Environment Effects Statement

Western Renewables Link

TECHNICAL REPORT

Q Geology and Soils Impact Assessment

Western Renewables Link EES Technical Report
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Geology and Soils Impact Assessment

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Glossary

Adaptive management	Approach for iteratively implementing and improving management strategies by learning about which management actions are most effective at achieving specified objectives via ongoing inspections
AGS	Australian Geomechanics Society
Alluvium	Sediment of river and beaches
ASC	Australian Soil Classification
ASS	Acid Sulfate Soils
AS	Australian Standard
AusNet	AusNet Transmission Group Pty Ltd
CEMP	Construction Environmental Management Plan
CMA	Catchment Management Authority
Colluvium	Loose earth sediment that has accumulated at the base of a hill, through the action of gravity
Construction Footprint	The Construction Footprint is indicative and contained within the 'Project Area' and encompasses the land required to facilitate construction of the Project, including the vegetation removal required to achieve the operational safety clearance zone for the transmission line. The construction footprint includes: ▪ The existing Bulgana, Sydenham, and Elaine terminal station sites ▪ The new 500kV terminal station near Bulgana ▪ The temporary laydown areas required at existing Bulgana and Sydenham Terminal Stations ▪ The temporary intermediate laydown areas located at Ballan and Lexton ▪ Tower assembly areas ▪ Stringing pads ▪ Temporary hurdle locations, including the installation of stay blocks, poles, cross beams and protective netting ▪ Distribution line crossovers ▪ Access tracks (both temporary and permanent) ▪ Vegetation clearance required to maintain safe clearances and fuel load requirements around transmission line infrastructure.
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEECA	Department of Energy, Environment and Climate Action
DELWP	The former Department of Environment, Land, Water and Planning
DJSIR	Department of Jobs, Skills, Industry and Regions
DEM	Digital Elevation Model
DEPI	Department of Environment and Primary Industries
DJPR	Department of Jobs, Precincts and Regions (now DJSIR)
Ece	Electrical conductivity of a saturated soil extract, normally measured in micro Siemens per centimetre (μS/cm)

Environment Effects Act	*Environment Effects Act 1978*
EES	Environment Effects Statement
EMO	Erosion Management Overlay as displayed on planning scheme mapping, and developed in accordance with Clause 44.01 (last updated 6 September 2021) of the Victoria Planning Provisions
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)*
EPR	Environmental Performance Requirements
Environment Protection Act	*Environment Protection Act 2017*
Erosion	Natural surface processes that remove soil, rock, or dissolved material from one location and then transports it to another location
Geological unit	A volume of rock or soil of identifiable origin and age range that is defined by distinctive characteristics
Geomorphological unit	An area that has been identified and defined by similar geomorphic processes, landforms and landform components
GFS	Groundwater Flow System
GSA	Geological Society of Australia
HA	Hand Auger
IECAA	International Erosion Control Association Australasia
Igneous rock	Formed from magma, either erupted from a volcano or cooled below ground in an intrusion
km	Kilometre
kV	kilovolt
LGA	Local Government Area
LiDAR	Light Detection and Ranging
LL	Liquid Limit is the water content where the soil starts to behave as a liquid
Metamorphic rock	A rock which has re-crystallised due to heat and/or pressure.
Operational Footprint	The Operational Footprint is indicative and contained within the Project Area and encompasses the land proposed to be used for operational and maintenance purposes for the Project. The Operational Footprint includes: ▪ Indicative location of the transmission line easement ▪ Any permanent access tracks ▪ Terminal stations. The proposed transmission line easement may be subject to refinement within the ‘Proposed Route’ based on the findings of the EES, and landholder engagement.
PASS	Potential Acid Sulfate Soils
PI	Plasticity Index is the range of water content where soils exhibit plastic properties

Planning and Environment Act	*Planning and Environment Act 1987*
Principal Contractor	During the construction stage, there will be multiple principal contractors and sub-contractors involved in the delivery of the different project components. This EES refers to Principal Contractor as a catch all term for the contractor responsible for the works.
Project Area	The Project Area encompasses all areas that would be used to support the construction and operational components of the Project considered in the EES. The Project Area is contained within the Project Land and encompasses the following: ▪ Permanent infrastructure: - Transmission tower structures - Upgrade and connection to the Bulgana Terminal Station - Connection to the Sydenham Terminal Station - An upgrade of Elaine Terminal Station - The new 500kV terminal station near Bulgana - Access tracks required for operation ▪ Temporary construction areas: - Distribution line crossovers - Hurdles - Laydown areas - Stringing pads - Access tracks - Tower assembly areas - Workforce accommodation facilities.
Project Land	The Project Land encompasses all land parcels that could be used for the purpose of temporary Project construction and permanent operational components. The Project Land corresponds with the extent of the Specific Controls Overlay proposed in the draft Planning Scheme Amendment for the Project. This generally includes the entire land parcel intersected by a Project component.
Proposed Route	The Proposed Route is approximately 100 to 170m wide and encompasses the nominal future easement (including a buffer either side), and the terminal station areas. The Proposed Route is located within the Project Area.
Salinity	The concentrations of salts in water or soils
Sedimentary rock	Any rock made up of sediment grains
SLO	Significant Landscape Overlay
Slope instability	The mass movement of soil and/or rock downslope in response to gravity
Soil dispersion	The behaviour of clay particles separating from one other in a moist soil
Soil reactivity	The behaviour of clay soils as they change volume in response to changes in moisture content

Study area	The study area applied for this assessment is the same as the Project Land
VRO	Victorian Resources Online
220kV	220kV transmission line
500kV	500kV transmission line

Executive summary

The Western Renewables Link (the Project) proposes a new transmission line starting at Bulgana, near Stawell in Victoria's west, and extending approximately 190km to Sydenham in Melbourne's north-west. The Project will enable the connection of new renewable energy generated in western Victoria into the National Electricity Market and increase the Victorian transmission capacity. The Project is being delivered by AusNet Transmission Group Pty Ltd (AusNet).

This Geology and Soils Impact Assessment forms part of the Environment Effects Statement (EES) prepared for the Project in accordance with the *Environment Effects Act 1978*. This report and the methodology applied in preparing this report, respond to the requirements set out in the EES scoping requirements, with a view to assessing the issues, including those related to geology and soils that are associated with the Project.

Overview

To support the connection of the new transmission line, a new terminal station comprising a 500kV switchyard and associated equipment is proposed near the existing Bulgana Terminal Station, together with the expansion of the existing Bulgana Terminal Station. Project works will be required to enable connection of the transmission line into the Sydenham Terminal Station. Upgrades are also required at the existing Elaine Terminal Station. Construction is expected to take approximately two years.

The Project has potential to cause impacts to geology and soils if the Project stages are not planned and managed with respect to the geological conditions and relevant legislation and guidelines.

Geology and soils refer to the surface and sub-surface soil and rock conditions and the natural earth processes that shape the landscape and associated landforms. This report documents the existing conditions relating to geology and soils, provides an assessment of potential Project impacts and provides recommendations for appropriate control measures to mitigate potential impacts at each Project stage. Key issues identified from the assessment that may impact the environment include construction and operation of Project infrastructure in areas of hills and ridgelines that may cause slope instability, and construction and operation of Project infrastructure in areas of erosive and/or dispersive soil, saline soil, reactive soil and potentially compressible soil that may impact surrounding landforms and waterways. In addition, sites of geological significance and other geologically important features that are subject to the Significant Landscape Overlay (SLO) in the relevant planning scheme are close to or within the study area and have been assessed accordingly.

The study area for the Geology and Soils Impact Assessment is the same as the Project Land (refer to Section 3.1) and includes areas identified within the Project Land considered likely to be subject to ground disturbance works during construction.

Existing conditions

Existing conditions relating to geology and soils have been described for the study area based on four separate sections, which have been defined based on distinctive geological and geomorphological conditions. A summary of existing conditions within each of these four sections, as well as a separate summary for the terminal station sites and the intermediate laydown areas is presented below:

- **Bulgana to Lexton**
  - Situated within the Western Uplands geomorphic province, this section is characterised by undulating hills and ridges formed by sedimentary rock units intersected by valleys filled with narrow creek valleys and broad low-lying areas.
  - Several instances of gully erosion were identified in this section, mainly associated with fine grained residual soil and colluvium on steep slopes and creeks in hilly areas. Minor localised instability was also observed on steep hill and valley slopes in the form of hummocky terrain and soil creep. Observations are consistent with Department of Energy, Environment and Climate Action (DEECA) erosion and

landslide susceptibility mapping, which indicates generally high susceptibility to erosion in hilly areas and ridgelines, and low susceptibility to landslides.

- Dispersive soils are likely to be present in this section, as indicated by mapped soil types (Sodosols, which are known to be dispersive) and supported by the results of geotechnical laboratory testing.
- Possible soil salinity was indicated by the presence of bare patches of soil in some areas. Limited soil salinity testing indicated that soils are slightly/moderately saline to non-saline.
- Reactive soils are unlikely to be encountered in this section.
- Compressible soils are likely to be encountered around creeks and rivers where the Quaternary aged alluvial deposits (Qa1) have been mapped.
- One site of geological significance was identified in this section, associated with a granite hill named Mount Direction.

▪ **Lexton to Ballan**
  - Situated within the Western Uplands geomorphic province, this section is characterised by gently undulating hills formed by the Quaternary-Tertiary aged lava flows with isolated steep hills associated with local volcanic eruption points.
  - Several areas in this section are subject to Erosion Management Overlay (EMO) mapping developed under Clause 44.01 (last updated 6 September 2021) of the Victoria Planning Provisions and displayed on relevant planning scheme mapping, which are mainly associated with surface watercourses and scoria deposits (eruption points).
  - Limited examples of soil gully erosion were identified and where these instances occurred, they are generally associated with areas of steep slopes and around existing creeks. Observations are consistent with DEECA erosion mapping, which indicates low susceptibility to erosion on the gently undulating volcanic landscape.
  - Localised minor land instability was observed in this section, mainly occurring where creek banks have incised the underlying basalt rock resulting in some soil creep. Observations are consistent with DEECA landslide susceptibility mapping, which indicates low susceptibility to landslides in this section.
  - Soil types are mapped as predominantly Dermosols, Ferrosols and Kurosols from Lexton to Kingston, Ferrosols from Kingston to Bolwarrah and Sodosols and Chromosols from Bolwarrah to Ballan.
  - Dispersion testing was conducted on a single sample which returned Emerson Class 4, which indicates this sample was slightly to non-dispersive. Further Emerson testing is required to determine dispersion characteristics in this section, particularly between Bolwarrah and Ballan where Sodosols have been mapped.
  - This section is situated within the Upper Loddon Volcanic Plains and Upper Moorabool salinity provinces. No obvious signs of soil salinity were observed in this section or indicated in reference materials reviewed. One soil salinity test conducted within this section indicated that the soil is non-saline.
  - The likelihood for encountering reactive soils is high, with mapped areas of Vertosols present, as well as large areas of residual soils of the Newer Volcanic Group, both of which are prone to shrink-swell behaviour. Atterberg testing conducted indicated samples of the Newer Volcanic Group residual soils obtained from shallow depths displayed low to moderate soil reactivity.
  - Compressible soils are likely to be encountered around creeks and rivers where the Quaternary aged alluvial deposits (Qa1) have been mapped.
  - Two sites of geological significance were identified in this section, Hepburn Lagoon and Kangaroo Hills. Additionally, this section contains several volcanic eruption points that are subject to the SLO in the relevant planning scheme, which are close to and intersecting the study area.

- **Ballan to Melton West**
  - Situated within the Western Uplands and Western Plains geomorphic provinces, characterised by undulating hills with steep hills ranges formed by sedimentary rock units with broad low-lying areas dominated by alluvium units.
  - Several examples of active and inactive gully erosion were identified, mainly associated with steep slopes. This is consistent with DEECA erosion susceptibility mapping, that indicates the section has a high susceptibility to gully erosion on hills and ridgelines.
  - The Ballan to Melton West section is mapped as having Low landslip susceptibility, and whilst this may be applicable for some of the Proposed Route in this area, observations and mapping indicate landslide processes have been active relatively recently on slopes that are close to the study area, or within geological units that are in the study area.
  - Soil types are mapped as predominately Sodosols with a small section of Vertosols between Ballan and Myrniong, Dermosols from Myrniong to the Lerderderg River and Sodosols and Chromosols from Lerderderg River to Melton West.
  - Evidence of erosion possibly resulting from soil dispersion was observed. Dispersion testing conducted on two samples recorded Emerson Class 3, which indicates moderately dispersive soils are present.
  - No signs of soil salinity were observed in this section.
  - The likelihood for encountering reactive soils is high, with mapped areas of Vertosols and the presence of the Pentland Hills Volcanic Group and the Newer Volcanic Group units.
  - Compressible soils are likely to be encountered around creeks and rivers where the Quaternary aged alluvial deposits (Qa1) have been mapped.
  - Two sites of geological significance were identified near Bacchus Marsh that range from national to international significance, which include the Permian aged glacigene sediments and exposures of the Permian aged glacial deposits.
- **Melton West to Sydenham**
  - Situated within the Western Plains geomorphic province, characterised by flat Tertiary aged Volcanic plains with low-lying areas associated with watercourse and drainage lines.
  - Limited areas of gully erosion are present within this section however, it was found that residual soils of the Newer Volcanic Group are susceptible to dispersion which may lead to tunnel and gully erosion where soils may be exposed. This is consistent with DEECA erosion susceptibility mapping in this section, that indicates low susceptibility to erosion.
  - Localised land instability and rock outcropping were observed on steep valley slopes of Kororoit Creek.
  - Soil types are predominantly described as Sodosols between Melton West to Sydenham, which indicates soils are prone to dispersion and subsequent erosion.
  - No obvious signs of soil salinity were observed in this section, however a large are of recorded soil salinity is present near Kororoit Creek 5km south of the Proposed Route.
  - The likelihood for encountering reactive soils is high, with a majority of the section mapped as the Newer Volcanic Group basalt. Shrinkage cracking was observed in residual soils in this section and Atterberg limit testing on one sample indicated high to very high soil reactivity.
  - Compressible soils are likely to be encountered around creeks and rivers (e.g., Toolern Creek) where the Quaternary aged alluvial deposits (Qa1) have been mapped.
  - One site of geological significance was identified, which is Mount Kororoit, that is described as a breached cone of basalt with lava outcrops. This feature, which is located within the Melton LGA, is covered by the SLO in the relevant planning scheme. Mount Kororoit is also a key landform identified in the 'Western Plains North Green Wedge Management Plan'.

- **Terminal stations**
  - Located within both the Western Uplands and Western Plains geomorphic provinces, the geomorphic conditions at the terminal station sites include:
    - Terraces and floodplains with hills, valley slopes and plains composed of the Palaeozoic aged sedimentary rock units (existing Bulgana Terminal Station)
    - Terraces and floodplains with plateaux and rises of residual Cainozoic age landscapes (new 500 kV terminal station near Bulgana)
    - Predominantly plateaux and rises of residual Cainozoic age landscapes with hills, valley slopes and plains composed of the Palaeozoic age rock units (Elaine Terminal Station)
    - Stony rises of the volcanic plains (Sydenham Terminal Station).
  - No erosion at existing terminal station sites was observed, likely due to the sites being levelled during construction and active erosion control measures put in place (e.g., drainage and hardstands).
  - The terminal station sites are mapped as having a Low to Very Low landslip susceptibility and no evidence of past landslide activity was observed at any of the existing terminal station sites.
  - Mapped soil types at terminal station locations include:
    - Kandosols and Chromosols at the existing Bulgana Terminal Station
    - Chromosols at the new 500kV terminal station near Bulgana
    - Chromosols with minor Kurosols at the Elaine Terminal Station
    - Sodosols at the Sydenham Terminal Station.
  - No visible signs of soil salinity were observed at the terminal station sites; however, areas of recorded soil salinity are indicated within 2-3km of Elaine Terminal Station.
  - The likelihood of encountering reactive soils is high where terminal stations are located in areas underlain by the Newer Volcanic Group basalt (Sydenham Terminal Station). At other sites, where this unit is not present the likelihood of encountering reactive soils is low (the existing Bulgana and Elaine Terminal Stations and the new 500kV terminal station near Bulgana).
  - No sites of geological significance are present at any of the terminal station sites. In addition, none of the terminal stations are shown to be close to or within a zone.
- **Intermediate laydown areas**
  - Located within the Western Uplands geomorphic province, the geomorphic conditions at the (temporary) intermediate laydown areas include eruption points and volcanic plains of Quaternary-Tertiary lava flows.
  - Although Lexton and Ballan laydown areas are mapped as having a low gully erosion susceptibility, it has been found that residual soils of the Newer Volcanic Group are susceptible to dispersion which may lead to tunnel and gully erosion where soils may be exposed.
  - The intermediate laydown areas are mapped as having a Low landslip susceptibility, consistent with observations undertaken on the site walkover.
  - Mapped soil types at intermediate laydown areas include:
    - Chromosols at the Lexton laydown area
    - Sodosols at the Ballan laydown area.
  - Dispersive soils are likely to be present at the Ballan laydown area, which is mapped on Sodosols, known to be dispersive.
  - Both intermediate laydown areas are located in areas underlain by the Newer Volcanic Group basalt so the likelihood of encountering reactive soils is high.

- Large amounts of compressible soils are unlikely to be present at both intermediate laydown areas.
- No sites of geological significance are present at both the intermediate laydown areas. In addition, neither are shown to be close to or within a SLO zone.

▪ **Distribution line crossovers**
  - The geomorphology at each distribution line crossover varies depending on the location. Conditions at the majority of the distribution line crossovers feature eruption points and volcanic plains of Quaternary-Tertiary lava flows.
  - The susceptibility to gully erosion varies depending on the location. High gully susceptibility is mapped at distribution line crossovers in geomorphological units with steep slopes (hills, valley slopes, ridges, escarpments, mountains), between Bulgana and Lexton. Additionally, several instances of gully erosion are mapped close to the proposed distribution line crossovers in this section.
  - The distribution line crossovers are mapped as having a Low to Very Low landslip susceptibility, consistent with observations undertaken on the site walkover.
  - Majority of the distribution line crossovers are mapped on either Ferrosols, Chromosols or Sodosols with some of the crossings mapped on Rudosols, Dermosols, Kurosols and Vertosols. Dispersive soils are likely to be present where distribution line crossovers are mapped on Sodosols, which are known to be dispersive.
  - The likelihood of encountering reactive soils is high where the distribution line crossovers are located in areas of either the Newer Volcanic Group or Pentland Hills Volcanic Group basalt. At other sites, where these units are not present the likelihood of encountering reactive soils is low.
  - Soft, compressible soils that may potentially be saturated are likely to be encountered at the distribution line crossovers mapped on recent alluvial deposits (Qa1). Compressible soils are also expected to occur locally around creeks and waterways.
  - Three sites of geological significance were identified at or close to the distribution line crossovers, named Landsborough Fault, Lerderderg River Morven Terrace and Lerderderg River Permian sequence. Additionally, several distribution line crossovers are located within or close to SLO areas, associated with eruption points and steep valleys to the west of Bacchus Marsh.

Impact assessment key findings

Key findings of the Geology and Soils Impact Assessment include:

▪ The Project is not expected to significantly impact geology and soils during construction, operation and decommissioning, provided that appropriate control measures are applied to the key issues identified.

▪ Key issues identified included slope instability; disturbance or re-use of dispersive and/or erosive soils, compressible soils, reactive soils, saline soils; and damage or restriction to sites of geological significance.

▪ Key mitigation strategies to manage potential impacts during all Project stages include:
  - Undertaking Project specific geomorphological assessment and geotechnical site investigations to appropriately characterise site conditions based on the design stage of the Project.
  - Mitigate impacts through construction, operation and decommissioning stages including:
    - Minimising construction on slopes where possible.
    - Designing and implementing appropriate erosion control measures during construction.
    - Incorporating appropriate design and construction of foundations, slopes, earthworks and subgrade treatment, drainage design and temporary and permanent access roads.
    - Ongoing inspections and maintenance of erosion control design options and measures.
  - Development of an Erosion and Sediment Control and Stormwater Quality Management Plan as part of the Construction Environment Management Plan (CEMP), which includes measures to deal with

erosive, dispersive and saline soils and measures to maintain access to geologically significant sites. These measures, where appropriate, must also be included in AusNet's operational procedures.

- Appropriate design and placement of transmission towers to avoid geologically significant sites as far as reasonably practicable.

- Construction, operation and decommissioning stages of the Project can be managed such that the objective of limiting the adverse impacts of the Project on soil stability and erosion can be met.

Environmental Performance Requirements

Four Environmental Performance Requirements (EPRs) have been recommended in order to meet the EES evaluation objective. These include:

- **GSL1:** Develop and implement a pre-construction Site Investigation Plan for geotechnical site investigations to inform detailed design. The plan must consider the findings of the geotechnical site investigations, with detailed design undertaken in accordance with relevant standards and incorporating appropriate design measures as reasonably practicable to reduce the potential for erosion and sedimentation, and impact to geologically significant sites.
- **GSL2:** Develop and implement a Sediment and Erosion Control Management Plan as part of the Construction Environmental Management Plan (CEMP) (EPR EM2) which details measures to minimise vegetation clearance, stabilise exposed soils where applicable, manage vehicle movement, reinstate vegetation, install sediment controls and treat dispersive or reactive soils.
- **GSL3:** Develop and implement an inspection and maintenance schedule as part of the Construction Environmental Management Plan (CEMP) (EPR EM2) and AusNet's operational procedures to inform adaptive management to maintain integrity of infrastructure during and post construction. The schedule will detail requirements for ongoing inspections, maintenance of permanent erosion management controls and remediation requirements for areas subject to unexpected disturbance.
- **GSL4:** Develop and implement access controls and measures as part of the Construction Environmental Management Plan (CEMP) (EPR EM2) and AusNet's operational procedures to maintain safe access (where sites are currently accessible by the general public) to geologically significant sites during construction and operation.

