Balaenoptera edeni		
Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat may occur within area
Carcharhinus longimanus		
Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Eubalaena australis as Balaena glacialis australis		
Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat may occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa sahulensis as Sousa chinensis Australian Humpback Dolphin [87942]		Foraging, feeding or related behaviour likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Symposiachrus trivirgatus as Monarcha trivirgatus Spectacled Monarch [83946]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat likely to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Charadrius leschenaultii		
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area overfly marine area
Diomedea antipodensis		
Antipodean Albatross [64458]	Vulnerable	Species or species habitat may occur within area
Diomedea antipodensis gibsoni as Diomedea gibsoni		
Gibson's Albatross [82270]	Vulnerable	Species or species habitat may occur within area
Diomedea epomophora		
Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans		
Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor		
Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Gallinago megala		
Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area
Gallinago stenura		
Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area overfly marine area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma cervicalis White-necked Petrel [59642]		Species or species habitat may occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area
Sterna striata White-fronted Tern [799]		Foraging, feeding or related behaviour likely to occur within area
Sternula albifrons as Sterna albifrons Little Tern [82849]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Symposiachrus trivirgatus as Monarcha trivirgatus		
Spectacled Monarch [83946]		Species or species habitat known to occur within area overfly marine area
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini		
Salvin's Albatross [64463]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area overfly marine area
Fish		
Acentronura tentaculata		
Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area
Campichthys tryoni		
Tryon's Pipefish [66193]		Species or species habitat may occur within area
Corythoichthys amplexus		
Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Corythoichthys ocellatus Orange-spotted Pipefish, Ocellated Pipefish [66203]		Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish [66229]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus kelloggi Kellogg's Seahorse, Great Seahorse [66723]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]	Endangered	Species or species habitat likely to occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Micrognathus andersonii Anderson's Pipefish, Shortnose Pipefish [66253]		Species or species habitat may occur within area
Micrognathus brevirostris thorntail Pipefish, Thorn-tailed Pipefish [66254]		Species or species habitat may occur within area
Microphis manadensis Manado Pipefish, Manado River Pipefish [66258]		Species or species habitat may occur within area
Solegnathus dunckeri Duncker's Pipehorse [66271]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Solenostomus paradoxus Ornate Ghostpipefish, Harlequin Ghost Pipefish, Ornate Ghost Pipefish [66184]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Hydrophis elegans Elegant Sea Snake, Bar-bellied Sea Snake [1104]		Species or species habitat may occur within area
Hydrophis platura as Pelamis platurus Yellow-bellied Sea Snake [93746]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hydrophis stokesii as Astrotia stokesii Stokes' Sea Snake [93510]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area

Whales and Other Cetaceans		[Resource Information]
Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Sousa sahulensis Australian Humpback Dolphin [87942]		Foraging, feeding or related behaviour likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Protected Area Name	Reserve Type	State
Cudgen	Nature Reserve	NSW

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included. Please see the associated resource information for specific caveats and use limitations associated with RFA boundary information.

RFA Name	State
North East NSW RFA	New South Wales

Nationally Important Wetlands [Resource Information]

Wetland Name	State
Cudgen Nature Reserve	NSW

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Kings Forest Residential Development	2012/6328		Post-Approval
Controlled action			
Staged commercial, industrial and residential development	2002/715	Controlled Action	Completed
Tugun Bypass	2004/1861	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Tugun Bypass Four-lane Dual Motorway	2003/1122	Controlled Action	Completed
Not controlled action			
construction of two sports fields, car park, amenities block and access road fro	2004/1376	Not Controlled Action	Completed
Hanson Tweed Sand Plant Expansion	2021/9095	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
Koala Beach Estate -Stage 7	2003/1306	Not Controlled Action	Completed
Tourist resort and public recreation area	2002/805	Not Controlled Action	Completed
Referral decision			
Breeding program for Grey Nurse Sharks	2007/3245	Referral Decision	Completed

Biologically Important Areas		[Resource Information]
Scientific Name	Behaviour	Presence
Dolphins		
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging	Likely to occur
Tursiops aduncus Indo-Pacific/Spotted Bottlenose Dolphin [68418]	Breeding	Likely to occur
Marine Turtles		
Caretta caretta Loggerhead Turtle [1763]	Nesting	Known to occur
Sharks		
Carcharias taurus Grey Nurse Shark [64469]	Foraging	Known to occur
Whales		
Megaptera novaeangliae Humpback Whale [38]	Migration (north and south)	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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10 Appendix C: Predicted threatened species assessment

Likelihood of impact to threatened species identified by database searches (IBRA subregion, MNES and BioNet) and field survey is considered in the following table:

Profile information is taken from:

- BioNet, (NSW Department of Planning and Environment, 2024)
- Atlas of Living Australia (ALA), (Atlas of Living Australia, 2024)
- Species Profile and Threat Database (SPRAT), (Depart of Climate Change, Energy, the Environment and Water, 2024)

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Amphibian						
Assa darlingtoni	Pouched Frog	Vulnerable	Not listed	Unlikely Species is not known to occur at elevations as low as those in the subject land. Higher elevation cool forest is required.	No	No
Crinia tinnula	Wallum Froglet	Vulnerable	Not listed	Possible on sand substrates Numerous records within 1500m	Possible	Yes
Litoria aurea	Green and Golden Bell Frog	Endangered	Not listed	Possible on sand substrates Species is known to use grassy areas beside suitable wetland habitat	Possible	Yes
Litoria brevipalmata	Green-thighed Frog	Vulnerable	Not listed	Possible on sand substrates Species is known to use leaf litter habitat beside suitable wetland habitat	Possible	Yes
Litoria olongburensis	Wallum Sedge Frog	Vulnerable	Vulnerable	Possible on sand substrates Species may use grassy areas beside suitable wetland habitat	Possible	Yes
Mixophyes fleayi	Fleay's Barred Frog	Endangered	Endangered	Unlikely Species prefers permanent running streams, which are not found in the subject land. Species is not found in ponds or ephemeral pools	No	No
Mixophyes iteratus	Giant Barred Frog	Vulnerable	Vulnerable	Possible Species is known to use direr forest areas and degraded riparian remnants beside suitable wetland habitat	Possible	Yes
Invertebrate						
Argynnis hyperbius	Australian Fritillary	Endangered	Critically Endangered	Possible The food plant for this species was not recorded in the subject land however it may occur in adjacent vegetation and the adults may travel up to 1km to feed.	Possible	Yes

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Petalura litorea	Coastal Petaltail	Endangered	Not listed	Unlikely Species in known to occupy vegetation close to breeding swamp.	Unlikely Adults resting within the subject land would have opportunity to move to adjacent vegetation.	No
Phyllodes imperialis southern subspecies	Southern Pink Underwing Moth	Endangered	Endangered	Unlikely The food plant for this species was not recorded in the subject land, and the species requires low light conditions which are not present in the somewhat disturbed remnants within the subject land.	No	No
Thersites mitchellae	Mitchell's Rainforest Snail	Endangered	Critically Endangered	Unlikely Numerous records exist within 1500m. Suitable leaf litter is unlikely to occur within the subject land due to past disturbances. Critical Habitat for this species lies approximately 3.5km west of the subject land.	Unlikely	No
Birds						
Amaurornis moluccana	Pale-vented Bush-hen	Vulnerable	Not listed	Unlikely It is unlikely suitable cover, and foraging habitat is present in the subject land. Notwithstanding, there is a thicket of Lantana beneath the powerline to be decommissioned which would only minimally be disturbed and not removed.	No	No
Anseranas semipalmata	Magpie Goose	Vulnerable	Not listed	Possible This species may rest or forage in the subject land	Possible	Yes
Anthochaera phrygia	Regent Honeyeater	Critically Endangered	Critically Endangered	Unlikely Main food trees are not present in the subject land, and breeding habitat does not occur in the region.	No	No
Ardenna carneipes	Flesh-footed Shearwater	Vulnerable	Not listed	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Ardenna grisea	Sooty Shearwater	Not listed	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Artamus cyanopterus cyanopterus	Dusky Woodswallow	Vulnerable	Not listed	Possible This species may rest or forage in the subject land	Possible	Yes
Botaurus poiciloptilus	Australasian Bittern	Endangered	Endangered	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Burhinus grallarius	Bush Stone-curlew	Endangered	Not listed	Possible Suitable resting habitat may exist in adjacent bushland. This species may forage within the subject land.	Possible	Yes
Calidris acuminata	Sharp-tailed Sandpiper	Not listed	Vulnerable	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Calidris alba	Sanderling	Vulnerable	Not listed	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Calidris canutus	Red Knot	Not listed	Vulnerable	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Calidris ferruginea	Curlew Sandpiper	Endangered	Critically Endangered	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Calidris tenuirostris	Great Knot	Vulnerable	Vulnerable	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Calyptorhynchus banksii banksii	Red-tailed Black-Cockatoo (coastal subspecies)	Critically Endangered	Not listed	Unlikely Suitable food and nesting trees do not occur in the subject land.	No	No
Calyptorhynchus lathami lathami	South-eastern Glossy Black-Cockatoo	Vulnerable	Vulnerable	Unlikely Suitable food and nesting trees do not occur in the subject land.	No	No
Carterornis leucotis	White-eared Monarch	Vulnerable	Not listed	Unlikely This species usually occupies rainforest and high forest canopies. Rainforest is only present in an isolated small patch within the subject land.	No	No
Charadrius leschenaultii	Greater Sand-plover	Vulnerable	Vulnerable	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Charadrius mongolus	Lesser Sand-plover	Vulnerable	Endangered	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Chthonicola sagittata	Speckled Warbler	Vulnerable	Not listed	Unlikely This species occurs in large and relatively undisturbed Eucalyptus woodlands which are not present in the subject land.	No	No
Circus assimilis	Spotted Harrier	Vulnerable	Not listed	Possible Potential foraging habitat occurs in the subject land	Possible	Yes
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	Vulnerable	Vulnerable	Unlikely Suitable Eucalypt woodlands do not occur in the subject land	No	No
Coracina lineata	Barred Cuckoo-shrike	Vulnerable	Not listed	Possible Potential foraging habitat occurs in the subject land	Possible	Yes
Cyclopsitta diophthalma coxeni	Coxen's Fig-Parrot	Critically Endangered	Critically Endangered	Unlikely This species usually occupies rainforest which is only present in an isolated small patch within the subject land.	No	No
Daphoenositta chrysoptera	Varied Sittella	Vulnerable	Not listed	Unlikely Preferred mature forest and woodland canopy species are not present in the subject land.	No	No
Diomedea antipodensis	Antipodean Albatross	Vulnerable	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Diomedea antipodensis gibsoni	Gibson's Albatross	Vulnerable	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Diomedea epomophora	Southern Royal Albatross	Not listed	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Diomedea exulans	Wandering Albatross	Endangered	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Dromaius novaehollandiae - endangered population	Emu population in the New South Wales North Coast Bioregion and Port Stephens local government area	Endangered Population	Not listed	Unlikely The subject land does not occur in either of the relevant Local Government Areas	No	No
Ephippiorhynchus asiaticus	Black-necked Stork	Endangered	Not listed	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Erythrotriorchis radiatus	Red Goshawk	Endangered	Endangered	Possible Potential foraging habitat occurs in the subject land.	Possible	Yes
Esacus magnirostris	Beach Stone-curlew	Critically Endangered	Not listed	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Falco hypoleucos	Grey Falcon	Vulnerable	Vulnerable	Unlikely This species occurs further inland.	No	No
Falco subniger	Black Falcon	Vulnerable	Not listed	Possible While this species is mostly an inland species, potential foraging habitat occurs in the subject land.	Possible	Yes
Fregetta grallaria grallaria	White-bellied Storm Petrel	Vulnerable	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Gallinago hardwickii	Latham's Snipe	Vulnerable	Vulnerable	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Glossopsitta pusilla	Little Lorikeet	Vulnerable	Not listed	Unlikely Primarily forages in Eucalypt forest which are not present in the subject land	No	No
Grus rubicunda	Brolga	Vulnerable	Not listed	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Gygis alba	White Tern	Vulnerable	Not listed	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Haematopus fuliginosus	Sooty Oystercatcher	Vulnerable	Not listed	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Haematopus longirostris	Pied Oystercatcher	Endangered	Not listed	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Haliaeetus leucogaster	White-bellied Sea-Eagle	Vulnerable	Not listed	Unlikely While this species may occur locally, suitable foraging and nesting habitat is not present in the subject land	No	No
Hieraaetus morphnoides	Little Eagle	Vulnerable	Not listed	Possible Potential foraging habitat occurs in the subject land.	Possible	Yes
Hirundapus caudacutus	White-throated Needletail	Vulnerable	Vulnerable	Unlikely Species rarely lands, and forages over forest canopies. The cleared nature of much of the surrounding landscape suggests it would be unlikely to interact with the habitat in the subject land.	No	No
Irediparra gallinacea	Comb-crested Jacana	Vulnerable	Not listed	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Ixobrychus flavicollis	Black Bittern	Vulnerable	Not listed	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Lathamus discolor	Swift Parrot	Endangered	Critically Endangered	Unlikely Preferred food trees are not present in the subject land. Species breeds in Tasmania	No	No
Lichenostomus fasciogularis	Mangrove Honeyeater	Vulnerable	Not listed	Unlikely The subject land does not include mangrove habitat and is not adjacent to mangrove habitat	No	No
Limicola falcinellus	Broad-billed Sandpiper	Vulnerable	Not listed	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Limosa lapponica baueri	Nunivak Bar-tailed Godwit	Not listed	Endangered	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Limosa limosa	Black-tailed Godwit	Vulnerable	Endangered	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Lophoictinia isura	Square-tailed Kite	Vulnerable	Not listed	Possible Potential foraging habitat occurs in the subject land.	Possible	Yes

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Macronectes giganteus	Southern Giant Petrel	Endangered	Endangered	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Macronectes halli	Northern Giant-Petrel	Vulnerable	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Menura alberti	Albert's Lyrebird	Vulnerable	Not listed	Unlikely This species usually occupies rainforest which is only present in an isolated small patch within the subject land.	No	No
Ninox connivens	Barking Owl	Vulnerable	Not listed	Possible Potential foraging habitat occurs in the subject land.	Possible	Yes
Ninox strenua	Powerful Owl	Vulnerable	Not listed	Unlikely The disturbed, fragmented nature of the local landscape suggest the habitat in the subject land is not used by this species as it generally requires large tracts of forest or woodland.	No	No
Numenius madagascariensis	Eastern Curlew	Not listed	Critically Endangered	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Onychoprion fuscata	Sooty Tern	Vulnerable	Not listed	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Oxyura australis	Blue-billed Duck	Vulnerable	Not listed	Unlikely Suitable wetland habitat is not present in the subject land	No	No
Pachycephala olivacea	Olive Whistler	Vulnerable	Not listed	Unlikely Mostly inhabits wet forests above 500m elevation.	No	No
Pachycephala turtur subantarctica	Fairy Prion	Not listed	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Pandion cristatus	Eastern Osprey	Vulnerable	Not listed	Unlikely Species may occur in the general area; however, breeding and foraging habitat does not occur in the subject land.	No	No
Petroica boodang	Scarlet Robin	Vulnerable	Not listed	Unlikely This species favours, and breeds at least slightly higher elevations on ridges and associated foothills	No	No
Petroica phoenicea	Flame Robin	Vulnerable	Not listed	Unlikely This species favours, and breeds at least slightly higher elevations on ridges and associated foothills	No	No
Phaethon rubricauda	Red-tailed Tropicbird	Vulnerable	Not listed	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No

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Phoebetria fusca	Sooty Albatross	Vulnerable	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Podargus ocellatus	Marbled Frogmouth	Vulnerable	Not listed	Unlikely This species occupies deep, wet, sheltered gullies and this habitat is not present in the subject land.	No	No
Pterodroma leucoptera leucoptera	Gould's Petrel	Vulnerable	Endangered	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Pterodroma neglecta neglecta	Kermadec Petrel (west Pacific subspecies)	Vulnerable	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Pterodroma nigripennis	Black-winged Petrel	Vulnerable	Not listed	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Ptilinopus magnificus	Wompoo Fruit-Dove	Vulnerable	Not listed	Unlikely This species usually occupies rainforest which is only present in an isolated small patch within the subject land.	No	No
Ptilinopus regina	Rose-crowned Fruit-Dove	Vulnerable	Not listed	Unlikely This species usually occupies rainforest which is only present in an isolated small patch within the subject land. Further, this species are shy pigeons and are unlikely to inhabit the fringes of wooded patches as is in subject land.	No	No
Ptilinopus superbus	Superb Fruit-Dove	Vulnerable	Not listed	Unlikely This species usually occupies rainforest and high forest canopies. Rainforest is only present in an isolated small patch within the subject land.	No	No
Rostratula australis	Australian Painted Snipe	Endangered	Endangered	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Stagonopleura guttata	Diamond Firetail	Vulnerable	Vulnerable	Unlikely This is a species of Eucalypt woodlands which are not present in the subject land	No	No
Sternula albifrons	Little Tern	Endangered	Not listed	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Sternula nereis nereis	Australian Fairy Tern	Not listed	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Stictonetta naevosa	Freckled Duck	Vulnerable	Not listed	Unlikely Suitable wetland habitat is not present in the subject land	No	No
Thalassarche carteri	Indian Yellow-nosed Albatross	Not listed	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Thalassarche cauta	Shy Albatross	Not listed	Endangered	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Thalassarche impavida	Campbell Albatross	Not listed	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Thalassarche melanophris	Black-browed Albatross	Not listed	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Thalassarche salvini	Salvin's Albatross	Not listed	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Thalassarche steadi	White-capped Albatross	Not listed	Vulnerable	Unlikely This is an ocean/ marine species which is unlikely to use the habitat in the subject land.	No	No
Todiramphus chloris	Collared Kingfisher	Vulnerable	Not listed	Unlikely This species is virtually restricted to mangrove associations which are not present in the subject land.	No	No
Tringa nebularia	Common Greenshank	Not listed	Endangered	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Turnix melanogaster	Black-breasted Button-quail	Critically Endangered	Vulnerable	Unlikely It is unlikely suitable cover, and foraging habitat is present in the subject land. Notwithstanding, there is a thicket of Lantana beneath the powerline to be decommissioned which would only minimally be disturbed and not removed.	No	No
Tyto longimembris	Eastern Grass Owl	Vulnerable	Not listed	Possible BioNet records for this species within 500m of the subject land	Possible	Yes
Tyto novaehollandiae	Masked Owl	Vulnerable	Not listed	Possible Potential foraging habitat occurs in the subject land.	Possible	Yes
Tyto tenebricosa	Sooty Owl	Vulnerable	Not listed	Unlikely Roosts in large tree hollows or dense vegetation. Breeds in large tree hollows. No suitable habitat is present in the subject land. Low likelihood of prey species in subject land	No	No

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Xenus cinereus	Terek Sandpiper	Vulnerable	Vulnerable	Unlikely Suitable foraging habitat for wading bird species is not present in the subject land.	No	No
Reptiles						
Cacophis harriettae	White-crowned Snake	Vulnerable	Not listed	Possible May occur in coastal heathland and moist forest habitats and may use foraging habitat in the subject land on sandy substrates	Possible	Yes
Caretta caretta	Loggerhead Turtle	Endangered	Endangered	Unlikely No habitat suitable for marine turtles occurs in the subject land	No	No
Chelonia mydas	Green Turtle	Vulnerable	Vulnerable	Unlikely No habitat suitable for marine turtles occurs in the subject land	No	No
Coeranoscincus reticulatus	Three-toed Snake-tooth Skink	Vulnerable	Vulnerable	Possible Habitat may, although limited, may occur in the subject land.	Possible	Yes
Delma torquata	Adorned Delma	Not listed	Vulnerable	Unlikely This species occupies eucalypt-dominated woodlands and open-forests which are not present in the subject land.	No	No
Dermochelys coriacea	Leatherback Turtle	Endangered	Endangered	Unlikely No habitat suitable for marine turtles occurs in the subject land	No	No
Eretmochelys imbricata	Hawksbill Turtle	Not listed	Vulnerable	Unlikely No habitat suitable for marine turtles occurs in the subject land	No	No
Furina dunmalli	Dunmall's Snake	Not listed	Vulnerable	Unlikely Soil and associated vegetation types do not occur in the subject land.	No	No
Hoplocephalus bitorquatus	Pale-headed Snake	Vulnerable	Not listed	Unlikely This species inhabits Eucalypt forests/ woodlands, cypress forest, and occasionally rainforest/ wet forest types. This species occupies tree hollows which are not present in the subject land.	No	No
Hoplocephalus stephensii	Stephens' Banded Snake	Vulnerable	Not listed	Unlikely Species occupies eucalypt forests, and rainforests. One patch of a rainforest PCT occurs which is isolated and unlikely to provide suitable habitat.	No	No
Lepidochelys olivacea	Olive Ridley Turtle	Not listed	Endangered	Unlikely No habitat suitable for marine turtles occurs in the subject land	No	No

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Natator depressus	Flatback Turtle	Not listed	Vulnerable	Unlikely No habitat suitable for marine turtles occurs in the subject land	No	No
Fish						
Epinephelus daemelii	Black Rockcod	Not listed	Vulnerable	Unlikely No habitat suitable for fish occurs in the subject land	No	No
Hippocampus whitei	White's Seahorse,	Not listed	Endangered	Unlikely No habitat suitable for fish occurs in the subject land	No	No
Seriolella brama	Blue Warehou	Not listed	Conservation Dependent	Unlikely No habitat suitable for fish occurs in the subject land	No	No
Thunnus maccoyii	Southern Bluefin Tuna	Not listed	Conservation Dependent	Unlikely No habitat suitable for fish occurs in the subject land	No	No
Sharks						
Carcharias taurus (east coast population)	Grey Nurse Shark (east coast population)	Not listed	Critically Endangered	Unlikely No habitat suitable for fish occurs in the subject land	No	No
Carcharodon carcharias	White Shark	Not listed	Vulnerable	Unlikely No habitat suitable for fish occurs in the subject land	No	No
Galeorhinus galeus	School Shark	Not listed	Conservation Dependent	Unlikely No habitat suitable for fish occurs in the subject land	No	No
Rhincodon typus	Whale Shark	Not listed	Vulnerable	Unlikely No habitat suitable for fish occurs in the subject land	No	No
Sphyrna lewini	Scalloped Hammerhead	Not listed	Conservation Dependent	Unlikely No habitat suitable for fish occurs in the subject land	No	No
Mammals – bats						
Chalinolobus dwyeri	Large-eared Pied Bat	Vulnerable	Endangered	Possible Potential foraging habitat/ environment occurs in the subject land. Roosting habitat does not occur in the subject land.	Possible	Yes
Chalinolobus nigrogriseus	Hoary Wattled Bat	Vulnerable	Not listed	Possible Potential foraging habitat/ environment occurs in the subject land. Roosting habitat does not occur in the subject land.	Possible	Yes
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Vulnerable	Not listed	Possible Potential foraging habitat/ environment occurs in the subject land. Roosting habitat does not occur in the subject land.	Possible	Yes

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	Vulnerable	Not listed	Possible Potential foraging habitat/ environment occurs in the subject land. Roosting habitat does not occur in the subject land.	Possible	Yes
Miniopterus australis	Little Bent-winged Bat	Vulnerable	Not listed	Possible Potential foraging habitat/ environment occurs in the subject land. Roosting habitat does not occur in the subject land.	Possible	Yes
Miniopterus orianae oceanensis	Large Bent-winged Bat	Vulnerable	Not listed	Possible Potential foraging habitat/ environment occurs in the subject land. Roosting habitat does not occur in the subject land.	Possible	Yes
Myotis macropus	Southern Myotis	Vulnerable	Not listed	Possible Potential foraging habitat/ environment occurs in the subject land. Roosting habitat does not occur in the subject land.	Possible	Yes
Nyctimene robinsoni	Eastern Tube-nosed Bat	Vulnerable	Not listed	Possible Potential foraging habitat/ environment occurs in the subject land. Roosting habitat does not occur in the subject land.	Possible	Yes
Nyctophilus bifax	Eastern Long-eared Bat	Vulnerable	Not listed	Possible Potential foraging habitat/ environment occurs in the subject land. Roosting habitat does not occur in the subject land.	Possible	Yes
Ozimops lumsdenae	Northern Free-tailed Bat	Vulnerable	Not listed	Possible Potential foraging habitat/ environment occurs in the subject land. Roosting habitat does not occur in the subject land.	Possible	Yes
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable	Vulnerable	Possible Potential foraging habitat/ environment occurs in the subject land. Roosting habitat does not occur in the subject land.	Possible	Yes
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Vulnerable	Not listed	Possible Potential foraging habitat/ environment occurs in the subject land. Roosting habitat does not occur in the subject land.	Possible	Yes
Scoteanax rueppellii	Greater Broad-nosed Bat	Vulnerable	Not listed	Possible Potential foraging habitat/ environment occurs in the subject land. Roosting habitat does not occur in the subject land.	Possible	Yes

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Syconycteris australis	Common Blossom-bat	Vulnerable	Not listed	Possible Potential foraging habitat/ environment occurs in the subject land. Roosting habitat does not occur in the subject land.	Possible	Yes
Mammals – other than bats						
Aepyprymnus rufescens	Rufous Bettong	Vulnerable	Not listed	Possible Forested areas adjacent to the subject land may house populations of this species, with grazing habitat available in the subject land.	Possible	Yes
Balaenoptera musculus	Blue Whale	Not listed	Endangered	Unlikely No marine mammal habitat exists in the subject land.	No	No
Cercartetus nanus	Eastern Pygmy-possum	Vulnerable	Not listed	Possible Forested areas adjacent to the subject land may house populations of this species, with foraging habitat available in the subject land.	Possible	Yes
Dasyurus maculatus	Spotted-tailed Quoll	Vulnerable	Endangered	Possible Forested areas adjacent to the subject land may house populations of this species, with foraging habitat available in the subject land.	Possible	Yes
Eubalaena australis	Southern Right Whale	Not listed	Endangered	Unlikely No marine mammal habitat exists in the subject land.	No	No
Petauroides volans	Southern Greater Glider	Endangered	Endangered	Unlikely Suitable old growth/ established forests do not occur in the subject land, or adjacent to it.	No	No
Petaurus australis	Yellow-bellied Glider	Vulnerable	Endangered	Unlikely Suitable old growth/ established forests do not occur in the subject land, or adjacent to it.	No	No
Petaurus norfolcensis	Squirrel Glider	Vulnerable	Not listed	Possible Forested areas adjacent to the subject land may house populations of this species, with foraging habitat available in the subject land.	Possible	Yes
Phascogale tapoatafa	Brush-tailed Phascogale	Vulnerable	Not listed	Possible Forested areas adjacent to the subject land may house populations of this species, with foraging habitat available in the subject land.	Possible	Yes
Phascolarctos cinereus	Koala	Endangered	Endangered	Possible Numerous Koala records exist within 500m	Possible	Yes
Planigale maculata	Common Planigale	Vulnerable	Not listed	Possible Potential foraging habitat exists in the subject land	Possible	Yes
Potorous tridactylus	Long-nosed Potoroo	Vulnerable	Vulnerable	Possible Potential foraging habitat exists in the subject land	Possible	Yes