Other EPRs relevant to the Geology and Soils Impact Assessment include:

- **EM2:** Developing and implementing a Construction Environmental Management Plan to manage the environmental impacts associated with construction in accordance with the mitigation hierarchy.
- **EM11:** Developing and implementing a Decommissioning Management Plan to mitigate potential impacts during the decommissioning stage of the Project.

Conclusion

The Project has potential to cause impacts to geology and soils if construction and earthworks are not planned and managed with respect to the geological conditions encountered, relevant legislation and guidelines, appropriate mitigation measures and the application of EPRs outlined in Section 11.

This report considers the existing conditions relating to geology and soils in the study area and how they relate to the Project in order to minimise potential impacts to geology and soils during all Project stages and provide appropriate controls.

1. Introduction

1.1 Background

The Western Renewables Link Project (the Project) proposes a new transmission line starting at Bulgana, near Stawell in Victoria's west, and extending approximately 190km to Sydenham in Melbourne's north-west. The Project will enable the connection of new renewable energy generated in western Victoria into the National Electricity Market and increase the Victorian transmission capacity. The Project is being delivered by AusNet Transmission Group Pty Ltd (AusNet).

The Project was originally referred to the former Minister for Planning under the *Environment Effects Act* 1978 (Environment Effects Act) on 9 June 2020 by AusNet and it was determined that an Environment Effects Statement (EES) was required. On 22 August 2023, the Minister for Planning determined that the Project has the potential to cause significant environmental effects and that an EES was required to inform decision-makers in the granting of key approvals for the Project. In summary the key changes in the new proposed Project scope are:

- The urgent Sydenham Terminal Station Rebuild will be assessed and approved separately. A connection into the Sydenham Terminal Station forms part of Western Renewables Link scope
- The 220kV portion of the transmission line is proposed to be uprated to 500kV
- The new terminal station north of Ballarat will no longer be required
- A new 500kV terminal station near Bulgana will be required, including a new 220kV connection to the existing Bulgana Terminal Station.

The Commonwealth Government's Department of Agriculture, Water and the Environment (DAWE) — now Department of Climate Change, Energy, the Environment and Water (DCCEEW) — has also confirmed that the Project is a 'controlled action' and will require assessment and approval under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* (EPBC Act). The Commonwealth has determined that it will use the bilateral assessment agreement and rely on the Victorian Government's assessment process (EES) to inform an approval decision under the EPBC Act.

1.2 Purpose of this report

The purpose of this report is to assess the potential geology and soil impacts associated with the Project, and to define any Environmental Performance Requirements (EPRs) determine the environmental outcomes that the Project must meet, to be achieved through the implementation of mitigation measures during construction, operation and decommissioning, and address the EES evaluation objectives.

In the context of this report, geology and soils refers to the surface and sub-surface soil and rock conditions as well as natural earth processes (e.g., geomorphological process such as erosion, transportation and deposition of sediment) that shape the landscape and associated landforms.

Construction of the transmission line and associated infrastructure has the potential to alter geomorphological processes and disturb the existing condition of soil and/or rock. For this Project, existing soil and rock conditions and geomorphological processes will be altered through activities such as construction of access tracks, construction of foundations for transmission towers and terminal stations and earthworks activities associated with the Project.

The management of activities that disturb soil and rock is a necessary consideration in the planning, design, construction and operation of this Project due to the potential to result in:

- Soil erosion where construction occurs in areas of erosive and / or dispersive soils.
- Slope instability and erosion where transmission towers, access tracks and other infrastructure will be constructed on hills, ridgelines and slopes.

- Disturbance of soils of special characteristics such as reactive soil, compressible soil and saline soil where present along the Proposed Route.
- Damage or limitations on access to sites considered to have geological significance.

Potential impacts related to soil erosion and slope instability can include damage to assets and infrastructure, vegetation, landforms and land use, which have the potential to cause long term land management impacts for landholders. Slope instability can result in movement of soil and / or rock material down slopes, impacting landforms such as hills, ridgelines and valley sides if not managed effectively. It is important that design and construction works on slope are undertaken in accordance with good hillside construction practice as outlined in Australian GeoGuide LR8 to manage slope instability risks.

Saline soils can have a significant impact on farming, local community and economy, water quality and physical condition of rivers and streams, and can result in soil structural decline and erosion (Agriculture Victoria, 2020b). Regions where dryland salinity is common can have chloride concentrations in soil exceeding that of seawater, which if not suitably managed (e.g., planting vegetation and fencing off discharge sites, or construction of appropriate surface drainage) can result in the salinisation of nearby water bodies. Additionally, saline soil and water may corrode concrete structures installed in the soil (AS2159-2009).

Reactive soils refer to soil that exhibits shrink and swell behaviour due to changes in moisture. The shrink and swell behaviour in soils can result in vertical ground movement of the upper soil horizon. Compressible soils refer to soils that compress or settle under minimal loading. These soils have been deposited during the Quaternary period, and usually comprise of alluvial material that has been deposited close to present day creeks and rivers. Potential impacts associated with reactive and compressible soils include damage to infrastructure that may ultimately impact land use and the environment.

The earthworks and construction activities required for this Project have the potential to encounter existing areas of saline, reactive and compressible soils that, if not planned or managed with respect to relevant legislation and guidelines, has the potential to pose risk of harm to the environment and both Project and nearby infrastructure.

Sites of geological significance are geological heritage sites that were identified in Victoria as part of a study undertaken for the then Victorian State Government's Department of Conservation, Forests and Lands (now Department of Energy, Environment and Climate Action (DEECA). The sites were selected on the basis that they either represent a specific characteristic of the region, or that they include an outstanding, rare, or possibly unique geological or geomorphological feature. Responsibility for the status of the significance of geological sites in Victoria lies with the Geological Society of Australia (Victorian Division).

The protection of Victorian sites of geological and geomorphological significance under Federal and Victorian State legislation is limited. It is often the case that the only protection provided is when the sites are covered by planning overlays at a local government level, and only a few local government jurisdictions have geological sites listed in their heritage overlays. In some instance geoscience sites may have *de facto* protection by virtue of coinciding with values of significant vegetation and cultural heritage (Environmental GeoSurveys, 2022). In addition, there are also geologically important features that are not classified as a site of geological significance however they are subject to a Significant Landscape Overlay (SLO) and planning requirements related to that overlay.

1.3 Structure of the report

The report is structured in the following way:

- **Introduction** (this section) which provides background details for the Project and outlines the purpose and structure of the Geology and Soils Impact Assessment.
- **EES scoping requirements** (Section 2) where the EES scoping requirements relevant to geology and soils are set out, and an indication of where each component of the EES scoping requirements has been considered and addressed in the Geology and Soils Impact Assessment.

- **Project description** (Section 3), where Project components and activities relevant to the assessment are explained including the locations and activities with the highest associated geology and soils-related impacts.
- **Legislation, policy and guidelines** (Section 4) which lists the Commonwealth, state and other documents relevant to the assessment.
- **Method** (Section 5) where the approach applied to assess potential geology and soils impacts associated with the Project is explained.
- **Existing conditions** (Section 6) which identifies background conditions related to geology and soils based on four separate sections, which have been defined based on distinctive geological and geomorphological conditions.
- **Impact assessment** (Section 7 to Section 10), where initial and residual geology and soils impacts during the construction, operation and decommissioning of the Project, including potential cumulative impacts from other nearby developments and projects are evaluated. Measures to mitigate or otherwise effectively manage the potential impacts are also presented here.
- **Environmental Performance Requirements** (Section 11) which set out the environmental outcomes to be achieved through the implementation of mitigation measures during construction, operation and decommissioning. While some EPRs are performance based to allow flexibility in how they will be achieved, other include more prescriptive measures that must be implemented. Compliance with the EPRs will be required as a condition of the Project's approval.
- **Conclusion** (Section 12) where the objectives, methods, outcomes and recommendations of the assessment are presented.

1.4 Related studies

This report must be read in conjunction with the following related technical reports, from which this report draws specific information:

- **Technical Report A: Biodiversity Impact Assessment** discusses EPRs relating to vegetation removal, which has potential to cause erosion.
- **Technical Report D: Landscape and Visual Impact Assessment** describes potential visual impacts on Sites of Geological Significance that are identified in this report.
- **Technical Report E: Land Use and Planning Impact Assessment** describes SLOs that cover two volcanic eruption points close to Waubra and EMOs that cover areas of Project Land within Ballarat and Hepburn local government areas (LGAs). The report also outlines stakeholder consultation with the former Department of Jobs, Precincts and Regions (DJPR) Resources Branch (now part of DEECA) and Ballarat City Council and Hepburn Shire Council that is relevant to geology and soils.
- **Technical Report R: Contaminated Land Impact Assessment** identifies areas of possible soil contamination, such as areas associated with potential acid sulfate soils (PASS) and historical mining activity and discusses impacts on construction due to disturbance of potentially contaminated soils and groundwater.
- **Technical Report S: Groundwater Impact Assessment** identifies areas of groundwater that may be impacted by saline runoff discharged from areas of saline soils that may enter the groundwater system and discusses the impact of foundations and earthworks on groundwater.
- **Technical Report T: Surface Water Impact Assessment** identifies waterways and bodies of water that may be impacted by saline runoff discharged from areas of saline soils and environmental values that require protection.

2. EES scoping requirements

The Scoping Requirements – Western Renewables Link Environment Effects Statement (DTP, 2023) set out in detail the matters to be investigated, assessed and documented in the EES for the Project and are referred to in this report as the EES scoping requirements.

2.1 EES evaluation objectives

The EES scoping requirements specify evaluation objectives which provide a framework to guide an integrated assessment of environmental effects of the Project, in accordance with the *Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978, Eighth edition, 2023*. The evaluation objectives identify desired outcomes in the context of key legislative and statutory policies, as well as the principles and objectives of ecologically sustainable development and environmental protection, including net community benefit.

The evaluation objective relevant to the Geology and Soils Impact Assessment is set out in Section 4.6 Catchment values and hydrology of the EES scoping requirements:

> *"Maintain the functions and values of aquatic environments, surface water and groundwater quality and stream flows and prevent adverse effects on protected beneficial uses."*

In order to meet the evaluation objective, it is necessary to understand the potential impact of the Project on functions and values of the geology and soils so that impacts can be appropriately avoided or mitigated. Understanding these impacts requires an impact assessment, for which the starting point is a clear understanding of the existing site conditions.

2.2 Assessment of specific environmental effects

The scoping requirements set out the key issues that the Project proposes to address to meet the evaluation objective, together with the features and values of the existing environment that are to be characterised – these are referred to as the 'existing conditions'. The scoping requirements also list potential effects of the Project and identify where mitigation measures may be required.

The scoping requirements pertaining to geology and soils are set out in Section 4.6 Catchment values and hydrology of the scoping requirements. These are reproduced in Table 2.1, together with directions to the reader as to where these items have been addressed in this report (and other reports as applicable).

Table 2.1: Geology and soils scoping requirements

Aspect	Scoping requirement	Relevant sections
Key issues	Potential for disturbance of contaminated, saline, dispersive or acid sulfate soils.	▪ Presence of dispersive, saline, reactive, and compressible soils discussed in Section 6. ▪ Potential impacts, mitigation measures and EPRs are discussed in Sections 7 to 11. ▪ Contaminated Land Impact Assessment covers presence of contaminated and acid sulfate soils (refer to EES Technical Report -Contaminated Land Impact Assessment).
	Potential for erosion resulting from construction and operation due to vegetation loss or other factors.	▪ Presence of existing erosion shown is Section 6. ▪ Potential impacts and mitigation. measures and EPRs due to erosion are discussed in Sections 7 to 11.

Aspect	Scoping requirement	Relevant sections
	Potential for adverse effects on the functions, values and beneficial uses of groundwater due to the project's activities, including water extraction, interception or diversion of flows, discharges or seepage from tower foundations or other earthworks and changes to salinity.	▪ The presence of saline soils is discussed in Section 6, with impacts, mitigation measures and EPRs relating to soil salinity discussed in Sections 7 to 11. ▪ Groundwater Impact Assessment covers groundwater in detail, including impacts to groundwater caused by saline soils (Refer to EES Technical Report - Groundwater Impact Assessment).
Existing environment	Characterise soil types and structures in the section and identify the potential location and disturbance of potentially dispersive, acid sulfate, saline or contaminated soils, or soils of other special characteristics that could affect or be affected by the project.	▪ Potentially dispersive, saline, reactive, and compressible soils and soils susceptible to erosion and landslide are outlined in Section 6. ▪ Contaminated Land Impact Assessment covers presence of contaminated and acid sulfate soils (refer to EES Technical Report - Contaminated Land Impact Assessment).
Mitigation measures	Describe further potential and proposed design options and measures that could avoid or minimise significant effects on soil stability.	▪ Potential impacts, mitigation measures and EPRs are discussed in Sections 7 to 11.
Likely effects	Identify and assess potential effects of the project on soil stability, erosion and the exposure and disposal of contaminated or hazardous soils (e.g., acid sulfate soils).	▪ Potential effects of the Project on soil stability and erosion covered in Sections 7 to 10. ▪ Contaminated Land Impact Assessment covers effects of contaminated and hazardous soils (refer to EES Technical Report - Contaminated Land Impact Assessment).
Performance criteria	Describe proposed measures and performance indicators to manage and monitor effects on catchment values and identify likely residual effects.	▪ EPRs are presented in Section 11.
	Describe contingency measures for responding to unexpected but foreseeable impacts such as disturbance of acid sulfate, saline, dispersive or contaminated soils.	▪ Potential impacts, mitigation measures and EPRs are discussed in Sections 7 to 11.

3. Project description

3.1 Project overview

The Project aims to address the current constraints of the western Victorian transmission network by providing the additional capacity, reliability and security needed to drive the development of further renewable electricity generation in western Victoria. By doing so, the Project supports the transition from coal-generated electricity to renewables and the efficient connection of renewable electricity into the National Electricity Market.

The Project comprises the construction and operation of a new approximately 190km overhead double circuit 500kV transmission line between Bulgana in Victoria's west and Sydenham in Melbourne's north-west. To support the connection of the new transmission line, the following works are proposed:

- The construction and operation of a new 500kV terminal station near Bulgana and a 220kV transmission line connection to the existing Bulgana Terminal Station
- Expansion of the existing Bulgana Terminal Station
- Connection works at the Sydenham Terminal Station including the modification of a bay and a bay extension with associated infrastructure
- Upgrade of the existing Elaine Terminal Station, through the diversion of an existing line
- Protection system upgrades at connected terminal stations.

The Project's main features are summarised in Figure 3.1 and the location is shown in Figure 3.2.

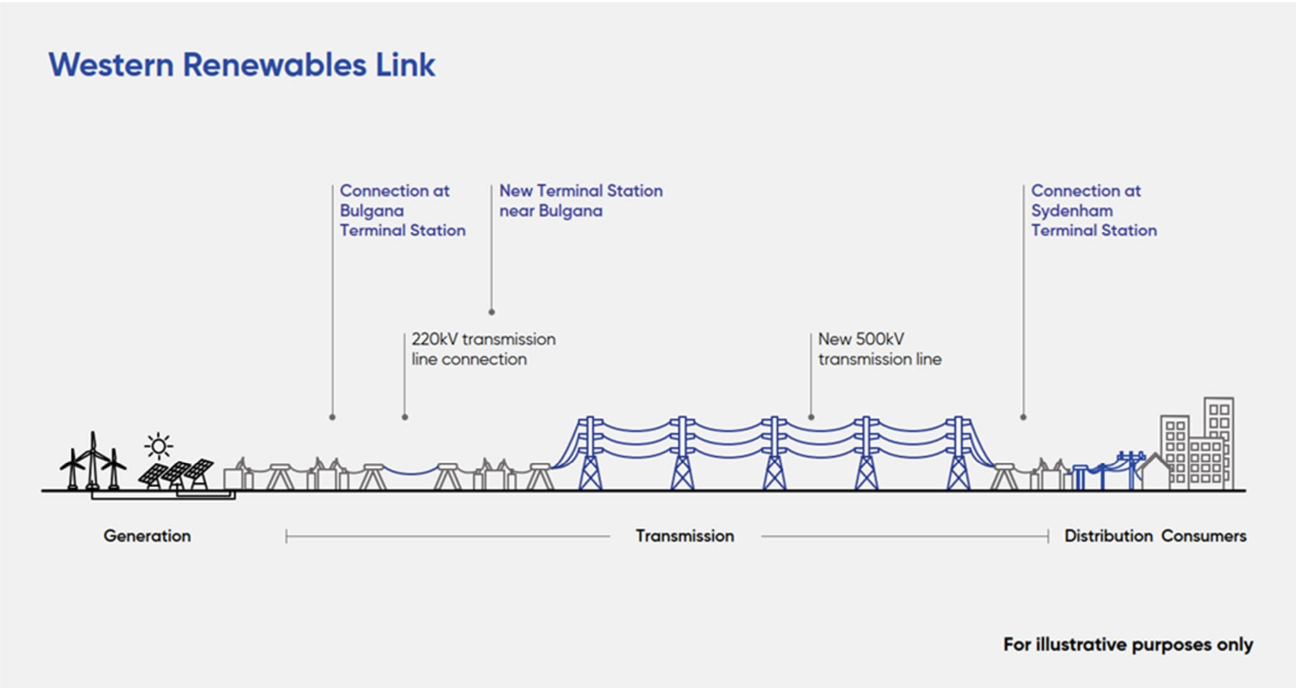

Figure 3.1: Western Renewables Link (Source: AusNet, 2024)

The Project can be described by the following key terms:

- **Project Land**: The Project Land encompasses all land parcels that could be used for the purpose of temporary Project construction and permanent operational components. The Project Land is shown in Figure 3.2.
- **Project Area**: The Project Area is contained within the Project Land and encompasses all areas that would be used to support the construction and operation of the Project. The Project Area is shown in Figure 3.2.

- **Proposed Route**: The Proposed Route is approximately 100 to 170m wide and encompasses the nominal future easement for the proposed new transmission line (including a buffer either side), and the terminal station areas. The Proposed Route is located within the Project Area.

The Proposed Route commences at the existing Bulgana Terminal Station with a 220kV transmission line connection to the new 500kV terminal station approximately 2.3km to the north-east. The Proposed Route then runs from the new 500kV terminal station to the north of the existing Ballarat to Horsham transmission line where it runs parallel to the existing transmission line for approximately 60km. East of Lexton, the Proposed Route deviates from the Ballarat to Horsham transmission line, passing through the northern section of the Waubra Wind Farm between Mount Bolton and Mount Beckworth. Continuing east, the Proposed Route passes south of the Berry Deep Lead gold mining precinct and north of Allendale and Kingston. North of Kingston the Proposed Route turns south-east to Mount Prospect. From Mount Prospect to near Dean, the Proposed Route is adjacent to the existing Ballarat to Bendigo transmission line. Near Dean, the Proposed Route deviates from the existing transmission line to run south, then east through Bolwarrah, Bunding and Myrniong to Darley. The Proposed Route then continues eastward crossing Merrimu Reservoir north of Long Forest and along the northern boundary of MacPherson Park at Melton, connecting to the existing electricity network at the Sydenham Terminal Station.

The Project crosses six local government areas (LGAs), namely:

- Shire of Northern Grampians
- Shire of Pyrenees
- City of Ballarat
- Shire of Hepburn
- Shire of Moorabool
- City of Melton.

For the purposes of this Geology and Soils Impact Assessment, the 'study area' adopted is the same as the Project Land. This is further discussed in Section 5.2.

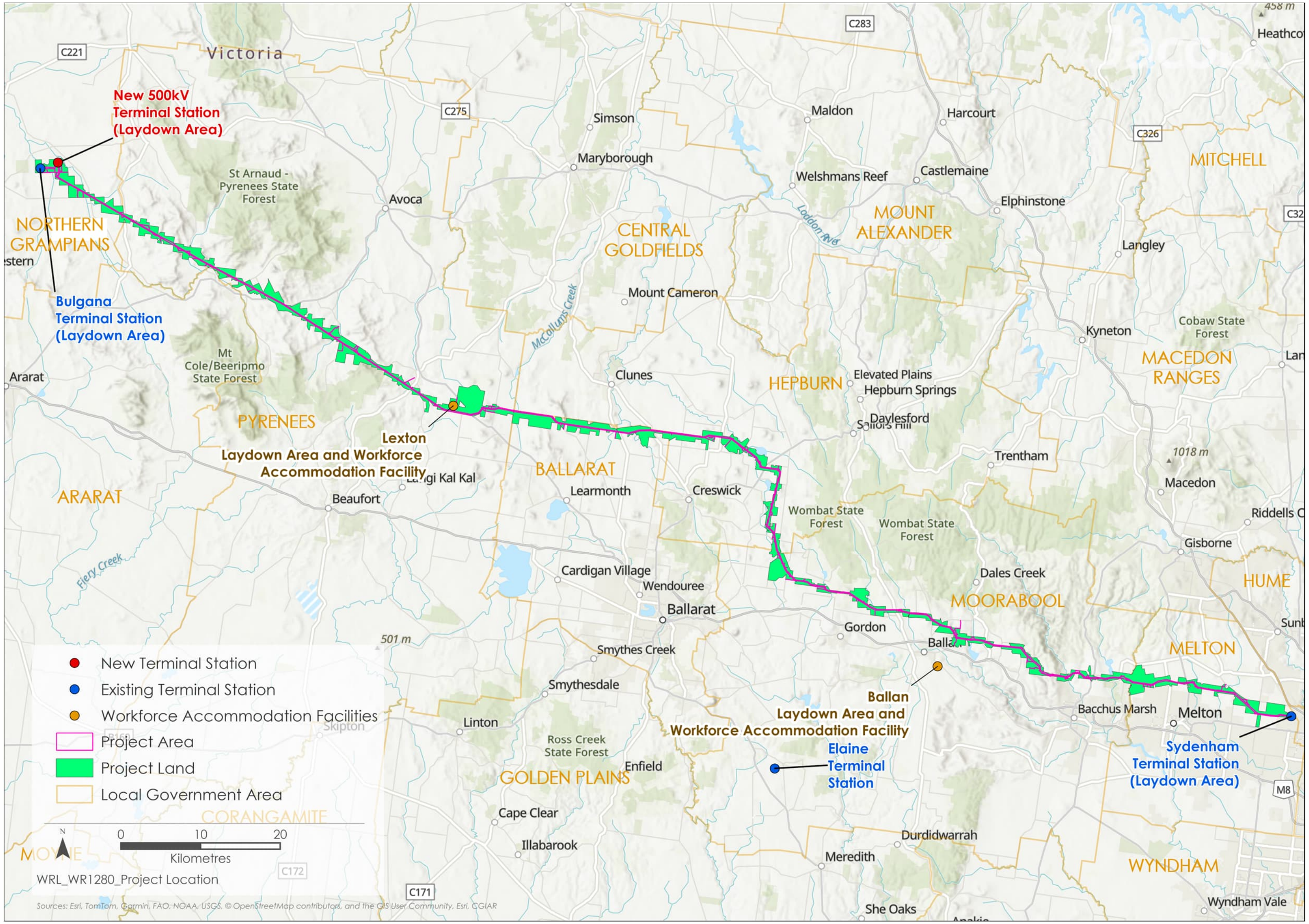

Figure 3.2: Project location (Source: Jacobs 2025)

3.2 Project infrastructure

The Project includes both permanent and temporary infrastructure, as described in Sections 3.2.1 and 3.2.2. The Project has been progressively refined from an initial broad area of interest as described in **EES Chapter 5: Project development**.

3.2.1 Permanent infrastructure

The proposed Project includes the construction of infrastructure listed in Table 3.1. Further detail is provided in **EES Chapter 6: Project description**.

Table 3.1: Project infrastructure – key components*

Double circuit lattice towers	418 double circuit towers
Single circuit lattice towers	36 single circuit towers (18 sets of two side-by-side)
Approximate length of 500kV transmission line route	Approximately 190km, between Bulgana in Victoria's west to Sydenham in Melbourne's north-west.
Approximate length of 220kV transmission line route	Approximately 2.5km, between the existing Bulgana Terminal Station to the new terminal station
Terminal Stations	A new 500kV terminal station and associated infrastructure near Bulgana to be connected to the existing Bulgana Terminal Station via a 220kV connection.
	Expansion of the existing Bulgana Terminal Station to support connection of the new 500kV terminal station near Bulgana.
	A connection to the Sydenham Terminal Station, including the modification of a 500kV bay and a new 500kV bay extension with associated infrastructure
	Relocation and diversion of existing 220kV transmission lines at Elaine Terminal Station.

* Note: These figures are approximate and subject to final detailed design, which will consider further landholder consultation and geotechnical, site and other investigations.

For the safe and reliable operation of the transmission line, an easement is needed for the operation of the transmission line, and other related infrastructure to protect public safety and provide access for maintenance and repair purposes. The transmission line easements will be typically between 70 and 100m wide for the Project.

The transmission line design requirements are specified by the Australian standard AS/NZS 7000:2016 Overhead Line Design and AusNet's Electricity Safety Management Scheme. Key assumptions and considerations of the transmission towers that will form part of the Project and have been used as the basis of this report are described below.

- Transmission towers (towers) support the overhead conductors (wires or lines) at the required height above the ground to meet regulations and safety requirements. The preferred tower configuration will be a galvanised steel lattice structure similar to those found elsewhere across Victoria and within the national network. The typical tower height for the Project is between 60 and 80m.
- Each tower has four footings which will typically be 1.8m in diameter and 9m deep. The four footings base width will be between 10 to 17m wide. During construction, ground disturbance around each tower will typically be no greater than 50 by 70m.
- The spacing or span length between each tower is determined by the height from the ground that the conductors need to be to achieve the required ground clearance in the middle of the span. Typical span length is between 450 and 550m for the transmission line. Longer span lengths are possible over sensitive areas or to avoid impacts. However, longer spans require taller towers to provide safe ground clearances and wider easements to allow for greater sway of the conductors. Similarly, where it is difficult to achieve

the required ground clearance in the middle of the span, due to topography or obstacles, the tower span may be reduced.

- Each span comprises 26 conductors, made up of 12 conductors on each side of the tower cross arms and two ground wires across the top of the tower. Each conductor is approximately 32mm thick and made of aluminium wire strands with a steel core.

As part of the Project, the existing Bulgana Terminal Station will be expanded to support the connection of the new 500kV terminal station into the existing 220kV switchyard. The new 500kV terminal station will support the connection of the Project transmission line and future connections. The new terminal station will require additional land to the north-east of the existing Bulgana Terminal Station.

Upgrades required at Elaine Terminal Station will involve the relocation of existing 220kV transmission lines and diversion of an existing 220kV line into the terminal station. The footprint of the terminal station will not change, and all new equipment will be approximately the same height and scale as existing structures and equipment at the Elaine Terminal Station.

Connection works are proposed at Sydenham Terminal Station. The existing Sydenham Terminal Station will be re-built through the Sydenham Terminal Station Rebuild Project, prior to the Project works. The Project will connect into Sydenham through the modification of a 500kV bay and new 500kV bay extension.

3.2.2 Temporary infrastructure

During construction there will be additional work areas, including vehicle access tracks, temporary tower stringing pads, distribution line crossover points, potential hurdle locations, temporary laydown areas and workforce accommodation facilities.

Temporary laydown areas associated with the terminal stations and the transmission line will be used to sort materials, pre-assemble Project components and store equipment, vehicles and other supplies that support construction activities. Temporary fencing, gates, security systems and lighting will also be installed at the laydown areas. The Project will establish five laydown areas; two of which will be located at existing terminal station sites (Bulgana and Sydenham), one at the new 500kV terminal station near Bulgana, and an additional two sites at intermediate locations between the stations south-east of Lexton and south-east of Ballan. The two intermediate laydown areas are required for the construction of the transmission line. The size of each site (including workforce accommodation facilities) will vary depending on storage requirements. The site south-east of Lexton will be up to approximately 12ha and the site south-east of Ballan will be up to approximately 24ha.

AusNet proposes to utilise temporary workforce accommodation facilities to accommodate construction workforce personnel. Two facilities are proposed; one in each of the western and eastern portions of the Project, co-located with each of the intermediate laydown areas. Each facility will have capacity for up to 350 personnel and will provide individual accommodation units, a communal kitchen and meals area, laundry, gym facilities, mobile and Wi-Fi boosters and serviced cleaning. The layouts of the proposed accommodation facilities will be determined by the Principal Contractor.

3.3 Summary of key Project activities

3.3.1 Construction

Construction of the Project will include preparatory activities (e.g., site investigations, establishment of laydown areas etc.), establishment of temporary infrastructure (such as water and wastewater infrastructure and power supplies), construction of towers and transmission line stringing works; construction works at terminal stations; site rehabilitation works; and pre-commissioning activities.

The overall construction duration of the Project is approximately two years. This schedule is dependent on adjustments required to deliver the Project and the granting of approvals within certain timeframes. For tower assembly and transmission line stringing, work will not be constant, with specialist crews following each other along the route doing specific jobs (clearing, site preparation, tower construction, conductor stringing, site rehabilitation, etc). As each work crew leaves a site (or property) there may be days, weeks, or possibly months of inactivity until the next crew arrives. The cumulative duration of construction work at each tower (i.e., time on each property) will be approximately 9 to 22 weeks (over a two-year period). Once construction is complete, site rehabilitation will occur and commissioning activities will include final inspections and other safety and pre-operational checks. Construction of the Project is anticipated to commence in late 2026 and be completed by late 2028.

Key activities associated with the construction of towers include:

- Site preparations, including necessary vegetation clearance
- Construction of vehicle access tracks and minor upgrades to existing roads and tracks
- Tower foundation works
- Tower structure assembly and erection
- Transmission line stringing works
- Commissioning
- Site rehabilitation.

The works proposed at the new 500kV terminal station near Bulgana, the existing Bulgana Terminal Station and Sydenham Terminal Station will be constructed over a period of approximately 20 months, with key activities including:

- Site preparations, access and necessary vegetation clearance
- Earthworks
- Construction of footings, foundations and drainage systems
- Installation of structures and equipment
- Commissioning
- Landscaping and rehabilitation.

3.3.2 Operations

The operation and maintenance of transmission lines are subject to stringent regulatory controls to ensure public safety and the uninterrupted supply of electricity. All transmission line operators are required to comply with these controls and provide regular reports to the relevant authorities, including Energy Safe Victoria.

The key operation stage activities for the transmission line include:

- Scheduled inspections of the transmission line and easement (either by vehicle patrols or LiDAR/aerial surveys)
- Ongoing vegetation management to maintain safety clearances under the transmission line
- Tower maintenance inspections
- Repairs and maintenance to address issues found in above inspections.

While the terminal stations are operated remotely, staff are present at stations for inspections or maintenance. Routine inspections will occur bi-monthly, with personnel checking the overall condition of the terminal station’s assets.

3.3.3 Decommissioning

The Project’s transmission line is designed for a service life of 80 years, while the terminal station works have been designed for a minimum life of 45 years. The terminal station works will be maintained and upgraded to enable the terminal stations to remain operational for the service life of the transmission line. At the end of the service life of the transmission line, the infrastructure will either be decommissioned or upgraded to extend its service life to maintain the security and reliability of the transmission network as determined by the network planner at that time. In the event of decommissioning, the key activities may involve:

- Lowering the overhead transmission line and ground wires to the ground and cutting them into manageable lengths to roll onto drums or reels for disposal as scrap metal
- Removing insulators and line hardware from structures at the site and disposal at an approved waste facility
- Dismantling towers in manageable sections, removing from the site and selling steel as scrap
- Excavation of footings below finish surface level
- Decommissioning and removal of terminal stations
- Easement restoration and rehabilitation, where required.

3.3.4 Activities relevant to the Geology and Soils Impact Assessment

The Project has the potential to impact geology and soils during construction, operation and decommissioning. The Project has the potential to interact with geology and soils if Project stages are not planned and managed with respect to the geological conditions encountered, naturally occurring earth processes and relevant legislation and guidelines. Project activities relevant to the Geology and Soils Impact Assessment have been described below.

3.3.4.1 Transmission tower construction – tower assembly areas

At the base of all tower sites, a work area, referred to as the tower assembly area, will need to be established for use during construction and assembly of the towers. These areas will be placed around the tower legs and include an area for a crane, an elevated work platform for vehicles to work from, an area for foundation drilling equipment, and areas for the assembly of the tower components and to string the conductors.

The tower assembly area will be established by clearing an area typically no greater than 50 by 70m. Site-specific conditions, such as the slope of the land or soil conditions, may influence the size and shape of the cleared area. Minor ground improvement works (e.g., levelling works, or benching) may be needed at the site to provide safe access for construction workers and equipment. Figure 3.3 shows an example of a tower assembly area.

The location of the tower assembly area will be selected based on the location of the tower and preparatory site investigations, considering terrain, fences, landholder requests, or any other identified constraints. Depending on the ground conditions, an area of compacted rock may be required to create a work area (hardstand) for the foundation work equipment and crane pads used to assemble the tower. Construction of the tower assembly areas will depend on the specific soil and rock type, considering water levels, soil bearing capacity, construction constraints, rock levels and soil properties.

The extent of the crane pad area within the tower assembly area will typically be in the range of 12 by 12m. The pad will align with the access track to the tower assembly area, as shown in Figure 3.3.

Blasting is not anticipated to be required to construct the towers or any other elements of the Project.

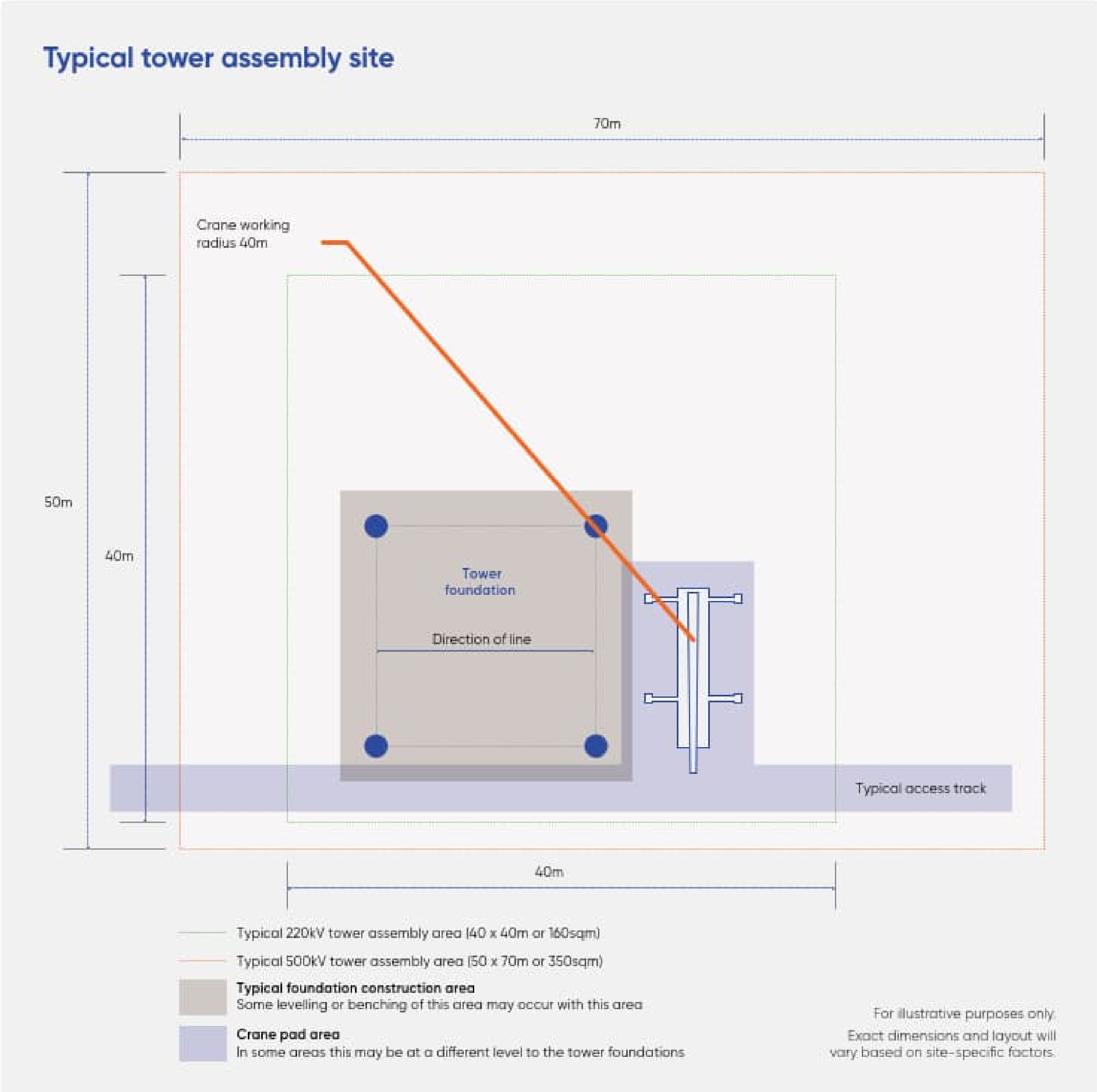

Figure 3.3: Indicative diagram of tower assembly area (Source: AusNet, 2025)

3.3.4.2 Transmission tower construction - below ground works

Transmission tower dimensions are shown in Figure 3.4 below. Each transmission tower includes construction of four concrete pile footings (or foundations). Geotechnical assessments will be conducted prior to construction to determine the appropriate foundation type for each structure. The choice of foundation is dependent on the specific soil and rock type considering water levels, soil bearing capacity, construction constraints, rock levels and soil properties. The structure type, height and soil conditions on site will determine the dimensions of the foundation.

The likely construction method for the tower footings is bored piles. Construction of structure foundations will initially require placement of temporary pegs on site to mark out the location of the drilling. Once pegs are in position, track mounted drill rigs will be utilised for drilling the pile foundations. The depth of the foundation excavation will be dependent on the geotechnical condition of the surrounding soil. Typical pile depths are shown in Figure 3.4 below. In unstable ground conditions, steel liners may be inserted into the drilled hole to stabilise the excavation. In areas where rock is encountered, additional rock drilling equipment could be used to construct the tower foundations. Geotechnical investigation works undertaken during preparatory works will identify these areas to inform the style of foundation to be designed and installed. Temporary formwork will be used for the foundation sections above ground, concrete will be poured in accordance with standard construction practice and formwork will be removed after curing is complete. Backfilling will then be completed either using the excavated material, if suitable, or otherwise imported fill will be used.

The depth and location of below ground works will determine whether groundwater is encountered. If groundwater is encountered during piling activities, it is likely piling activities will be conducted in ‘wet conditions’, whereby a tremie pipe is lowered to the bottom of the drilled hole and cement is pumped. The cement will displace the groundwater at the surface of the bored pile. The slurry displaced by the cement will include a mixture of groundwater, cement and drill cuttings. The slurry will be managed using standard construction practices to provide containment and protect nearby waterways.

If piling in dry conditions is required, immediately prior to the cement pour, the bored hole will be dewatered with a sump pump to the base and then cement poured (i.e., a once-off dewatering of one bored hole volume may take place).

The below ground work at each tower will take approximately four weeks, with about nine days per footing for excavation, installation of reinforcement and concrete pouring. The overall construction duration could extend to approximately seven weeks from mobilisation to de-mobilisation. Construction may occur at multiple transmission towers at the same time.

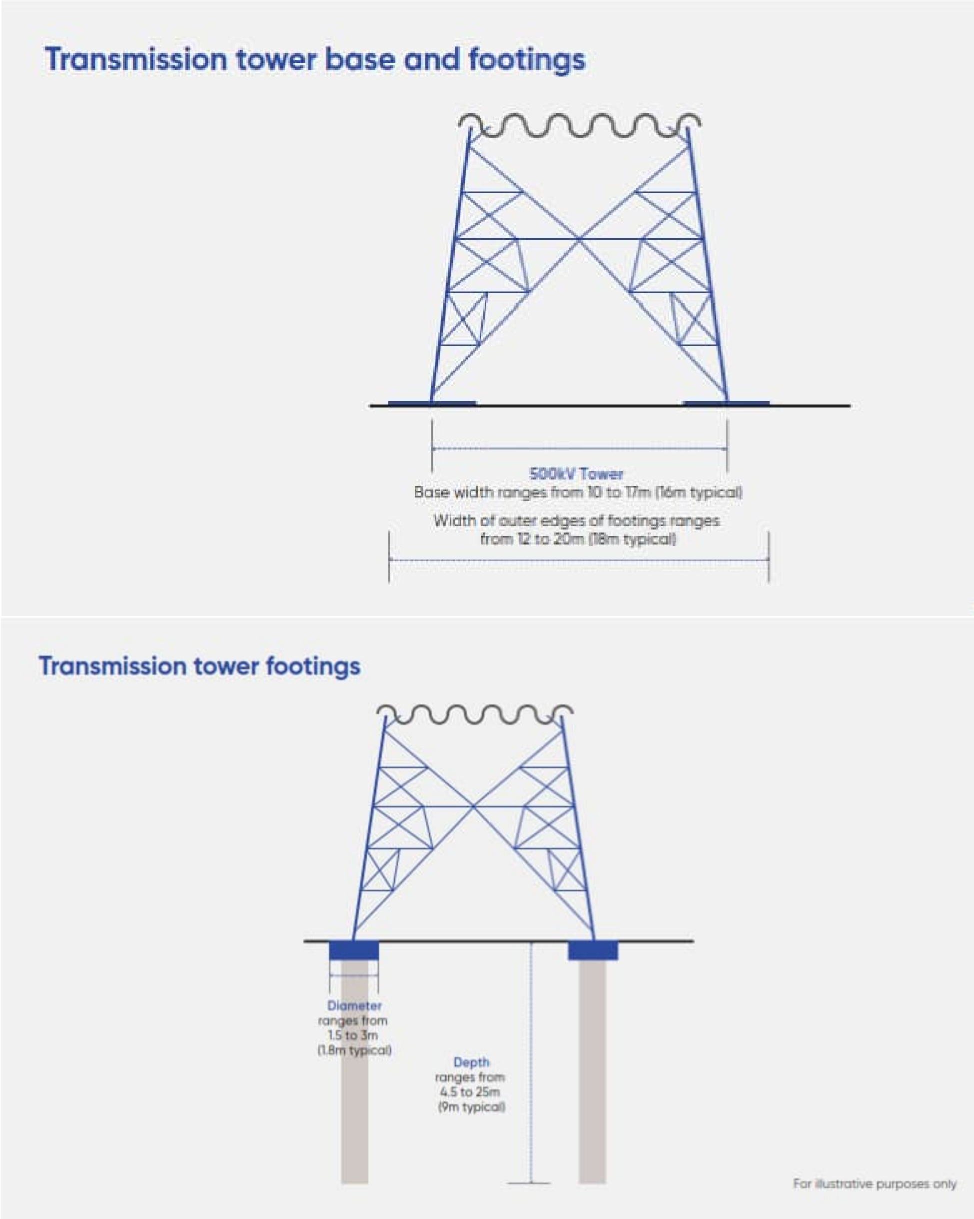

Figure 3.4: Proposed transmission line tower base and footings dimensions (Source: AusNet, 2025)

3.3.4.3 Transmission tower construction - construction on slopes

At several locations, transmission towers will need to be constructed on steep slopes, which may require temporary or permanent slope stability control measures to allow for the construction of the tower and for maintaining long term slope stability over the life of the tower.