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Potorous tridactylus - endangered population	Long-nosed Potoroo, Cobaki Lakes and Tweed Heads West population	Endangered Population	Vulnerable Population not listed	Unlikely This population is confined to an area north of Cobaki Broadwater, which is north of the subject land.	No	No
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	Vulnerable	Not listed	Possible Potential foraging habitat exists in the subject land on sandy substrates	Possible	Yes
Pseudomys novaehollandiae	New Holland Mouse	Not listed	Vulnerable	Possible Potential foraging habitat exists in the subject land on sandy substrates	Possible	Yes
Thylogale stigmatica	Red-legged Pademelon	Vulnerable	Not listed	Unlikely It is unlikely the vegetation in the subject land provides the required dense shrubby forest cover required by this species.	No	No
Xeromys myoides	Water Mouse	Not listed	Vulnerable	Unlikely Mangroves and associated vegetation are not present in the subject land	No	No
Plants						
Acacia bakeri	Marblewood	Vulnerable	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Acalypha eremorum	Acalypha	Endangered	Not listed	Plant not recorded in the subject land during the field assessment. Suitable rainforest or vine thicket are not present in the subject land.	No	No
Acronychia littoralis	Scented Acronychia	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Allocasuarina defungens	Dwarf Heath Casuarina	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Angiopteris evecta	Giant Fern	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Archidendron hendersonii	White Lace Flower	Vulnerable	Not listed	Unlikely Species previously recorded within 1500m. Plant not recorded in the subject land during the field assessment	No	No

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Arthraxon hispidus	Hairy Jointgrass	Vulnerable	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Backhousia subargentea	Giant Ironwood	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Baloghia marmorata	Marbled Balogia	Not listed	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Belvisia mucronata	Needle-leaf Fern	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Bosistoa transversa	Yellow Satinheart	Vulnerable	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Caesalpinia bonduc	Knicker Nut	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Cassia marksiana	Cassia marksiana	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Centranthera cochinchinensis	Swamp Foxglove	Endangered	Not listed	Unlikely It is unlikely suitable swampy areas occur in the subject land	No	No
Chamaesyce psammogeton	Sand Spurge	Endangered	Not listed	Unlikely Species occurs on foredunes, pebbly strandlines and exposed headlands which are not in the subject land.	No	No
Coatesia paniculata	Axe-Breaker	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Corokia whiteana	Corokia	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Cryptocarya foetida	Stinking Cryptocarya	Vulnerable	Vulnerable	Unlikely Species previously recorded within 1500m. Plant not recorded in the subject land during the field assessment	No	No
Cryptostylis hunteriana	Leafless Tongue Orchid	Vulnerable	Vulnerable	Possible Suitable habitat may be present and not readily recorded during the field assessment. Records exist within 1500m	Possible	Yes

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Cupaniopsis serrata	Smooth Tuckeroo	Endangered	Not listed	Unlikely Species previously recorded within 1500m. Plant not recorded in the subject land during the field assessment	No	No
Cynanchum elegans	White-flowered Wax Plant	Endangered	Endangered	Possible Suitable habitat may be present and not readily recorded during the field assessment.	Possible	Yes
Cyperus aquatilis	Water Nutgrass	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment. Suitable moist habitat is unlikely to be present in the subject land.	No	No
Cyperus semifertilis	Missionary Nutgrass	Endangered	Vulnerable	Unlikely Open forest with associated species is not present in the subject land.	No	No
Davidsonia jerseyana	Davidson's Plum	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Davidsonia johnsonii	Smooth Davidson's Plum	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Dendrobium melaleucaphilum	Spider orchid	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment. An epiphyte that was not present on Melaleuca/ trees within the subject land.	No	No
Dendrocnide moroides	Gympie Stinger	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Desmodium acanthocladum	Thorny Pea	Vulnerable	Vulnerable	Unlikely Species previously recorded within 1500m. Plant not recorded in the subject land during the field assessment	No	No
Diospyros mabacea	Red-fruited Ebony	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Diospyros yandina	Shiny-leaved Ebony	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Diploglottis campbellii	Small-leaved Tamarind	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Diuris byronensis	Byron Bay Diuris	Endangered	Not listed	Unlikely Species occurs in heath on clay soil which was not present in the subject land	No	No

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Doryanthes palmeri	Giant Spear Lily	Vulnerable	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Drynaria rigidula	Basket Fern	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Eidothea hardeniana	Nightcap Oak	Endangered	Critically Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Elaeocarpus sedentarius	Minyon Quandong	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Elaeocarpus williamsianus	Hairy Quandong	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Eleocharis tetraquetra	Square-stemmed Spike-rush	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment. Suitable moist habitat is unlikely to be present in the subject land.	No	No
Elionurus citreus	Lemon-scented Grass	Endangered	Not listed	Possible Suitable habitat may be present and not readily recorded during the field assessment.	Possible	Yes
Endiandra floydii	Crystal Creek Walnut	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Endiandra hayesii	Rusty Rose Walnut	Vulnerable	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Endiandra muelleri subsp. bracteata	Green-leaved Rose Walnut	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Floydia praealta	Ball Nut	Vulnerable	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Fontainea australis	Southern Fontainea	Vulnerable	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Geodorum densiflorum	Pink Nodding Orchid	Endangered	Not listed	Possible Potential habitat occurs within the subject land, the species would not have been above ground during the field assessment, and is known from within 1500m	Possible	Yes

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Gossia fragrantissima	Sweet Myrtle	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Grevillea hilliana	White Yiel Yiel	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Harnieria hygrophiloides	Native Justicia	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Hicksbeachia pinnatifolia	Red Boppel Nut	Vulnerable	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Hygrocybe rubronivea	*Hygrocybe rubronivea*	Vulnerable	Not listed	Unlikely Plant not recorded in the subject land during the field assessment. Associated plant community (gallery warm temperate forests) and associated species are not present in the subject land.	No	No
Isoglossa eranthemoides	Isoglossa	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment. Suitable moist habitat is unlikely to be present in the subject land.	No	No
Leichhardtia longiloba	Clear Milkvine	Listed as *Marsdenia longiloba* in NSW	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Lepiderema pulchella	Fine-leaved Tuckeroo	Vulnerable	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Lindsaea brachypoda	Short-footed Screw Fern	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment. Suitable very moist habitat is unlikely to be present in the subject land.	No	No
Lindsaea fraseri	Fraser's Screw Fern	Endangered	Not listed	Unlikely Plant previously recorded within 1500m. Plant not recorded in the subject land during the field assessment. Suitable poorly drained soil is not present in the subject land.	No	No
Macadamia integrifolia	Macadamia Nut	Not listed	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment	No	No

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Macadamia tetraphylla	Rough-shelled Bush Nut	Vulnerable	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Marsdenia longiloba	Slender Marsdenia	Endangered	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Maundia triglochinoides	Maundia triglochinoides	Vulnerable	Not listed	Unlikely Suitable wetland/ water habitat is not present in the subject land.	No	No
Melicope vitiflora	Coast Euodia	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Myrsine richmondensis	Ripple-leaf Muttonwood	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Niemeyera chartacea	Smooth-leaved Plum	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Niemeyera whitei	Rusty Plum, Plum Boxwood	Vulnerable	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Oberonia complanata	Yellow-flowered King of the Fairies	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment. An epiphyte that was not present on trees within the subject land.	No	No
Oberonia titania	Red-flowered King of the Fairies	Vulnerable	Not listed	Unlikely Plant not recorded in the subject land during the field assessment. An epiphyte that was not present on trees within the subject land.	No	No
Ochrosia moorei	Southern Ochrosia	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Oldenlandia galioides	Sweet False Galium	Endangered	Not listed	Possible Suitable habitat may be present and not readily recorded during the field assessment. Records exist within 1500m	Possible	Yes
Owenia cepiodora	Onion Cedar	Vulnerable	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Ozothamnus vagans	Wallumbin Dogwood	Endangered	Vulnerable	Unlikely Occurs at higher altitudes.	No	No

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Peristeranthus hillii	Brown Fairy-chain Orchid	Vulnerable	Not listed	Unlikely Plant not recorded in the subject land during the field assessment. An epiphyte that was not present on trees within the subject land.	No	No
Phaius australis	Southern Swamp Orchid	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment. Suitable habitat may be present; however, species was not present in the subject land.	No	No
Phyllanthus microcladus	Brush Sauropus	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment. Streamside habitats are not present in the subject land.	No	No
Pomaderris notata	McPherson Range Pomaderris	Vulnerable	Not listed	Unlikely Plant not recorded in the subject land during the field assessment. Species occurs on rocky basalt ranges or scrubby rainforest valley floors which are not present in the subject land.	No	No
Pterostylis nigricans	Dark Greenhood	Vulnerable	Not listed	Unlikely Species occurs in coastal heathland with Heath Banksia which is not present in the subject land. Where sandy soils are present they are/ have been historically disturbed to varying degrees.	No	No
Pultenaea maritima	Coast Headland Pea	Vulnerable	Not listed	Unlikely Plant not recorded in the subject land during the field assessment. Species occurs on exposed coastal headlands and adjoining low coastal heath which is not present in the subject land.	No	No
Randia moorei	Spiny Gardenia	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Rhodamnia maideniana	Smooth Scrub Turpentine	Critically Endangered	Critically Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Rhodamnia rubescens	Scrub Turpentine	Critically Endangered	Critically Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Rhodomyrtus psidioides	Native Guava	Critically Endangered	Critically Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Rhynchosia acuminatissima	Pointed Trefoil	Vulnerable	Not listed	Unlikely Plant not recorded during the field assessment, and associated species are not present in the subject land.	No	No
Rotala tripartita	Rotala tripartita	Endangered	Not listed	Unlikely The subject land does not include suitable water's edge habitat	No	No
Sarcochilus fitzgeraldii	Ravine Orchid	Vulnerable	Vulnerable	Unlikely Occurs on rocks at higher altitudes	No	No
Sarcochilus hartmannii	Hartman's Sarcochilus	Vulnerable	Vulnerable	Unlikely Occurs on cliff faces and steep ridges	No	No
Sarcochilus weinthalii	Blotched Sarcochilus	Vulnerable	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment. Usually in higher altitudes.	No	No
Senna acclinis	Rainforest Cassia	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Sophora fraseri	Brush Sophora	Vulnerable	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Sophora tomentosa	Silverbush	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Symplocos baeuerlenii	Small-leaved Hazelwood	Vulnerable	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment. Occurs on soils derived from rhyolite, and usually at higher elevations	No	No
Syzygium hodgkinsoniae	Red Lilly Pilly	Vulnerable	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Syzygium moorei	Durobby	Vulnerable	Vulnerable	Unlikely Species previously recorded within 1500m. Plant not recorded in the subject land during the field assessment	No	No
Thesium australe	Austral Toadflax	Vulnerable	Vulnerable	Unlikely Plant not recorded in the subject land during the field assessment. Associated species not recorded in the subject land.	No	No
Tinospora tinosporoides	Arrow-head Vine	Vulnerable	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No

Scientific name	Common name	NSW Status	EPBC Status	Likely to occur in the subject land	Likely to be impacted	Test of significance required?
Triflorensia cameronii	Cameron's Tarenna	Endangered	Not listed	Unlikely Occurs on rock basalt derived soils which are not present in the subject land	No	No
Tylophora woollsii	Cryptic Forest Twiner	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment	No	No
Uromyrtus australis	Peach Myrtle	Endangered	Endangered	Unlikely Plant not recorded in the subject land during the field assessment. Occurs on soils derived from rhyolite	No	No
Wahlenbergia scopulicola	Rock-face Bluebell	Endangered	Not listed	Unlikely Species occurs on cliffs at high altitude	No	No
Xylosma terrae-reginae	Queensland Xylosma	Endangered	Not listed	Unlikely Plant not recorded in the subject land during the field assessment	No	No

11 Appendix D: Tests and Assessments of significance

Where habitat requirements and associated impacts are similar for species, single tests of significance have been completed.

EPBC Act Assessments of Significance

MNES Endangered and Critically Endangered Species

MNES –Endangered, Critically Endangered - Flora species: • ***Cynanchum elegans*** **White-flowered Wax Plant**	
Significant impact criteria	
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Statement	**Response**
• lead to a long-term decrease in the size of a population	This proposal may temporarily reduce the size of a population if this species occurs in the subject land. The subject land would be allowed to naturally revegetate following completion of the construction work. This proposal is unlikely to lead to a long-term decrease it the size of a population.
• reduce the area of occupancy of the species	The proposal may temporarily reduce the area of occupancy of this species if it occurs in the subject land. The subject land would be allowed to naturally revegetate following completion of the construction work such that the net area available to this species would not notably change.
• fragment an existing important population into two or more populations	The subject land would be allowed to naturally revegetate following completion of the construction work such that no fragmentation potential would remain.
• adversely affect habitat critical to the survival of a species	The subject land does not provide habitat critical to the survival of this species.
• disrupt the breeding cycle of a population	The proposal may impact disrupt the breeding cycle of this species if it occurs in the subject land and if construction impacts immature plants or during flowering/ fruiting season. The subject land would be allowed to naturally revegetate following completion of the construction work such that the net area available to this species would not notably change.
• modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subject land would be allowed to naturally revegetate following completion of the construction work such that the net area available to this species would not notably change.
• result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	Invasive flora species are abundant in the local area. It is possible they would opportunistically establish in the subject land.
• introduce disease that may cause the species to decline, or • interfere with the recovery of the species.	It is unlikely this proposal would introduce disease that may cause this species to decline. It is unlikely this proposal would introduce disease that may interfere with the recovery of this species.
Summary statement: This proposal would not pose a significant impact to this species.	
What is an important population of a species? An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal • populations that are necessary for maintaining genetic diversity, and/or • populations that are near the limit of the species range.	
What is an invasive species?	

MNES –Endangered, Critically Endangered - Flora species:
An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.
What is habitat critical to the survival of a species or ecological community?
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary: • for activities such as foraging, breeding, roosting, or dispersal • for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • to maintain genetic diversity and long-term evolutionary development, or • for the reintroduction of populations or recovery of the species or ecological community. Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

MNES –Endangered, Critically Endangered – Mammal (not bat) species: • *Dasyurus maculatus* Spotted-tailed Quoll	
Significant impact criteria	
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Statement	**Response**
• lead to a long-term decrease in the size of a population	This proposal may temporarily reduce the area of foraging habitat which would not lead to a long-term decrease it the size of a population.
• reduce the area of occupancy of the species	The proposal may temporarily reduce the area of foraging habitat which would not reduce the area of occupancy of this species.
• fragment an existing important population into two or more populations	The subject land would be allowed to naturally revegetate following completion of the construction work such that no fragmentation potential would remain.
• adversely affect habitat critical to the survival of a species	The subject land does not provide habitat critical to the survival of this species.
• disrupt the breeding cycle of a population	The proposal would not disrupt the breeding cycle of a population as no suitable breeding dens occur in the subject land or were noted nearby.
• modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subject land would be allowed to naturally revegetate following completion of the construction work such that the net area available to this species would not notably change.
• result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	Invasive flora species are abundant in the local area. It is possible they would opportunistically establish in the subject land.
• introduce disease that may cause the species to decline, or • interfere with the recovery of the species.	It is unlikely this proposal would introduce disease that may cause this species to decline. It is unlikely this proposal would introduce disease that may interfere with the recovery of this species
Summary statement: This proposal would not pose a significant impact to this species.	
What is an important population of a species? An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal • populations that are necessary for maintaining genetic diversity, and/or • populations that are near the limit of the species range.	
What is an invasive species?	

MNES –Endangered, Critically Endangered – Mammal (not bat) species:

An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

What is habitat critical to the survival of a species or ecological community?

'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:
• for activities such as foraging, breeding, roosting, or dispersal
• for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
• to maintain genetic diversity and long-term evolutionary development, or
• for the reintroduction of populations or recovery of the species or ecological community.
Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

MNES –Endangered, Critically Endangered - Mammal (not bat) species:

- ***Phascolarctos cinereus*** **Koala**

Significant impact criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Statement	Response
• lead to a long-term decrease in the size of a population	This proposal would not remove any feed trees or any large trees. It would impact a small area of cover for this species which would not lead to a long-term decrease it the size of a population.
• reduce the area of occupancy of the species	The proposal may temporarily reduce the area of cover provided by trees and shrub species which would not reduce the area of occupancy of this species.
• fragment an existing important population into two or more populations	The subject land would be allowed to naturally revegetate following completion of the construction work such that no fragmentation potential would remain.
• adversely affect habitat critical to the survival of a species	The subject land does not provide habitat critical to the survival of this species.
• disrupt the breeding cycle of a population	The proposal would not disrupt the breeding cycle of a population as no suitable breeding habitat occurs in the subject land.
• modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subject land would be allowed to naturally revegetate following completion of the construction work such that the net area available to this species would not notably change.
• result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	Invasive flora species are abundant in the local area. It is possible they would opportunistically establish in the subject land.
• introduce disease that may cause the species to decline, or • interfere with the recovery of the species.	It is unlikely this proposal would introduce disease that may cause this species to decline. It is unlikely this proposal would introduce disease that may interfere with the recovery of this species.
Summary statement: This proposal would not pose a significant impact to this species.	

What is an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:
• key source populations either for breeding or dispersal
• populations that are necessary for maintaining genetic diversity, and/or
• populations that are near the limit of the species range.

What is an invasive species?

MNES –Endangered, Critically Endangered - Mammal (not bat) species:
An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.
What is habitat critical to the survival of a species or ecological community?
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary: • for activities such as foraging, breeding, roosting, or dispersal • for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • to maintain genetic diversity and long-term evolutionary development, or • for the reintroduction of populations or recovery of the species or ecological community. Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

MNES –Endangered, Critically Endangered – Mammal (bat) species: • ***Chalinolobus dwyeri*** **Large-eared Pied Bat**	
Significant impact criteria	
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Statement	**Response**
• lead to a long-term decrease in the size of a population	This proposal may temporarily reduce the area of foraging habitat which would not lead to a long-term decrease it the size of a population.
• reduce the area of occupancy of the species	The proposal may temporarily reduce the area of foraging habitat which would not reduce the area of occupancy of this species.
• fragment an existing important population into two or more populations	The subject land would be allowed to naturally revegetate following completion of the construction work such that no fragmentation potential would remain.
• adversely affect habitat critical to the survival of a species	The subject land does not provide habitat critical to the survival of this species.
• disrupt the breeding cycle of a population	The proposal would not disrupt the breeding cycle of a population as no suitable breeding sites occur in the subject land.
• modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subject land would be allowed to naturally revegetate following completion of the construction work such that the net area available to this species would not notably change.
• result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	Invasive flora species are abundant in the local area. It is possible they would opportunistically establish in the subject land.
• introduce disease that may cause the species to decline, or • interfere with the recovery of the species.	It is unlikely this proposal would introduce disease that may cause this species to decline. It is unlikely this proposal would introduce disease that may interfere with the recovery of this species
Summary statement: This proposal would not pose a significant impact to this species.	
What is an important population of a species? An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal • populations that are necessary for maintaining genetic diversity, and/or • populations that are near the limit of the species range.	

MNES –Endangered, Critically Endangered – Mammal (bat) species:

What is an invasive species?

An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

What is habitat critical to the survival of a species or ecological community?

'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:
• for activities such as foraging, breeding, roosting, or dispersal
• for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
• to maintain genetic diversity and long-term evolutionary development, or
• for the reintroduction of populations or recovery of the species or ecological community.
Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

MNES –Endangered, Critically Endangered – Bird species:

- ***Erythrotriorchis radiatus*** **Red Goshawk**

Significant impact criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Statement	Response
• lead to a long-term decrease in the size of a population	This proposal may temporarily reduce the area of foraging habitat which would not lead to a long-term decrease it the size of a population.
• reduce the area of occupancy of the species	The proposal may temporarily reduce the area of foraging habitat which would not reduce the area of occupancy of this species.
• fragment an existing important population into two or more populations	The subject land would be allowed to naturally revegetate following completion of the construction work such that no fragmentation potential would remain.
• adversely affect habitat critical to the survival of a species	The subject land does not provide habitat critical to the survival of this species.
• disrupt the breeding cycle of a population	The proposal would not disrupt the breeding cycle of a population as no suitable breeding sites occur in the subject land.
• modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subject land would be allowed to naturally revegetate following completion of the construction work such that the net area available to this species would not notably change.
• result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	Invasive flora species are abundant in the local area. It is possible they would opportunistically establish in the subject land.
• introduce disease that may cause the species to decline, or • interfere with the recovery of the species.	It is unlikely this proposal would introduce disease that may cause this species to decline. It is unlikely this proposal would introduce disease that may interfere with the recovery of this species
Summary statement: This proposal would not pose a significant impact to this species	

What is an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:
• key source populations either for breeding or dispersal
• populations that are necessary for maintaining genetic diversity, and/or
• populations that are near the limit of the species range.

MNES –Endangered, Critically Endangered – Bird species:

What is an invasive species?

An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

What is habitat critical to the survival of a species or ecological community?

'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:
- for activities such as foraging, breeding, roosting, or dispersal
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- to maintain genetic diversity and long-term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

MNES –Endangered, Critically Endangered – Invertebrate species:

- ***Argynnis hyperbius*** **Australian Fritillary**

Significant impact criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Statement	Response
• lead to a long-term decrease in the size of a population	This proposal may temporarily reduce the area of foraging habitat which would not lead to a long-term decrease it the size of a population.
• reduce the area of occupancy of the species	The proposal may temporarily reduce the area of foraging habitat which would not reduce the area of occupancy of this species.
• fragment an existing important population into two or more populations	The subject land would be allowed to naturally revegetate following completion of the construction work such that no fragmentation potential would remain.
• adversely affect habitat critical to the survival of a species	The subject land does not provide habitat critical to the survival of this species.
• disrupt the breeding cycle of a population	The proposal would not disrupt the breeding cycle of a population as no suitable breeding sites occur in the subject land.
• modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subject land would be allowed to naturally revegetate following completion of the construction work such that the net area available to this species would not notably change.
• result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	Invasive flora species are abundant in the local area. It is possible they would opportunistically establish in the subject land.
• introduce disease that may cause the species to decline, or • interfere with the recovery of the species.	It is unlikely this proposal would introduce disease that may cause this species to decline. It is unlikely this proposal would introduce disease that may interfere with the recovery of this species
Summary statement: This proposal would not pose a significant impact to this species	

MNES –Endangered, Critically Endangered – Invertebrate species:

What is an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

What is an invasive species?

An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

What is habitat critical to the survival of a species or ecological community?

'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- to maintain genetic diversity and long-term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

MNES Vulnerable Species

MNES – Vulnerable - Flora species: • ***Cryptostylis hunteriana*** **Leafless Tongue Orchid**	
Significant impact criteria	
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Statement	**Response**
• lead to a long-term decrease in the size of an important population of a species	The assessment area does not have an important population, as defined in the EPBC Act Significant Impact Guidelines 1.1.
• reduce the area of occupancy of an important population	The assessment area does not have an important population, as defined in the EPBC Act Significant Impact Guidelines 1.1.
• fragment an existing important population into two or more populations	The subject land would be allowed to naturally revegetate following completion of the construction work such that no fragmentation potential would remain.
• adversely affect habitat critical to the survival of a species	The proposal would not impact habitat which would be critical to the survival of this species.
• disrupt the breeding cycle of an important population	The assessment area does not have an important population, as defined in the EPBC Act Significant Impact Guidelines 1.1
• modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subject land would be allowed to naturally revegetate following completion of the construction work such that the net area available to this species would not notably change.
• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Invasive flora species are abundant in the local area. It is possible they would opportunistically establish in the subject land.
• introduce disease that may cause the species to decline, or • interfere substantially with the recovery of the species.	It is unlikely this proposal would introduce disease that may cause this species to decline. It is unlikely this proposal would introduce disease that may interfere with the recovery of this species
Summary statement: This proposal would not pose a significant impact to this species	
What is an important population of a species? An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal • populations that are necessary for maintaining genetic diversity, and/or • populations that are near the limit of the species range.	
What is an invasive species? An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.	
What is habitat critical to the survival of a species or ecological community?	
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary: • for activities such as foraging, breeding, roosting, or dispersal • for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • to maintain genetic diversity and long-term evolutionary development, or • for the reintroduction of populations or recovery of the species or ecological community. Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.	

MNES – Vulnerable - Mammal (not bat) species:

- ***Potorous tridactylus*** **Long-nosed Potoroo**
- ***Pseudomys novaehollandiae*** **New Holland Mouse**

Significant impact criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Statement	Response
• lead to a long-term decrease in the size of an important population of a species	The assessment area does not have an important population, as defined in the EPBC Act Significant Impact Guidelines 1.1. This proposal may temporarily reduce the area of foraging habitat.
• reduce the area of occupancy of an important population	The assessment area does not have an important population, as defined in the EPBC Act Significant Impact Guidelines 1.1. This proposal may temporarily reduce the area of foraging habitat.
• fragment an existing important population into two or more populations	The subject land would be allowed to naturally revegetate following completion of the construction work such that no fragmentation potential would remain.
• adversely affect habitat critical to the survival of a species	The subject land does not provide habitat critical to the survival of this species.
• disrupt the breeding cycle of an important population	The assessment area does not have an important population, as defined in the EPBC Act Significant Impact Guidelines 1.1 No suitable breeding sites occur in the subject land.
• modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subject land would be allowed to naturally revegetate following completion of the construction work such that the net area available to this species would not notably change.
• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Invasive flora species are abundant in the local area. It is possible they would opportunistically establish in the subject land.
• introduce disease that may cause the species to decline, or • interfere substantially with the recovery of the species.	It is unlikely this proposal would introduce disease that may cause this species to decline. It is unlikely this proposal would introduce disease that may interfere with the recovery of this species

Summary statement: This proposal would not pose a significant impact to this species

What is an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:
• key source populations either for breeding or dispersal
• populations that are necessary for maintaining genetic diversity, and/or
• populations that are near the limit of the species range.