Permanent slope stability control measures may include construction of appropriate batter slopes, soil nails, rock bolts, piled walls, vegetation and slope drainage. Each tower foundation constructed on steep slopes will require a specific geotechnical assessment to determine the appropriate control measures.

Additional temporary slope stability controls may also be required for construction of temporary hardstands acting as laydown areas adjacent to the tower locations.

3.3.4.4 Terminal station construction – site preparation

Surfaces at terminal station sites will be prepared using a cut and fill process to provide a level base. The extent of the earthworks is contingent upon each terminal station's geological profile and surveys completed prior to the construction. Extensive below ground works are not proposed as part of the Project at the terminal stations, and the extent of earthworks will be determined by geotechnical assessment. Potential below ground works include levelling of site formation, construction of footings, foundations and drainage systems. Temporary laydown areas, used for the construction stage, will be established within the existing boundaries of the Bulgana Terminal Station and Sydenham Terminal Station on land owned by AusNet.

3.3.4.5 Construction of temporary intermediate laydown areas

Construction of the temporary laydown areas typically involves:

- Removing topsoil and vegetation, where required, using graders or tracked bulldozers
- Stockpiling of topsoil for reuse
- Levelling the ground surface using a roller
- Adding crushed rock and
- Rolling the ground for compaction.

Vegetation clearance will be undertaken in accordance with the EPRs, the planning and regulatory approvals issued for the Project and with AusNet's *Vegetation Management Plan.*

Once construction is completed, all temporary laydown areas used for the Project will be reinstated. Materials will be loaded onto appropriate tip trucks for removal, reuse and disposal off-site.

3.3.4.6 Construction of distribution line crossovers

Power distribution lines supply lower voltage electricity to consumers, like individual residencies and commercial businesses. At 70 locations, the proposed transmission line route crosses over the path of the existing power distribution lines. These distribution lines are operated by Powercor.

Distribution line crossover services are proposed to be placed underground, where they intersect with the Project easement. AusNet has completed a design process to determine the most appropriate location for placement and construction techniques. This work has considered surrounding land uses and the need to avoid areas of significant environmental and cultural heritage values. The detailed design and construction of each distribution line crossover point will be undertaken by Powercor.

Typical buried distribution services involve a trench approximately 600mm wide and 1m deep. Trenches are expected to be 100 to 300m long with a construction impact area around 3 to 4m wide (to dig a 600mm wide trench). The trench will normally extend from just outside the edges of the Project easement, meaning that its length will be dependent on the angle at which the crossover lines intersect with the Project transmission line. The temporary impact of this trenching work will vary and is highly dependent on the location and terrain. The impacts associated with trenching and installation of these crossovers have been assessed as part of this EES.

A diagram of a typical distribution line crossover point is shown in Figure 3.5 below.

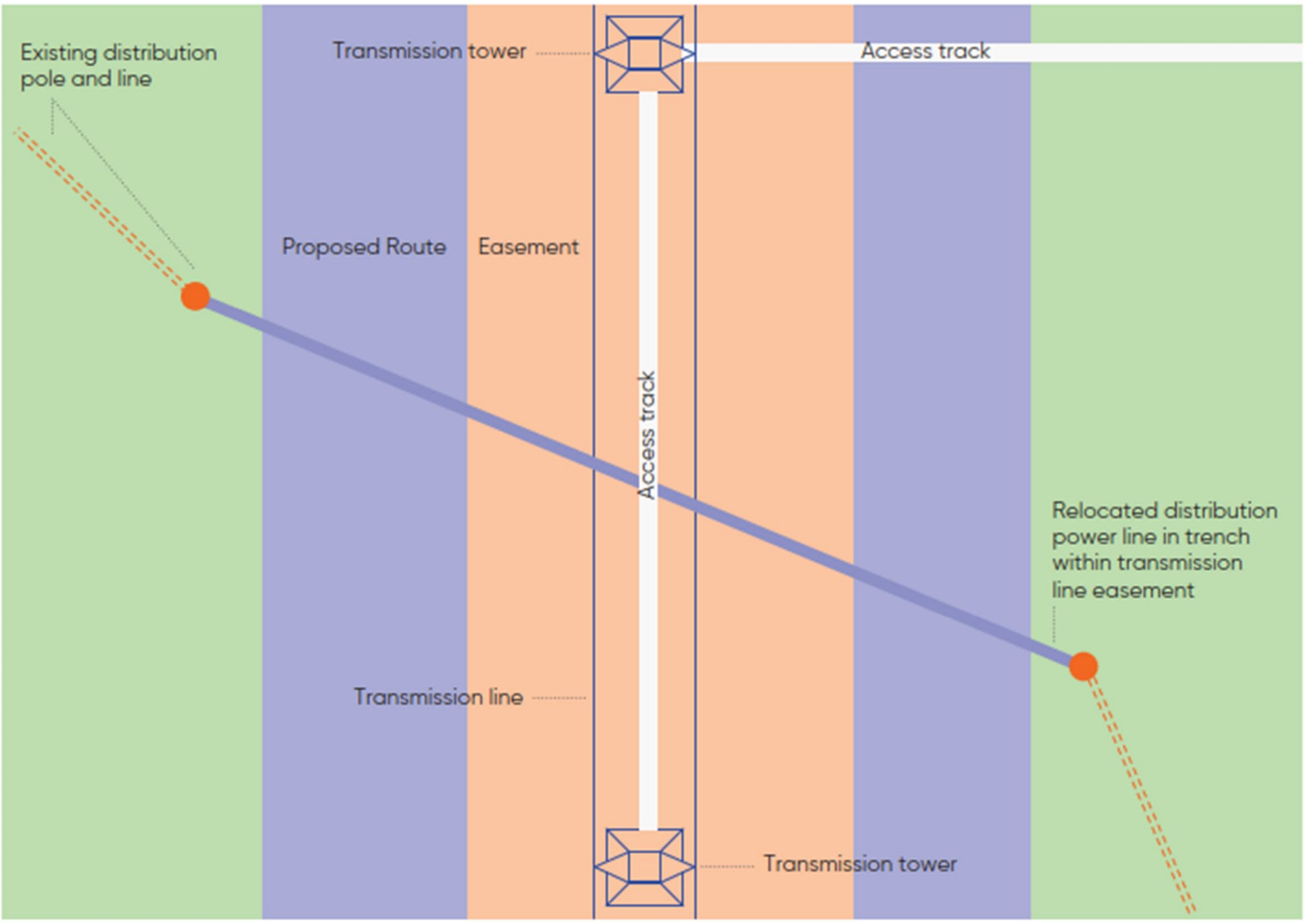

Figure 3.5: Configuration of distribution line crossover points (Source: AusNet, 2025)

3.3.4.7 Other existing infrastructure

To prevent damage and utility disruption, a search of existing utility services (for example, Dial Before You Dig) will be conducted prior to any construction works to identify their location. Where necessary, these services will be relocated. If the relocation of services is not possible, it may be necessary to adjust the tower position within the Proposed Route. AusNet will work with each relevant utility services provider to enable adequate separation between assets.

Where the Project crosses roads, railways, electricity lines or communication lines, protective works (such as hurdles, scaffolding and nets) will be installed temporarily during construction. In addition, protective scaffolding or hurdles will be installed on low and medium voltage lines to protect people and the existing infrastructure from being damaged if any construction issues occur during the period of the works.

There are two common ways of installing hurdles. The first method involves drilling and inserting at least two timber poles into the ground using an auger drill and crane and installing a crossbeam between the poles, which acts as a barrier to prevent conductors falling or contacting the ground. Where drilling cannot be undertaken due to environmental or cultural heritage constraints or where it is difficult to implement, purpose-built prefabricated concrete stay blocks will be placed on the ground and timber poles inserted into these blocks and cross-beams installed. These poles have stay wires installed that are tied back to additional concrete blocks to provide further support. Examples of these protective works are shown in Figure 3.6 below.

Figure 3.6: Examples of protective hurdle works during construction (AusNet, 2024)

3.3.4.8 Construction of access tracks

Access tracks are required to facilitate the transportation of plant and equipment to the to the tower assembly sites and other temporary construction areas (such as stringing pads). Tracks will typically be a trafficable width of 4 to 6m wide with a one metre allowance on either side for drainage and retaining batters, where required. At a very small number of locations – for example, where the access track is on a steep slope – the full width (trafficable width plus allowances) may need to extend to 10 to 15m.

The overarching principles for the selection and siting of access tracks are:

- Site assessment with landholders, wherever possible, to identify existing tracks that can be used
- Ease of access to and from the nearest public road
- Minimising disturbance to ecological and cultural heritage values
- Minimising disturbance to soils and vegetation
- Avoiding or minimising waterway and drainage line crossings
- Avoiding steep slopes, waterlogged land and potentially unstable ground
- Avoiding interaction with PASS and contaminated groundwater.

Existing tracks (such as those used for farm vehicles or for other projects) will be used where practical to minimise disturbance to landholders and users. If upgrades to existing tracks are required, this will be done in consultation with landholders. Tracks will be upgraded by laying a road base material (crushed rock) and compacting the material using a roller.

Where there is no existing access track that can be used, a new all-weather access track will be built. Construction of these new tracks may involve:

- Removal of topsoil (up to 150mm) using graders or tracked bulldozers
- Stockpiling of topsoil for reuse
- Surface levelling using a roller
- Adding crushed rock
- Compaction rolling

- Installation of drainage control measures, including drainage diversions and outlet structures.

Access tracks may be temporary (used only to support construction activities) or permanent (used to support the Project on an ongoing basis). The Principal Contractor will determine which access tracks are required for ongoing operation and maintenance purposes and these will remain in place after construction.

Temporary tracks will be reinstated to previous conditions, subject to the requirements of the landholder who may prefer to use the track for other purposes. Requests from landholders for permanent access tracks will be considered. An example of typical access tracks is shown in Figure 3.7 below.

Figure 3.7: Examples of typical access tracks (Source: AusNet, 2024)

3.3.4.9 Development adjacent to sites of geological significance

Construction of transmission towers and access tracks adjacent to sites of geological significance will be required. Examples of geologically significant features may include hills or eruption points, rock outcrops and fault lines. Appropriate assessment of tower locations will be required to minimise the potential for physical impacts to sites of geological significance. This will also be controlled by adopting best practice construction methods to limit disturbance to these areas. Where limited disturbance is required, such as when constructing tower locations at the base of an eruption point, this will be undertaken in accordance with the planning and environmental approvals issued for the Project and as specified in the CEMP.

3.3.4.10 Decommissioning

The process of decommissioning the transmission line and terminal station at the end of their service life is described in Section 3.3.3.

Demolition of the towers will generally include excavation of the ground surrounding each tower, including the tower leg/holding down bolts and encasing concrete. The excavation will be backfilled and compacted with suitable material (imported, if necessary).

In specific situations, the tower footings may be cut off deeper (to avoid any potential interference with ploughing machinery) and backfilled with better quality soil.

The process of dismantling and removal of the terminal station will include removal of footings to typically 1m below ground level (with the lower end of the footing remaining in place). The excavation then will be backfilled and compacted with suitable (imported, if necessary) material.

4. Legislation, policy and guidelines

This section provides an overview of key Commonwealth and state legislation relevant to geology and soils matters, including identifying primary and likely secondary approval requirements for the Project.

4.1 Commonwealth legislation

Table 4.1: Key Commonwealth legislation relevant to geology and soils

Legislation	Relevance to this report
Environment Protection and Biodiversity Conservation Act 1999	
The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) provides the legal framework to protect and manage matters of national environmental significance (MNES), which includes world heritage properties; national heritage places; wetlands of international importance (Ramsar); listed threatened species and communities; listed migratory species; Commonwealth marine areas; the Great Barrier Reef Marine Park; nuclear actions; and water resources, in relation to coal seam gas and large coal mining development. Any project that is likely to have a significant impact on MNES, must be referred to the Commonwealth Minister for the Environment via the DCCEEW for a decision on whether the project is a 'controlled action' requiring assessment and approval under the EPBC Act.	The Project was referred to the Commonwealth Minister for the Environment, who determined that the Project is a 'controlled action' requiring assessment and approval under the EPBC Act before it can proceed. The Minister's referral decision (EPBC 2020/8741) issued on 2 September 2020 determined that the Project is a 'controlled action' due to its potential to have a significant impact on listed threatened species and communities, and further stipulates that the Project will be assessed under the assessment bilateral agreement between the Commonwealth and Victorian Governments. The proposed action referred was varied on 20 November 2024 to reflect the Project description. Under the Victorian *Environment Effects Act 1978*, the EES process is an accredited assessment process under the bilateral (assessment) agreement.

4.2 State legislation

Table 4.2: Key state legislation relevant to geology and soils

Legislation	Relevance to this report
Environment Effects Act 1978	
The *Environment Effects Act 1978* (Environment Effects Act) provides for the assessment of projects that may have a significant effect on the environment by enabling the Minister administering the Act to decide that an EES should be prepared. An EES may be required where: • There is a likelihood of regionally or State significant adverse environmental effects • There is a need for an integrated assessment of social and economic effects of a project or relevant alternatives • Normal statutory processes would not provide a sufficiently comprehensive, integrated, and transparent assessment. The process under the Environment Effects Act is not an approval process in itself; rather it is an assessment process that enables statutory decision-makers to make decisions about whether a project with potentially significant environmental effects should proceed.	On 22 August 2023, the Minister for Planning determined that the Project requires assessment through an EES under the Environment Effects Act, due to matters as set out in the Statement of Decision on Referral No. 2023R-04, and summarised below: ▪ The area of interest for the Project supports significant environmental values, and other social values, potential aggregate impacts on which are of at least regional significance. ▪ Multiple alignment and design alternatives for the Project within the area of interest require rigorous and transparent assessment and refinement. ▪ An EES responds to community interest in project siting, alignment and design alternatives by providing appropriate opportunities for public input. The Minister for Planning issued the EES scoping requirements in November 2023 (Section 2), which have informed this assessment.

Legislation	Relevance to this report
Planning and Environment Act 1987	
The *Planning and Environment Act 1987* (Planning and Environment Act) regulates the use and development of land in Victoria. The Act sets out the framework and procedures for preparing and amending planning schemes, obtaining planning permits, settling disputes, enforcing compliance with planning schemes, and other administrative procedures. The purpose of the Victorian Planning Schemes is to: ▪ Provide clear and consistent framework within which decisions about the use and development of land can be made. ▪ To express state, regional, local and community expectations for areas and land uses. ▪ To provide for the implementation of State, regional and local policies affecting land use and development.	The construction and operation of the Project would occur in the municipalities of Northern Grampians, Pyrenees, Ballarat, Hepburn, Moorabool and Melton and is subject to a range of planning controls under planning schemes for these municipal areas. The Planning Policy Framework of these planning schemes provides clauses for geology and soils as follows: <u>Clause 13 Environmental Risks and Amenity</u> ▪ Clause 13.04 Soil Degradation a) *Clause 13.04-2S Erosion and landslip:* This clause outlines objectives and strategies to protect areas prone to erosion, as well as highlighting applicable policies. *b)* *Clause 13.04-3S Salinity:* This clause outlines objectives and strategies to minimise the impact of salinity on land uses, as well as highlighting applicable policies. Other Victorian Planning Provisions related to geology and soils include: ▪ Clause 42 Environmental and Landscape Overlays - *Clause 42.03 Significant Landscape Overlay:* This clause describes the purpose and objectives of the SLO, as well as the permit requirements for construction within an SLO area. - *Clause 44.01 Erosion Management Overlay:* This clause describes the purpose and objectives of the EMO, as well as the permit requirements for construction within an EMO area. Environmental and landscape overlays such as SLOs and EMOs are used to protect significant landscapes and areas prone to erosion from land disturbance and inappropriate development.
Catchment and Land Protection Act 1994	
The Catchment and Land Protection Act 1994 (CaLP Act) defines requirements to: avoid land degradation; conserve soil; protect water resources; and to eradicate and prevent the establishment and spread of noxious weeds and pest animals. The CaLP Act provides the power to declare 'pest animal' species and 'noxious weed' species and defines four categories of noxious weeds: State Prohibited Weeds; Regionally Prohibited Weeds; Regionally Controlled Weeds; and Restricted Weeds. Noxious weed species and the category they are placed in is specific to individual catchment management authority (CMA) regions. Under the CaLP Act, all landholders (or a third party to whom responsibilities have been legally transferred) have legal obligations regarding the management of declared noxious weeds and pest animals on their land.	The CaLP Act Statement of Obligations requires CMAs and Melbourne Water to “advise on planning referrals regarding floodplain management, dryland salinity, irrigation management, and soil erosion. Any applicable regional catchment strategy and any associated implementation plan or strategy (particularly salinity management plans and regional vegetation plans). This legislation is relevant to the Project because it defines requirements to avoid land degradation and conserve soil, which is inherently linked to geology and soils aspects such as soil salinity and erosion.

4.3 Policy, guidelines and standards

Table 4.3: Policy, guidelines and standards relevant to geology and soils

Policy, Guidelines and Standards	Description	Relevance to this report
Australian Standard AS2159-2009: Piling-design and installation	This sets out minimum requirements for the design construction and testing of piled footings for the transmission towers.	The design of the transmission towers will need to consider potentially corrosive ground conditions (e.g., corrosive soil and groundwater) in accordance with this standard.
Australian/New Zealand Standard AS/NZS 7000-2016: Overhead line design	This standard sets out the minimum design requirements for overhead lines, including an informative appendix which provides advice on structure footing design and guidelines for the geotechnical parameters of soils and rocks.	The design of transmission towers will need to meet the requirements of the overhead line design standard.
Australian Standard AS5100.3:2017: Bridge Design Part 3 Foundations and soil supporting structures	This standard sets out the minimum design requirement for anchors where required as part of the foundation design.	The design of transmission towers will need to consider the use of anchors, including anchor testing requirements, in certain ground profiles in accordance with this standard.
Australian Standard AS2870-2011: Residential slabs and footings	This standard provides the basis for determination of swelling and shrinkage movements of reactive clay soils due to moisture changes.	This standard sets the basis for estimating ground movements due to shrink-swell behaviour in reactive clay soils. The design of transmission tower foundations and access roads will need to consider potential impacts of ground movements due to shrink-swell behaviour.
Australian Standard AS1726-2017: Geotechnical site investigations	This standard establishes the requirements for the execution of effective geotechnical site investigations and provides a standardized system for the description and classification of soils and rocks.	This standard provides a standardised system for geotechnical site investigations and classification of soils and rocks that will ultimately be adopted to inform the geotechnical design of the Project.
Australian Standard AS3798-2007: Guidelines on earthworks for commercial and residential developments	This standard provides guidance to those responsible for or involved with the design, specification, supervision and control testing of earthworks for commercial and residential developments.	This standard provides guidance for the design, compaction and testing of earthworks. As it relates to AusNet projects the SDM 05-0400 and SDM 05-10400 take precedence over the Australian Standard, and this standard is referenced in the SDMs.
IECAA Best Practice Erosion and Sediment Control, 2008	The International Erosion Control Association Australasia (IECAA) has developed a set of best practice guidelines for erosion and sediment control. Appendix K of this guideline describes the best practice for erosion and sediment control as it relates to the construction of access tracks and trails.	Earthworks and the construction of access tracks and will be required as part of the Project and ensuring that earthworks and access tracks are constructed using best practice erosion and sediment control measures will reduce the impacts on the environment that may result from erosion and sediment run-off.
AGS Australian Geoguides for Slope Management and Maintenance, 2007	The AGS published the Australian Geoguides for Slope Management and Maintenance in 2007, which provide a guideline on slope management and maintenance, as part of the landslide risk management guidelines developed under the National Disaster Funding Program (NDMP).	This document provides recommendations relating to construction on slopes, slope management and maintenance that will be relevant to the construction and operation of the Project. Construction of transmission towers on steep slopes resulting in slope instability has been identified as one of the key risks.

Policy, Guidelines and Standards	Description	Relevance to this report
AusNet Earthworks Station Design Manual SDM 05-0400, 2015	This standard is applicable to the design of earthworks within terminal stations, zone substations, and power station switchyards.	This document provides applicable design and construction specification standards for earthworks within AusNet stations and switchyards, including geotechnical investigation requirements. Design of earthworks will be required for construction of transmission tower assembly areas, access tracks and terminal stations.
AusNet Earthworks, Road Pavements and Drainage Construction Specification SDM 05-10400, 2015	This specification sets out the requirements for site clearing, excavation, fill, backfill, road pavements, drainage and yard surfacing.	This document sets out specific requirements for earthworks, excavations, and pavement construction. Design of earthworks and excavations will be required for construction of transmission tower assembly areas, access tracks and terminal stations.
AusNet Overhead Transmission Lines Design Standard SDM 08-0100, 2021	The purpose of this document is to describe engineering requirements for the AusNet existing and new 66 kV, 220 kV, 275 kV, 330 kV and 500 kV transmission lines infrastructure.	This document describes AusNet engineering requirements for existing and new transmission line infrastructure. This design standard is applicable as it relates to the design of the 500kV transmission lines and towers. This standard follows AS/NZS 7000 in most instances, however, also provides specific advice relation to geotechnical investigation requirements to inform design and construction of AusNet transmission lines.
Civil Construction, Building and Demolition Guide (EPA Pub 1834.1, September 2023)	These guidelines would be incorporated within the CEMP of the Project.	This would include development of a CEMP, including a dewatering strategy (if required) and implementation of groundwater control measures and soil and spoil management strategies and implementation of control measures.
Department of Sustainability and Environment. 2010. Victoria's best practice guidelines for assessing and managing coastal acid sulfate soils.	Guidelines for Assessing and Managing Coastal Acid Sulfate Soils (BPMG) to guide landowners, developers, planners and decision makers through a risk identification approach that will assist them to make decisions about the assessment and management of coastal acid sulfate soils (CASS).	Any construction works will need to consider the potential for acid sulfate soils to be present. However, given the Project's distance from coastal areas, and ground elevations (above sea level), the likelihood of encountering acid sulfate soils is considered low. Measures to manage CASS should it be encountered are included in Technical Report R (Contaminated Land Impact Assessment).

5. Method

5.1 Overview

This section describes the method that was used to assess the potential impacts of the Project. Risk screening was applied to prioritise the key issues for impact assessment. Measures to avoid, minimise and manage potential effects have then been developed to address these impacts. The following sections outline the method adopted for the Geology and Soils Impact Assessment.

5.2 Study area

The study area for the Geology and Soils Impact Assessment is shown in Figure 5.1 and is the same as the Project Land. The width of the study area generally varies from approximately 0.3 to 4km along the Proposed Route. The geology and soils study area included areas identified within the Project Land considered likely to be subject to ground disturbance works during construction.

For the purposes of defining existing conditions and undertaking the impact assessment, the study area has been split into four sections that are defined based on distinctive geological and geomorphological conditions:

- **Bulgana to Lexton:** Within the Western Uplands geomorphic province, characterised by undulating hills and ridges formed by sedimentary rock units intersected by valleys filled with narrow creek valleys and broad low-lying areas.
- **Lexton to Ballan:** Within the Western Uplands geomorphic province, characterised by gently undulating hills formed by Tertiary lava flows with isolated steep hills associated with local volcanic eruption points.
- **Ballan to Melton West:** Within the Western Uplands and Western Plains geomorphic provinces, characterised by undulating hills with steep hills ranges formed by sedimentary rock units with broad low-lying areas dominated by Alluvium units.
- **Melton West to Sydenham**: Within the Western Plains geomorphic province, characterised by flat Tertiary Volcanic plains with low-lying areas associated with watercourse and drainage.

These study area sections are shown below in Figure 5.1 and in Figure A.1.0 in Appendix A.

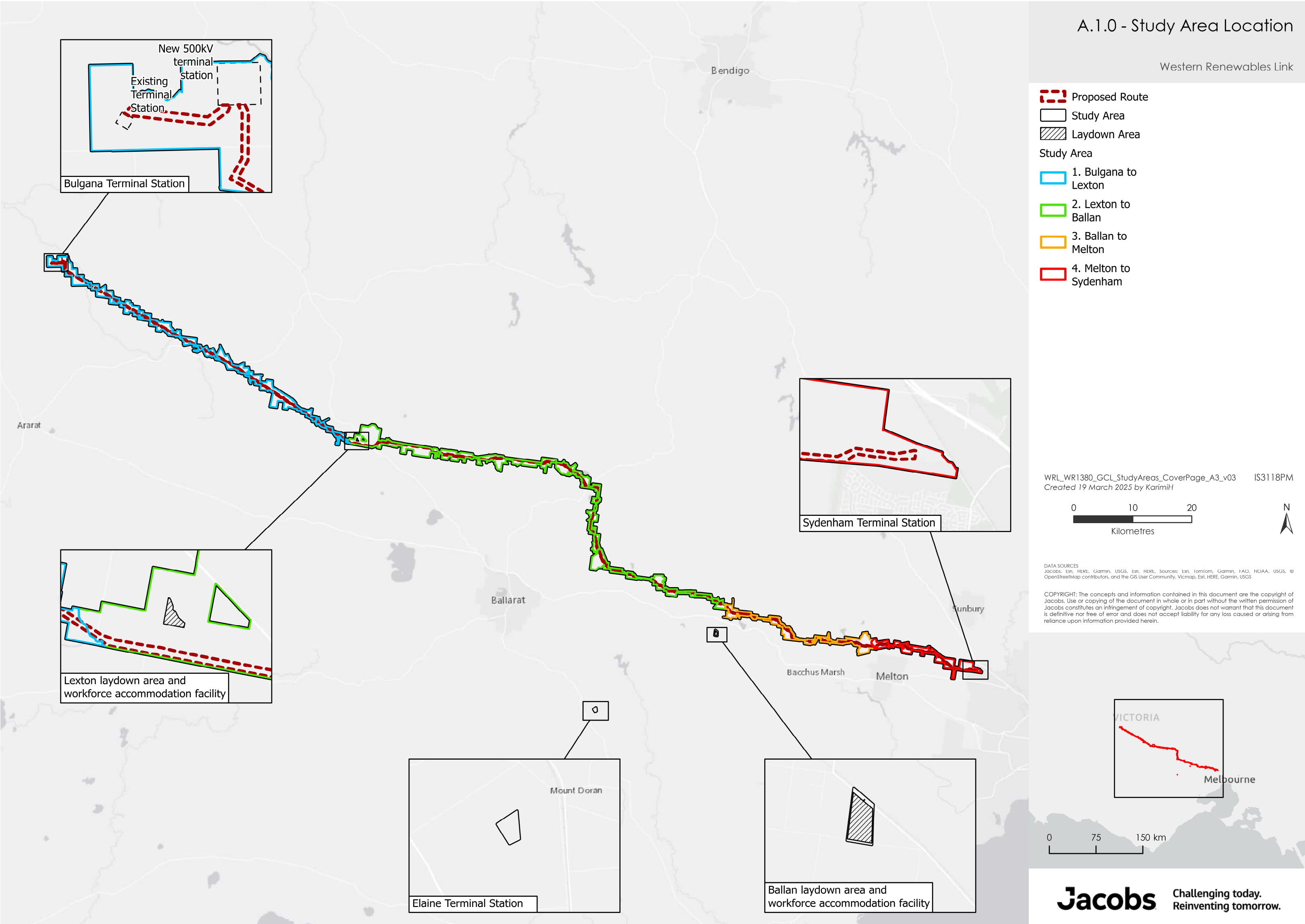

Figure 5.1: Study area sections (Source: Jacobs, 2025)

5.3 Existing conditions

An existing conditions assessment was used to characterise the geology and soils within the four study area sections defined in Section 5.2 that may impact the associated design, construction and operation of the Project. The existing conditions assessment included the completion of a desktop search of publicly available information; site walkover of selected areas, limited laboratory testing and consideration of available geotechnical investigation data (e.g., Bulgana Terminal Station), with results used to inform the risk and impact assessment.

Key elements of the geology and soils existing conditions assessment included:

- Review of published maps and reports, including:
  - Geomorphology of Victoria (Department of Jobs, Skills, Industry and Regions (DJSIR)). 2023. 1:250,000 Scale Tier 3 Geomorphological Unit Mapping.
  - Jacobs Group (Australia) Pty Ltd. 2018. Bulgana Terminal Station Geotechnical Report (Ref: RO110300-CG-RP-0001, Rev 1).
  - Seamless Geology (DEECA). 2014. 1:250,000 Scale Geological Unit Mapping - Victoria.
  - Statewide Geotechnical (Aust) Pty Ltd. 2015. Geotechnical Site Investigation, Water Tank Installation, Sydenham Terminal Station (File No: 19635-1).
  - Statewide Geotechnical (Aust) Pty Ltd. 2020. Geotechnical Site Investigation, Final Report (Geotechnical Interpretative Report – GIR), Bulgana Terminal Station Upgrades, Joel Joel, Victoria (Project No: 26285-1).
- Review of Victorian planning schemes relating to geology and soils, including:
  - Erosion Management Overlay (EMO)
  - Significant Landscape Overlay (SLO).
- Review of published soil overlays and hazard susceptibility mapping, including:
  - Review of published data including soil overlays and hazard susceptibility mapping was conducted to assess the susceptibility of land (not subject to an EMO) to land degradation processes (gully erosion, landslip, wind erosion)
  - Overlays were obtained from the Geomorphology of Victoria dataset, which provides hazard levels for land degradation processes based on the geomorphological unit. The mapped units are based on the Victorian Geomorphological Framework (VGF), which is a spatial framework consisting of geomorphological unit and landform descriptions and is available as a three-tier mapping system:
    - Tier 1 - Contains eight level one divisions across whole state
    - Tier 2 - Level two divisions of Tier 1 units
    - Tier 3 - Level three divisions of Tier 2 units. Allows for complexity within larger units to be separated into units that had not been defined in previous geomorphology systems. Provides geomorphological mapping at 1:250,000 scale.
  - Susceptibility hazards levels range between very low and very high and are assigned based on the typical lithology, topography and physical processes associated with each Tier 3 unit
  - Specific datasets referenced include:
    - Gullying erosion susceptibility
    - Landslide susceptibility
    - Wind erosion susceptibility.
- Review of Soil Types:

- The Victorian Soil Types dataset provides the mapped soil types in Victoria, in accordance with the Australian Soil Classification (ASC; Isbell, 2002). The dataset categorises soils based on the soil attributes with relevance to land use and soil management.

▪ Review of Victoria's Salinity Provinces:
  - Review of Victoria's Salinity Provinces was conducted, which provides a framework to describe land and water (surface and groundwater) salinity in Victoria. Each province provides an indication of where there is a greater incidence of land and/or water salination. A review was conducted of the published information about soil salinity within each salinity province intersected by the Project Land. This information includes:
    - Salinity province
    - Catchment region
    - Province area
    - Recorded soil salinity area (mapped areas of soil salinity, noting limitations of this data listed in Section 5.8).

▪ Review of published Sites of Geological and Geomorphological significance:
  - Review of published locations of Sites of Geological and Geomorphological significance was conducted. Reference was made to the mapped dataset of geologically significant features as determined by the GSA. Significance is determined by the GSA using set criteria (unpublished). The significance levels range from local to international significance.
  - For the purpose of this assessment, features designated as having a significance level of "local" or higher (i.e., local, regional, state, national or international significance) have been described where they are situated within or partially within the study area.

▪ Site walkover inspection of selected sites:
  - Geology and soils site walkover inspection of selected sites was conducted to identify any further at-risk geological conditions not identified by the desktop review.
  - The geology and soils site walkover was completed between 25 August and 27 August 2021.
  - For the purpose of the geology walkover, selected sites were referred to as checkpoint locations. The locations of checkpoints were selected based on the results of the desktop review. Checkpoint locations were assigned to a type according to their specific reason (e.g., Erosion and gullying susceptibility, Landslide susceptibility, etc.).
  - A total of thirty-eight (38) checkpoints were visited along the Proposed Route within publicly accessible areas. The checkpoint locations included:
    - 22 Erosion and gullying susceptibility (EG) checkpoints (EG-CP01 - EG-CP23)
    - 2 Landslide susceptibility (LS) checkpoints (LS-CP01 - LS-CP02)
    - 11 Erosion Management Overlay (EMO) checkpoints (EMO-CP01 - EMO-CP11)
    - 1 Geologically Significant Feature (GSF) checkpoint (GSF-CP02)
    - 2 Other (O) checkpoints (O-CP01 - O-CP02)
    - Note: EG-CP14 and GSF-CP01 were not completed due to unavailable public access at the time of the walkover.

The locations of these checkpoints within each of the study area sections are shown below in Figure 5.2 to Figure 5.5 and in Figure A.1.1 to Figure A.1.4 and Figure A.11 in Appendix A.

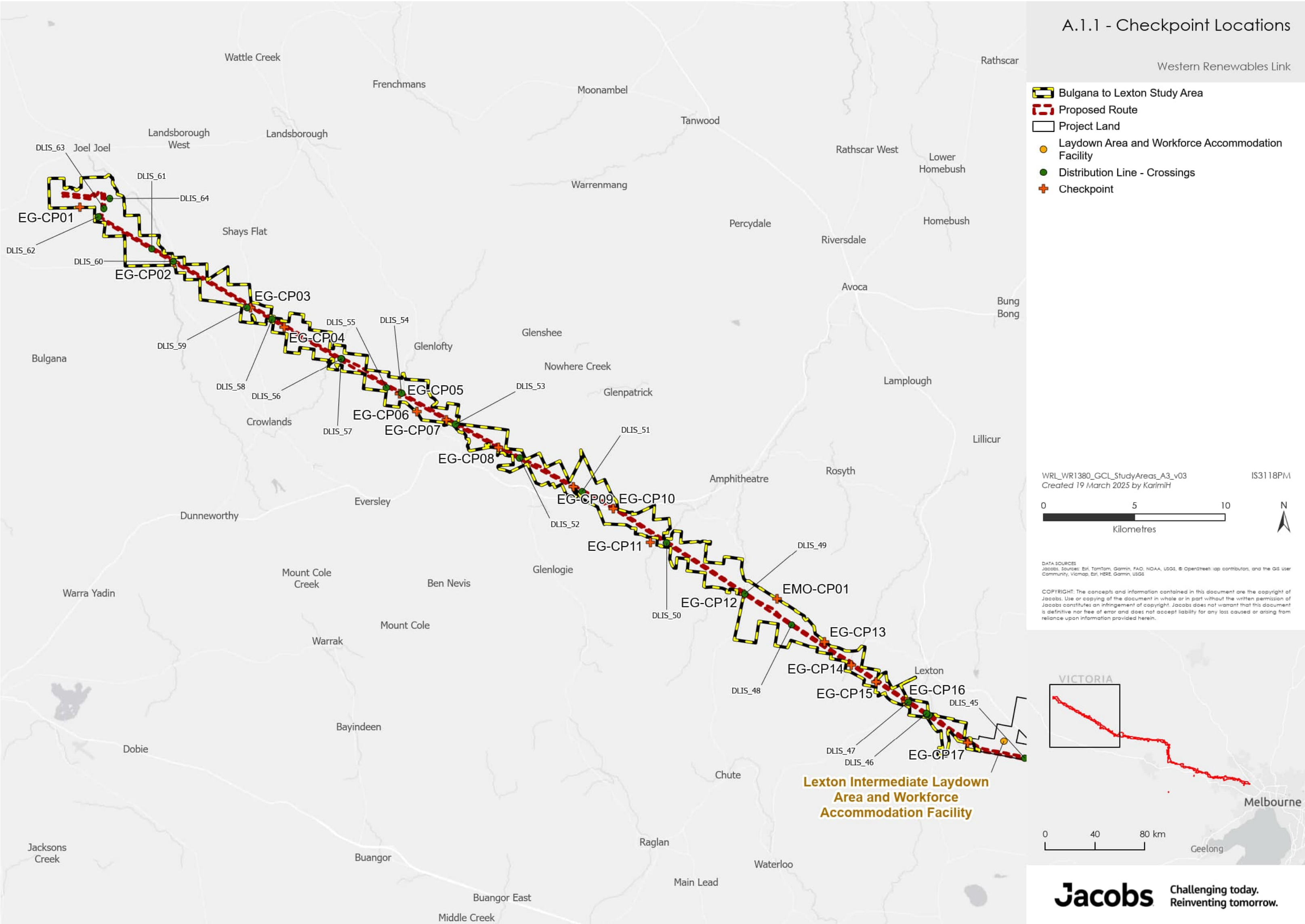

Figure 5.2: Checkpoint locations - Bulgana to Lexton (Source: Jacobs, 2025)

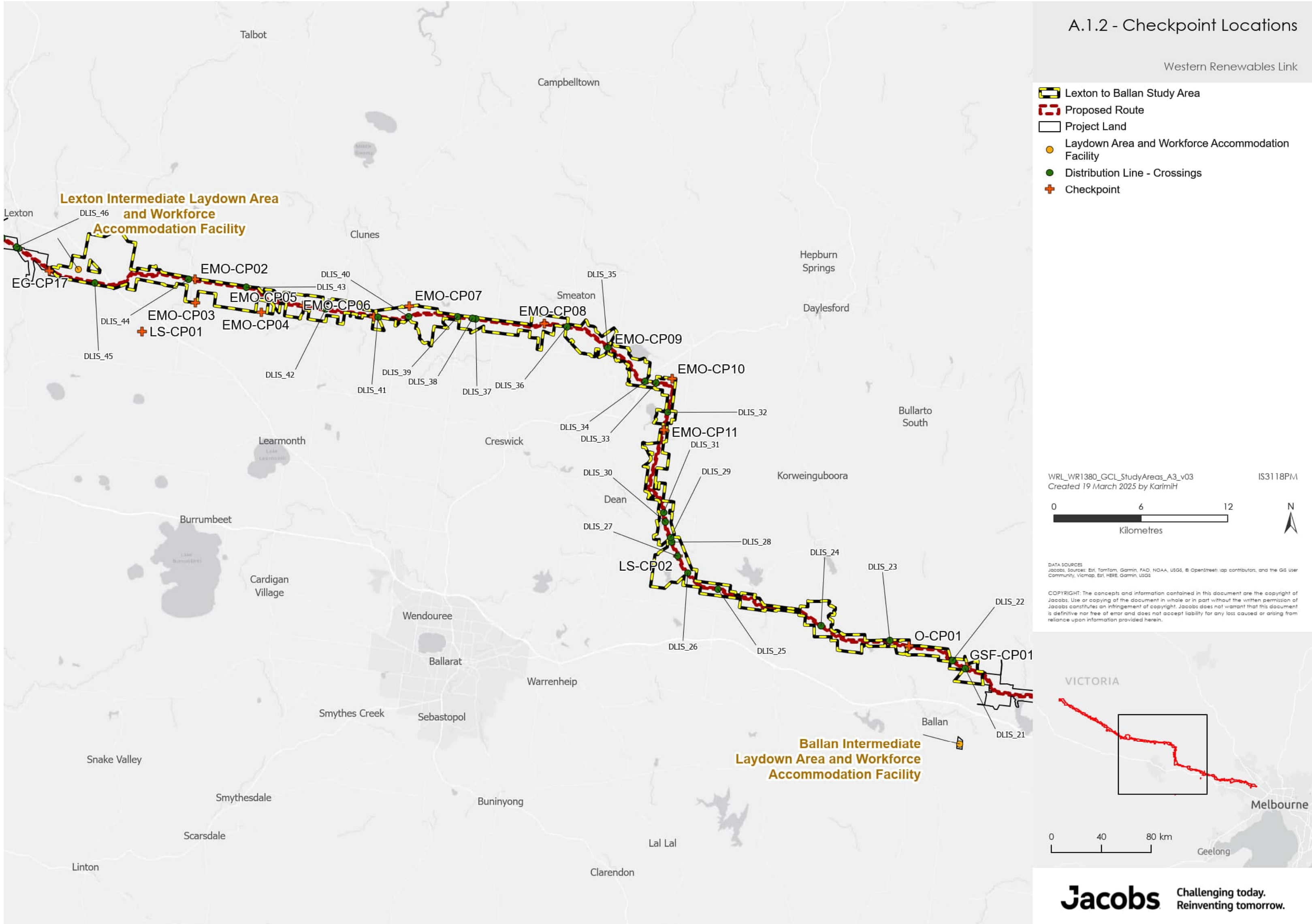

Figure 5.3: Checkpoint locations - Lexton to Ballan (Source: Jacobs, 2025)