What is an invasive species?

An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

What is habitat critical to the survival of a species or ecological community?

'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:
• for activities such as foraging, breeding, roosting, or dispersal
• for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
• to maintain genetic diversity and long-term evolutionary development, or
• for the reintroduction of populations or recovery of the species or ecological community.
Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

MNES – Vulnerable – Mammal (bat) species: • *Pteropus poliocephalus* Grey-headed Flying-fox	
Significant impact criteria	
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Statement	**Response**
• lead to a long-term decrease in the size of an important population of a species	The assessment area does not have an important population, as defined in the EPBC Act Significant Impact Guidelines 1.1. This proposal may temporarily reduce the area of foraging habitat however no evidence of camps was recorded during the field assessment.
• reduce the area of occupancy of an important population	The assessment area does not have an important population, as defined in the EPBC Act Significant Impact Guidelines 1.1. This proposal may temporarily reduce the area of foraging habitat.
• fragment an existing important population into two or more populations	The subject land would be allowed to naturally revegetate following completion of the construction work such that no fragmentation potential would remain.
• adversely affect habitat critical to the survival of a species	The subject land does not provide habitat critical to the survival of this species.
• disrupt the breeding cycle of an important population	The assessment area does not have an important population, as defined in the EPBC Act Significant Impact Guidelines 1.1 No suitable breeding sites occur in the subject land and no evidence of camps was recorded during the field assessment.
• modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subject land would be allowed to naturally revegetate following completion of the construction work such that the net area available to this species would not notably change.
• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Invasive flora species are abundant in the local area. It is possible they would opportunistically establish in the subject land.
• introduce disease that may cause the species to decline, or	It is unlikely this proposal would introduce disease that may cause this species to decline. It is unlikely this proposal would introduce disease that may interfere with the recovery of this species
• interfere substantially with the recovery of the species.	The assessment area does not have an important population, as defined in the EPBC Act Significant Impact Guidelines 1.1. This proposal may temporarily reduce the area of foraging habitat.
Summary statement: This proposal would not pose a significant impact to this species	
What is an important population of a species? An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal • populations that are necessary for maintaining genetic diversity, and/or • populations that are near the limit of the species range.	
What is an invasive species? An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.	
What is habitat critical to the survival of a species or ecological community?	
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary: • for activities such as foraging, breeding, roosting, or dispersal • for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • to maintain genetic diversity and long-term evolutionary development, or • for the reintroduction of populations or recovery of the species or ecological community. Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.	

MNES – Vulnerable - Reptile species: • *Coeranoscincus reticulatus* Three-toed Snake-tooth Skink	
Significant impact criteria	
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Statement	**Response**
• lead to a long-term decrease in the size of an important population of a species	The assessment area does not have an important population, as defined in the EPBC Act Significant Impact Guidelines 1.1.
• reduce the area of occupancy of an important population	The assessment area does not have an important population, as defined in the EPBC Act Significant Impact Guidelines 1.1.
• fragment an existing important population into two or more populations	The subject land would be allowed to naturally revegetate, and the soil would be reinstated following completion of the construction work such that no fragmentation potential would remain.
• adversely affect habitat critical to the survival of a species	The subject land does not provide habitat critical to the survival of this species.
• disrupt the breeding cycle of an important population	The assessment area does not have an important population, as defined in the EPBC Act Significant Impact Guidelines 1.1
• modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subject land would be allowed to naturally revegetate following completion of the construction work such that the net area available to this species would not notably change.
• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Invasive flora species are abundant in the local area. It is possible they would opportunistically establish in the subject land.
• introduce disease that may cause the species to decline, or • interfere substantially with the recovery of the species.	It is unlikely this proposal would introduce disease that may cause this species to decline. It is unlikely this proposal would introduce disease that may interfere with the recovery of this species
Summary statement: This proposal would not pose a significant impact to this species	
What is an important population of a species? An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal • populations that are necessary for maintaining genetic diversity, and/or • populations that are near the limit of the species range.	
What is an invasive species? An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.	
What is habitat critical to the survival of a species or ecological community?	
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary: • for activities such as foraging, breeding, roosting, or dispersal • for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • to maintain genetic diversity and long-term evolutionary development, or • for the reintroduction of populations or recovery of the species or ecological community. Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.	

MNES – Vulnerable - Amphibian species: • *Litoria olongburensis* Wallum Sedge Frog • *Mixophyes iteratus* Giant Barred Frog	
Significant impact criteria	
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Statement	**Response**
• lead to a long-term decrease in the size of an important population of a species	For Giant Barred Frog: The assessment area does not have an important population, as defined in the EPBC Act Significant Impact Guidelines 1.1. For Wallum Sedge Frog: It is possible an Important Population occurs within 500m of the proposal alignment. A known population occurs within 500m and beyond, and that population is the subject of a national recovery plan. It is unlikely however that this proposal would lead to the long-term decrease of that population because it would not impact breeding habitat, and foraging habitat would not be decreased at the completion of this proposal.
• reduce the area of occupancy of an important population	The proposal would not reduce the area of occupancy of an important population. Area available for breeding and foraging would not be reduced at the conclusion of this proposal.
• fragment an existing important population into two or more populations	The subject land would be allowed to naturally revegetate, and the soil would be reinstated following completion of the construction work such that no fragmentation potential would remain.
• adversely affect habitat critical to the survival of a species	The subject land does not provide habitat critical to the survival of this species. Breeding habitat for the Wallum Sedge Frog within 500m however it would not be impacted by this proposal.
• disrupt the breeding cycle of an important population	No waterbodies or wetland habitat would by impacted by this proposal. Breeding habitat for the Wallum Sedge Frog within 500m however it would not be impacted by this proposal.
• modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subject land would be allowed to naturally revegetate following completion of the construction work such that the net area available to this species would not notably change.
• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Invasive flora species are abundant in the local area. It is possible they would opportunistically establish in the subject land following construction completion.
• introduce disease that may cause the species to decline, or • interfere substantially with the recovery of the species.	It is unlikely this proposal would introduce disease that may cause this species to decline. It is unlikely this proposal would introduce disease that may interfere with the recovery of this species
Summary statement: This proposal would not pose a significant impact to this species	
What is an important population of a species? An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal • populations that are necessary for maintaining genetic diversity, and/or • populations that are near the limit of the species range.	
What is an invasive species? An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.	
What is habitat critical to the survival of a species or ecological community?	

MNES – Vulnerable - Amphibian species:

'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:
• for activities such as foraging, breeding, roosting, or dispersal
• for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
• to maintain genetic diversity and long-term evolutionary development, or
• for the reintroduction of populations or recovery of the species or ecological community.
Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

BC Act Tests of Significance

BC listed Flora and Fauna

BC Act Test of Significance for amphibian species: • ***Crinia tinnula*** **Wallum Froglet** • ***Litoria aurea*** **Green and Golden Bell Frog** • ***Litoria brevipalmata*** **Green-thighed Frog** • ***Litoria olongburensis*** **Wallum Sedge (Olongburra) Frog** • ***Mixophyes iteratus*** **Giant Barred Frog**	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	**Response**
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	This proposal would not impact any waterbodies or wetland habitat. The frog lifecycle would not be impacted by this proposal. Foraging or roaming habitat for these species may be impacted. Suitable breeding and foraging habitat would persist in abundance outside the subject land.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded from suitable habitat at any time. Impacted vegetation would be allowed to fully revegetation at the conclusion of the construction of this proposal.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species, particularly if mitigation measures found in section 6 are followed.
Summary statement: The proposal would not pose a significant impact to the species.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Act Test of Significance for invertebrate species: • *Argynnis hyperbius* Australian Fritillary	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	**Response**
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	Breeding habitat will not be impacted. Suitable breeding (if the larval food plant occurs) and foraging habitat would persist in abundance outside the subject land.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded from suitable habitat at any time. Impacted vegetation would be allowed to fully revegetation at the conclusion of the construction of this proposal.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species, particularly if mitigation measures found in section 6 are followed.
Summary statement: the proposal would not result in a significant impact to this species.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Act Test of Significance for bird species: ground dwelling • *Anseranas semipalmata* Magpie Goose • *Burhinus grallarius* Bush Stone-curlew	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	**Response**
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed	Foraging habitat for these species may be impacted by this proposal but not to the extent the life cycles of these birds will be affected. Suitable breeding and foraging habitat would persist in abundance outside the subject land. No nests were observed in the

BC Act Test of Significance for bird species: ground dwelling • *Anseranas semipalmata* Magpie Goose • *Burhinus grallarius* Bush Stone-curlew	
at risk of extinction	subject land during the field assessment.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded from suitable habitat at any time. Impacted vegetation would be allowed to fully revegetation at the conclusion of the construction of this proposal.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species, particularly if mitigation measures found in section 6 are followed.
Summary statement: The proposal would not pose a significant impact to the species.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Act Test of Significance for bird species: woodland species • *Artamus cyanopterus cyanopterus* Dusky Woodswallow • *Coracina lineata* Barred Cuckoo-shrike	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	**Response**
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	Foraging habitat for these species may be impacted by this proposal not to the extent the life cycles of these birds will be affected. Suitable breeding and foraging habitat would persist in abundance outside the subject land. No nests were observed in the subject land during the field assessment.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or	N/A

BC Act Test of Significance for bird species: woodland species • *Artamus cyanopterus cyanopterus* Dusky Woodswallow • *Coracina lineata* Barred Cuckoo-shrike	
critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded from suitable habitat at any time. Impacted vegetation would be allowed to fully revegetation at the conclusion of the construction of this proposal.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species, particularly if mitigation measures found in section 6 are followed.
Summary statement: The proposal would not pose a significant impact to the species.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Act Test of Significance for species: Diurnal birds of prey • *Circus assimilis* Spotted Harrier • *Erythrotriorchis radiatus* Red Goshawk • *Falco subniger* Black Falcon • *Hieraaetus morphnoides* Little Eagle • *Lophoictinia isura* Square-tailed Kite	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	**Response**
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	Foraging habitat for these species may be impacted by this proposal not to the extent the life cycles of these birds will be affected. Suitable breeding and foraging habitat would persist in abundance outside the subject land. No nests were recorded during the field assessment.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the	N/A

BC Act Test of Significance for species: Diurnal birds of prey • *Circus assimilis* Spotted Harrier • *Erythrotriorchis radiatus* Red Goshawk • *Falco subniger* Black Falcon • *Hieraaetus morphnoides* Little Eagle • *Lophoictinia isura* Square-tailed Kite	
proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded from suitable habitat at any time. Impacted vegetation would be allowed to fully revegetation at the conclusion of the construction of this proposal.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species, particularly if mitigation measures found in section 6 are followed.
Summary statement: The proposal would not pose a significant risk to the species.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Act Test of Significance for bird species: owls • *Ninox connivens* Barking Owl • *Tyto longimembris* Eastern Grass Owl • *Tyto novaehollandiae* Masked Owl	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	**Response**
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	Foraging habitat for these species may be impacted by this proposal not to the extent the life cycles of these birds will be affected. Breeding habitat for Barking Owl and Masked Owl will not be impacted – no tree hollows occur on the subject land. Suitable breeding and foraging habitat would persist in abundance outside the subject land. No nests, including no areas which may have been used by Eastern Grass Owl were recorded during the field assessment.

BC Act Test of Significance for bird species: owls • *Ninox connivens* Barking Owl • *Tyto longimembris* Eastern Grass Owl • *Tyto novaehollandiae* Masked Owl	
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded from suitable habitat at any time. Impacted vegetation would be allowed to fully revegetation at the conclusion of the construction of this proposal.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species, particularly if mitigation measures found in section 6 are followed.
Summary statement: The proposal would not pose a significant impact to the species.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Act Test of Significance for reptile species: • *Cacophis harriettae* White-crowned Snake • *Coeranoscincus reticulatus* Three-toed Snake-tooth Skink	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	**Response**
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	Foraging habitat for these species may be impacted by this proposal not to the extent where it would impact the life cycles. These species have non-specific breeding habitat, and it is unlikely the leaflitter in the subject land would be substantial enough to provide suitable breeding habitat. Further, no suitable logs or rocks occur within the subject land. Suitable breeding and foraging habitat would persist in abundance outside the subject land.
Adverse effects on ecological communities	N/A

BC Act Test of Significance for reptile species: • ***Cacophis harriettae*** **White-crowned Snake** • ***Coeranoscincus reticulatus*** **Three-toed Snake-tooth Skink**	
(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded from suitable habitat at any time. Impacted vegetation would be allowed to fully revegetation at the conclusion of the construction of this proposal.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species, particularly if mitigation measures found in section 6 are followed.
Summary statement: The proposal would not pose a significant impact to the species.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Act Test of Significance for mammal (bat) species:

- ***Chalinolobus dwyeri*** **Large-eared Pied Bat**
- ***Chalinolobus nigrogriseus*** **Hoary Wattled Bat**
- ***Falsistrellus tasmaniensis*** **Eastern False Pipistrelle**
- ***Micronomus norfolkensis*** **Eastern Coastal Free-tailed Bat**
- ***Miniopterus australis*** ***Little Bent-winged Bat***
- ***Miniopterus orianae oceanensis*** **Large Bent-winged Bat**
- ***Myotis macropus*** **Southern Myotis**
- ***Nyctimene robinsoni*** **Eastern Tube-nosed Bat**
- ***Nyctophilus bifax*** **Eastern Long-eared Bat**
- ***Ozimops lumsdenae*** **Northern Free-tailed Bat**
- ***Pteropus poliocephalus*** **Grey-headed Flying-fox**
- ***Saccolaimus flaviventris*** **Yellow-bellied Sheathtail-bat**
- ***Scoteanax rueppellii*** **Greater Broad-nosed Bat**
- ***Syconycteris australis*** **Common Blossom-bat**

Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:

Statement	Response
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	Foraging habitat for these species may be impacted by this proposal not to the extent where it would impact the life cycles. Breeding habitat (large trees, tree hollows, caves, rock crevices) will not be impacted. Suitable breeding and foraging habitat may persist in abundance outside the subject land.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded from suitable habitat at any time. Impacted vegetation would be allowed to fully revegetation at the conclusion of the construction of this proposal.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species, particularly if mitigation measures found in section 6 are followed.
Summary statement: the proposal would not pose a significant impact to the species.	

In determining the nature and magnitude of an impact, matters were considered such as:

- pre-construction, construction and occupation/maintenance phases
- all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management

BC Act Test of Significance for mammal (bat) species:

- ***Chalinolobus dwyeri*** **Large-eared Pied Bat**
- ***Chalinolobus nigrogriseus*** **Hoary Wattled Bat**
- ***Falsistrellus tasmaniensis*** **Eastern False Pipistrelle**
- ***Micronomus norfolkensis*** **Eastern Coastal Free-tailed Bat**
- ***Miniopterus australis*** ***Little Bent-winged Bat***
- ***Miniopterus orianae oceanensis*** **Large Bent-winged Bat**
- ***Myotis macropus*** **Southern Myotis**
- ***Nyctimene robinsoni*** **Eastern Tube-nosed Bat**
- ***Nyctophilus bifax*** **Eastern Long-eared Bat**
- ***Ozimops lumsdenae*** **Northern Free-tailed Bat**
- ***Pteropus poliocephalus*** **Grey-headed Flying-fox**
- ***Saccolaimus flaviventris*** **Yellow-bellied Sheathtail-bat**
- ***Scoteanax rueppellii*** **Greater Broad-nosed Bat**
- ***Syconycteris australis*** **Common Blossom-bat**

zones
- all direct and indirect impacts
- the frequency and duration of each known or likely impact/action
- the total impact which can be attributed to that action over the entire geographic area affected, and over time
- the sensitivity of the receiving environment
- the degree of confidence with which the impacts of the action are known and understood.

All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker

BC Act Test of Significance for mammal (not bat) species: Ground dwelling

- ***Aepyprymnus rufescens*** **Rufous Bettong**
- ***Dasyurus maculatus*** **Spotted-tailed Quoll**
- ***Planigale maculata*** **Common Planigale**
- ***Potorous tridactylus*** **Long-nosed Potoroo**
- ***Pseudomys gracilicaudatus*** **Eastern Chestnut Mouse**
- ***Pseudomys novaehollandiae*** **New Holland Mouse**

Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:

Statement	Response
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	Foraging habitat for these species may be impacted by this proposal not to the extent the impact to the life cycles will be affected. Breeding habitat will not be impacted – no coarse woody debris would be impacted; dense scrub would not be impacted to the point that it would cease to provide suitable cover. Suitable breeding and foraging habitat would persist in abundance outside the subject land. No nests/ dens were recorded during the field assessment.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No

BC Act Test of Significance for mammal (not bat) species: Ground dwelling • *Aepyprymnus rufescens* Rufous Bettong • *Dasyurus maculatus* Spotted-tailed Quoll • *Planigale maculata* Common Planigale • *Potorous tridactylus* Long-nosed Potoroo • *Pseudomys gracilicaudatus* Eastern Chestnut Mouse • *Pseudomys novaehollandiae* New Holland Mouse	
or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	individuals would be excluded from suitable habitat at any time. Impacted vegetation would be allowed to fully revegetation at the conclusion of the construction of this proposal.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species, particularly if mitigation measures found in section 6 are followed.
Summary statement: The proposal would not pose a significant impact to the species.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Act Test of Significance for mammal (not bat) species: arboreal • *Cercartetus nanus* Eastern Pygmy-possum • *Petaurus norfolcensis* Squirrel Glider • *Phascogale tapoatafa* Brush-tailed Phascogale	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	**Response**
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	Foraging habitat for these species may be impacted by this proposal not to the extent the life cycles will be affected. Breeding habitat (tree hollows, large trees, tree stumps, coarse woody debris) will not be impacted. Suitable breeding and foraging habitat would persist in abundance outside the subject land.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the

BC Act Test of Significance for mammal (not bat) species: arboreal • *Cercartetus nanus* Eastern Pygmy-possum • *Petaurus norfolcensis* Squirrel Glider • *Phascogale tapoatafa* Brush-tailed Phascogale	
or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	extent that these species are likely to decline. No individuals would be excluded from suitable habitat at any time. Impacted vegetation would be allowed to fully revegetation at the conclusion of the construction of this proposal.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species, particularly if mitigation measures found in section 6 are followed.
Summary statement: This proposal would not pose a significant impact to the species.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Act Test of Significance for mammal (not bat) species: Koala • *Phascolarctos cinereus* Koala	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	**Response**
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	Foraging habitat (Eucalyptus species) is not present in the subject land, and hence is unlikely a koala population would exist in the subject land for breeding purposes. Suitable breeding and foraging habitat may persist in abundance outside the subject land.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed,	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded from suitable habitat at any time. Impacted vegetation would be allowed to fully revegetation at the conclusion of the construction of this proposal.

BC Act Test of Significance for mammal (not bat) species: Koala • *Phascolarctos cinereus* Koala	
modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species, particularly if mitigation measures found in section 6 are followed.
Summary statement: The proposal would not pose a significant impact to the species.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Act Test of Significance for plant species: • *Cryptostylis hunteriana* Leafless Tongue Orchid • *Cynanchum elegans* White-flowered Wax Plant • *Elionurus citreus* Lemon-scented Grass • *Geodorum densiflorum* Pink Nodding Orchid • *Oldenlandia galioides* Sweet False Galium	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	**Response**
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	These species were not recorded during the field assessment. Land within the subject land represent generally poor habitat values for these species. Any population of these species which occurs within the subject land is likely to also extend to more suitable, and less disturbed habitat outside the subject land. Breeding may be disrupted where plants occur within the subject land, and where a seed bank exists for these species, the disturbance of this proposal may provide opportunity.
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	N/A
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed,	Adverse impacts on habitat to the extent the species would become locally extinct are unlikely. The proposal will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that these species are likely to decline. No individuals would be excluded from suitable habitat at any time. Land impacted by this proposal would be allowed to revegetate. There would be almost no net lost to the extent of suitable habitat for these species following the construction of this proposal.

BC Act Test of Significance for plant species: • ***Cryptostylis hunteriana*** **Leafless Tongue Orchid** • ***Cynanchum elegans*** **White-flowered Wax Plant** • ***Elionurus citreus*** **Lemon-scented Grass** • ***Geodorum densiflorum*** **Pink Nodding Orchid** • ***Oldenlandia galioides*** **Sweet False Galium**	
modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	The proposal will not have an adverse effect on any declared area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	The proposal would exacerbate the KTPs listed in Section 5.3. The exacerbations are unlikely to result in significant impacts to the species, particularly if mitigation measures found in section 6 are followed. Encroachment from exotic flora species may opportunistically occur within the disturbed subject land.
Summary statement: The proposal is unlikely to pose a significant impact to the species.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

BC Listed TECs

BC Act Test of Significance for threatened ecological communities: • *Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions* • *Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*	
Significant impact criteria - An action is likely to have a significant impact on a protected matter if there is a real chance or possibility that it will have:	
Statement	**Response**
Adverse effects on the life cycle of a species (a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	N/A
Adverse effects on ecological communities (b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction	This proposal would impact an area of these communities; however, the disturbed ground would be allowed to revegetate following completion of construction. Exotic flora species may have opportunity to occupy the cleared land given abundance in the local landscape. Given this local abundance, especially for the Lowland Rainforest community, this is unlikely to substantially change the composition of the patch.
Adverse effects on habitats (c) in relation to the habitat of a threatened species or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality	This proposal would temporarily disturb land used by native fauna species. Vegetation would be allowed to reestablish following construction. No key habitat features such as hollow bearing trees or wetland values would be impacted by this proposal. Relevant threatened species may be temporarily disturbed, however habitat values provided by these communities would be significantly retained adjacent to the subject land.
Adverse effects on areas of outstanding biodiversity value (d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)	This proposal would not impact an area of outstanding biodiversity value.
Key threatening processes (e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process	This proposal would temporarily involve minor clearing of native vegetation. This proposal may increase the prevalence of local weed species identified as KTPs such as Latana, within the subject land. This proposal may contribute to climate change due to operation of construction equipment.
Summary statement: This proposal would not have a significant impact on these communities.	
In determining the nature and magnitude of an impact, matters were considered such as: • pre-construction, construction and occupation/maintenance phases • all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones • all direct and indirect impacts • the frequency and duration of each known or likely impact/action • the total impact which can be attributed to that action over the entire geographic area affected, and over time • the sensitivity of the receiving environment • the degree of confidence with which the impacts of the action are known and understood. All factors should be considered as well as any other information considered relevant to the test. Sources and currency of data and information are to be documented and referenced. Limitations, uncertainties and known gaps in information are also to be documented to inform the decision-maker	

Appendix F: Aboriginal Heritage Due Diligence Assessment (AREA Environment & Heritage, 2024)

AREA Environmental & Heritage Consultants ABN: 29 616 529 867

- ✓ Environmental impact assessments and approvals : REFs, MW REFs, PEAs
- ✓ Ecology, Aboriginal and historic heritage assessments
- ✓ Biodiversity assessment method (BAM) assessments (BDAR) and offsetting (BSAR)
- ✓ Plans of Management
- ✓ Aboriginal community engagement
- ✓ Stakeholder and community engagement
- ✓ Peer review / project briefs / budgeting assistance / expert witness

Prepared for Essential Energy

Proposed installation of underground 33kV cables: Kings Forest

Aboriginal Due Diligence Assessment

Tweed Shire Council Local Government Area, NSW

December 2024





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AREA Environmental & Heritage Consultants acknowledges

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Executive Summary

Essential Energy (the proponent) proposes to install a four-kilometre underground 33kV powerline extending from the existing Cudgen Zone Substation (ZS) at 571 Cudgen Road, Cudgen, to the termination point of previously installed underground 33kV cables on Leda-owned land (Lot 1 DP781633).

The proposal includes the installation of new fibre optic communication cables and earthing cables alongside the underground 33kV electricity cables, as well as the installation of two new underground-overhead (UGOH) poles within the existing overhead 33kV powerline corridor, specifically at the southern end of the proposal site. Additionally, approximately 460 meters of existing overhead 33kV powerline will be decommissioned and removed between the new UGOH poles.

AREA Environmental & Heritage Consultants (AREA) has been engaged to conduct an Aboriginal heritage due diligence assessment for this proposal. In accordance with this assessment, the proponent will adhere to the Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales (DECCW, 2010b).

A field survey of the development footprint was conducted on July 10, 2024, by Phillip Cameron of AREA. His assessment was supported by an updated AHIMS database search and a review of Ainsworth Heritage (2014), which evaluated similar proposals in collaboration with Aboriginal parties.

The survey found no recorded Aboriginal sites within the development footprint, and the proposal will avoid all previously identified Aboriginal sites.

Based on this assessment, the following recommendations are made:

- All recorded Aboriginal heritage sites within the development footprint will be avoided, and an Aboriginal Heritage Impact Permit is not required.
- Site supervisors should be informed about the location of Aboriginal site 04-2-0142 on the AHIMS database are incorrect. The landforms and directions of how to access this site do not match where it plots per the site card. The location of the incorrect coordinates provided on the AHIMS site card do not pose a constraint to the proposal.
- Site supervisors should also be aware of Aboriginal site 04-2-0187, which is listed in the AHIMS database as ‘destroyed’ and will re appear on any updated AHIMS database search is no longer a constraint.
- If any objects of suspected Aboriginal heritage origin are discovered during construction, work in the area should cease immediately, and the unexpected finds protocols (Appendix B) should be implemented.
- Should there be any changes to the proposed works that may impact areas outside the current development footprint, further archaeological investigation may be required.
- If suspected human remains are encountered at any stage of the works, all activity must stop immediately, and the NSW police must be notified.

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Terms and acronyms used in this document

Acronym	Definition
AHIMS	Aboriginal Heritage Management System
AHIP	Aboriginal Heritage Impact Permit
AS	Artefact Scatter
CMT	Culturally Modified Tree (scarred)
DECCW	Department of Environment, Climate Change and Water
Development footprint	Land directly affected by the UEC , OFC, including plough, trench, bore pit points (the impact footprint) and excludes areas of haul and bore.
GDA	Geocentric Datum of Australia
GPS	Global positioning system
GSD	Ground Surface Disturbance
GSV	Ground Surface Visibility
HH	Historic Heritage
IBRA	Interim Biogeographic Regionalisation of Australia
IF	Isolated Find
LALC	Local Aboriginal Land Council
LGA	Local Government Area
NPW Act	National Parks and Wildlife Act 1979
NPWS	National Parks & Wildlife Service
OEH	Office of Environment and Heritage
PAD	Potential Archaeological Deposit
OFC	Optical Fibre Cable
Study Area	Land in and around the development footprint, defined by a 500-metre buffer around the alignment.
Strahler stream order	Strahler stream order and are used to define stream size based on a hierarchy of tributaries.
TSR	Travelling Stock Routes
UEC	Underground Electricity Cable

1 Introduction

Essential Energy proposes to install approximately four kilometres of new underground 33kV electricity cables between Essential Energy's existing Cudgen Zone Substation (ZS) at 571 Cudgen Road, Cudgen, and the termination point of previously installed underground 33kV cables on Leda-owned land (Lot 1 DP781633).

The project also includes the installation of new fibre optic communication cables and earthing cables alongside the 33kV underground electricity cables. Additionally, two new underground-to-overhead (UGOH) poles will be installed within the existing overhead 33kV powerline corridor on Leda-owned land at the southern end of the proposal site.

The proposal also involves the decommissioning and removal of approximately 460 metres of the existing overhead 33kV powerline between the newly installed UGOH poles.

AREA Environmental & Heritage Consultants (AREA) has been engaged by Essential Energy to assess the potential impact of the proposal on Aboriginal heritage. The proponent has elected to follow the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (NSW Department of Environment, Climate Change and Water [DECCW], 2010). This report presents the findings of the assessment and provides recommendations for the protection and management of Aboriginal heritage.

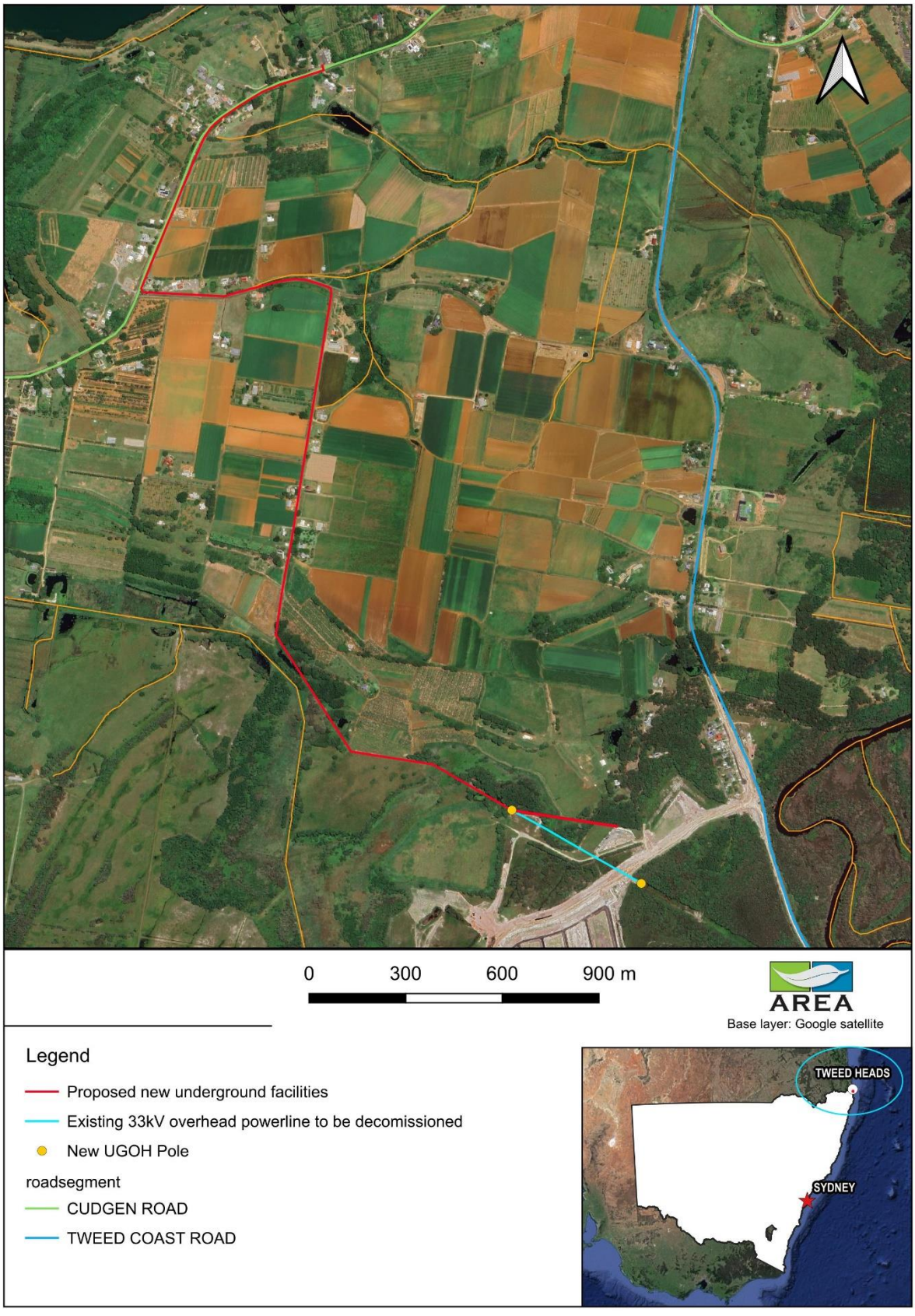
1.1 Locality

The proposed OFC route is located within the Tweed Local Government Area (LGA) (Figure 1-1). The regional geographical context of the study area is provided in Table 1-1.

Table 1-1: Regional geographical context of the study area

Criteria	Study area
Coordinates (GDA94 z55) Start | Finish	Cudgen Zone Substation (ZS) z56 GDA 554045E, 6872969N Depot Rd project end z56 GDA, 554045N, 6872969E
Interim Biogeographic Regionalisation for Australia (IBRA Region)	South Eastern Queensland biorehion > Burringbar-Conodale Ranges subregion
State	NSW
Local Government Area	Tweed LGA
Local Aboriginal Land Council area (LALC)	Tweed-Byron LALC
Schedule of Native Title Determination Applications (Claims, ILUA Future Acts etc.)	There are no accepted Native Title claims across the study area
Nearest town / locality	Cudgel
Accessed from nearest town by	Cudgel Rd (Nth) or Depot Rd (Sth)
Land use / disturbance	Infrastructure corridors (road, rail, gas, telecommunications and power), farmland
Spot point Australian Height Datum (AHD)	30 – 6 m
Surrounding land use	Residential, farming, road corridor

Figure 1-1: Proposal location



1.2 Definitions

Two terms are used in this report to describe the proposal:

- development footprint – land directly affected by the UEC, OFC, including plough, trench, bore pit points (the impact footprint).
- study area – land in and around the development footprint, defined by a 500-metre buffer around the alignment.

1.3 Project description

Essential Energy proposes to install approximately four kilometres of new underground 33kV electricity cables between the existing Cudgen Zone Substation (ZS), located at 571 Cudgen Road, Cudgen, and the termination point of previously installed underground 33kV cables on Leda-owned land (Lot 1 DP781633).

The proposal also includes the installation of new fibre optic communication cables and earthing cables alongside the 33kV underground electricity cables, as well as the installation of two new underground-to-overhead (UGOH) poles within the existing overhead 33kV powerline corridor on Leda-owned land at the southern extent of the project site (refer to Figures 1 and 2). Additionally, the project involves the decommissioning and removal of approximately 460 metres of existing overhead 33kV powerline between the newly installed UGOH poles (see Figures 1 and 2).

1.3.1 Key Components of the Proposal:

Essential Energy proposes to install approximately four kilometres of new underground 33 kilovolt electricity cables between Essential Energy's existing Cudgen ZS, located at 571 Cudgen Road, Cudgen, and the termination of underground 33kV cables installed previously on Leda owned land (Lot 1 DP781633).

The proposal includes installation of new fibre optic communication cables and earthing cable alongside the 33kV underground electricity cables and installation of two new underground-overhead (UGOH) poles within the existing overhead 33kV powerline corridor, and Leda owned land at the southern extent of the proposal site Figure 1-2.

Decommissioning and removal of approximately 460 metres of existing overhead 33kV powerline between the new UGOH poles referred to above Figure 1-2.

Bore construction is proposed to minimise environmental and social impacts. A summary of the proposal has been provided in Table 1-2. In more detail, the proposal includes:

- Installation of approximately four kilometres of new underground 33 kilovolt cables within the road reserves of Cudgen Road, Plantation Road and Reardons Road, and across low lying land from approximately the end of Reardons Road to the connection point with previously installed underground 33 kilovolt cables.
- Construction methodology will be primarily by open trenching along the road reserves, although several short, shallow (i.e., approximately one to three metres depth) underbores via horizontal directional drilling (HDD) will likely be used where required to avoid and

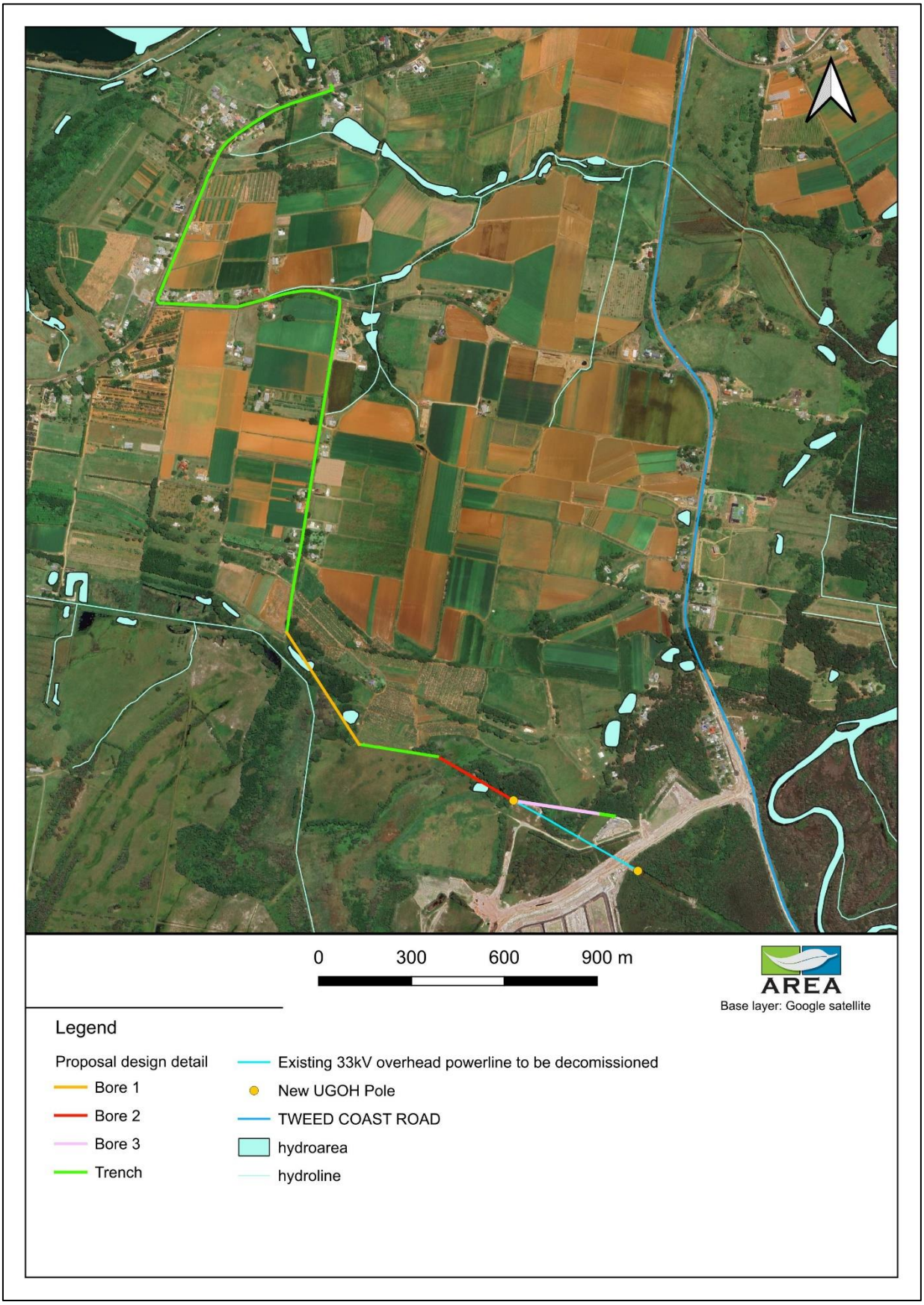
minimise impacts to roads, driveways and planted ornamental vegetation. The exact location and length of the short, shallow underbores is yet to be finalised.

- Trench dimensions will be approximately 0.7 metres wide by 1.35 metres deep. Trenches will likely be excavated using a small to medium sized excavator (i.e. eight to 16 tonne), although this will be confirmed by the successful civil contractor.
- Several cable jointing pits and associated earth link boxes will be installed along the proposal route. These will be permanent structures installed below ground level with trafficable lids to allow access for inspection and maintenance from the surface when required. The approximate dimensions of the joining pits are 6.3 metres long by 2.7 metres wide by 2.0 metres deep. The earth link boxes will be approximately 1.6 metres long by 0.9 metres wide by 0.75 metres deep.
- Three longer, deeper underbores via HDD will be required in the southern portion of the proposal to avoid and minimise impacts to remnant vegetation, farms dams, and wetland environments, comprising the following:
    - Underbore 1: entry from approximately the end of Reardons Road, progressing in a southeasterly direction through Lot 1 DP12737 and Lot 4 DP629229, to an exit point in a cleared paddock on Leda owned land (Lot 1 DP781633), a total of approximately 426 metres.
    - Underbore 2: entry from Leda owned land (Lot 1 DP781633), off Depot Road, progressing in a north westerly direction across the corner of Lot 2 DP597802 and back to Leda owned land (Lot 1 DP781633) on the western side of the mapped coastal wetland, with the exit point near the proximity of an existing power pole 38946, a total of approximately 271 metres
    - Underbore 3: entry will be from approximately the same entry point as Underbore 2 (i.e., the eastern extent of underbore 2), progressing in an easterly direction to the connection point with the previously installed underground 33kV cables all on Leda owned land (Lot 1 DP781633), a total of approximately 280 metres. Underbore 3 will require two separate bores spaced approximately two metres apart. Two separate bores are required at Underbore 3 to facilitate a second set of cables installed to a new UGOH pole.

Table 1-2: Approximate surface disturbance areas associated with underbores

Underbore surface disturbance areas	Disturbance Type	Approximate total disturbance area
Underbore 1 - Entry	Excavation of entry pit (approximately 2.0m long by x 1.5m wide by 1.0m deep) within broader disturbed area of approximately 20m by 50m). Requires access for excavator, vacuum trucks, light vehicles and room for semi-trailers to enter and exit and parking of equipment and machinery. May require hardstand (i.e., imported rock) if ground soft at time of drilling.	1250m^2 (20m x 50m)
Underbore 1 - Exit	Excavation of entry pit (approximately 2.0m long by x 1.5m wide by 1.0m deep) within broader disturbed area of approximately 20m by 10m. Requires access for excavator, vacuum trucks, and light vehicles.	200m^2 (20m 10m)
Underbore 2 and 3 - Entry (combined)	Excavation of entry pit (approximately 2.0m long by x 1.5m wide by 1.0m deep) within broader disturbed area of approximately 40m by 30m. Requires access for excavator, vacuum trucks, and room for semi-trailers to enter and exit, parking of equipment and machinery and Site shed, facilities and tools/spares. May require hardstand (i.e., imported rock) if ground soft at time of drilling.	1200m^2 (40m x 30m)
Underbore 2 - Exit	Excavation of entry pit (approximately 2.0m long by x 1.5m wide by 1.0m deep) within broader disturbed area of approximately 20m by 10m. Requires access for excavator, vacuum trucks, and light vehicles.	200m^2 (20m x 10m)
Underbore 3 - Exit	Excavation of entry pit (approximately 2.0m long by x 1.5m wide by 1.0m deep) within broader disturbed area of approximately 20m by 10m. Requires access for excavator, vacuum trucks, and light vehicles.	200m^2 (20m x 10m)
Turkeys Nest (if required at Underbore 2 and 3)	Approximately 20m x 10m with 0.5m high bund, lined with geofabric or similar. Requires access for excavator, vacuum trucks and light vehicles	200m^2 (20m x 10m)
Conduit Stringing Laydown Area for Underbore 1 and 2	Requires access for excavator and light vehicles. No excavation required	1200m^2 (240m x 5m)
Conduit Stringing Area for Underbore 3	Requires access for excavator and light vehicles. No excavation required.	500m^2 (130m x 5m)

Figure 1-2: Proposal detail



1.4 Aboriginal community involvement

Ainsworth Heritage assessed this alignment with Tweed-Byron Local Aboriginal Land Council Aboriginal Sites Officers in 2012 (Ainsworth 2014). AREAs contract was to ground truth the same proposal but having regard to a change of alignment to avoid impact upon native vegetation and culturally sensitive landscapes. This change of alignment uses a combination of under bore and trench construction type and is located on land subject to prior significant land surface disturbance.

1.5 Project personnel

This assessment was carried out by appropriately experienced and qualified staff (Table 1-2). The field survey was conducted and written by Phillip Cameron of AREA.

Table 1-3: Summary the project team's qualifications

Name	Position	Qualifications	Responsibilities
Dave Sturman	Project Manager	• B. Env. Sc. Land and Water Specialisation Charles Sturt University	• Editing
Phil Cameron	Director	• BSc. Macquarie University • Ass Dip App Sci. University of Queensland • Certified Environmental Practitioner (EIANZ) and practicing member. • Suitably experienced heritage assessor by having undertaken archaeological assessments of similar scope professionally since 2004	• Project management • Field assessment • Editing

2 Landscape features

2.1 Overview

A review of the proposal route in the landscape context allows for comparison with other archaeologically investigated areas. It also assists in assessing existing and previous disturbances which may have affected the integrity of archaeological remains. Environmental features such as landforms, topography, water sources, geology, soils, and vegetation are also relevant for an archaeological assessment.

The proposed OFC route is located within the Burringbar-Conondale Ranges subregion of the South Eastern Queensland IBRA bioregion.

2.2 Landforms, geology, vegetation and soils

Ainsworth (2014) provides a review of the geology and geomorphology attributes in Section 2.4 *Current Site Condition and Description*. In this chapter she refers to four landscapes with four different vegetation patterns.

When ground truthed in 2024 the author agrees with her conclusions.

The following information simplifies and updates Ainsworth (2014) with currently accepted mapping spatial layers (Mitchell Landscapes) and specifically having regard to the updated alignment.

The proposal is on two NSW Landscapes (Figure 2-1):

- **The Lamington Volcanic Slopes** contain raw materials suitable for the manufacture of Aboriginal stone objects. However, the likelihood of Aboriginal sites being present and detected is lower due to significant ground surface disturbance from intensive agriculture, as well as activities related to cut-and-fill processes such as road construction, paddock levelling, plantations and powerline installation within the proposal area.
- **The Byron-Tweed Alluvial Plains** have a higher likelihood of containing Aboriginal objects in areas that have not been impacted by sand mining. Ainsworth (2014) identified such areas east of the Tweed Coast Road, where they are associated with intact sand dunes in relation to the current proposal (The proposal is however west of Tweed Coast Road).

Further detail of these landscapes is provided below:

2.2.1 Lamington Volcanic Slopes (SEQ Volcanics)

This landscape features extensive hills and ridges arranged in a broadly circular pattern, approximately 50 km in diameter, with radial drainage centred on Mount Warning. The Tertiary Lamington volcanic complex consists of multiple layers of basalt, rhyolite, trachyte, and pyroclastics, including tuff and agglomerate, all of which are suitable materials for the creation of Aboriginal objects (Table 2-1, Figure 2-2). The elevation ranges from 50 to 1,120 metres, with local relief varying significantly, reaching up to 500 metres in higher areas.

The soils are predominantly red and brown, structured loams with high organic content and fertility, making them ideal for intensive agricultural use. On the lower slopes near valleys, red, brown, and grey-brown texture-contrast soils are common.

Most of the landscape is covered by subtropical closed forests, with stands of cool temperate Antarctic beech found above 1,000 metres. Typical subtropical species include white booyong (*Argyrodendron trifoliolatum*), red carabeen (*Geissois benthamii*), rose marara (*Pseudoweinmannia lanchnocarpa*), pigeonberry ash (*Cryptocarya erythroxylon*), myrtle ebony (*Diospyros pentamera*), incense cedar (*Anthocarapa* sp.), and emergent Moreton Bay fig (Ficus macrophylla) and strangling fig (*Ficus watkinsiana*). Giant stinging tree (*Dendrocnide excelsa*) and yellow carabeen (*Sloanea woollsii*) are also prevalent.

Drier sites and less fertile soils support forests of Sydney blue gum (*Eucalyptus saligna*), brush box (*Lophostemon confertus*), broad-leaved apple (*Angophora subvelutina*), flooded gum (*Eucalyptus grandis*), turpentine (*Syncarpia glomulifera*), blackbutt (*Eucalyptus pilularis*), and coachwood (*Ceratopetalum apetalum*). On the lower slopes, tallowwood (*Eucalyptus microcorys*), grey gum (*Eucalyptus punctata*), white mahogany (*Eucalyptus acmenoides*), manna gum (*Eucalyptus viminalis*), and forest oak (*Allocasuarina torulosa*) are common.

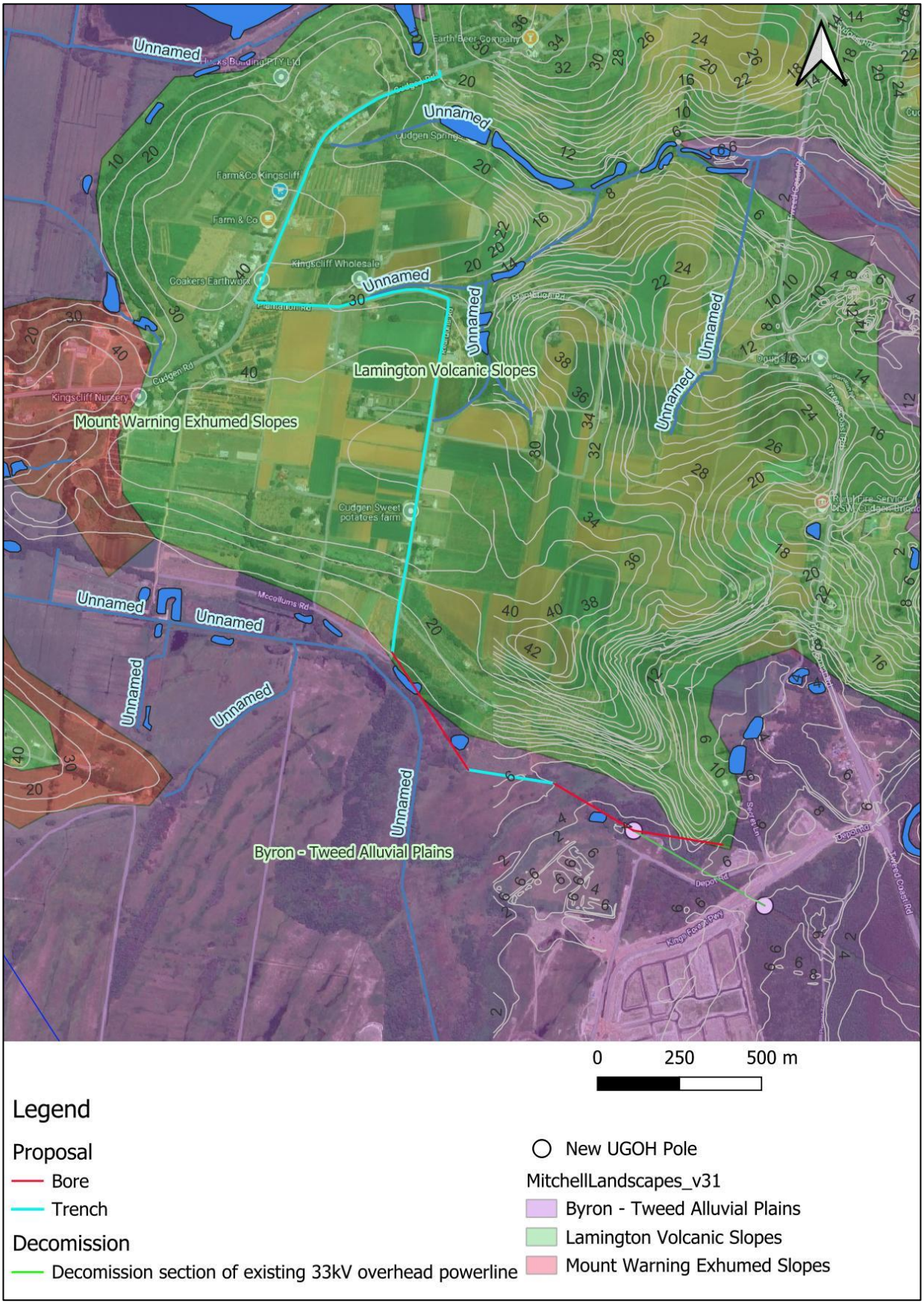
2.2.2 Byron - Tweed Alluvial Plains SEQ Clarence Basin

The Tweed River and other coastal streams run through channels, floodplains, terraces, and estuaries, situated on Quaternary alluvium with a general elevation ranging from 0 to 50 metres and a local relief of up to 15 metres. The floodplains contain uniform brown earths and structured brown clays, while terrace remnants feature brown texture-contrast soils with high organic content (Table 2-1, Figure 2-2).