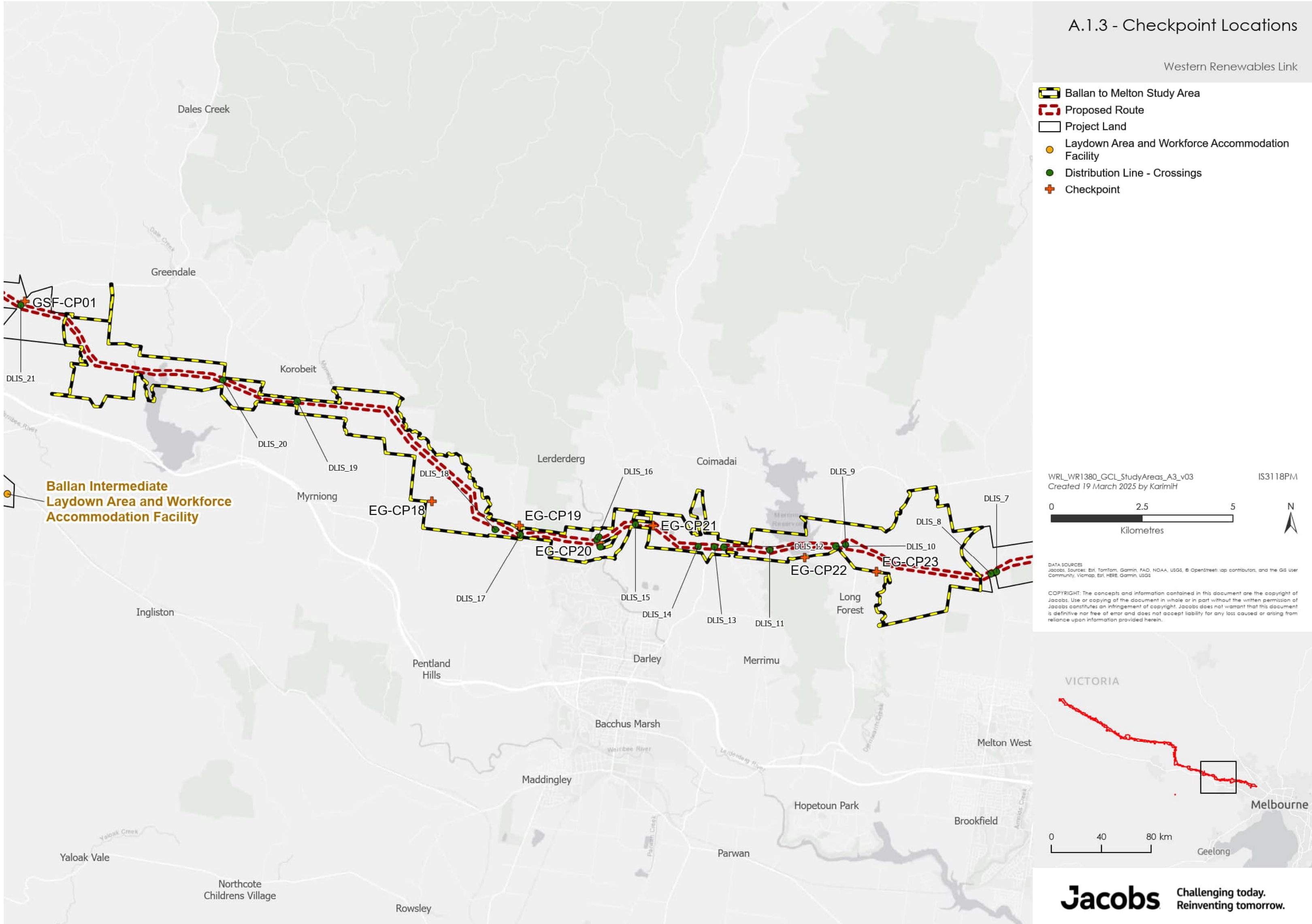

Figure 5.4: Checkpoint locations - Ballan to Melton West (Source: Jacobs, 2025)

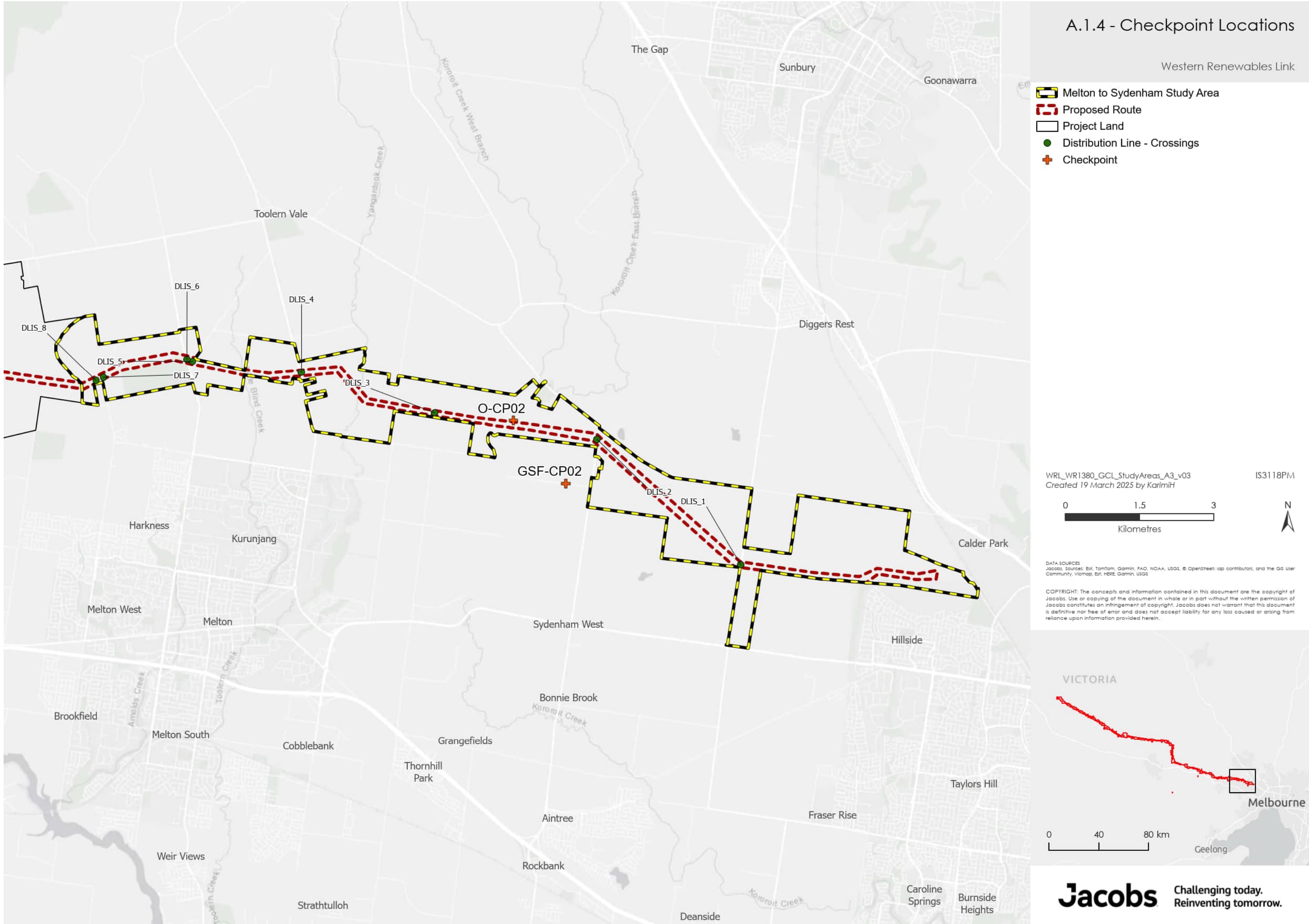

Figure 5.5: Checkpoint locations - Melton West to Sydenham (Source: Jacobs, 2025)

- Soil sampling and laboratory testing
  - Soil sampling was undertaken in areas of potential concern within the study area where access was permitted by the landholders and in publicly accessible areas. Soil samples were collected adjacent to checkpoint locations using a hand trowel and additional samples were collected as part of the contaminated land walkover using a hand auger (HA).
  - A total of twenty-nine (29) soil samples were collected for the Geology and Soils Impact Assessment, and this included:
    - 24 soil samples collected adjacent to geology walkover checkpoint locations (Sample 1 to Sample 23 and Sample 15b)
    - 5 soil samples collected from contaminated land hand auger locations (HA02-HA04, HA17, HA19) (Refer to Contaminated Land Impact Assessment for further details on contaminated land investigation).
  - The positions of these soil sample locations are shown in Figure A.11 in Appendix A.
  - Laboratory analysis was conducted on collected samples, including Emerson Class, Particle size distribution, Atterberg limits and soil salinity testing. Details of the geology laboratory testing conducted is shown in Table 5.1 below. A full summary of test results and laboratory testing certificates are presented in Appendix B and Appendix C respectively.

Table 5.1: Summary of geology and soils laboratory testing

Test	Standard	Number of Tests
Dispersion (Emerson Class)	AS 1289.3.8.1	10
Particle Size Distribution	AS 1289.3.6.1	7
Atterberg Limits with Linear Shrinkage	AS 1289.3.1.2, 3.2.1, 3.3.1, 3.4.1	3
Soil Salinity Testing	N/A	3

- Review of Digital Elevation Model (DEM) and landslide/erosion mapping:
  - A review of Digital Elevation Model (DEM) generated from project specific LiDAR survey of the study area was conducted to determine if there is evidence of landslides and areas of erosion in the study area
  - Areas of landslide, erosion and other important geology features were mapped along the Proposed Route. These mapped features included both polygon and line datasets that highlight areas with evidence of erosion, possible historic landslides, existing drainage pathways and waterways
  - The locations of mapped geological features within the study area are shown in Figure A.11 in Appendix A
  - Note: The locations of mapped features were identified solely based on the results of the site walkover, review of the DEM and satellite imagery. No detailed on-site mapping of erosion features or landslides was conducted as part of this assessment. Further ground truthing and geological mapping is required to confirm the presence of mapped features during future Project stages.

5.4 Risk screening

A risk screening process was undertaken to identify the geology and soils-related risks associated with the design, construction, operation and decommissioning of the Project and to provide for the appropriate level of investigation. The outcomes of the risk assessment identified the key issues that were taken forward into the impact assessment stage (see Sections 7.1, 8.1 and 9).

5.5 Impact assessment method

The method for the geology and soils assessment included:

- Identifying key issues (as described in Section 5.4) to be addressed in the impact assessment
- Identifying potential impacts of Project construction, operation, and decommissioning including the likely extent, magnitude and duration of the changes on soil erosion, dispersion, reactivity, salinity, and potential for land instability, and impact to geologically significant sites according to the impact ratings developed for geology and soils summarised in Table 5.2 below
- Potential impacts of the Project were measured against the existing conditions by assessing the significance of the impacts, taking into consideration mitigation measures. Mitigation measures to reduce the potential impacts have been recommended in accordance with the mitigation hierarchy (avoid, minimise, manage, rehabilitate and offset) and these have then informed the development of Environmental Performance Requirements (EPRs).
- Identifying any other potential developments that could lead to cumulative impacts when considered together with the Project
- Prepare EPRs to define the environmental outcomes to be achieved through the implementation of mitigation measures during construction, operation and decommissioning. While some EPRs are performance based to allow flexibility in how they will be achieved, others include more prescriptive measures that must be implemented. Compliance with all the EPRs will be required as a condition of the Project's approval.
- Development of mapping which displays the location of identified areas of potentially saline or erosive soils, areas of observed existing erosion, existing landslips and land susceptible to instability, and soils of other special characteristics in the study area that may be impacted from the construction and operation stage of the Project.
- Development of mapping which displays the location of geological sites of significance in the study area that may be impacted by the construction and operation stages of the Project.
- Determining the residual impacts associated with the construction, operation, and decommissioning of the Project, and evaluating their significance in accordance with the criteria described above.

Table 5.2 shows the specific ratings applied when assessing relevant aspects of potential geology and soils impacts. These criteria were used to assess the overall residual impact of Project activities on geology and soils.

Table 5.2: Discipline specific impact ratings for geology and soils

Rating	Geology and soils impact ratings
Negligible	No impact on landscape, environment, existing land-use and assets due to negligible erosion or landslip activity OR No impact on landscape, environment, existing land-use and assets due to negligible disturbance of saline or other problematic soils OR No temporary or permanent disruption to access or damage to sites of geological significance
Minor	Potential minor, localised and/or short-term disruption to landscape, environment, existing land use and assets due to some erosion or landslip activity OR Potential minor, localised and/or short-term disruption to landscape, environment, existing land-use and assets due to disturbance of some saline or other problematic soil OR Potential minor, localised and/or short-term disruption to access or minor damage to sites of geological significance

Rating	Geology and soils impact ratings
Moderate	Potential moderate, medium scale (within the study area), and/or ongoing (for the life of the Project), infrequent disruption to landscape, environment, existing land-use and assets due to moderate erosion or landslip activity OR Potential moderate, medium scale (within the study area), and/or ongoing (for the life of the Project), infrequent disruption to landscape, environment, existing land-use and assets due to disturbance of saline or other problematic soil OR Potential moderate, medium scale (within the study area), and/or ongoing (for the life of the Project), infrequent disruption to access or moderate damage to sites of geological significance
Major	Landscape, environment, existing land-use and assets significantly compromised by erosion or landslip activity, resulting in major, widespread (within and beyond the study area) and/or long-term (beyond the life of the Project) impact OR Landscape, environment, existing land-use and assets significantly compromised due to disturbance of saline or other problematic soil, resulting in major, widespread (within and beyond the study area) and/or long-term (beyond the life of the Project) impact OR Significant disruption to access or significant damage to sites of geological significance, resulting in major, widespread (within and beyond the study area) and/or long-term (beyond the life of the Project) impact
Severe	Potential severe, regional scale and/or irreversible damage to landscape, environment, existing land-use and assets caused by erosion or landslip activity OR Potential severe, regional scale and/or irreversible damage to landscape, environment, existing land-use and assets caused by disturbance of saline or other problematic soil OR Potential severe, regional scale and/or irreversible damage to sites of geological significance

5.5.1 Construction

The impact assessment for the construction stage focuses on the potential for the disturbance of soil and rock that may result in erosion or land instability. The significance of impacts was determined using criteria outlined in Table 5.2.

The methodology for the Geology and Soils Impact Assessment included.

- Identification of relevant Project components such as infrastructure and construction methods that have the potential to disturb soils
- Proposal of appropriate mitigation measures and EPRs that can be implemented during construction to manage the identified impacts
- Assessing residual impacts following the application of management and mitigation measures
- Assessing pre-mitigated impacts.

5.5.2 Operation

The operation of the Project infrastructure may require ongoing management to mitigate impacts on the environment with respect to geology and soils. The impact assessment methodology included further assessment of the interaction of infrastructure with geology and soils and proposal of appropriate mitigation measures. The significance of impacts was determined using criteria outlined in Table 5.2. Impacts were assessed pre-mitigation and following the application of management and mitigation measures.

5.5.3 Decommissioning

The decommissioning of the Project infrastructure will result in similar potential impacts to the construction stage and therefore the same methodology was adopted as described above in Section 5.5.1 to assess impacts during decommissioning.

5.5.4 Cumulative impacts

Cumulative impacts were assessed with other proposed relevant future projects in the vicinity of the Project. This assessment included evaluation of projects that have a spatial and temporal relationship to the Project and are likely to cause significant disturbance to geology and soils throughout the Project service life. EES Chapter 4: EES assessment framework and approach details the criteria for identifying relevant future projects and the full list of projects that were considered in the assessment. The cumulative impacts relevant to geology and soils are discussed at Section 10 of this report.

5.6 Stakeholder engagement

Stakeholders and the community were consulted to support the preparation of this report and to inform the development of the Project and understanding of its potential impacts.

Table 5.3 lists specific engagement activities that have occurred in relation to geology and soils, with more general engagement activities occurring at all stages of the Project. Feedback received during community consultation sessions is summarised in Section 5.9 relevant to the Geology and Soils Impact Assessment.

Table 5.3: Stakeholder engagement undertaken for geology and soils

Activity	Date	Matters discussed
EPA Victoria	2021-2022	▪ The presence and activity of fault zones within the study area may potentially impact the design and construction of Project infrastructure ▪ The presence of fault zones and an indication of expected fault activity is discussed in Section 6 ▪ Mitigation strategies shall include appropriate seismic design for Project infrastructure
DEECA (formerly DELWP)	2021-2022	▪ Potential erosion impacts may occur due to vegetation removal and other factors resulting from construction of Project infrastructure ▪ Areas that may be susceptible to erosion are discussed in Section 6 ▪ The potential impacts and control measures for erosion are outlined as part of the impact assessment in Section 7

5.7 Community feedback

In addition to consultation undertaken with specific stakeholders, AusNet has undertaken ongoing consultation with the community throughout the design development and the EES. Feedback relevant to the Geology and Soils Impact Assessment is summarised in Table 5.4, along with where and how those topics are addressed in this report.

Table 5.4: Community consultation feedback for geology and soils

Matter raised	Where matter has been addressed
Project impacts on geological sites, including Hepburn Lagoon, historical lava flows, rock outcrops and other features.	Refer to Section 6 for description of Sites of Geological Significance and Section 7 to 9 for description of potential impacts and suggested mitigation measures to avoid impact to geological sites.
Project construction impacts on steep, erosion prone areas within the Project Area (including steep hills near Landsborough Fault west of Glenlofty and to the west of the Lerderderg River)	Refer to Section 6 for description of existing erosion and land stability and Section 7 to 9 for description of potential impacts and suggested mitigation measures to avoid erosion and land stability impacts.
Project construction impacts on existing erosion management measures around creeks and waterways. Landholder near Bunding provided direct feedback about the trees and vegetation they had planted in vicinity of a creek running through their property to assist with erosion control.	Refer to Section 6 for summary of existing erosion management measures around waterways observed and Section 7 to 9 for description of potential impacts and suggested mitigation measures to avoid impacts to existing erosion management measures.
Area of unstable ground associated with a volcanic flow and existing water bores highlighted by a landholder in Myrniong. Landholder also highlighted areas of soft ground in southeast corner of property. Also highlighted that there is an ash layer between basalt flows, mentioning that basalt is poor quality for foundations.	Refer to Section 6 for description of existing erosion and land stability and Section 7 to 9 for description of potential impacts and suggested mitigation measures to avoid erosion and land stability impacts. Compressible soils highlighted as potential issue, with mitigation measures shown in Section 7 to 9. Control measures recommended in Section 7 to conduct detailed geotechnical investigations and foundation design.

5.8 Assumptions, limitations and uncertainties

The following assumptions, limitations and uncertainties apply to this impact assessment:

- The existing conditions assessment is limited to publicly and readily available information, site walkover of selected areas and limited laboratory testing.
- Where selected sites could not be assessed as part of field assessment due to access restrictions, these areas were assessed based on publicly available information, project specific LiDAR and existing mapping.
- This impact assessment is based on conditions that existed at the time the assessment was completed. Its findings and conclusions may be affected by the passage of time or by events such as construction on or adjacent to the Project Land.
- The soil type is based on land mapping conducted at different times, at variable scale, and for different purposes. Land units are therefore of variable scale and quality in relation to the soil they are representing. Many units comprise multiple soil types and a range of soil properties, and local variability (e.g., at paddock scale level) can also sometimes be high. The mapping, therefore, is intended to represent the dominant, or most prevalent, broad soil type within the map unit.
- The Recorded Soil Salinity Areas that have been mapped as having, or showing symptoms of, dryland soil salinity by DEECA (or its predecessors) at some time (past or present). As dryland soil salinity occurrence in the Victorian landscape exhibits many different levels of severity and can change due to climate, land use and vegetation cover etc., previously mapped areas may no longer be showing symptoms of salinity and/or new areas may have occurred since the mapping was completed. In addition, as not all parts of the state have been mapped, or mapped in the same way, the mapping has not captured all occurrences.
- Soil reactivity is commonly estimated based on site classification using AS2870-2011, which incorporates shrink-swell index of the soil, depth of moisture influence and potential moisture change at the site. Given the limited knowledge on the depth of the soil profile in these areas no detailed assessment of characteristic surface movement was undertaken as part of this assessment and soil reactivity was instead estimated based on soil index properties.

The geological assessment has considered the risk of soil erosion which may result in increased sedimentation to water bodies and disturbance of potentially saline soils increasing waterbody salinity. The resulting impact of these plumes on the water bodies have been assessed as part of EES Technical Report S: Groundwater Impact Assessment.

6. Existing conditions

6.1 Introduction

Existing conditions in the study area are presented in four sections that are defined based on distinctive geological and geomorphological conditions:

- **Bulgana to Lexton:** Within the Western Uplands geomorphic province, characterised by undulating hills and ridges formed by sedimentary rock units intersected by valleys filled with narrow creek valleys and broad low-lying areas.
- **Lexton to Ballan:** Within the Western Uplands geomorphic province, characterised by gently undulating hills formed by Tertiary age lava flows, with isolated steep hills associated with local volcanic eruption points.
- **Ballan to Melton West:** Within the Western Uplands and Western Plains geomorphic provinces, characterised by undulating hills with steep hills ranges formed by sedimentary rock units with broad low-lying areas dominated by alluvium units.
- **Melton West to Sydenham:** Within the Western Plains geomorphic province, characterised by flat Tertiary aged Volcanic plains with low-lying areas associated with watercourse and drainage lines.

These study area sections are shown in Figure 5.1 and in Figure A.1.0 in Appendix A. Throughout this section, site observations and laboratory testing results are described based on visited site walkover checkpoint locations. The locations of site walkover checkpoint locations are shown in Figure 5.2 to Figure 5.5 in Section 5.3 and in Figure A.1.1 to Figure A.1.4 and Figure A.11 in Appendix A.

The existing conditions at the terminal station locations (including the laydown areas within the terminal stations sites) are described separately in Section 6.6, the existing conditions at the intermediate laydown areas in Section 6.7 and the existing conditions at the distribution line crossovers in Section 6.8.