Although much of the valley has been cleared, it originally supported subtropical closed forests, including species like white booyong (*Argyrodendron trifoliolatum*) and red cedar (*Toona australis*). The area also retains rare species such as heart-leaved bosistoa (*Bosistoa selwynii*), velvet laurel (*Endiandra hayesii*), red-fruited ebony (*Diospyros mabacea*), and southern fontainea (*Fontainea australis*).

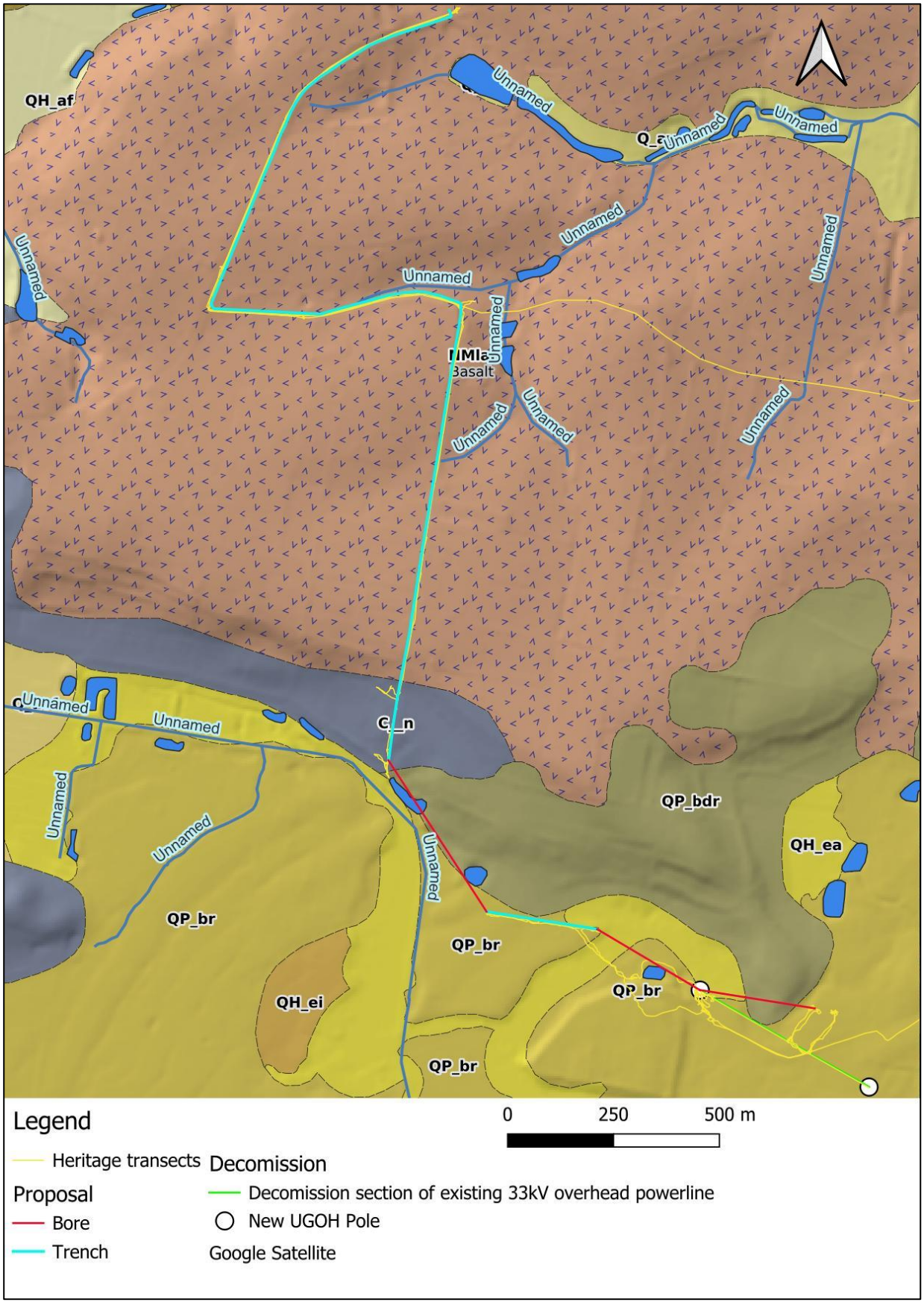
Dry coastal hardwood forests dominate the terraces and slopes, comprising species such as cabbage gum (*Eucalyptus amplifolia*), forest red gum (*Eucalyptus tereticornis*), broad-leaved apple (*Angophora subvelutina*), river oak (*Casuarina cunninghamiana*), silky oak (*Grevillea robusta*), rough-barked apple (*Angophora floribunda*), native teak (*Flindersia australis*), coastal grey box (*Eucalyptus bosistoana*), pink bloodwood (*Corymbia intermedia*), spotted gum (*Corymbia maculata*), grey ironbark (*Eucalyptus paniculata*), broad-leaved paperbark (*Melaleuca quinquenervia*), blackwood (*Acacia melanoxylon*), and black she-oak (*Casuarina litoralis*).

Figure 2-1: NSW Landscapes, topography and hydrology



Note: The NSW data set for contours is more detailed east of the proposal than over the proposal

Figure 2-2: NSW geology map (See Table 2-1 re codes and archaeological potential)



Note: Yellow line = assessors transects.

Table 2-1: Summary of geological attributes and their archaeological potential

NSW code	Unit name	Description	Dominant lithology	Archaeological relevance to the proposal
QP_bdr	Coastal deposits - bedrock-mantling dune facies	Indurated marine-deposited and aeolian-reworked fine- to coarse-grained quartz-lithic sand with abundant carbonate, sporadic humic debris in stabilised dunes.	Sand	The landscape and geological features of the stabilised dunes in the area make them important for archaeological investigation. The presence of quartz-lithic sands suggests potential stone tool assemblages, while the environmental conditions offer clues about ancient habitation, resource use, and possibly burial practices.
QP_br	Coastal deposits - beach ridge	Fine- to coarse-grained quartz-lithic-carbonate sand (marine-deposited), shell and shell-fragment-rich beds, polymictic gravel.	Sand	The fine- to coarse-grained quartz-lithic-carbonate sands, shell-rich beds, and polymictic gravel of the area present a landscape with strong archaeological potential, especially in the context of Aboriginal use of marine resources, midden formation, and tool-making activities. The combination of materials suggests an environment where Aboriginal groups likely exploited the rich coastal ecosystem, leaving behind a range of cultural artefacts that could reveal much about their subsistence and adaptation strategies.
QH_ea	Estuarine palaeochannel fill	Organic mud, peat, clay, silt, fine- to medium-grained lithic-carbonate-quartz sand (marine-deposited).	Organic rich sediment	The organic mud, peat, clay, silt, and fine- to medium-grained lithic-carbonate-quartz sand (marine-deposited) suggest a landscape rich in both natural resources and archaeological potential. The wetland-like characteristics and marine influence provide a setting where organic artefacts, stone tools, and midden deposits may be well-preserved. The environmental variability and stratigraphy point to a complex history of Aboriginal occupation, resource use, and adaptation to changing coastal environments. These attributes make this landscape significant for archaeological investigation, particularly in revealing both subsistence strategies and cultural practices.
C__n	Neranleigh-Fernvale beds	Feldspathic and lithic meta-arenite, metasiltstone and conglomerate proximal turbidite, with structurally intercalated or stratigraphically underlying chert, jasper and mafic meta-volcanics.	Sandstone	The feldspathic and lithic meta-arenite, metasiltstone, conglomerate proximal turbidite, and intercalated chert, jasper, and mafic meta-volcanics in the area present a geologically rich landscape with high archaeological potential. The presence of high-quality stone materials such as chert and jasper indicates the likelihood of stone tool production sites, including quarries and associated artefact scatters. The complex geological history, including the intercalation of these materials, suggests that this landscape was a valuable resource area for Aboriginal people, both for tool-making and possibly for other cultural uses of stone materials.
NMlal	Lismore Basalt	Predominantly tholeiitic with occasional alkaline types of formations	Basalt	The predominantly tholeiitic with occasional alkaline types of formations in the area represent a geologically rich landscape with high potential for stone tool production and quarry sites. The durability and availability of basalt, particularly tholeiitic varieties, would have made it a key resource for Aboriginal tool-making, with the occasional presence of alkaline basalt providing additional variety for specialised tools or ornaments. The landscape's volcanic origin, with exposed outcrops and rugged features, would likely have served both practical and possibly cultural purposes, offering important insights into how Aboriginal people utilised and valued the geological resources of the area.

2.3 Waterways

Figure 2-2 shows any geological unit identified as ‘Estuarine palaeochannel fill’ (QH_ea) is a drainage line.

The waterways in the vicinity of the alignment are largely naturally occurring but have modified hydrology modified trough draining activities or by development.

The proposal intersects:

- one Estuarine palaeochannel fill adjacent to the old landfill site, this drainage line is under bored.
- one waterbody on Estuarine palaeochannel fill, this drainage line is under bored.
- one unnamed 1st Order drainage line on Lismore Basalt (NMlal). The Figure 2-2 shows it is trenched however in the field the headwaters to this was not visible in the landscape where mapped, likely due to paddock levelling activities though intensive agriculture.

2.4 Climate

The Bureau of Meteorology (BoM) data for the Tweed area, Northern NSW, and SE QLD shows a subtropical climate characterised by warm, humid summers and mild winters, with significant rainfall. The region receives annual rainfall of around 1,500 to 2,000 millimetres, with a wet season influenced by tropical weather systems and occasional cyclones. This rainfall pattern supports the lush subtropical rainforests and wetlands that are characteristic of the region today.

Prior to European settlement, this climate likely remained largely similar, although there have been long-term variations influenced by factors like El Niño and La Niña. Aboriginal people living in the Tweed region adapted to these wet and warm conditions, using the abundant natural resources supported by the area's climate. The consistent availability of water and rich plant and animal life in the Tweed River floodplains, coastal wetlands, and subtropical rainforests would have made this an ideal location for Aboriginal communities.

The Tweed area experiences mild winter temperatures, typically ranging from 10°C to 20°C, which would have allowed Aboriginal people to live comfortably throughout the year without the need for significant shelter or seasonal migration to warmer areas.

Summer temperatures are generally warm, ranging from 25°C to 30°C, which would have supported a year-round abundance of resources, including plant growth, animal activity, and marine life in coastal and riverine areas.

2.5 Land Use

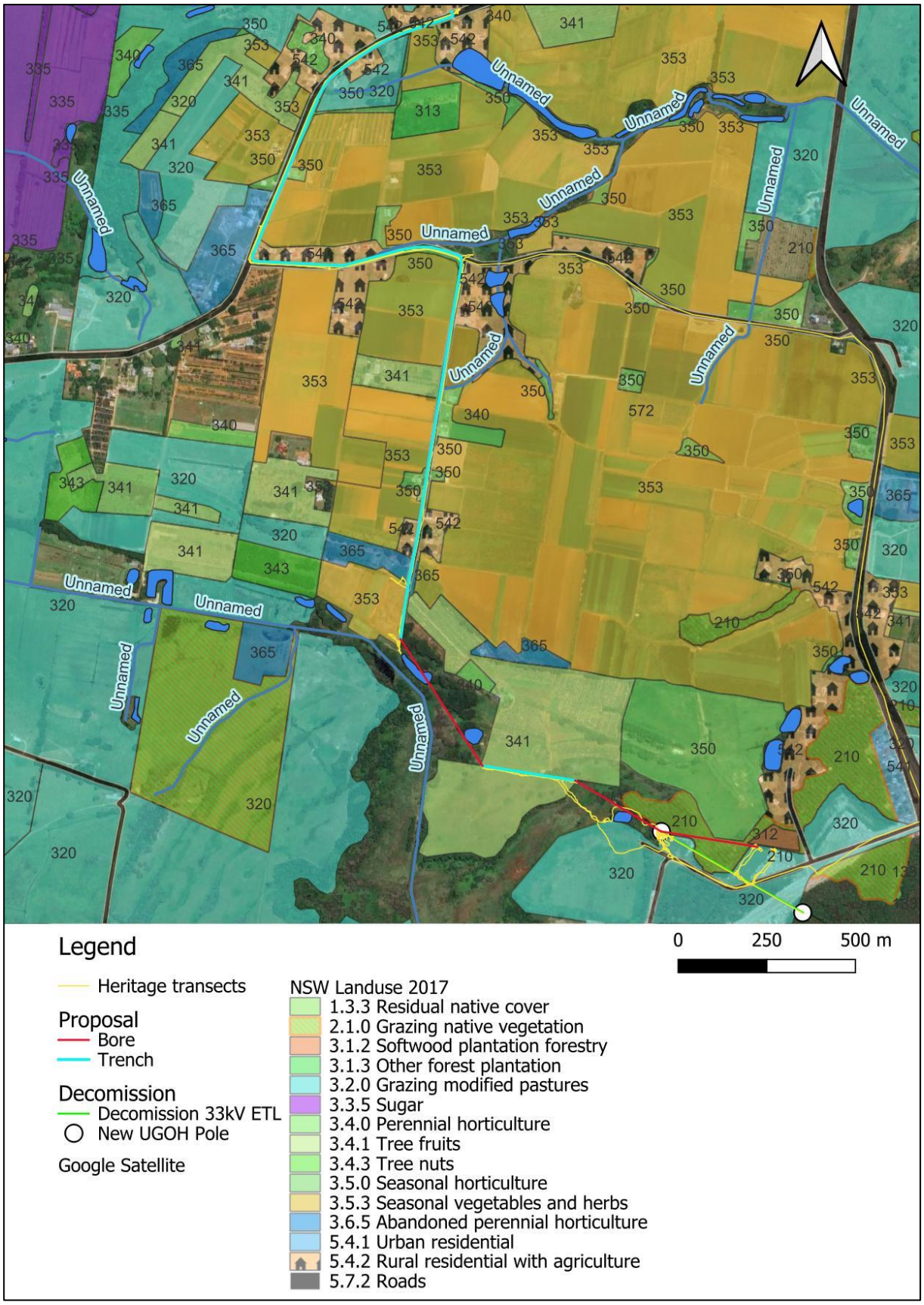
The NSW Landuse 2017 map (NSW Department of Planning and Environment (DPE), 2017) captures how land in the state is utilised across various sectors such as residential, commercial, agricultural, and services (Figure 2-3, Table 2-2).

The land uses described reflect a broad range of agricultural and rural activities, from seasonal and perennial horticulture to grazing and forestry plantations. Sustainable land management practices are key for all these uses, particularly to avoid environmental degradation, overgrazing, and biodiversity loss. Rural residential areas with agricultural activity suggest mixed land use, while roads are critical for accessibility.

Table 2-2: NSW Landuse

Tertiary Code	Tertiary – detail
353	3.5.3 Seasonal vegetables and herbs
350	3.5.0 Seasonal horticulture
353	3.4.0 Perennial horticulture
353	5.4.2 Rural residential with agriculture
340	2.1.0 Grazing native vegetation
340	3.6.5 Abandoned perennial horticulture
542	3.1.2 Softwood plantation forestry
542	3.4.1 Tree fruits
542	3.2.0 Grazing modified pastures
353	3.1.3 Other forest plantation
353	3.4.3 Tree nuts
210	5.7.2 Roads

Figure 2-3: Land Use across the proposal



Note: Yellow line = transects. 350 = 3.5.0 in key etc

3 Archaeological context

Ainsworth (2014) provides a comprehensive review of Aboriginal history and previous reporting in the areas. This report will summarise but not repeat this work for brevity but provide additional information as required. If further detail is required refer to Ainsworth (2014).

3.1 The Aboriginal People of the Tweed Coast Region

The Bundjalung Nation is the primary Aboriginal group of the Tweed Coast in Northern NSW. The Bundjalung people have maintained a profound spiritual and cultural connection to the land, sea, and waterways for tens of thousands of years. Their traditional territory spans across Northern NSW and Southern Queensland, with the Tweed Coast being an integral part. Although colonisation impacted their language and traditions, efforts are underway to revive the Bundjalung language and preserve their cultural heritage.

The Bundjalung view the natural landscape, including Mount Wollumbin (Mount Warning), as sacred, and their connection to the land encompasses coastal environments, rainforests, rivers, and wetlands. The Tweed River and its ecosystems provided rich resources such as fish, shellfish, and plants, while the coastlines and estuaries were vital for hunting and gathering.

3.1.1 Impact of colonisation

The arrival of Europeans in the 19th century led to the displacement of the Bundjalung people from their land. Traditional hunting grounds and sacred sites were lost or destroyed due to colonisation. Missions and reserves further disrupted their way of life, yet many Bundjalung people continued practicing their culture, often in secret or adapted forms.

Today, there is a resurgence of cultural pride and language revival, alongside efforts to protect and manage Aboriginal cultural heritage. Organisations like the Tweed Byron Local Aboriginal Land Council work actively to preserve Bundjalung heritage. Registered Native Title Groups, such as the Danggan Balun (Five Rivers) People, play a key role in advocating for the rights of local Aboriginal communities.

3.1.2 Archaeological record of the Tweed Coast region

The archaeological record[1] highlights the long-term occupation of the Tweed Coast by the Bundjalung people, showcasing their reliance on the natural environment and their environmental management. Shell middens, stone artefacts, and burial sites form parts of the archaeological landscape, dating back thousands of years.

Key archaeological studies include:

- McBryde, I. (1974): *Aboriginal Prehistory in New England: An Archaeological Survey of Northeastern New South Wales*.

[1] Note: The archaeological record is an academic exercise distinct from the cultural knowledge shared by a Traditional Custodian. Cultural knowledge often includes non-physical aspects such as culturally significant site types, areas, objects, or species which are inaccessible through archaeology alone.

- Ainsworth, R. (2014): *Aboriginal Cultural Heritage Assessment: Tweed Coast Road Realignment*.
- Robins, R. (1997): *Sites of Significance: Aboriginal Cultural Heritage in the Tweed Coast Region*.
- Appleton, J., et al. (2010): *Archaeological Investigations of Coastal Dune Systems: Tweed Heads to Byron Bay*.
- Sullivan, M. and Hughes, P. (1983): *Cultural Resources of the North Coast: An Archaeological Survey of the Coastal Lands from the Queensland Border to Port Stephens*.

3.1.3 Key archaeological findings and predictive model

Shell middens:

Common features along the Tweed Coast, shell middens contain remains of shellfish (e.g., oysters, pipis), fish bones, and stone tools used for processing food. Middens offer a chronological record of Aboriginal resource use and environmental changes, with some dating back over 4,000 years.

In the proposal, before European settlement, shell middens would be associated with QP_bdr Coastal deposits - bedrock-mantling dune facies, QP_br Coastal deposits - beach ridge and QH_ea Estuarine palaeochannel fill which all were associated with sand-based landforms. (Figure 2-2).

Stone artefact scatters:

Artefact scatters, often located near water sources, include tools made from quartz, chert, and jasper, reflecting the Bundjalung's tool-making practices.

In the proposal, before European settlement, these could occur anywhere along the proposal.

Rock shelters and cave sites:

Found primarily in the volcanic hinterlands, rock shelters preserve rock art, charcoal, and artefacts, offering insight into ceremonial and daily life.

These site types would not be found in association with the proposal.

Burial sites:

Occasionally uncovered in coastal sand dunes, these sites reflect the cultural importance of certain areas for both daily life and funerary practices.

In the proposal, before European settlement, burials would be associated with QP_bdr Coastal deposits - bedrock-mantling dune facies, QP_br Coastal deposits - beach ridge and QH_ea Estuarine palaeochannel fill which all were associated with sand-based landforms. (Figure 2-2).

Environmental and resource use:

Evidence of seasonal movement and resource management, such as fire-stick farming, highlights the Bundjalung's environmental practices promoting biodiversity and sustainable resource use.

In the proposal, before European settlement, these could occur anywhere along the proposal.

Conclusion:

The archaeological record of the Tweed Coast provides evidence of cultural connection of the Bundjalung people to their land. Their reliance on coastal and riverine ecosystems, stone tool-making and environmental management demonstrate the complexity of their society.

3.2 Database results

The results of cultural heritage database searches are presented in this section. The objective of these searches is to identify any recorded Aboriginal objects, sites or places within the development footprint and to provide archaeological context for the proposal. The results of the database searches are summarised in Table 3-1.

The location of Aboriginal sites is considered culturally sensitive information. This information, including the Aboriginal Heritage Information Management System (AHIMS) data appearing on the heritage map for the proposal should be removed from this report if it is to enter the public domain.

Table 3-1: Summary of database searches for Aboriginal cultural heritage

Database	Date	Parameters	Results
AHIMS (Client ID: 864050 and 864047)	11/06/2024	1500m search area centred on the proposal	23 Aboriginal sites have been recorded within the search parameters. Most (all) are associated with sand lithologies (Figure 3-1, Table 3-1). See Table 2-2 for detail.
Tweed LEP 2014	11/06/2024	Schedule 5: Environmental Heritage	124 Heritage Sites are listed in the Local Environmental Plans. Two sites are in Cudgen both sites will be avoided. The closest is Cudgen Dry stone walls 463 Cudgen Road, 501 Cudgen Road Lots 7 and Lot 8, DP 812933 Local Heritage Item. This site is 'across the other side of the road form the proposal (Figure 3-2)
Native Title Vision	11/06/2024	NSW	No accepted Native Title claim covers the development footprint
State Heritage Register	11/06/2024	500m buffer around development footprint	All sites listed in the region as State Significant are avoided by the proposal

Figure 3-1: AHIMS data search results (showing geology)

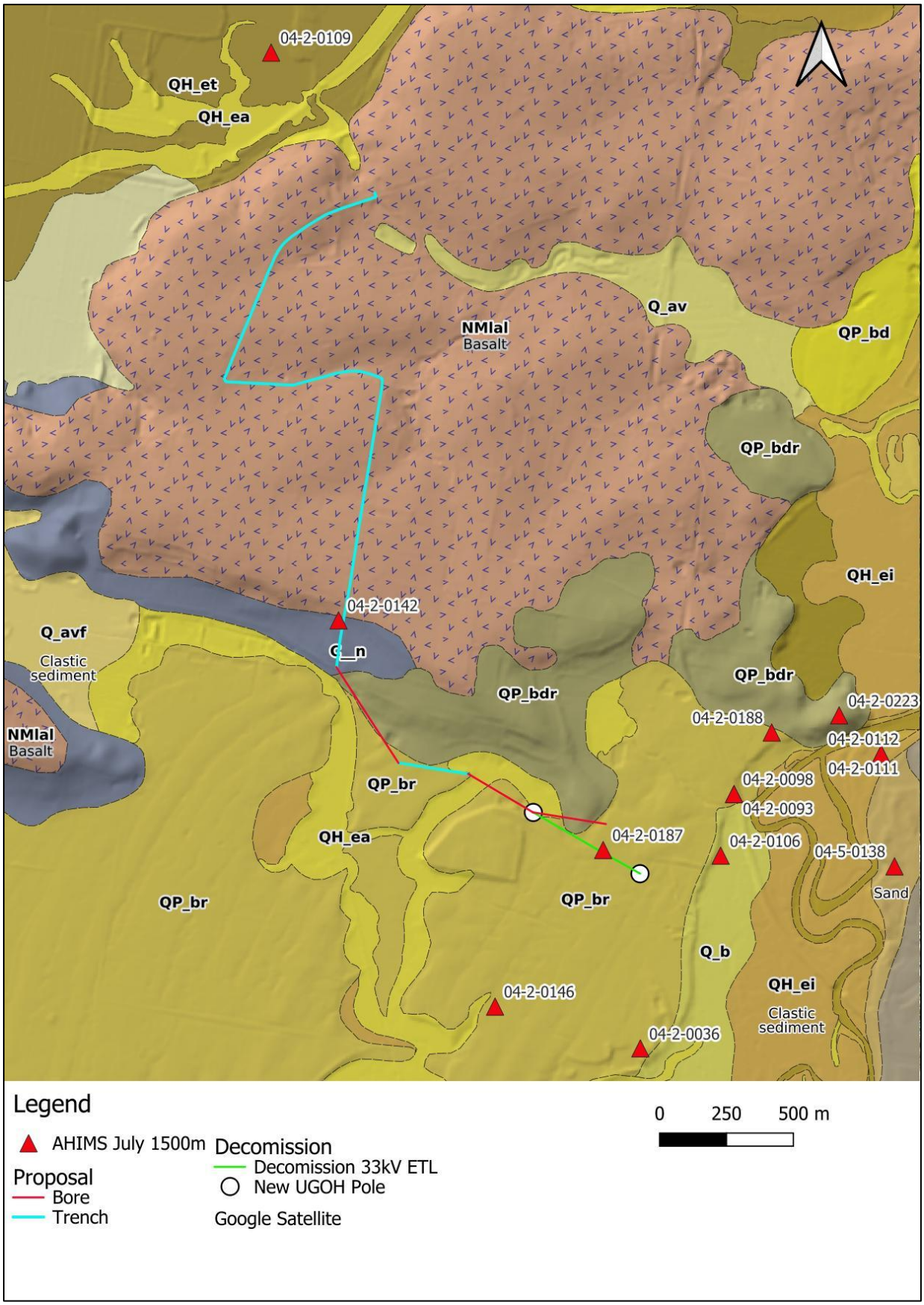


Figure 3-2: Cudgen Dry stone walls 463 & 501 Cudgen Road





A total of 23 Aboriginal sites were recorded within the AHIMS search area (Figure 3-1 and Table 3-2, Appendix A). The most common site type identified was artefact scatters (n=21), with two of these also containing middens (shell deposits). These sites were primarily located near creeks, waterways, wetlands, or on sandy areas, indicating a close association with key natural resources.

Two previously recorded sites are located less than 100 metres from the development footprint, as detailed in Table 3-2. Site 04-2-0187 was noted as 'destroyed' prior to this assessment, and Ainsworth (2014) was unable to relocate 04-2-0142, despite good ground surface visibility in the area.

Table 3-2: Summary of Aboriginal sites in close vicinity to development footprint

Site ID	Site name	Context	Site status	Site features	Site types	Recorders	Reports	Permits
04-5-0140	Kings Beach 3	Open site	Valid	Artefact : -	Open Camp Site	Ms.Jacqueline Collins	0	0
04-5-0139	Kings Beach 2	Open site	Valid	Artefact : -	Open Camp Site	Ms.Jacqueline Collins	0	0
04-5-0138	Kings Beach 1	Open site	Valid	Artefact : - Shell : -	Open Camp Site	Ms.Jacqueline Collins	0	0
04-2-0223	Cudgen Ridge South East Tweed ACH Artefacts	Open site	Valid	Artefact : -		Mr.Ian Fox	0	0
04-2-0190	Kings Forest 10	Open site	Valid	Artefact : 1		Everick Heritage Pty Ltd	0	0
04-2-0189	Kings Forest 9	Open site	Valid	Artefact : 1		Everick Heritage Pty Ltd	0	0
04-2-0188	Kings Forest 13	Open site	Destroyed	Artefact : 1		Everick Heritage Pty LtdEverick Heritage Pty Ltd	0	0
04-2-0187	**King Forest 12**	**Open site**	**Destroyed**	**Artefact : 1**		**Ms.Claire EverettEverick Heritage Pty Ltd**	**0**	**0**
04-2-0146	Kings Forest 7	Open site	Partially Destroyed	Artefact : 102		Mr.Adrian PiperEverick Heritage Pty Ltd	0	0
04-2-0142	**KF-CE 1**	**Open site**	**Valid**	**Artefact : 5**		**Ms.Jacqueline Collins**	**0**	**0**
04-2-0113	SEASIDE CITY 2	Open site	Valid	Shell : - Artefact : -		Mr.Adrian Piper	98082	0
04-2-0112	seaside city a	Open site	Valid	Shell : -		Mr.Adrian Piper	0	0
04-2-0111	seaside city 1	Open site	Valid	Shell : -		Mr.Adrian Piper	0	0
04-2-0109	Crescent St 1	Open site	Valid	Artefact : -		Ms.Rebecca Edwards-Booth	0	0
04-2-0106	Kings Forest 3	Open site	Valid	Shell : - Artefact : -	Midden	Mr.Adrian Piper	0	0
04-2-0103	Kings Forest 1	Open site	Partially Destroyed	Artefact : -	Open Camp Site	Mr.Adrian PiperEverick Heritage Pty Ltd	0	0

Site ID	Site name	Context	Site status	Site features	Site types	Recorders	Reports	Permits
04-2-0102	Kings Forest 2	Open site	Valid	Artefact : -	Isolated Find	Mr.Adrian Piper	0	0
04-2-0098	CudgenOld Bogangar Rd	Open site	Valid	Artefact : -	Open Camp Site	Mr.Adrian Piper	0	0
04-2-0093	Cudgen	Open site	Valid	Artefact : -	Open Camp Site	Mr.Adrian Piper	4065	1130
04-2-0091	Duranbah 3	Open site	Valid	Artefact : -	Open Camp Site	Mr.Adrian Piper	0	0
04-2-0090	Duranbah 2	Open site	Valid	Artefact : -	Open Camp Site	Mr.Adrian Piper	0	0
04-2-0089	Duranbah 1	Open site	Valid	Artefact : -	Isolated Find	Mr.Adrian Piper	0	0
04-2-0036	Cudgen ck 1	Open site	Valid	Artefact : -	Open Camp Site	Klim Gollan	0	0

3.3 Previous studies

Adrian Piper 1997 An archaeological survey at Old Bogangar Road Realignment Cudgen, North Coast NSW

This report was commissioned to assess the potential presence of Aboriginal sites in the vicinity of Old Bogangar Road, Cudgen, with participation from the Tweed Byron Local Aboriginal Land Council.

One Aboriginal site, Cudgen 1 (#04-2-0093), was identified, consisting of a piece of red ochre, a stone flake (material unspecified), and a broken chalcedony flake. The artefacts were found in a sand exposure along the eastern edge of cleared land. It is considered likely the artefacts were redeposited during past land-clearing activities, as the assessment noted the entire area had been heavily disturbed.

Adrian Piper 2001 An archaeological survey of 'Seaside City' south of South Kingscliff Cudgen, North Coast NSW

This report was part of a Draft Local Environment Plan, with participation from the Tweed Byron Local Aboriginal Land Council.

The study area extended from form the coastline west to Cudgen Creek and was joined immediately to the south by the suburb of Casuarina.

Land use included sand mining and associated disturbances. Three Aboriginal sites were recorded (#04-2-0113, #04-2-0112, #04-2-0111), a Pipi midden and a low-density scatter of shell and stone artefatcs adjacent to Cudgen Creek. The midden site had high archaeological significance to NPWS and the Tweed Byron Local Aboriginal Land Council because it was rare in the region as it was intact.

Ainsworth Heritage 2014 Cudgen to Casuarina 33kV Powerline Due Diligence Report

The report evaluates the potential for Aboriginal heritage impacts related to the installation of a 33kV powerline between Cudgen and Casuarina in Northern NSW.

During the field survey, a single Aboriginal site was identified (Site AHKFTL001), which consisted of a white chert flake. While this artefact was isolated, its discovery contributes to

the broader understanding of Aboriginal use of the area. This site does not appear on the AHIMS database, but it is located in the vicinity of #04-2-0106.

Additionally, the report highlights the landscape contains areas with moderate potential for further Aboriginal archaeological sites, particularly given the proximity to water, ridge lines, and dune systems. It mentions artefact scatters, middens, and other cultural heritage sites found nearby, including sites listed in the AHIMS database.

The report recommends proceeding with caution during development due to the likelihood of encountering more Aboriginal cultural materials, and outlines a Stop Work Procedure in case any unexpected finds occur.

Everick 2012 Cultural Heritage Assessment report for the Kings Forest Residential Development

The report outlines extensive archaeological investigations conducted in the area. The report synthesises data from multiple prior surveys and presents findings on recorded Aboriginal sites within the Kings Forest region.

Key Findings:

Aboriginal Sites: Seventeen Aboriginal sites were identified within the project area (Table 3-2), of which:

- Six sites will not be disturbed by the development and will be preserved in situ.
- Eleven sites have undergone archaeological excavations or surface collections to mitigate potential impacts as part of the nearby residential development.

The identified sites include artefact scatters, shell middens, and isolated artefacts, primarily associated with raised sand dunes and areas near watercourses. The artefacts are made predominantly of chalcedony, chert, and other siliceous materials.

The report recommends preserving six significant sites in areas earmarked for environmental protection. These areas will not undergo development. Fencing, signage, and strict management protocols were recommended to protect the cultural heritage of these sites. Further archaeological monitoring is advised during construction phases to ensure no additional sites are disturbed.

The project area has experienced significant environmental disturbances over the past 50 years, primarily due to sand mining, logging, and agricultural activities. These disturbances have impacted the visibility and integrity of archaeological sites. Despite this, some areas with little disturbance still hold considerable potential for subsurface artefacts.

Despite the small and somewhat disturbed nature of the artefact scatters, they are valued by the Aboriginal community due to the relative scarcity of such sites in the region, emphasised by historical land use impacts such as logging, grazing, and sand mining.

Salvage excavations, surface collections, and management plans were implemented to safeguard Aboriginal cultural heritage. Artefacts collected during these processes were to be curated in a keeping place, and interpretive signage will be installed in consultation with Aboriginal stakeholders to inform the public about the cultural heritage of the area.

Aboriginal stakeholders, particularly the Tweed Byron Local Aboriginal Land Council, were consulted throughout the assessment process. They played a key role in decision-making regarding the preservation and management of significant sites.

The Kings Forest Residential Development encompasses an area of significant cultural heritage value, particularly for the local Aboriginal communities. The development will proceed with cultural heritage management protocols to ensure the preservation of Aboriginal sites, with ongoing monitoring and involvement from Aboriginal stakeholders. Further research and archaeological investigations may continue as the development progresses to ensure all cultural heritage is adequately protected and preserved.

3.4 Predictive model

Areas of archaeological potential are regarded as any sensitive landform with a reasonable level of intactness (non-disturbed land). The definition of disturbance or disturbed land used here is in accordance with Regulation 58(4) of the *NSW National Parks and Wildlife Regulation 2019*. Sensitive landforms follow the definitions supplied in the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (Due Diligence code of practice) (DECCW, 2010):

- Within 200m of waters
- Located within a sand dune system
- Located on a ridge top, ridge line or headland
- Located within 200m below or above a cliff face
- Within 20m of or in a cave, rock shelter, or a cave mouth.

Much of the development footprint is located within land subject to significant ground disturbance previously impacted by intensive farming, the construction and installation of roads and tracks, electrical infrastructure, pipelines and optic fibre cables, the old tip and sandmining and associated activities. The level of this historic ground surface disturbance will likely be a major impact across the development footprint as these disturbances will impact the preservation of sites.

The results of the AHIMS search of previous studies indicates a high potential for stone artefact scatters on sandy substrates in proximity to both permanent and ephemeral water sources, including creeks, rivers and perched wetlands.

Based on the results of the AHIMS search, the local archaeological context and previous research a model can be developed for predicting where sites might be encountered along the development footprint:

- Aboriginal sites are likely to occur in land that has been subject to moderate to low levels of historic ground surface disturbance.
- Stone artefact scatters, hearths and burials are likely on sandy substrates within one kilometre of water sources, in areas exposed to little or no previous impacts.
- Stone artefact scatters and middens are likely on open ground with good drainage (a sandy substrate).
- Culturally modified trees (carved and scarred) are possible where trees are present. These are unlikely to occur due to the very high levels of tree clearing in the area.

- Grinding grooves are possible in association with waterways and appropriate bedrock. There is a low probability of these being encountered as the predominant geology of the development footprint is basalt and sand. The one exception is Neranleigh-Fernvale beds which is a sandstone derived geological unit. There is a possibility of portable grinding stones, likely associated with camp sites (stone artefact scatters and hearths) or rock shelters.
- Stone and ochre quarries are possible on Lismore Basalt geologies on the Lamington Volcanic Slopes (SEQ Volcanics) where appropriate stone and minerals outcrops occur.
- Rock art is possible where caves and rock shelters occur however few previous rock art sites have been recorded (Flood, 1980:232). These are unlikely to be encountered as there are no rock shelters within the development footprint.

4 Fieldwork results

4.1 Overview

A field survey of the proposal as conducted on 10 July 2024 by Phil Cameron (Archaeologist) AREA Environmental & Heritage Consultants.

4.2 Methodology

The aim of this survey is to identify and record all Aboriginal sites along the development footprint, including surface exposures (such as artefact scatters and shell middens), landscape features (e.g., rock shelters, rock art, and culturally modified trees like scarred or carved trees), and potential archaeological deposits (PADs) where there is a high likelihood of Aboriginal objects or material traces being present.

Special attention was given to areas with ground surface disturbance, compensating for low ground surface visibility. These areas were assessed by considering the presence of flora species that respond to such conditions, which serve as a highly accurate indicator of site disturbance.

The survey was conducted by walking transects across sections of the proposed development area, with vehicles used for transportation between sampling locations and for reconnaissance inspections. Transects were walked directly along the development footprint to maximise coverage.

Due to the linear nature of the development footprint, a sampling strategy was employed. This strategy was based on archaeologically sensitive landforms (as outlined in the predictive model in Section 3.4), culturally sensitive landscapes (as defined by Aboriginal traditional knowledge and previously recorded sites), ground surface visibility (GSV), and the existing levels of disturbance.

- Care was taken to observe areas of cut, fill and paddock levelling along the Lamington Volcanic Slopes (SEQ Volcanics) and sand mining and impacts from the old tip on the Byron - Tweed Alluvial Plains SEQ Clarence Basin NSW Landscapes. Collectively keen observations were taken to identify Significant Ground Disturbance (SGD).
- All mature trees within the development footprint were inspected to determine if they were Culturally Modified Trees (scarred or carved).
- All high archaeological or culturally sensitive landforms with low to moderate levels of historic disturbance were assessed in full, on foot.
- All previously recorded sites in the vicinity of the development footprint were inspected to determine the extent and condition of the site.
- Where ground surface visibility was low, irrespective of previous levels of disturbance all exposures identified during the reconnaissance inspections were inspected. In addition, nearby areas of higher ground surface visibility (GSV) were inspected to provide a sample from which results could potentially be extrapolated.
- Low archaeological or culturally sensitive landforms with high levels of historic disturbance were sampled.

A GPS was used to ensure the survey covered the development footprint. Photographic and written records were made of the landscape features relevant to archaeological potential. These features include landform, soil information, land surface conditions, GSV, ground disturbance levels and any newly or previously recorded sites.

If new sites were recorded an AHIMS Site Recording Form was completed.

4.3 Results

No Aboriginal sites were recorded during the survey, and none were thought to be undetected due to the significant ground surface disturbance.

4.3.1 Previously recorded sites

AHIMS #04-2-0187 King Forest 12 recorded by Everick (2012), (Figure 4-1, Figure 4-2)

This site is listed as destroyed in the AHIMS search.

It was recorded by Everick (2012) on an open sand flat on the northern side of Depot Road and consisted of a low-density scatter of stone artefacts (<1 artefact/sq m). The area at the time it was recorded had been heavily disturbed by activities such as sand mining, road construction, and possibly pine cultivation. The site is approximately 100 metres from a water source.

Everick noted that, the opinion of the Registered Stakeholders regarding the Cultural Significance of Kings Forest 12 was that, due to the high level of disturbance, artefacts found at the site should be collected and stored in an appropriate Keeping Place.

Everick (2012) recorded a total of eight artefacts on the soils surface, predominantly made of chalcedony and representing two technological classes. It was considered unlikely that these surface artefacts indicate the presence of significant subsurface deposits.

Everick (2012) Management Recommendations:

- Surface collection of artefacts and storage in a suitable Keeping Place (undertaken).
- Further recommendations and details can be found in the Cultural Heritage Assessment and Excavation Reports.

A comparison of the sites location at the time it was recorded in 2012 and in July 2024 during this assessment are shown on Figure 4-2.

Figure 4-1: Location of previously recorded Aboriginal sites



Figure 4-2 (image from Evericks AHIMS site card [top] and AREAs July 2024 assessment below)





Note – the carparking area is likely where the top photo was taken

AHIMS #04-2-0142 KF-CE 1 recorded by Jacqueline Collins in 2005 (Figure 4-1, Figure 4-3)

The site card states the Aboriginal objects were recorded on an undulating plain within a dune landform unit. This is inconsistent with the mapped coordinates which currently places it in the Lamington Volcanic Slopes NSW Landscape / Lismore Basalts geological unit.

The site card also references grassland, revegetation, and forestry, which does not align with the actual landform mapped by the coordinates, as this area is a ploughed agricultural paddock as it had been in 2005 upon reviewing historical aerial photography.

The description provided for relocation of the site is similarly inconsistent. The directions indicate: *From Tweed Coast Road south of Cudgen, travel 2.5 km, then turn right onto Depot Road and follow it to the end. Turn right heading west, travel 1 km to a track, then go north for 1.3 km to the end, and turn right along the boundary fence track for 160 m – artefacts are located on the track*. However, the site is plotted off Reardon's Road, which is located at least one kilometre north-west from Depot Road, at the nearest point. (Note – consideration was given to the old Depot Rd being accessed).

While the site card plots correctly based on the coordinates provided, the actual coordinates listed on the site card are not correct and are inconsistent the locations description in the site card. The site is likely located within a dune landform unit well away from the where the site is recorded in AHIMS, on the Lamington Volcanic Slopes NSW Landscape / Lismore Basalts geological unit. AHIMS data may on occasion have errors for a suite of reasons which is a common occurrence and reason for the reader to check the source data and ancillary descriptors and not just rely upon the coordinates provided.

Figure 4-3: Location of previously recorded Aboriginal site 04-2-0142 per AHIMS database (not likely the actual site location)



4.3.2 Landscape features

The development footprint spans two NSW landscapes (Figure 2-1):

Lamington Volcanic Slopes:

The Lamington Volcanic Slopes contain raw materials that are suitable for the manufacture of Aboriginal stone tools. However, the likelihood of finding Aboriginal sites is reduced due to significant ground surface disturbance caused by intensive agriculture, road construction, paddock levelling, and powerline installation in the proposal area.

Geological and archaeological features:

Lismore Basalt: Predominantly tholeiitic basalt with occasional alkaline formations. This geologically rich landscape holds high potential for stone tool production and quarry sites. The durability and availability of tholeiitic basalt made it a key resource for Aboriginal tool-making, with alkaline basalt offering additional materials for specialised tools or ornaments. The volcanic origin, with its exposed outcrops and rugged terrain, likely served practical purposes and may also have had cultural significance, providing insights into how Aboriginal people utilised and valued these geological resources.

Coastal Deposits – Beach Ridge: Consisting of fine to coarse-grained quartz-lithic-carbonate sand (marine-deposited), shell-rich beds, and polymictic gravel. These deposits present strong archaeological potential, particularly in relation to Aboriginal use of marine resources, midden formation, and tool-making activities. The variety of materials in this environment suggests a dynamic coastal ecosystem that Aboriginal groups thrived in, leaving behind cultural artefacts which offer insights into their subsistence and adaptation strategies.

Neranleigh-Fernvale Beds: Comprising feldspathic and lithic meta-arenite, metasiltstone, conglomerate proximal turbidite, and intercalated chert, jasper, and mafic meta-volcanics. These formations offer rich archaeological potential, with high-quality stone materials such as chert and jasper indicating likely stone tool production sites, including quarries and artefact scatters. The complex geological history of the area suggests this landscape was a valuable resource for both tool-making and possible cultural or symbolic use of stone materials.

Byron-Tweed Alluvial Plains:

The Byron-Tweed Alluvial Plains have a higher likelihood of containing Aboriginal objects in areas which have not been impacted by sand mining. Ainsworth (2014) identified such areas east of Tweed Coast Road, associated with intact sand dunes, though the current proposal is located west of Tweed Coast Road avoiding these areas. The geological and archaeological features include:

Coastal Deposits – Beach Ridge: As with the Lamington Volcanic Slopes, the fine- to coarse-grained quartz-lithic-carbonate sands, shell-rich beds, and polymictic gravel in this area have strong archaeological potential, particularly regarding Aboriginal marine resource use, midden formation, and tool-making activities. The diversity of these deposits suggests a thriving Aboriginal presence, with artefacts that reveal much about their subsistence patterns and environmental adaptation.

Estuarine Palaeochannel Fill: Composed of organic mud, peat, clay, silt, and fine- to medium-grained lithic-carbonate-quartz sand (marine-deposited). These organic-rich sediments

indicate a landscape with significant archaeological potential. The wetland characteristics, combined with marine influences, provide ideal conditions for the preservation of organic artefacts (wooden implements), stone tools, and midden deposits. The environmental complexity and stratigraphic layers point to a long history of Aboriginal occupation, resource use, and adaptation to changing coastal conditions, making it a prime area for archaeological investigation.

Ground surface visibility (GSV) varied, in some areas it was 100 per cent (mostly associated with ploughed land) while other areas there it was variable and largely dependent on exposures (Figures 4-4 to 4-9).

Ground surface disturbance (GSD) was high throughout the development footprint.

Figure 4-4: Proposed trenching on Lamington Volcanic Slopes. High GSV and GSD



Figure 4-5: Proposed bore entry on Byron-Tweed Alluvial Plains. High GSV and GSD



Figure 4-6: Proposed bore entry on Byron-Tweed Alluvial Plains. Moderate GSV high GSD



Figure 4-7: Proposed trenching on Lamington Volcanic Slopes. Low GSV and high GSD



Figure 4-8: Proposed trenching on Lamington Volcanic Slopes. Low GSV and high GSD



Figure 4-9: Proposed trenching on Byron-Tweed Alluvial Plains. Low GSV high GSD



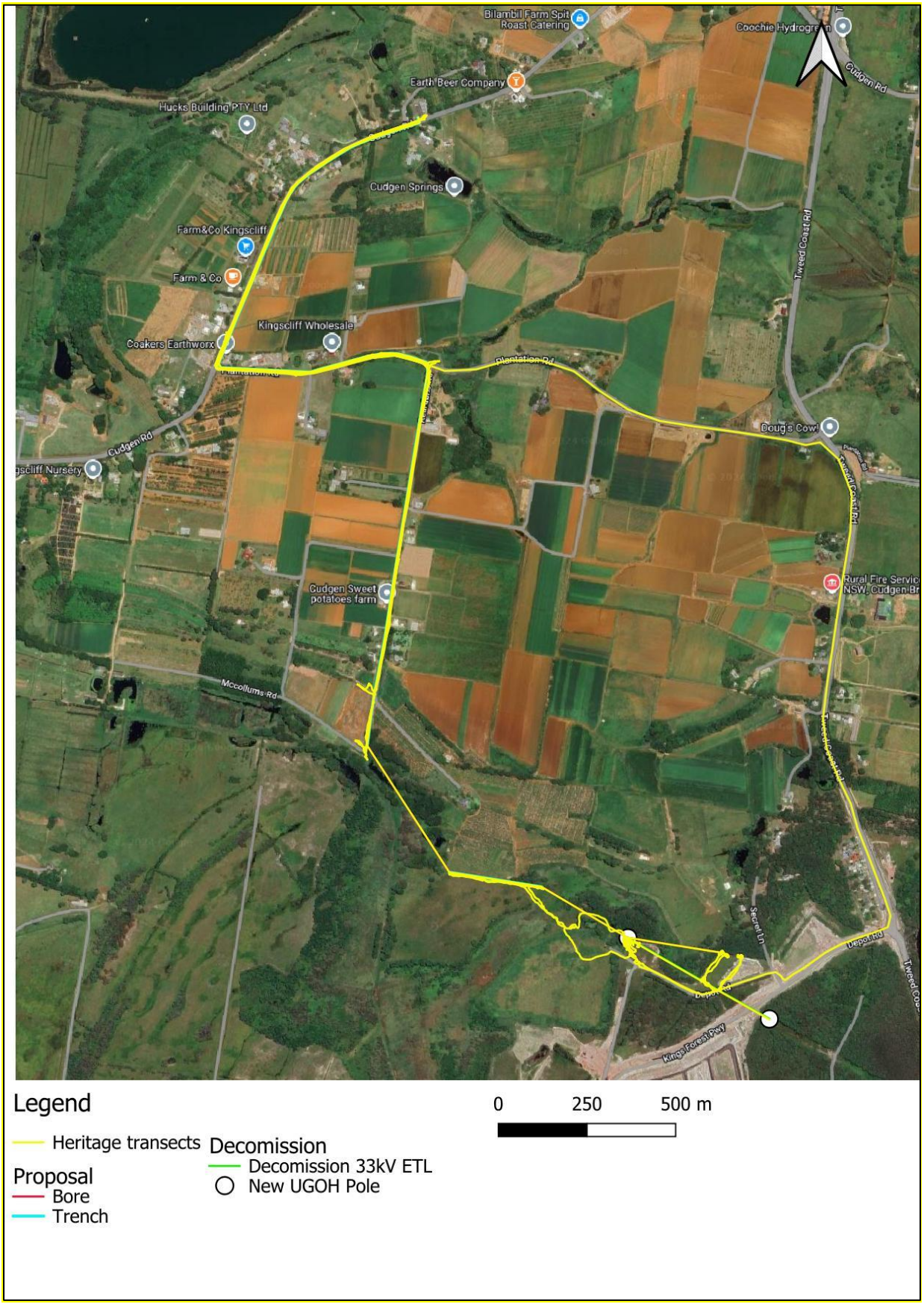
4.3.3 Survey effort

The development footprint was assessed by pedestrian survey with survey effort dictated by a sampling method taking account for factors such as ground surface visibility (GSV), existing levels of disturbance, archaeologically sensitive landscapes and archaeological context (Figure 4-10). Areas of high archaeological potential were surveyed by foot where GSV was considered sufficient. Where GSV was low along the development footprint, nearby driveways and unsealed tracks, that provided ground surface exposures, were also inspected to extrapolate the potential of artefact scatters.

Recent rain falls in the months prior to the survey had resulted in thick ground cover and limited GSV across most of the development footprint. In these areas that offered low archaeological potential vehicles were used to travel along the development footprint and spot checks undertakes at locations that offered higher archaeological potential (e.g. locations containing exposures) In this manner all exposures and mature trees were assessed along the development footprint.

A GPS was used to ensure the survey covered the subject land.

Figure 4-10:Survey Effort



4.4 Discussion

The predictive model outlined in Section 3.4 provided a solid framework for interpreting the results along the development footprint. The construction methods were carefully designed to minimise the risk of harm to Aboriginal objects by focusing activities in areas where significant ground surface disturbance had already occurred.

For example, trenching on the Lamington Volcanic Slopes, where the original soil surface is highly disturbed, was considered appropriate due to the reduced archaeological risk in such areas.

In contrast, on the Byron-Tweed Alluvial Plains, under-boring was employed near waterways to address the higher risk posed by sandy deposits, which have an increased potential to contain Aboriginal objects. This method reflects consideration of the greater archaeological sensitivity in these less disturbed, sand-rich environments. Additionally, the use of trenching in areas that have already experienced substantial ground disturbance, such as existing overhead powerline corridors ensures that residual potential heritage sites in less disturbed areas are avoided.

5 Assessment of significance

As no Aboriginal objects are recorded in the proposal, the rest of this chapter has been omitted.

6 Impacts and management

6.1 Overview

Cultural heritage values require management for any proposal where they have been identified. Whether an impact is direct, indirect, or possible, Aboriginal sites will require some level of intervention to avoid harm where possible. As a general principal, avoidance of impact to sites of Aboriginal cultural heritage is the preferred method of management and is implemented in the first instance by Essential Energy. This is advocated in the Burra Charter (Australia ICOMOS, 2013) as well as various other guidelines and codes of practice. Total avoidance of all sites of heritage value is not always feasible. In the case avoidance presents a proponent with considerable difficulties, they may apply to damage or destroy a site.

6.2 Potential impact to cultural heritage

No Aboriginal objects were recorded during the assessment.

While subsurface archaeological remains and unrecorded surface remains are always possible, given the landscape and historic disturbance, no unrecorded, intact remains of archaeological significance are predicted to occur in the proposal. Consequently, impacts to Aboriginal objects is not likely to occur. Further archaeological investigation is not considered reasonable given the low likelihood of archaeologically significant remains and the scale of the proposal.

6.3 Proposed management of cultural heritage

The following mitigation is required to reduce the potential for inadvertent impact to other Aboriginal sites.