6.2 Bulgana to Lexton

6.2.1 Geological setting

The geology is dominated by the Cambrian aged sedimentary rock units (Pyrenees Formation, Beaufort Formation and Warrack Formation) which comprise sandstone and siltstone that form many of the positive relief landforms. The sedimentary rock units are variably weathered and are capped by variable thickness of residual soil. Alluvial deposits are present around watercourses that are incised into outcropping Cambrian age sedimentary rock units. The Quaternary-Tertiary aged Shepparton Formation and Tertiary aged White Hills Gravel are the predominant alluvial and colluvial units for the area. These units were deposited following periods of land subsidence in the Tertiary Period. More recently deposited Quaternary aged alluvium is associated with watercourses such as Mount Cole Creek and Wimmera River.

Granitic intrusions are present around Glenlogie and Mount Lonarch, formed from intrusion of igneous rock into the Earth’s crust during the Devonian (known as a pluton). The granite deposit has formed a hill (positive relief pluton) at Glenlogie, whilst around Mount Lonarch the granite has formed as a negative relief pluton resulting in a subdued area. Variable thicknesses of residual soil have formed from weathering of the granite, and granite derived colluvium is present on the sides and at bases of granite hill slopes. Occasionally the sedimentary rock has been metamorphosed to harder hornfels (likely associated with nearby granitic intrusions). The major geological units present within the Bulgana to Lexton section are listed in Table 6.1.

Table 6.1: Geological units – Bulgana to Lexton

Age	Unit name	Description	Relevant areas where the Proposed Route intersects unit
Quaternary	Alluvial deposits (Qa1)	Gravel, sand, silt, variably sorted, variably rounded	Wimmera River, Beaufort-Lexton Rd (likely former channel leading into Burnbank Creek)- Likely to be localised deposits around Six Mile Creek, Wimmera River, Spring Creek, Glenlofty Creek, Glenpatrick Creek, Sandy Creek, Hickman Creek, Amphitheatre Creek, Glenlogie Creek, Avoca River, Burnbank Creek
	Colluvial deposits (Qc4)	Granite derived colluvium, well sorted	Slopes around granite hillside at Glenlogie.
Quaternary - Tertiary	Shepparton Formation (Nws)	Fluvial clay, sand, silt, poorly sorted lenticular gravel	Valleys and low points around Six Mile Creek, Wimmera River, Spring Creek, Glenlofty Creek, Glenpatrick Creek, Sandy Creek, Hickman Creek, Amphitheatre Creek, Glenlogie Creek, Avoca River, Burnbank Creek
Tertiary	White Hills Gravel (Pxh)	Vein quartz conglomerate, sand, silt and clay; well-rounded pebbles and cobbles of quartz	
Devonian	Granite and granodiorite (G371, G372, G373)	Intrusive granite	Granite outcrops at Glenlogie and Mount Lonarch
Cambrian	St Arnaud Group sedimentary units (Cab, Cap, Caw)	Marine sandstone, siltstone, schist, occasional hornfels	Hills and ridgelines to the south of Glenlofty, ridgeline to north-east of Mount Lonarch, hills to the south of Lexton

Two geological fault lines intersect the Proposed Route to the south-east of Glenlofty in the Bulgana to Lexton section, as summarised in Table 6.2.

Table 6.2: Geological fault lines – Bulgana to Lexton

Named fault line	Observations of fault during walkover	Type	Activity[1]	Description
Glendhu Fault	Southern extent of fault approximately 400m north of Proposed Route.	Thrust	Inactive	The Glendhu Fault is approximately 9km long and runs from north of the study area in a north-north-westerly direction parallel to the Landsborough Fault. This fault line is entirely within the Warrack Formation.
Landsborough Fault	No obvious surface expression of fault observed at intersection with Proposed Route.	Thrust	Inactive	The Landsborough Fault is approximately 50km long and runs from Mount Cole in a north-north-westerly direction. The fault crosses the study area near Glenlofty. The fault line separates the Warrack Formation to the west and the Pyrenees Formation to the east.

Notes

1. Fault activity inferred based on assessment of Geoscience Australia's Neotectonic features online database and lack of visual evidence of recent displacement along fault line.

The geological fault lines are not identified on Geoscience Australia's Neotectonic features online database. Neotectonic features are faults or other features that are believed to be related to large earthquakes in the last 5 to 10 million years, indicating the faults have not been active in these timescales.

Figures showing the regional geology and fault lines in the Bulgana to Lexton section are presented in Figure A.2.1 in Appendix A.

6.2.2 Geomorphology, erosion and land stability

The section from Bulgana to Lexton lies within the Western Uplands geomorphic province. The landscape is characterised by undulating hills and ridges separated by valleys and incised creeks. The topography varies from moderate to steep slopes on valley sides to gently undulating areas valley bottoms. Examples of typical landscapes observed in this section are shown below in Figure 6.1 and Figure 6.2.

Figure 6.1: Creek incised into Shepparton Formation looking southeast along existing 220 kV from EG-CP05 (Source: Jacobs, 2022)

Figure 6.2: Hills of Beaufort Formation Hornfels with Avoca River and floodplain at base of slope (Shepparton Formation) looking northwest along existing 220 kV from EG-CP12 (Source: Jacobs, 2022)

Mapped geomorphological units that were accessed from the Geomorphology of Victoria dataset, are summarised along the Proposed Route in Table 6.3 below. The Tier 3 geomorphological units in the Bulgana to Lexton section are shown in Figure A.3.1 in Appendix A.

The Geomorphology of Victoria dataset also indicates susceptibility to gully and wind erosion, and susceptibility to landslide for each of the geomorphological units, which are also indicated in Table 6.3. The hills and mountains (Grampians, Pyrenees and Langi Ghiran range) in the Western Uplands along with colluvial granite and sedimentary slopes are prone to tunnel and gully erosion, and sheet and rill erosion especially where cleared (Robinson et al., 2005). This is reflected by the susceptibility mapping that indicates the slopes of the Cambrian sedimentary hills and ridges are generally mapped as high to very high susceptibility to gully erosion. The gully erosion susceptibility of the Bulgana to Lexton section based on the Geomorphology of Victoria dataset is shown in Figure A.4.1 in Appendix A.

Table 6.3: Summary of mapped geomorphological units, erosion and landslip susceptibility – Bulgana to Lexton

Geomorphological Units			**Erosion/landslide susceptibility**			**Relevant areas and link to geology**
Tier 1	**Tier 2**	**Tier 3**	**Gully erosion**	**Landslide**	**Wind erosion**	
Western Uplands	Dissected Uplands (formerly Midlands)	2.1.1 Ridges, escarpments, mountains on non-granitic Palaeozoic rocks	High	Low	Moderate	Sedimentary rock hills and ridgelines to the south of Glenlofty, hills to the south of Lexton.
		2.1.2 Hills, valley slopes and plains on non-granitic Palaeozoic rocks	Very high	Low	Moderate	Sedimentary rock ridgeline to north-east of Mount Lonarch.
		2.1.4. Hills, valley slopes and plains on granitic Palaeozoic rocks	Low	Very low	Very low	Slopes around granite hillside at Glenlogie.
		2.1.5. Plateaux and rises of residual Cainozoic landscapes	Low	Low	Low	Valleys and low points around rivers and creeks listed in Table 6-1, associated with Quaternary and Tertiary alluvial deposits.
		2.1.7. Terraces and floodplains	Moderate	Very low	Moderate	

Site observations undertaken during the site walkover generally indicated consistency with the susceptibility mapping. Areas of observed erosion generally appeared to be due to the disturbance or removal of topsoil for farming and road construction (see Figure 6.3 and Figure 6.4). Table 6.3 indicates a low susceptibility to gully erosion for granite derived colluvium, however particle size testing undertaken on a sample obtained from the colluvium shown in Figure 6.4 indicates the material has a high percentage of sand with some silt, and, therefore, likely to be susceptible to erosion by water and wind (refer to Appendix B and Appendix C for details).

Figure 6.3: Erosion of residual soils (Pyrenees Formation) adjacent to a road on a steep hillside close to the Proposed Route, observed at EG-CP07 (Source: Jacobs, 2022)

Figure 6.4: Bare soil (colluvium derived from granite) susceptible to erosion at base of granite hill (Mount Direction). Observed at EG-CP10 (Source: Jacobs, 2022)

Gully erosion, which is the removal of soil along drainage lines, was observed in the residual soil units at site walkover checkpoints EG-CP04 (see Figure 6.7), EG-CP15 (see Figure 6.9) and at EG-CP17 (see Figure 6.11). Slumping of gully sides and rock armouring to stabilise erosion were observed in creek at EG-CP04.

Numerous instances of gully erosion were observed at site walkover checkpoint EG-CP15 that appear to be active. The gully erosion at site walkover checkpoint EG-CP17 appears to be relatively inactive, and its sidewalls appear to have been stabilised by overgrown grass. Mapped areas of erosion and gullying within the Bulgana to Lexton section based on site observations, LiDAR DEM and aerial imagery are shown in Figure A.11 in Appendix A. Limited accessible checkpoints visited during the walkover were used to inform the mapping assessment, however further on-site assessment is required as part of future design stages to ground truth mapped features within private land. Examples of erosion associated with creeks and roadside drainage observed near site walkover checkpoints EG-CP01 and EG-CP07 are shown in Figure 6.5 and Figure 6.6. Mapped areas of gully erosion from the DEM assessment near site walkover checkpoints EG-CP04, EG-CP15 and EG-CP17 are shown alongside site observation photos in Figure 6.7 to Figure 6.12.

Figure 6.5: Creek with evidence of erosion on banks observed near site walkover checkpoint EG-CP01 (Source: Jacobs, 2022)

Figure 6.6: Erosion in roadside drain observed near site walkover checkpoint EG-CP07 (Source: Jacobs, 2022)

Figure 6.7: Slumping of gully sides observed at site walkover checkpoint EG-CP04, with active stabilisation measures (rock beaching) in the foreground (Source: Jacobs, 2022)

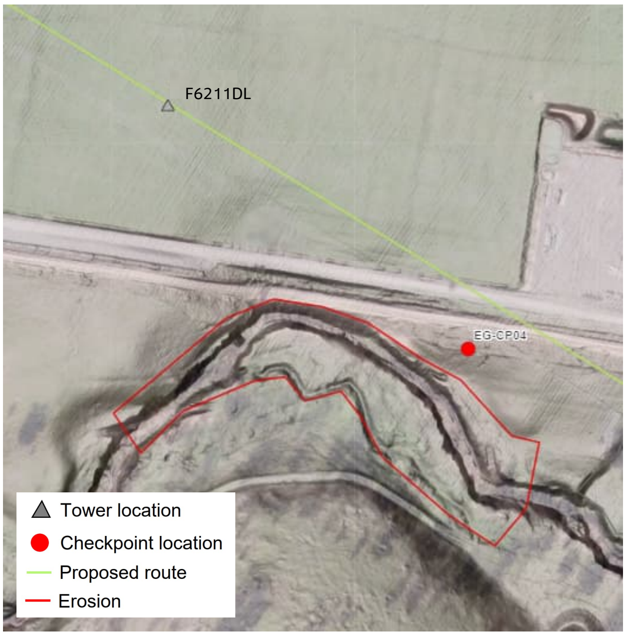

Figure 6.8: Mapped area of erosion associated with creek west of site walkover checkpoint EG-CP04 shown on LiDAR DEM (Source: Jacobs, 2024)

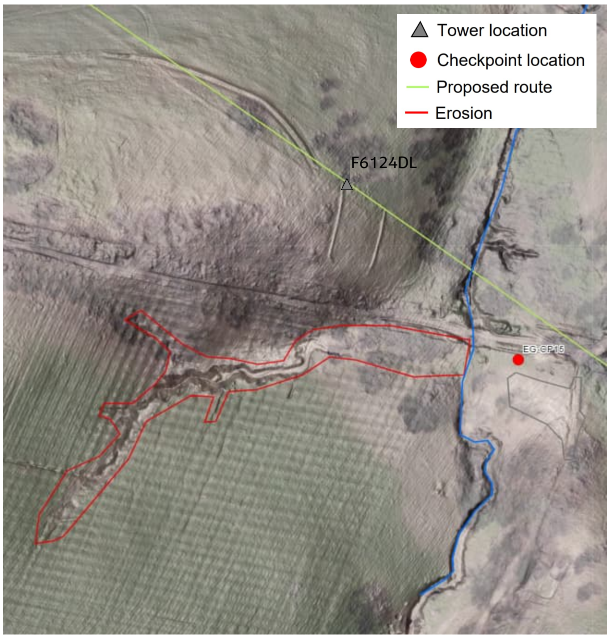

Figure 6.9: Active gullying observed on a slope west of site walkover checkpoint EG-CP15 (Source: Jacobs, 2022)

Figure 6.10: Mapped area of gully erosion west of site walkover checkpoint EG-CP15 with LiDAR DEM (Source: Jacobs, 2024)

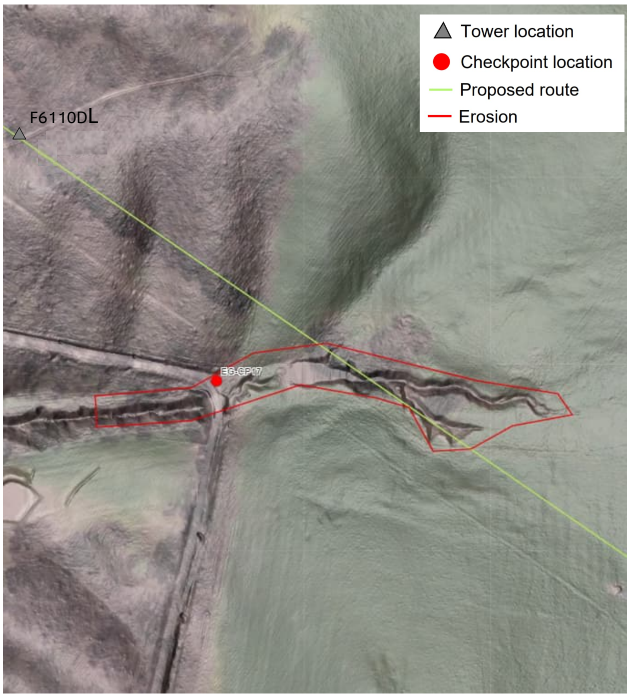

Figure 6.11: Recent gully erosion observed at site walkover checkpoint EG-CP17 (Source: Jacobs, 2022)

Figure 6.12: Mapped area of gully erosion near site walkover checkpoint EG-CP17 shown on LiDAR DEM (Source: Jacobs, 2024)

It was observed during the site walkover and from the DEM assessment that soil outside of areas that appear to be actively eroding appeared to be stable where it was covered with vegetation and has not been disturbed. The Northern Grampians and Pyrenees LGAs, which includes the study area from Bulgana to Lexton, do not have planning overlays related to erosion management.

Landslide activity observed during the site walkover between Bulgana and Lexton was limited, and this is consistent with the Low to Very Low landslip susceptibility indicated in Table 6.3 and in Figure A.5.1 in Appendix A.

Observations of possible historical landslide activity and soil instability was undertaken at two areas in the study area. In both instances the slopes are formed on the sedimentary units of the Pyrenees Formation. As shown in Figure 6.13, the slope to the east of site walkover checkpoint EG-CP05 was observed to have hummocky terrain, suggesting historical landslide activity of some sections of the slope, although some of the hummocks may also be due to the presence of shallow rock (detailed inspection of the area was not possible due to land access restrictions). An existing access track was also observed cutting across the hillside. The mapped landslide and erosion features are shown in Figure 6.14.

Soil creep was observed and mapped to the west of site walkover checkpoint EG-CP16, as shown in Figure 6.15 and Figure 6.16. Soil creep was observed in two locations, on the hill slope and at the bank of the creek.

Figure 6.13: Hummocky slope terrain suggesting past land instability, looking west from site walkover checkpoint EG-CP05 (Source: Jacobs, 2022).

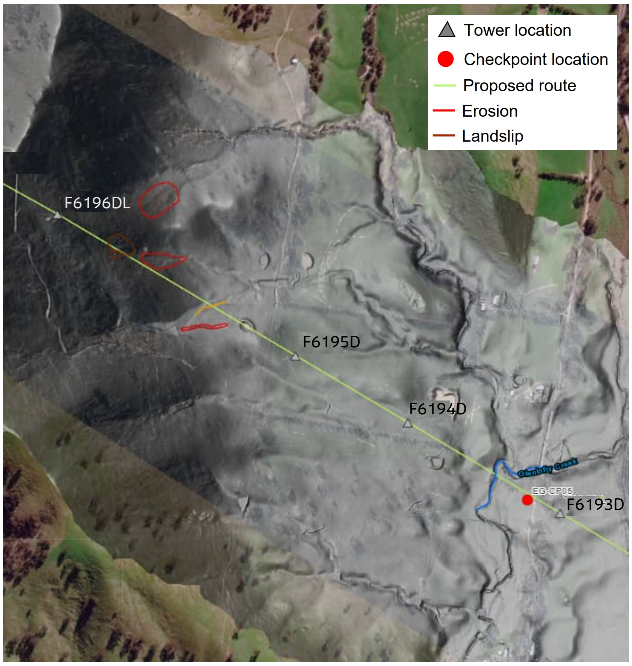

Figure 6.14: Mapped features west of site walkover checkpoint EG-CP05 shown on LiDAR DEM (Source: Jacobs, 2024).

Figure 6.15: Possible soil creep on hillslope west of site walkover checkpoint EG-CP16 (Source: Jacobs, 2022).

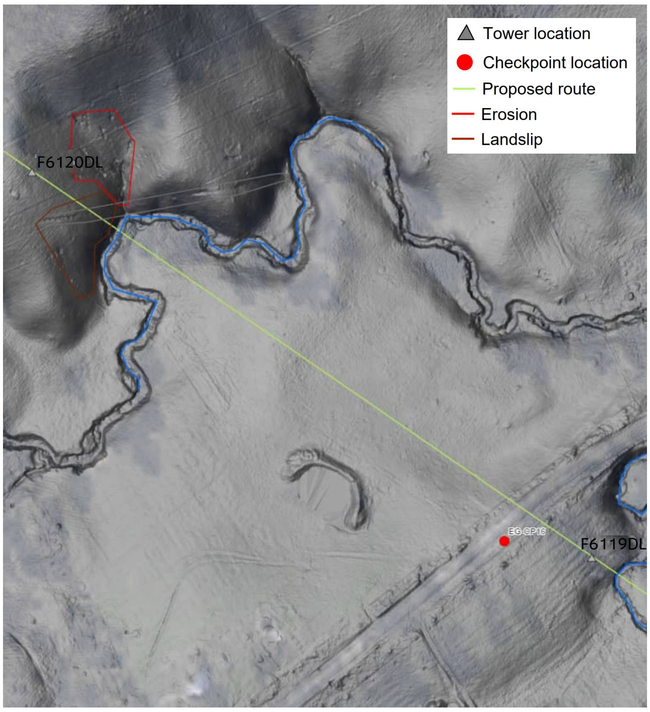

Figure 6.16: Mapped slope creep on hillslope west of site walkover checkpoint EG-CP16 shown on LiDAR DEM (Source: Jacobs, 2024).

Mapped areas of erosion and land instability in the Bulgana to Lexton section based on the LiDAR DEM assessment conducted are presented in Figure A.11 in Appendix A.

6.2.3 Soil types and presence of dispersive soils

A summary of the mapped soil types from Bulgana to Lexton is presented in Table 6.4 and is illustrated in Figure A.10.1 in Appendix A. The soil from Bulgana to around Amphitheatre Creek has been mapped as predominantly Chromosols and Rudosols which is reflective of the topography and mapped geology. Chromosols are typically characterised by silica-rich riverine deposits of low sodicity, while Rudosols are relatively young, poorly developed, rocky soils. Sodosols and Vertosols may also be present along this section.

From Amphitheatre Creek to Lexton, mapped soil comprises predominantly Sodosols that represent soils that have formed from weathering of Tertiary aged sediments that are present around Avoca River and Burnbank Creek. Minor areas of Chromosols, Rudosols, Dermosols and Kurosols have been mapped and are generally associated with soil formation of ridges and hills formed on sedimentary rock. Soils on hills and ridges may also be sodic, particularly in lower topographic positions.

The presence of Sodosols (sodic soils) is important along the study area from Bulgana to Lexton as the clay portion of the soil is sensitive to dispersion. Soil dispersion is the process of clay particles separating from one another upon wetting, resulting in structural decline of the soil and often leading to gullying and tunnel erosion. The risk of dispersion increases for sodic soils where the overlying topsoil is removed or if surface runoff is poorly managed.