- An unexpected finds protocols (Appendix B) should be implemented.
- If changes are made to the proposal further archaeological investigation may be required.

7 Recommendations

Cultural heritage values require management for any proposal where they have been identified. Whether an impact is direct, indirect, or possible, Aboriginal sites will require some level of intervention to avoid harm where possible.

The following recommendations are based on the on the consideration of:

- The requirements of the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (DECCW, 2010)
- The *NSW National Parks and Wildlife Act 1974*
- The results of the background research and fieldwork
- The likely impacts of the proposal.

All Aboriginal sites will be avoided by the proposal.

Based on this assessment, the following recommendations are made:

- No impacts to Aboriginal heritage are anticipated for recorded Aboriginal sites within the development footprint and works can proceed with caution.
- If any objects of suspected Aboriginal heritage origin be encountered during the proposed works, work in the area of the find should cease and the unexpected finds protocols (Appendix B) should be implemented.
- If changes are made to the proposed works which could impact locations outside of the current development footprint, further archaeological investigation may be required.
- If suspected human remains are located during any stage of the proposed works, work must stop immediately, and the NSW police must be notified.

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Appendix A: Database search results

AHIMS Web Services (AWS)

Note: This Excel report shows the sites found in AHIMS on the 30/06/2024. If this date is not the same as the original date of the Search Results letter obtained during the Basic Search, then the search results might be different. The PDF version of this report will always coincide with the Basic Search letter.

Site ID	Site name	Datum	Zone	Easting	Northing	Context	Site status	Primary contact	Site features	Site types	Recorders	Reports	Permits	Longitude GDA94	Latitude GDA94
04-2-0090	Duranbah 2	AGD	56	552550	6869300	Open site	Valid		Artefact : -	Open Camp Site	Mr.Adrian Piper			153.54	-28.30
04-2-0036	Cudgen ck 1	AGD	56	554800	6869650	Open site	Valid		Artefact : -	Open Camp Site	Klim Gollan			153.56	-28.30
04-2-0113	SEASIDE CITY 2	AGD	56	555870	6870700	Open site	Valid		Shell : -, Artefact : -		Mr.Adrian Piper	98082		153.57	-28.29
04-2-0142	KF-CE 1	AGD	56	553672	6871249	Open site	Valid	Searle	Artefact : 5		Ms.Jacqueline Collins			153.55	-28.28
04-2-0188	Kings Forest 13	GDA	56	555405	6871014	Open site	Destroyed		Artefact : 1		Everick Heritage Pty Ltd,Everick Heritage Pty Ltd			153.56	-28.29
04-5-0138	Kings Beach 1;	AGD	56	555750	6870330	Open site	Valid		Artefact : -, Shell : -	Open Camp Site	Ms.Jacqueline Collins			153.57	-28.29
04-5-0140	Kings Beach 3;	AGD	56	555630	6868830	Open site	Valid		Artefact : -	Open Camp Site	Ms.Jacqueline Collins			153.57	-28.30
04-2-0109	Crescent St 1	AGD	56	553420	6873370	Open site	Valid		Artefact : -		Ms.Rebecca Edwards-Booth			153.55	-28.26
04-2-0223	Cudgen Ridge South E	GDA	56	555657	6871078	Open site	Valid		Artefact : -		Mr.Ian Fox			153.57	-28.29
04-2-0106	Kings Forest 3	AGD	56	555100	6870370	Open site	Valid		Shell : -, Artefact : -	Midden	Mr.Adrian Piper			153.56	-28.29
04-2-0190	Kings Forest 10	GDA	56	553300	6869250	Open site	Valid		Artefact : 1		Everick Heritage Pty Ltd			153.54	-28.30
04-2-0103	Kings Forest 1	AGD	56	551718	6870504	Open site	Partially Destroyed		Artefact : -	Open Camp Site	Mr.Adrian Piper,Everick Heritage Pty Ltd			153.53	-28.29
04-2-0189	Kings Forest 9	GDA	56	553200	6869050	Open site	Valid		Artefact : 1		Everick Heritage Pty Ltd			153.54	-28.30
04-2-0091	Duranbah 3	AGD	56	552350	6869300	Open site	Valid		Artefact : -	Open Camp Site	Mr.Adrian Piper			153.53	-28.30
04-2-0111	seaside city 1	AGD	56	555700	6870750	Open site	Valid		Shell : -		Mr.Adrian Piper			153.57	-28.29
04-2-0112	sea side city a	AGD	56	555700	6870750	Open site	Valid		Shell : -		Mr.Adrian Piper			153.57	-28.29
04-5-0139	Kings Beach 2;	AGD	56	555730	6869350	Open site	Valid		Artefact : -	Open Camp Site	Ms.Jacqueline Collins			153.57	-28.30
04-2-0089	Duranbah 1	AGD	56	552670	6869170	Open site	Valid		Artefact : -	Isolated Find	Mr.Adrian Piper			153.54	-28.30
04-2-0098	Cudgen;Old Bogangar	AGD	56	555150	6870600	Open site	Valid		Artefact : -	Open Camp Site	Mr.Adrian Piper			153.56	-28.29
04-2-0093	Cudgen	AGD	56	555150	6870600	Open site	Valid		Artefact : -	Open Camp Site	Mr.Adrian Piper	4065	1130	153.56	-28.29
04-2-0102	Kings Forest 2	AGD	56	551600	6869900	Open site	Valid		Artefact : -	Isolated Find	Mr.Adrian Piper			153.53	-28.29
04-2-0146	Kings Forest 7	AGD	56	554257	6869806	Open site	Partially Destroyed	T Russell	Artefact : 102		Mr.Adrian Piper,Everick Heritage Pty Ltd			153.55	-28.29
04-2-0187	King Forest 12	GDA	56	554775	6870575	Open site	Destroyed		Artefact : 1		Ms.Claire Everett,Everick Heritage Pty Ltd			153.56	-28.29

Appendix B: Unanticipated finds protocol

Unanticipated Finds Protocol

The protocol to be followed in the event previously unrecorded or unanticipated Aboriginal object(s) are encountered during the proposed works is as follows:

- All ground surface disturbance in the area of the finds should cease immediately the finds are uncovered. With an appropriate buffer zone of at least 20 metres to allow for the assessment and management of the find. All site personal will be informed about the buffer zone with no further works to occur within the buffer zone.
- If the finds are of human remains, the environmental manager or other nominated senior staff member will contact the NSW Police on the non-emergency line (02) 131 444.
- A Heritage specialist will be engaged to assess the Aboriginal place or object encountered, representative(s) from the registered the Aboriginal Stakeholders for the Project may also be engaged to assess the cultural significance of the place or object.
- If the Aboriginal heritage places or objects are found to be covered under the existing approvals to impact Aboriginal heritage within the development footprint, works may continue to be conducted in accordance with mitigation measures and approval requirements.
- If the Aboriginal heritage places or objects are found to not be covered under the existing approvals to impact Aboriginal heritage within the development footprint, works will not recommence at the heritage place or object until advised to do so by Heritage NSW.
- If the heritage place or object can be managed in situ, works at the heritage location will not recommence until appropriate heritage management controls have been implemented, such as protective fencing.
- For historic relics, work must cease in the affected area and the Heritage Council must be notified in writing (heritagemailbox@environment.nsw.gov.au) This is in accordance with section 146 of the *Heritage Act 1977.*
- Depending on the nature of the discovery, additional assessment may be required prior to the recommencement of work in the area. At a minimum, any find should be recorded by an archaeologist.

Appendix G: Electric and Magnetic Field Assessment (Aurecon, 2024)

Kings Forest Installation of underground 33/66kV cables

Electric and Magnetic Fields Assessment

Essential Energy

Reference: 527792

Revision: 0

2024-12-13



aurecon

Bringing ideas to life

Document control record

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Client contact		Nathan Hegerty	**Client reference**			
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Current revision		**0**				

Approval			
Author signature		Approver signature	
Name	Cervantes Feng	Name	Tim Nath
Title	Electrical Engineer	Title	Senior Electrical Engineer

Executive Summary

Kings Forest Estate Pty Ltd has put forward a connection request to Essential Energy to install approximately 4.4 km of new underground 33/66 kV cables from Cudgen Zone Substation to the proposed new Kings Forest Zone Substation. Aurecon has been engaged to undertake an Electric and Magnetic Fields (EMF) assessment for the project.

The scope of Aurecon's assessment relating to the installed cable encompasses the following:

- Provision of a brief description of EMF in relation to human health.
- Calculation of the electric and magnetic field contribution of the proposed cable feeder at one metre above ground level, extending up to 30 metres on each side of their centrelines and covering sections AA, BB and CC, using conductor configurations and other relevant parameters associated with the proposed cables. Refer to Section 3.1 for specific cable arrangements.
- An assessment of the compliance of the anticipated field levels with the relevant national and international EMF guidelines.
- An assessment of compliance of the proposed cables with precautionary and prudent avoidance principles in accordance with the relevant guidelines.
- An assessment of EMF under both 33 kV and 66 kV operation.
- Preparation of a report covering the EMF assessment to inform the overall environment assessment.

The purpose of this assessment is to check the EMF levels of the proposed 33/66 kV cables against the International Commission on Non-Ionizing Radiation Protection (ICNIRP) public exposure guidelines as recommended by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA).

Aurecon has modelled the EMF associated with the proposed feeder and, based on the modelling results, has arrived at the following conclusions.

Magnetic Fields

The contribution of the proposed underground feeders to the magnetic field environment is predicted to be well within the ICNIRP Guideline Reference Level of 2,000 mG. Relevant magnetic field contributions directly above the cable are summarised in Table 1-1 below.

Table 1-1: Summarised magnetic field contributions directly above the cable

Section	Voltage Level (kV)	System Normal Average		System Normal Peak Load		Emergency Peak Load	
		(mG)	% of ICNIRP Guideline Ref. Level	(mG)	% of ICNIRP Guideline Ref. Level	(mG)	% of ICNIRP Guideline Ref. Level
Section AA & BB	33	27	1.4%	52	2.6%	82	4.1%
	66	22	1.1%	43	2.1%	65	3.2%
Section CC	33	25	1.3%	48	2.4%	75	3.7%
	66	20	1.0%	39	2.0%	59	3.0%

As shown in Table 1-1, the highest predicted magnetic field contribution of the proposed underground feeder is less than 4.1% of the ICNIRP Guideline Reference Level directly above the proposed feeders under 33 kV operation and less than 3.7% under 66 kV operation.

It can also be seen that the magnetic field contribution under 66 kV operation are lower than those for 33 kV operation. This is due to the load current during 33 kV operation being higher than for 66kV operation.

Electric Fields

Being of underground cable construction, the electric fields associated with the cables will be contained within them and, accordingly, the proposed feeder will not produce external electric fields.

Prudent Avoidance

It is widely accepted that, given the inconclusive nature of the science, a prudent/precautionary approach continues to be the most appropriate response to health concerns regarding EMF. Under this approach, the operators of electricity infrastructure should design their facilities to reduce the intensity of the magnetic fields they generate, and locate them to minimise the fields that people, especially children, encounter over prolonged periods, provided this can be readily achieved without undue inconvenience and at reasonable expense, and be consistent with good engineering and risk minimisation practice.

It is understood that, along with other members of the Energy Networks Association (ENA), Essential Energy has adopted the policy of prudent avoidance and, in this context, has advised that, over the course of the project, it has or will:

- Share information regarding the EMF/health issue and the proposed underground cables.
- Adopted an underground cable concept rather than less expensive overhead lines.
- Where practical, install the cable as far as practicable from dwellings.
- Selected the proposed cable route to pass primarily through rural and sparsely populated land, minimising potential EMF exposure to residents.
- In due course, re-configure the feeder to operate at 66 kV, thereby reducing the load currents and, hence, its magnetic field contribution.

Due to the uncertainty as to the existence or otherwise of adverse health effects, it cannot be said whether the above measures would result in any health benefit, but they are all appropriate and consistent with the principles of prudent avoidance.

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1 Background and Scope

1.1 Background

As part of a connection request from Kings Forest Estate Pty Ltd (known as “Leda”), Essential Energy is looking to install approximately 4.4 km of new underground 33/66 kV electricity cables between Cudgen Zone Substation (ZS) and the proposed new Kings Forest Zone Substation. The new underground cable will facilitate the serving of a new 4,500 dwelling, 856 hectare (ha) master-planned community development and improve local electricity infrastructure. Essential Energy has engaged Aurecon to undertake an assessment of the power frequency Electric and Magnetic Fields (EMF) likely to be associated with the proposed feeder.

As part of the Secretary’s Environmental Assessment Requirements (SEARs) issued for the Environmental Impact Statement (EIS), due to approximately 95 meters of the cable route intersecting a mapped coastal wetland, an EMF assessment of the proposed new 33/66 kV underground cable section has been triggered by Tweed Shire Council (TSC). The EMF assessment will focus on the 4 km of the proposed route between Cudgen ZS and the termination of the underground 33/66 kV cables on Leda-owned land (Lot 1 DP781633).

The proposed cable route is shown in Figure 1-1.



Figure 1-1: Proposed underground cable route from Cudgen Zone Substation and Leda Owned Land

1.2 Key Components of the Project

The key components of the proposed works in relation to the EMF assessment are the following:

- The cables will be energised at 33 kV initially. However, provision for future energisation at 66 kV will also be assessed as part of this report.

- There are three different cable sections along this cable route. However, only sections AA and CC will be assessed, due to sections AA and BB being geometrically the same, but with different backfill, which has no impact on EMF.
  - Sections AA and BB account for approximately 3.7 km of the cable run.
  - Section CC accounts for approximately 0.7 km of the cable run.

1.3 Purpose and Scope of this Report

Installation of about 400 meters of the proposed 4.4 km underground cable section within the Kings Forest development has already been completed and is covered under a Review of Environmental Factors (REF), which falls outside Aurecon's scope. Aurecon's scope will cover the remaining 4 km from Cudgen Zone Sub to Secret Lane.

The scope of Aurecon's assessment relates to the underground 33/66 kV cables and is to encompass the following:

- Provision of a brief description of EMF in relation to human health.
- Calculation of the electric and magnetic field contribution of the proposed cables at one metre above ground level, extending up to 30 metres on each side of their centrelines and covering route sections AA, BB and CC, using conductor configurations and other relevant parameters associated with the proposed cables. Refer to Section 3.1 for specific cable arrangements.
- An assessment of the compliance of the anticipated field levels with the relevant national and international EMF guidelines.
- An assessment of the compliance of the proposed cables with precautionary and prudent avoidance principles in accordance with the relevant guidelines.
- An assessment of EMF under both 33 kV and 66 kV operation.
- Preparation of a report covering the EMF assessment to inform the overall environment assessment.

The assessment of electric fields is excluded from further consideration as, due to being underground cables, the proposed feeders will not produce external electric fields.

The scope of this assignment is confined to power frequency EMF and electromagnetic radiation is excluded as underground cables do not emit electromagnetic radiation.

1.4 Structure of the Report

The structure and content of this report are as follows:

- Chapter 1 (Introduction) - outlines the overview, key components and the purpose and scope of this report.
- Chapter 2 (Overview of electric and magnetic fields) - provides a description of EMF and outlines the key guidelines relating to EMF.
- Chapter 3 (Input information and aspects of field predictions) - provides the approach and assumptions used in the EMF modelling.
- Chapter 4 (Field characterisation) - presents the EMF modelling results.
- Chapter 5 (Compliance with EMF guidelines and prudent avoidance principles) - discusses compliance with the key guidelines relating to EMF and the application of prudent avoidance.

2 Overview of Electric and Magnetic Fields

2.1 General Description

Whenever electrical equipment is in service, it produces an electric field and a magnetic field. The electric field is associated with the voltage of the equipment and the magnetic field is associated with the current (amperage). In combination, these fields cause energy to be transferred along electric wires. Being related to voltage, the electric fields associated with high voltage equipment remain relatively constant over time, except where the operating voltage changes. Conversely, being related to current, the magnetic field strength resulting from an electrical installation varies continually with time as the load on the equipment varies.

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

Further detail on EMFs can be found in Appendix A – General Description of Electric and Magnetic Fields.

2.2 Electric and Magnetic Fields and Health

The possibility of adverse health effects due to the EMFs associated with electrical equipment has been the subject of extensive research throughout the world for more than 40 years. To date, while adverse health effects have not been established, the possibility that they may exist cannot be ruled out. Further discussion of the EMF/health issue can be found in Appendix B.

2.3 Health Guidelines

Since late 2015, the relevant Australian regulator, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), has adopted the international guideline published by the International Commission on Non-Ionising Radiation Protection (ICNIRP) in 2010. Details of the current guideline “Reference Levels” for electric and magnetic field exposure can be found in Appendix C. These “Reference Levels” have been used as the principal assessment criteria for this assignment and are reproduced in Table 2-1. The criteria are independent of duration of exposure.

Table 2-1: ICNIRP Guideline Reference Levels (General Public)

Parameter	Reference Level
Electric Field – General Public	5,000 Volts per metre (V/m)
Magnetic Field - General Public	2,000 milligauss (mG)

2.4 Prudent Avoidance

Given the inconclusive nature of the science regarding EMF and human health, it is widely considered that a prudent approach is the most appropriate response under the circumstances. Under this approach, subject to modest cost and reasonable practicality, the owners of electric power infrastructure should design their facilities to reduce the intensity of the fields they generate in frequented areas.

In the Australian context, the Energy Networks Association (ENA), of which Essential Energy is a member, has produced an EMF Management Handbook (Ref D-5), which addresses Prudent Avoidance in the following terms:

> *“Prudent avoidance does not mean there is an established risk that needs to be avoided. It means that if there is uncertainty, then there are certain types of avoidance (no cost / very low-cost measures) that could be prudent.”*

It also states:

> *"Both prudent avoidance and the precautionary approach involve implementing no cost and very low-cost measures that reduce exposure while not unduly compromising other issues."*

Further discussion on this subject can be found in Appendix D.

3 Input Information and Aspects of Field Predictions

3.1 Input Information

The input data listed below, required for the calculations on which this assessment is based, has been provided by Essential Energy,

- Cable details
- Proposed cable loading information for both 33kV and 66kV operation under system normal average, system normal peak, and emergency (N-1) conditions.
- Cable route – The proposed 33/66 kV cable route primarily passes through rural and sparsely populated land, minimising residents' potential exposure to EMF.
- Easement widths
- Existing and proposed cable trench dimensions
- Cable spacing

The cable works have been divided into three cable trench layouts, based on the specific configurations, for analysis. The type of construction for the various sections of the cable route shown in Section 1.1 are described separately in Table 3-1.

Table 3-1: Cable run details for different sections along the route

Section	Location	Minimum depth to the top phase(mm)	Easement Width (mm)	Proposed Cable
AA	▪ Cudgen Road to Plantation Road ▪ Plantation Road to Reardon Road ▪ Various sections of off-road terrain between Reardon Road and Secret Lane ▪ Along Depot Road until Secret Lane	900	700	3 x 66 kV 1C 630 mm^2 TRXLPE/HDPE
BB	▪ Cross from West side of Cudgen Road to Plantation Road	900	700	3 x 66 kV 1C 630 mm^2 TRXLPE/HDPE
CC	▪ Various sections of off-road terrain between Reardon Road and Depot Road	900	350	3 x 66 kV 1C 630 mm^2 TRXLPE/HDPE

Essential Energy has also provided the cable arrangement for each of the cable sections. Section AA and section BB follow the cable arrangement shown in Figure 3-1. Section CC follows the cable arrangement shown in Figure 3-2.

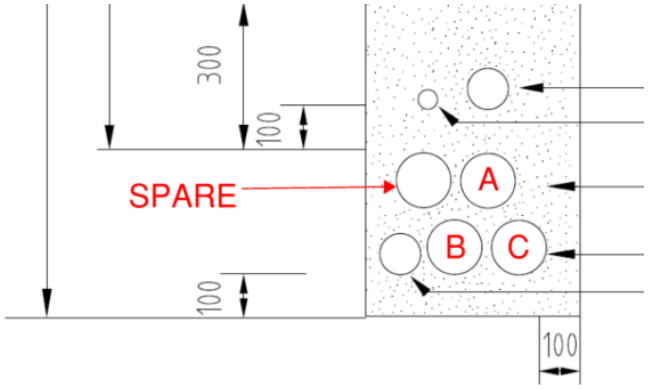


Figure 3-1: Section AA and section BB cable arrangement

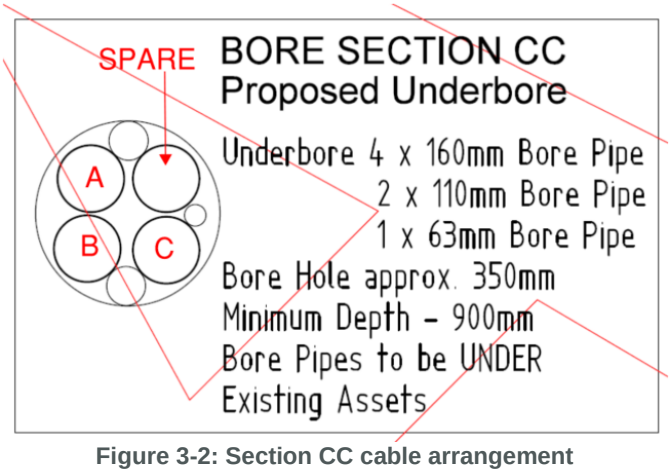


Figure 3-2: Section CC cable arrangement

3.2 Approach

As noted in Appendix A – General Description of Electric and Magnetic Fields, while EMFs involve both electric and magnetic components, electric fields are relatively constant over time, are readily shielded and, in the health context, are generally no longer associated with the same level of interest as magnetic fields. In the case of underground feeders, the electric fields are contained within the cables and, accordingly, the proposed feeder will not produce external electric fields and the remainder of this report is directed to magnetic fields.

To gain a comprehensive understanding of the magnetic field contributions from the proposed cables, the predicted field levels associated with the various sections of the Kings Forest cable route have been modelled separately as per Table 3-1.

The magnetic fields produced by cables is influenced by their physical arrangements. The cable arrangements used for modelling are as advised by Essential Energy.

In selecting the load conditions to be modelled for this assessment, Aurecon has examined the various possible combinations of load currents. For the purposes of reporting, Aurecon has selected the system normal average and maximum load cases as they cover most of the time. Emergency condition (N-1) load cases were also examined to determine the maximum magnetic field contribution experienced under any circumstances.

Based on the available design and loading information, the magnetic field contribution of the feeder has been modelled using established in-house software, which has been extensively validated against other comparable software.

In all cases, fields have been modelled at a height of one metre above ground level in accordance with international standards.

3.3 Data and Assumptions for Modelling

The following assumptions have been made in undertaking the EMF modelling:

- The loadings in the proposed cables have been taken as the system normal average and system normal peak values as applicable and listed in Table 3-2.
- In accordance with Essential Energy's brief, Aurecon has modelled the magnetic field contributions associated with the proposed 33/66 kV underground cable feeder only[1]

Table 3-2: Feeder loading conditions

Loading Condition	33kV Operation (A)	66kV Operation (A)
System Normal Average[2]	210	170
System Normal Peak	400	330
Emergency (N-1) Peak[3]	630	500

It will be noted that, following the change over to 66 kV operation, the magnetic field contributions will decrease[4].

4 Magnetic Field Characterisation

The results obtained from the magnetic field modelling of the proposed cables, under both 33 kV and 66 kV operation, are shown in the following sections. The magnetic field contributions are presented in the form of profiles indicating the magnetic field contribution along a line across the easement, perpendicular to the proposed cables.

4.1.1 Section AA and Section BB

The predicted magnetic fields contributions of the proposed underground cable Sections AA and BB under various loading conditions for 33 kV and 66 kV operation are shown in Figure 4-1 below.

[1] Essential Energy has advised that there is an existing overhead line running directly above the cable route but its possible contribution has not been modelled.
[2] System operating at its normal operation and covers most of the time.
[3] This is the highest possible loading condition which is estimated to occur 16 hours annually, making it a rare scenario.
[4] This is because, for a given load, the current (A) at 33 kV is higher than that at 66 kV.

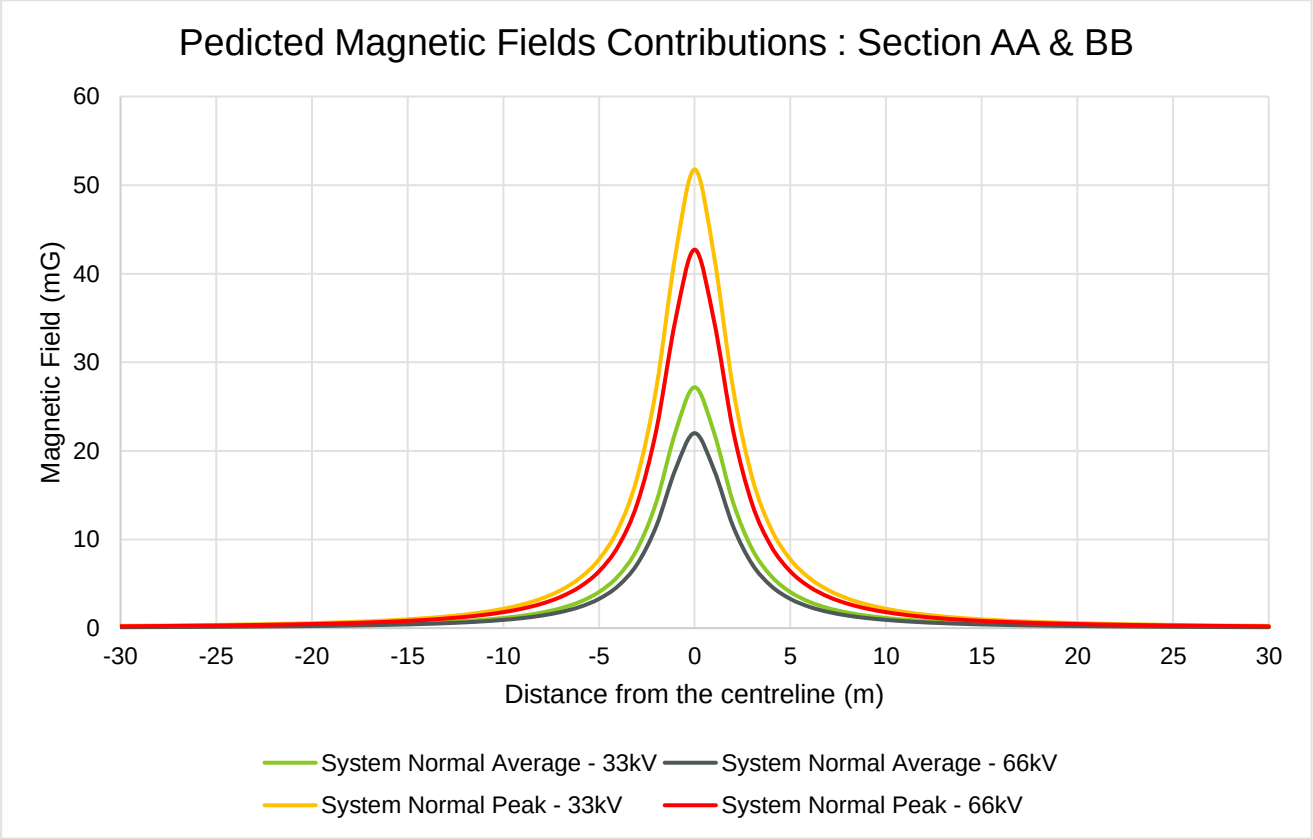


Figure 4-1: Predicted magnetic field profile for section AA and section BB under 33 kV and 66 kV operation

As depicted in Figure 4-1 above, under system normal average loading conditions, the predicted magnetic field contribution directly above the cable trench is 27.2 mG for 33 kV operation and 22 mG for 66 kV. At a distance 5 m from the trench centreline, where the closest dwelling is located, the predicted field decreases to 4.1 mG for 33 kVoperation and 3.3 mG for 66 kV.

For system normal peak loading conditions, the predicted magnetic field contribution directly above the cable trench is 51.8 mG for 33 kV operation and 42.7 mG for 66 kV. At a distance 5 m from the trench centreline, where the closest dwelling is located, the predicted field decreases to 7.8 mG for 33 kV operation and 6.4 mG for 66 kV.

Under contingency maximum loading conditions, magnetic field contributions of up to 1.6 times those shown in Figure 4-1 could be experienced for short periods.

4.1.2 Section CC

The predicted magnetic field contributions along the proposed underground cable Section CC under various loading conditions and 33 kV and 66 kV operation are shown in Figure 4-2 below.

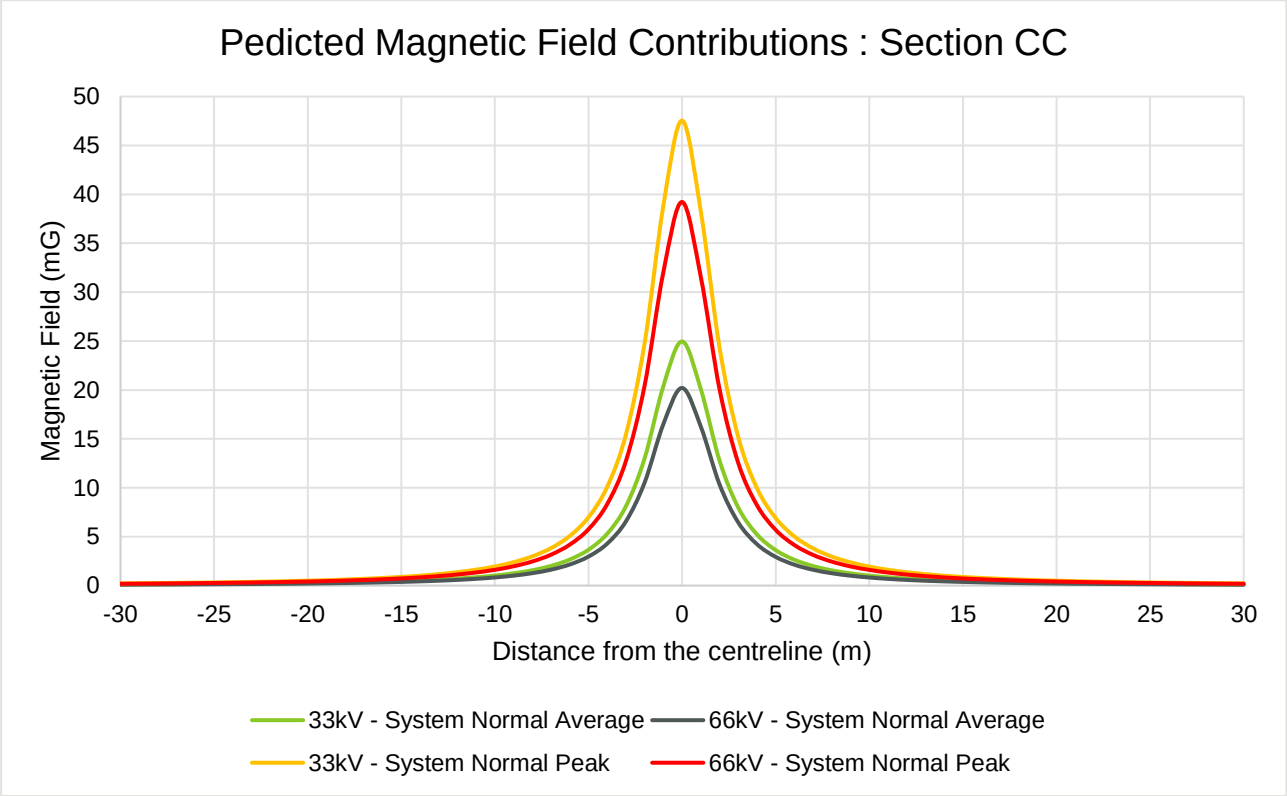


Figure 4-2: Predicted magnetic field profile for section CC under 33 kV and 66 kV operation

As depicted in Figure 4-2, under system normal average loading conditions, the predicted magnetic field contribution directly above the cable trench is 25.0 mG for 33 kV operation and 20.2 mG for 66 kV. Section CC is not installed near any dwellings.

For system normal maximum loading conditions, the predicted magnetic field contribution directly above the cable trench is 47.5 mG for 33 kV operation and 39.2 mG for 66 kV.

Under emergency loading conditions, the predicted magnetic field contribution directly above the cable trench is 1.6 times the system normal peak magnetic field contribution for 33 kV and 1.5 times for 66 kV.

According to the design, no dwellings are anticipated along this section of the cable route.

4.2 Magnetic Field Summary

As outlined in Sections 4.1.1 and 4.1.2, the highest predicted magnetic field contribution of the proposed Kings Forest feeder under system normal load conditions is shown in Table 4-1.

Table 4-1: Predicted highest magnetic field contribution directly above the trench

Section	Magnetic Field Contribution (mG) - System Normal Average		Magnetic Field Contribution (mG) – System Normal Maximum	
	33kV	66 kV	33kV	66kV
Section AA and BB	27.2	22.0	51.8	42.7
Section CC	25.0	20.2	47.5	39.2

4.3 Magnetic Fields Experienced in Everyday Life

In considering the fact that the predicted field levels associated with the proposed underground feeders are quite localised and will vary, depending on the actual loadings of the feeders, it is important to recognise that life in the modern world involves moving from one source of magnetic fields to another. To put the magnitude of the predicted magnetic fields into perspective, it is worth considering the range of typical magnetic field levels associated with common household appliances at normal user distances, and utility infrastructure, shown in Table 4-2.

Table 4-2: Magnetic field levels associate with appliances and utility infrastructure[5]

Appliances	Typical Measurement (mG)	Range of Measurements (mG)
Stove	6	2-30
TV	1	0.2-2
Electric Blanket	20	5-30
Hair Dryer	25	10-70
Refrigerator	2	2-5
Toaster	3	2-10
Kettle	3	2-10
Fan	1	0.2-2
Under Distribution Line	10	2-20
Under Transmission Line	20	10-200
Transmission Line – Edge of Easements	10	2-50

The magnetic field contribution of the proposed feeders at the nearest dwelling is well within the range of magnetic fields normally encountered in everyday life. Although Table 4-2 does not cover underground distribution feeders, it is noted that the predicted fields for the proposed cables are typical.

5 Compliance with EMF Standards and Prudent Avoidance/Precautionary Principles

5.1 Magnetic Fields Experienced Intermittently

While the field levels presented in Sections 4.1.1 to 4.1.2 are the most relevant in the health context, in the broader context of an environmental assessment[6], it is also appropriate to recognise that, in the longer term, under emergency conditions, magnetic field contributions of up to 1.6 times those presented above for system normal conditions could be experienced in some places for short periods over the life of the feeder. Such situations are only expected to arise for around 16 hours annually.

[5] *It is noted that the levels in Table 4-2 are typical only and fields may vary from the ranges shown.*
[6] *The ICNIRP Guideline Reference Levels are independent of duration and, accordingly, in assessing compliance with them, it is appropriate to consider the highest field which could theoretically occur.*

5.2 Compliance with health guidelines

5.2.1 Magnetic Fields

The contribution of the proposed underground feeders to the magnetic field environment is predicted to be well within the ICNIRP Guideline Reference Level of 2,000 mG. Relevant magnetic field contributions directly above the cable are summarised in Table 5-1 below.

Table 5-1: Magnetic field contribution directly above cable section AA, BB and CC

Section	Voltage Level (kV)	System Normal Average		System Normal Peak Load		Emergency Peak Load	
		(mG)	% of ICNIRP Guideline Ref. Level	(mG)	% of ICNIRP Guideline Ref. Level	(mG)	% of ICNIRP Guideline Ref. Level
Section AA & BB	33	27	1.4%	52	2.6%	82	4.1%
	66	22	1.1%	43	2.1%	65	3.2%
Section CC	33	25	1.3%	48	2.4%	75	3.7%
	66	20	1.0%	39	2.0%	59	3.0%

As shown in Table 5-1, the predicted maximum magnetic field contributions for the proposed underground feeder are less than 4.1% of the ICNIRP Guideline Reference Level of 2000 mG directly above the proposed feeders under 33 kV operation and less than 3.7% for 66 kV operation.

It can also be seen that the magnetic field contributions under 66 kV operation are lower than for 33 kV operation. This is due to the higher load current during 33 kV operation of the feeders.

At a distance of 5 m from the trench centreline where the closest dwelling is located, the magnetic field contributions are summarised in Table 5-2 below.

Table 5-2: Magnetic field contribution 5 m from cable section AA, BB and CC[7]

Section	Voltage Level (kV)	System Normal Average		System Normal Peak Load		Emergency Peak Load	
		(mG)	% of ICNIRP Guideline Ref. Level	(mG)	% of ICNIRP Guideline Ref. Level	(mG)	% of ICNIRP Guideline Ref. Level
Section AA/BB	33	4.1	0.2%	7.8	0.4%	12	0.6%
	66	3.3	0.2%	6.4	0.3%	9.7	0.5%
Section CC[8]	33	3.7	0.2%	7.0	0.4%	16	0.8%
	66	3.0	0.2%	5.8	0.3%	13	0.6%

5.2.2 Electric Fields

As noted previously, being underground cable construction, the proposed feeders will not produce external electric fields.

[7] *At a distance 5 m from the trench centreline, where the closest dwelling is located.*
[8] *Although no dwellings are expected along this CC section of the cable route as per the design, magnetic field values at 5 meters of the CC section are shown for reference only.*

5.3 Assessment against Prudent Avoidance Principles

As noted in Section 2.3, given the inconclusive nature of the science, it is considered that a prudent/precautionary approach continues to be the most appropriate response in the 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, especially children, encounter over prolonged periods, provided this can be readily achieved without undue inconvenience and at reasonable expense, and consistent with good engineering and risk minimisation practice.

It is understood that, along with other members of ENA, Essential Energy has adopted the policy of prudent avoidance and, in this context, Essential Energy, has advised that, over the course of the project, it has or will:

- Share information regarding the EMF/health issue and the proposed underground cables.
- Adopted an underground cable concept rather than less expensive overhead lines.
- Where practical, install the cable as far as possible from dwellings.
- Selected the proposed 33/66 kV cable route to pass primarily through rural and sparsely populated regions, minimising potential EMF exposure to residents.
- In due course, re-configure the feeder to operate at 66kV, thereby reducing the load currents and, hence, the magnetic field contributions.

While it cannot be said with certainty that any of these measures are beneficial in terms of human health, they are consistent with the concept of prudent avoidance. Given the low magnetic field contributions predicted in frequented areas, further field reduction measures are unlikely to be justified in the name of prudent avoidance.

6 References

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Appendix A – General Description of Electric and Magnetic Fields

The electric and magnetic fields associated with electrical equipment, whilst interrelated, are not dependent on each other and can exist independently. The electric field is associated with the voltage of the equipment and the magnetic field is associated with the current (amperage). In combination, these fields cause energy to be transferred along electric wires.

An electric field is a region where electric charges experience an invisible force. The strength of this force is related to the voltage, or pressure, which forces electricity along wires. Electric fields are strongest closest 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, so they are readily shielded and, for all practical purposes, do not penetrate buildings. They 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. (Ref A-1) Being related to voltage, the electric fields associated with HV aerial lines and electrical substations remain relatively constant over time, except where the operating voltage changes.

A magnetic field is a region where magnetic materials experience an invisible force produced by the flow of electricity (known as electric current and measured in Amperes). The strength of a magnetic field depends on the size of the current and decreases as distance from the source increases. The magnetic field strength resulting from an electrical installation varies continually with time and is affected by a number of factors including:

- The total electric load
- The size and nature of the equipment
- The design of the equipment
- The layout and electrical configuration of the equipment and its interaction with other equipment

While electric fields are blocked by common materials, this is not the case with magnetic fields. This is why locating equipment in enclosures or underground will eliminate any external electric field but not the magnetic field.

Alternating electric and magnetic fields are produced by any electric wiring or equipment carrying alternating current (AC). This current does not flow steadily in one direction but oscillates backwards and forwards at a frequency[9] of 50Hz and hence the fields produced by AC systems oscillate at the same frequency. This frequency falls into a range referred to as extremely low frequency (ELF), so the electric and magnetic fields are referred to as ELF fields.

Electromagnetic Radiation

It is not uncommon for the electric and magnetic fields (EMF) associated with electrical equipment to be confused with electromagnetic radiation (EMR). The fact that, in many jurisdictions, agencies which regulate the various forms of EMR are also involved in the setting of guidelines/standards for EMF tends to add to this confusion.

Electromagnetic radiation is a term we use to describe the movement of electromagnetic energy through the propagation of a wave. This wave, which moves at the speed of light in a vacuum, is composed of electric and magnetic waves which oscillate (vibrate) in phase with, and perpendicular to, each other. This is in contrast to EMF, where the electric and magnetic components are essentially independent of one another.

[9] F*requency is a measure of the number of times per second a wave oscillates or vibrates. The most common unit of measurement of frequency is the Hertz (Hz) where 1 Hz is equal to 1 cycle per second*

Electromagnetic radiation is classified into several types according to the frequency of its wave; these types include (in order of increasing frequency): radio waves, microwaves, terahertz radiation, infra-red radiation, visible light[10], ultraviolet radiation, X-rays, and gamma rays. Whereas EMR causes energy to be radiated outwards from its source e.g., light from the sun or radio-frequency signals from a television transmitter, EMFs cause energy to be transferred along electric wires.

In the context of the EMF/health issue, the distinction between EMF and EMR is addressed by the New Zealand Ministry of Health in its public information booklet "Electric and Magnetic Fields and Your Health" (Ref A-2) as follows:

> *"The electric and magnetic fields around power lines and electrical appliances are not a form of radiation. The word "radiation" is a very broad term, but generally refers to the propagation of energy away from some source. For example, light is a form of radiation, emitted by the sun and light bulbs. ELF fields do not travel away from their source but are fixed in place around it. They do not propagate energy away from their source. They bear no relationship, in their physical nature or effects on the body, to true forms of radiation such as x-rays or microwaves."*

References

A-1. World Health Organisation: Environmental Health Criteria Vol. 238: Extremely low frequency fields. (2007).

A-2. New Zealand Ministry of Health: Electric and Magnetic Fields and Your Health. (2009).

[10] *Visible light is a group (spectrum) of frequencies which can be sensed by the eyes of humans and various other creatures*.

Appendix B – Overview of EMF Health Issue

Research into EMFs and health is a complex area involving many scientific disciplines – from biology, physics and chemistry to medicine, biophysics, and epidemiology. Many of the health issues of interest to researchers are quite rare. In this context, it is well accepted by scientists that no study considered in isolation will provide a meaningful answer to the question of whether or not EMFs can contribute to adverse health effects. In order to make an informed conclusion from all of the research, it is necessary to consider the science in its totality. Over the years, governments and regulatory agencies around the world have commissioned independent scientific review panels to provide such overall assessments.

Extremely Low Frequency (ELF) Fields

The possibility of adverse health effects due to the EMFs associated with extremely low frequency electrical equipment has been the subject of extensive research throughout the world. To date, while adverse health effects have not been established, the possibility that they may exist cannot be ruled out.

While EMFs involve both electric and magnetic components, electric fields are relatively constant over time, are readily shielded and, in the health context, are generally no longer associated with the same level of interest as magnetic fields. Nevertheless, high electric field strengths, such as those associated with high voltage equipment in major substations can approach a level at which “nuisance shocks” can occur and this phenomenon needs to be managed. Magnetic fields are not readily shielded, are more ubiquitous and remain the subject of some debate. Accordingly, much of the remainder of this section is directed towards magnetic fields.

The most recent scientific reviews by authoritative bodies are reassuring for most potential health issues. However, statistical associations[11] between prolonged exposure to elevated magnetic fields and childhood leukaemia have persisted. This led the International Agency for Research on Cancer (IARC) (Ref. B-1) in 2002 to classify magnetic fields as a “possible carcinogen”[12]

The fact that, despite over 30 years of laboratory research, no mechanism for an effect has been established, lends weight to the possibility that the observed statistical associations reflect some factor other than a causal relationship. This point is made in the 2001 report of the UK National Radiological Protection Board’s (NRPB) Advisory Group, chaired by eminent epidemiologist, the late Sir Richard Doll (Ref. B-2)

> *“In the absence of clear evidence of a carcinogenic effect in adults, or of a plausible explanation from experiments on animals or isolated cells, the evidence is currently not strong enough to justify a firm conclusion that such fields cause leukaemia in children” (page 164)*

References

B-1. World Health Organisation, International Agency for Research on Cancer, Lyon, France: IARC Monographs on the evaluation of carcinogenic risks to humans. Non-Ionising Radiation Part 1: Static and Extremely Low Frequency (ELF) Electric and Magnetic Fields. (2001)

B-2. National Radiological Protection Board, (UK), ELF Electromagnetic Fields and the Risk of Cancer, Report of an Advisory Group on Non-Ionising Radiation, Chairman, Sir Richard Doll, NRPB Vol. 12 No. 1, 2001.

[11] *It should be noted that a statistical association does not necessarily reflect a cause-and-effect relationship.*

[12] *IARC publishes authoritative independent assessment by international experts of the carcinogenic risks posed to humans by a variety of agents, mixtures, and exposures. These agents, mixtures and exposures are categorised into 4 groups, namely:*
Group 1 - the agent is carcinogenic to humans – 132 agents are included in the group, including asbestos, tobacco, diesel engine exhaust and ultraviolet radiation
Group 2A - the agent is probably carcinogenic – 96 agents have been included in this group, including creosotes, hot beverages (above 65 deg. C.) and red meat consumption
Group 2B – the agent is possibly carcinogenic to humans – 320 agents have been included in this group, including gasoline, lead, nickel, petrol engine exhaust and extremely low frequency magnetic fields
Group 3 – the agent is not classifiable as to carcinogenicity – 499 agents have been included in this group, including caffeine, coffee, coal dust, acrylic fibres, extremely low frequency electric fields and static electric and magnetic fields
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Appendix C – Health Guidelines

Health Guidelines for Extremely Low Frequency Electric and Magnetic Fields

The World Health Organisation recognises two international EMF/Health guidelines:

- the Guidelines for Limiting Exposure to Time-varying Electric and Magnetic Fields (1Hz to 100kHz) produced by the International Commission on Non-Ionising Radiation Protection (ICNIRP) Ref C-1), and
- the IEEE Standard C95.1, produced by the International Committee on Electromagnetic Safety, Institute of Electrical and Electronics Engineers (IEEE) in the USA.

In July 2015, the relevant Australian regulator (ARPANSA) officially adopted the more conservative of the above two, the ICNIRP 2010 Guidelines, in full, stating:

> *"The ICNIRP ELF guidelines are consistent with ARPANSA's understanding of the scientific basis for the protection of the general public (including the foetus) and workers from exposure to ELF EMF." (Ref. C-2)*

In line with the regulator's advice, Aurecon has applied the current international ICNIRP guideline reference levels to this assessment.

The reference levels for both electric and magnetic fields contained in the current ICNIRP guidelines are summarised in Table C-6-1.

Table C-6-1: Health Guideline Reference Levels

Parameter	ICNIRP 2010 Reference Levels
Electric Fields – General Public	5 kV/m
Electric Fields – Occupational	10 kV/m
Magnetic Fields – General Public	2000 mG
Magnetic Fields – Occupational	10,000 mG

In applying the guidelines, it is to be noted that, unlike earlier versions, the various limits are now independent of duration of exposure.

In applying the ICNIRP Guideline, it is also important to recognise that the numerical limits, e.g., 2,000 mG, are based on established health effects. In ICNIRP's fact sheet on the guidelines (Ref. C-3), it notes that:

> *"It is the view of ICNIRP that the currently existing scientific evidence that prolonged exposure to low frequency magnetic fields is causally related with an increased risk of childhood leukaemia is too weak to form the basis for exposure guidelines. Thus, the perception of surface electric charge, the direct stimulation of nerve and muscle tissue and the induction of retinal phosphenes are the only well-established adverse effects and serve as the basis for guidance."*

Being based on established biological effects (which occur at field levels much higher than those normally encountered in the vicinity of electrical equipment), the (numerical) exposure limits in the guidelines and standards cannot be said to define safe limits for possible health effects, should these exist, from magnetic fields at levels normally encountered in the vicinity of electrical equipment.

It is in this context that precautionary measures for ELF magnetic fields such as "Prudent Avoidance" have arisen (see Appendix D – Prudent Avoidance).

References

C-1 International Commission on Non-Ionising Radiation Protection (2010: Guidelines for Limiting Exposure to Time-varying Electric and Magnetic Fields (1Hz to 100kHz): Health Physics 99(6):818-836; (2010).

C-2 ARPANSA: Extremely Low Frequency Electric and Magnetic Fields – 2015, accessed 10 May 2016.

C-3. ICNIRP Fact Sheet on the guidelines for limiting exposure to time-varying electric, and magnetic fields (1Hz-100kHz) published in Health Physics 99(6): 818-836; 2010, accessed 10 May 2016, <http://www.icnirp.org/cms/upload/publications/ICNIRPFactSheetLF.pdf>.

Appendix D – Prudent Avoidance

Extremely Low Frequency Magnetic Fields

Regarding the potential health effects from ELF magnetic fields, while compliance with the relevant guideline is important in protecting people from established health effects, it does not necessarily address possible health effects, should they exist, from fields at levels normally encountered in the vicinity of electrical equipment. The possibility of such effects has been comprehensively studied over several decades worldwide but, to this day, there is no clear understanding of how ELF electric or magnetic fields at low levels could pose a threat to human health.

Since the late 1980s, many reviews of the scientific literature have been published by authoritative bodies. There have also been several inquiries such as those by Sir Harry Gibbs in NSW (Ref. D-1) and Professor Hedley Peach in Victoria (Ref. D-2). These reviews and inquiries have consistently found that:

- Adverse health effects have not been established
- The possibility cannot be ruled out
- If there is a risk, it is more likely to be associated with the magnetic field than the electric field

Both Sir Harry Gibbs and Professor Peach recommended a policy of prudence or prudent avoidance, which Sir Harry Gibbs described in the following terms:

> *"… [doing] whatever can be done without undue inconvenience and at modest expense to avert the possible risk …"*

In 1999, the (US) National Institute of Environmental and Health Sciences (NIEHS) (Ref. D-3) found:

> *"In summary, the NIEHS believes that there is weak evidence for possible health effects from ELF-EMF exposures, and until stronger evidence changes this opinion, inexpensive and safe reductions in exposure should be encouraged." (Page 38)*

The practice of 'prudent avoidance' has been adopted by the (Australian) Energy Networks Association (ENA) and most Australian power utilities, including Essential Energy.

The World Health Organisation has also addressed the notion of prudence or precaution on several occasions, including in its 2007 publication Extremely low frequency fields. Environmental Health Criteria, Vol. 238 (Ref. D-4), which states:

> *"…the use of precautionary approaches is warranted. However, 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."*

It also states:

> *"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."*

Given the inconclusive nature of the science, it is considered that a prudent approach continues to be the most appropriate response in the circumstances. Under this approach, subject to modest cost and reasonable convenience, power utilities and transport authorities should design their facilities to reduce the intensity of the fields they generate, and locate them to minimise the fields that people, especially children, encounter over prolonged periods. While these measures are prudent, it cannot be said that they are essential or that they will result in any benefit.

In the Australian context, ENA's position, as adopted in their EMF Management Handbook (Ref. D-5), states:

> *"Prudent avoidance does not mean there is an established risk that needs to be avoided. It means that if there is uncertainty, then there are certain types of avoidance (no cost / very low-cost measures) that could be prudent."*

It also states:

> *"Both prudent avoidance and the precautionary approach involve implementing no cost and very low-cost measures that reduce exposure while not unduly compromising other issues."*

References

D-1. Gibbs, Sir Harry, Chairman, Inquiry into Community Needs and High Voltage Transmission Line Development, Submission to the NSW Government, February 1991.

D-2. Peach HG, Bonwick WJ and Wyse T (1992). Report of the Panel on Electromagnetic Fields and Health to the Victorian Government (Peach Panel Report). Melbourne, Victoria: September 1992.

D-3. National Institute of Environmental Health Sciences, National Institutes of Health, (USA), NIEHS report on health effects from exposure to power-line frequency electric and magnetic fields, NIH Publication No. 99-4493, 1999.

D-4. World Health Organisation: Environmental Health Criteria Vol. 238: Extremely low frequency fields. (2007).

D-5. Energy Networks Association: EMF Management Handbook. (2016)

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