Table 6.4: Key soil types – Bulgana to Lexton

Area	Major mapped soil type	Geomorphology/ landform association	Additional information regarding soil	Potential Hazard associated with soil type
Bulgana to Amphitheatre Creek	Yellow and red Chromosols and Kandosols	2.1.4. Hills, valley slopes and plains on granitic Palaeozoic rocks	According to Robinson et al. (2005) and State of Victoria (Agriculture Victoria, 2023) website, texture contrast soils, sodic yellow (Sodosols) and non-sodic (Chromosols) are common on these granite landscapes.	Although not mapped, sodic soils and Vertosols are associated with these landforms and might be present. Sodic soils are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour.
		2.1.5. Plateaux and rises of residual Cainozoic landscapes	According to Robinson et al. (2005) and State of Victoria (Agriculture Victoria, 2023) website, developed on these sediments are a suite of yellow, brown and red texture contrast soils (Sodosols and Chromosols) and red gradational or uniform soils (Dermosols and Kandosols).	
		2.1.7. Dissected uplands: Terraces and floodplains	Information from Robinson et al. (2005) and State of Victoria (Agriculture Victoria, 2023) website indicates that soils for this unit range from texture contrast soils, brown, yellow and grey sodic (Sodosols) or red non-sodic (Chromosols) to gradational earths and occasional clay (Vertosols, Dermosols) and sand soils (Tenosols). Within this unit most of the gradational yellow and brown soils (Kandosols) are found.	
	Leptic Rudosols	2.1.1 Ridges, escarpments, mountains on non-granitic Palaeozoic rocks	According to Robinson et al. (2005) and State of Victoria (Agriculture Victoria, 2023) website, soils that have developed on these landforms include red texture contrast soils (Chromosols) that may be sodic (Sodosols) especially where rainfall is lower and in lower topographic positions.	Although not mapped, sodic soils are associated with this landform and might be present. Sodic soils are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed.

Area	Major mapped soil type	Geomorphology/ landform association	Additional information regarding soil	Potential Hazard associated with soil type
				Consistent with gullying mapped in these landforms (possibly resulting from dispersion). Areas of gullying erosion has been mapped in these landforms, as shown in Figure A.11 in Appendix A.
Amphitheatre Creek to Lexton	Red and brown Sodosols, minor areas of leptic Rudosols and yellow Kurosols	2.1.1 Ridges, escarpments, mountains on non-granitic Palaeozoic rocks	Information from Robinson et al. (2005) and State of Victoria (Agriculture Victoria, 2023) website indicates soils that have developed on these landforms also include red texture contrast soils (Chromosols) that may be sodic (Sodosols) especially where rainfall is lower and in lower topographic positions.	Sodic soils may be present that are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Kurosols are known to display high acidity at surface (low pH level) that could potentially corrode construction materials. Although not mapped, Vertosols are associated with this landform 2.1.7 and might be present. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour.
		2.1.7. Dissected uplands: Terraces and floodplains	Information from Robinson et al. (2005) and State of Victoria (Agriculture Victoria, 2023) website indicates that soils for this unit range from texture contrast soils, brown, yellow and grey sodic (Sodosols) or red non-sodic (Chromosols) to gradational earths and occasional clay (Vertosols, Dermosols) and sand soils (Tenosols). Within this unit most of the gradational yellow and brown soils (Kandosols) are found.	
	Red Dermosols	2.1.2 Hills, valley slopes and plains on non-granitic Palaeozoic rocks	Information from Robinson et al. (2005) and State of Victoria (Agriculture Victoria, 2023) website indicates that red texture contrast soils (Chromosols) that tend to be sodic (Sodosols) in lower topographic positions have developed on these landforms.	Dermosols are generally stable soils; however, they can exhibit high silt content in areas which can lead to erosion. Although not mapped, sodic soils are associated with this landform and might be present. Sodic soils are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed.

Emerson Class testing, which measures the tendency of the clay fraction of a soil to go into colloidal suspension (i.e., potential for soil to disperse), was undertaken on soil samples obtained from EG-CP01 and EG-CP07. Testing indicated an Emerson Class No. 2, which indicates high dispersion potential and is consistent with the conditions observed. The results are summarised in Table 6.5 below, along with the results of Emerson Class testing at other site walkover checkpoint locations from Bulgana to Lexton, which indicate dispersive soils may be encountered in this area. The results of Emerson Class testing are presented in Appendix B, with detailed laboratory test certificates shown in Appendix C. Based on the results of lab testing, it is likely that dispersion is likely occurring and contributing to the observed creek bank and roadside drainage erosion shown in Figure 6.5 and Figure 6.6.

Table 6.5: Checkpoints where highly dispersive soils were identified (Emerson Class 2 or higher) – Bulgana to Lexton

Checkpoint Location	Sample depth (m bgl)	Unit	Mapped soil type	Soil description	Emerson class number	Observation
EG-CP01	0.0-0.5	Shepparton Formation (Nws)	Kandosol	Clayey SILT	2	Dispersive soils and erosion observed in creeks.
EG-CP07	0.0-0.5	Shepparton Formation (Nws)	Chromosol	CLAY/SILT	2	Dispersive soils and erosion observed in roadside drain.
EG-CP09	0.0-0.5	Glenlogie Granodiorite (G372)	Rudosol	CLAY	2	Small areas of exposed soils observed near location as well as evidence of gully erosion.
EG-CP15	0.0-0.5	Pyrenees Formation (Cap)	Sodosol	CLAY	2	Large area of gully soil dispersion and gully erosion observed near checkpoint.

Notes

1. For the purpose of this assessment, highly dispersive soils were classified as those with Emerson Class 1 or Class 2.

6.2.4 Saline soils

Saline soil is a result of the accumulation of salt within the soil. Saline soils do occur naturally (primary salinity), however European settlement in South-East Australia has expanded their occurrence (as secondary salinity) (Agriculture Victoria, 2020b).

The replacement of perennial native vegetation with annual crops and pastures, and the use of irrigation have both resulted in changes to the water balance resulting in a rising water table. If the water is sufficiently saline salt can accumulate in soil just below the ground surface, or on the surface itself. An accumulation of salt at the surface can kill off protective vegetation and leave the bare soil surface vulnerable to erosion, and can impact earthworks (e.g., soil reuse) (Agriculture Victoria, 2020b). Areas of saline soils can also display elevated concentrations of chlorides and sulfates, that may cause corrosion of concrete and metal structures, as described in Section 6.4 of 'Australian Standard Piling - Design and installation' (AS 2159-2009).

The Northern Grampians and Pyrenees LGAs, which includes the study area from Bulgana to Lexton, do not have planning overlays related to salinity management.

A review of the Victorian Salinity Provinces indicates that the Bulgana to Lexton section is located within the Elmhurst, Amphitheatre and Lexton salinity provinces. Salinity provinces (SPs) provide a framework for describing land and water (both surface and groundwater) salinity in Victoria. These are specific geographic areas where the landscape setting and physical processes contributing to salinity are similar, and where salinity management options are also similar. Each salinity province contains discrete salinity impacted areas where there is a concentration or higher incidence of land and/or water salinisation. A summary of each of the salinity provinces within the section is shown below in Table 6.6 and are illustrated in Figure A.9.1 in Appendix A. Recorded salinity areas in both the Elmhurst and Lexton salinity provinces are shown in Figure 6.17 and Figure 6.18 (DJSIR (formerly DEPI), 2014).

Table 6.6: Summary of Salinity Provinces – Bulgana to Lexton (DJSIR (formerly DEPI), 2014)

Salinity province	Catchment management region	Priority status[1]	Province area (ha)	Recorded soil salinity area[2] (ha)	Salinity area description
Elmhurst	Wimmera	High	69,530	137	A number of small salinity discharge sites are scattered within the upland alluvial plains, mainly adjacent to and along drainage lines.

Salinity province	Catchment management region	Priority status[1]	Province area (ha)	Recorded soil salinity area[2] (ha)	Salinity area description
Amphitheatre	North Central	Low	18,460	95	-
Lexton	North Central	High	9,910	235	Approximately 2% of the Province is salt affected land, which contributes a high salt load to the Loddon River. Some salinity is expressed as change of-slope, but most is mapped along drainage lines, many of which are deeply eroded.

Notes

1. High priority provinces:
   (a) Include (or intersect) the boundaries of significant environmental or cultural assets, high value infrastructure (including urban development), and/or priority biodiversity areas.
   (b) Contain significant salinity occurrences that pose a threat to land productivity, catchment health, downstream assets or water users, and/or high value infrastructure.
   (c) Have reasonable prospects for successful salinity management interventions or treatment options that are considered feasible from both 'practicality' and 'return on investment' points of view.
   Salinity Provinces that do not meet the above criteria are classified as Low priority.
2. Comprises the total geographic area that has been mapped as having, or showing symptoms of, dryland soil salinity at some time (past or present). Retrieved from http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/lwm_salinity-provinces (DJSIR (formerly DEPI), 2014).

Salt scalding, which indicates elevated soil salinity was observed at EG-CP04 and EG-CP15 are shown below in Figure 6.17 and Figure 6.18. These areas typically display exposed soils with little to no vegetation growth and a white crust on the surface.

Soil salinity testing was conducted by Jacobs at EG-CP04 on silt of the Shepparton Formation and at EG-CP15 on clayey silt of the Pyrenees Formation. These tests recorded electrical conductivity of a saturated soil extract (ECe) between 1216 and 3960 µS/cm, which indicates that the soil samples are non-saline to slightly saline (Agriculture Victoria, 2020c). This test constitutes a very small sample size and may not be representative of the broader study area. The results of soil salinity testing conducted in the study area section are summarised in Appendix B, with laboratory test certificates shown in Appendix C.

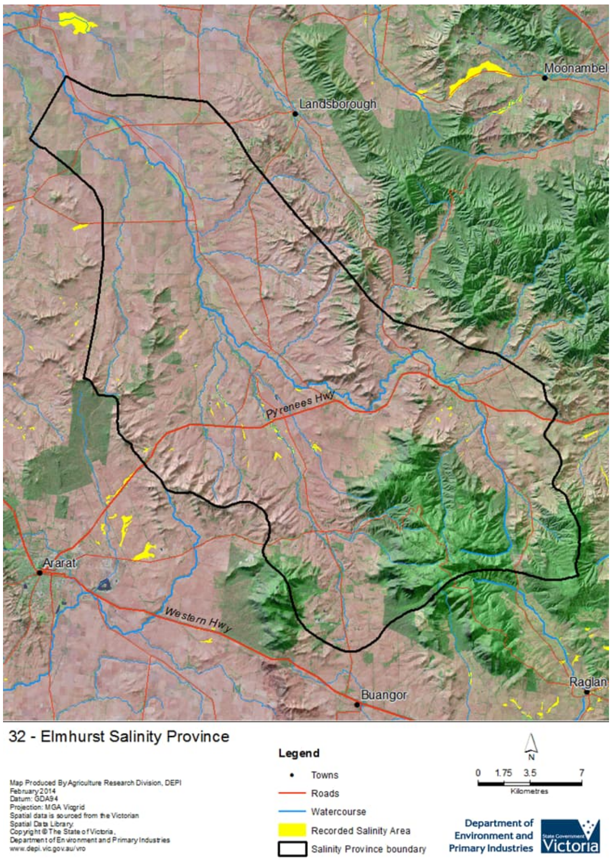

Figure 6.17: Elmhurst Salinity Province with mapped Soil Salinity Areas shown in yellow (Source: DJSIR (formerly DEPI), 2014)

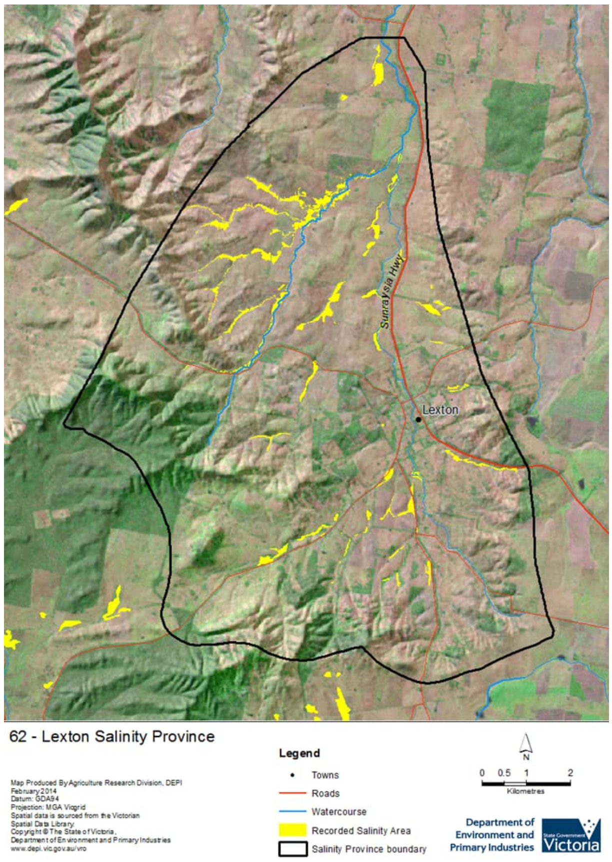

Figure 6.18: Lexton Salinity Province with mapped Soil Salinity Areas shown in yellow (Source: DJSIR (formerly DEPI), 2014)

Figure 6.19: Erosion and exposed soils observed at EG-CP04 (Source: Jacobs, 2022)

Figure 6.20: White crust observed on exposed soils at EG-CP15 (Source: Jacobs, 2022)

6.2.5 Reactive soils

The likelihood for encountering reactive soils in the Bulgana to Lexton section is low. The mapped soil types (refer Figures A.10.1 in Appendix A) indicate that Vertosols, that are clay-rich soils that shrink and swell in response to moisture change, are not present from Bulgana to Lexton.

Reactive soils are normally associated with high plasticity clays derived from calcium rich sediments (e.g., limestones, marls) or alkaline volcanic rock, such as the Newer Volcanic Group residual clay found extensively in western Victoria, which are not encountered from Bulgana to Lexton.

6.2.6 Compressible soils

Soft, compressible soils that may potentially be saturated are likely to be encountered around creeks and rivers. This likelihood is high where recent alluvial deposits (Qa1) have been mapped as shown on Figure A.2.1 in Appendix A. Localised compressible soils that are not shown on Figure A.2.1 in Appendix A may also be present around the creeks and rivers listed in Table 6.1.

6.2.7 Sites of geological significance

Sites of geological significance present within the Bulgana and Lexton section are listed and described in Table 6.7 and are illustrated in Figure A.8.1 in Appendix A. The Proposed Route passes close to Landsborough Fault (BL120), which is classified as having local significance. The feature marker for Mount Direction (BL123) is shown to be outside the study area; however, the northern boundary of the study area intercepts the lower slopes of Mount Direction.

The sites of geological significance are not subject to a Significant Landscape Overlay in the Pyrenees Planning Scheme.

Table 6.7: Sites of geological significance – Bulgana to Lexton

Significance level	Feature ID	Name	Description (as provided by GSA & Wakelin Associates, 2017)	Feature marker distance from Proposed Route (km)
Local (noted as Regional in Wakelin Associates, 2017)	BL120	Fault – high strain zone (Landsborough Fault)	Road cutting exposure of structural geology and sedimentary structures. Dominant structural element in these rocks is the s1 cleavage which parallels the west-dipping fault.	0.06
Regional	BL123	Mount Direction Roof Pendant Remnant, Elmhurst	Granite is currently exposed near top of intrusion, and shows mode of intrusion, and relationships with host rocks.	1.55 (study area intercepts the lower slopes of Mount Direction)

6.3 Lexton to Ballan

6.3.1 Geological setting

The geology from Lexton to Ballan is dominated by igneous rock units (Newer Volcanic Group) which comprise basalt and scoria characterised by widespread lava inundation from several local eruption centres. The igneous rock units are variably weathered and are capped by a variable thickness of residual soil. Alluvial deposits are present around watercourses that are incised into outcropping igneous rock units. The predominant alluvial unit for the area is the Quaternary aged alluvium which is associated with water courses such as Moorabool River and Werribee River.

Granitic intrusions are present around Mount Bolton and Mount Beckworth, formed from intrusion of igneous rock into the Earth's crust during the Devonian (known as a pluton). The granite deposit has formed hills (positive relief pluton) at both Mount Bolton and Mount Beckworth. Variable thicknesses of residual soil have formed from weathering of the granite, and granite derived colluvium is present on the sides and at bases of granite hill slopes.

The sedimentary intrusions occur in the south of the section, in particularly around Haydens Hill. The predominate sedimentary unit for the area is the Cambrian aged Castlemaine Group. Colluvial deposits are present on slopes and at the base of the sedimentary hills, predominately consisting of Tertiary aged White Hills Gravel. The major geological units present within the Lexton to Ballan section are listed and described in Table 6.8.

Table 6.8: Geological units – Lexton to Ballan

Age	Unit name	Description	Relevant areas where the Proposed Route intersects unit
Quaternary	Alluvial deposits (Qa1)	Gravel, sand, silt, variably sorted, variably rounded	Hepburn Lagoon, Rocky Lead Creek, Pinchgut Creek, Moorabool River, Werribee River. Localised deposits may be located around other creeks along the Proposed Route that have not been mapped.
	Colluvial deposits (Qc4)	Diamictite, gravel, sand, silt, clay, rubble	Minor deposits near Waubra and Dean.
	Swamp and lake deposits (Qm1)	Carbonaceous mud, silt, clay, minor peat	Tourello Creek, drainage lines from Mount Greencock Creek.
Quaternary-Tertiary	Shepparton Formation (Nws)	Fluvial clay, sand, silt, poorly sorted lenticular gravel	Low-lying areas around Rocky Lead Creek, Pinchgut Creek. Proposed Route
	Colluvium (Nc1 & Nc4)	Gravel, sand, silt and clay, containing clasts of sandstone, slate and vein quartz from bedrock (Nc1) or sand and gravel from granite (Nc4); generally, poorly sorted and subangular	Slopes around granite hills near Waubra and Mount Bolton.
	Newer Volcanic Group (Neo, Nes, Nep)	Basalt flows, scoria deposits and tuff rings	Dominant unit along Proposed Route from Lexton to Ballan, various eruption points and surrounding Hepburn Lagoon.
Tertiary	Calivil Formation (-Pxa)	Conglomerate, sandstone, silt, clay	Langdons Creek, Newlyn North.
	White Hills Gravel (Pxh)	Vein quartz conglomerate, sand, silt and clay; well-rounded pebbles and cobbles of quartz	On slopes and base of Castlemaine Group Hills near Haydens Hill (Bolwarrah).
Devonian	Granite (G312)	Intrusive granite	Granite hills near Waubra and Mount Bolton.
Ordovician-Cambrian	Castlemaine Group sedimentary units (Ocl, Occ, Ocb)	Marine sandstone, siltstone, shale	Proximity to Newlyn Reservoir, Rocklyn and Haydens Hill (Bolwarrah).

Between Lexton to Ballan, one geological fault line intersects the Proposed Route to the east of Bolwarrah, as summarised in Table 6.2.

Table 6.9: Geological fault lines – Lexton to Ballan

Named fault line	Observations of fault during walkover	Type	Activity[1]	Description
Muckleford Fault	n/a	Thrust	Active	West-dipping meridional reverse fault extending from near Ravenswood in the north, southwards to beyond Daylesford. It is considered by Willman et al. (2002) to be continuous with the Leichardt Fault to the north and the Meredith Fault to the south, which would give a total strike length of 160km. Seamless Geology 2014 Dataset shows that the southern extent of fault is shown approximately 700m north of Proposed Route. However, Geoscience Australia's Neotectonic features online database indicates the fault crosses the study area just east of Haydens Hill.

Notes

1. Fault activity inferred based on assessment of Geoscience Australia's Neotectonic features online database and lack of visual evidence of recent displacement along fault line.

The geological fault line is identified on Geoscience Australia's Neotectonic features online database. Neotectonic features are faults or other features that are believed to be related to large earthquakes in the last 5 to 10 million years, indicating the fault has been active in these timescales.

Figure A.2.1 in Appendix A shows the regional geology and fault lines in the Lexton to Ballan section.

6.3.2 Geomorphology, erosion and land stability

The section from Lexton to Ballan lies within the Western Uplands geomorphic province. Landforms are characterised by gently undulating hills with isolated steep hills associated with local volcanic eruption points. The topography varies from flat plains to steep slopes on valley sides and eruption point slopes to gently undulating areas in broad valleys. Examples of typical landscapes observed in this section are shown below in Figure 6.21 and Figure 6.22.

Figure 6.21: Granite hills surrounded by flat plains of the Newer Volcanic Group basalt and gently sloping deposits of colluvium at the base of hills, looking west from EMO-CP03 (Source: Jacobs, 2022)

Figure 6.22: Eruption point (Scoria cone) surrounded by flat plains of the Newer Volcanic Group basalt, looking north from EMO-CP08 (Source: Jacobs, 2022)

Mapped geomorphological units, accessed from the Geomorphology of Victoria dataset and based on the Victorian Geomorphology Framework (VGF), are summarised along the Proposed Route in Table 6.10 below. The Tier 3 geomorphological units in the Lexton to Ballan section are shown in Figure A.3.2 in Appendix A.

The Geomorphology of Victoria dataset also indicates susceptibility to gully and wind erosion, and susceptibility to landslide for each of the geomorphological units which are also indicated in Table 6.10.

Table 6.10: Summary of mapped geomorphological units, erosion and landslip susceptibility – Lexton to Ballan

Geomorphological Units			Erosion/landslide susceptibility			Relevant areas
Tier 1	Tier 2	Tier 3	Gully erosion	Landslide erosion	Wind erosion	
Western Uplands	Dissected Uplands (formerly Midlands)	2.1.6 Eruption points and volcanic plains	Low	Low	Low	Majority of Proposed Route - flat basalt plains with isolated volcanic eruption points.
		2.1.4 Hills, valley slopes and plains on plutonic Palaeozoic rocks	Low	Very Low	Very Low	Granite hills in the west of section, lower slopes.
		2.1.3 Ridges, escarpments, mountains on granitic Palaeozoic rocks	Moderate	Very Low	Moderate	Ridges and peak of Mount Bolton and Mount Beckworth.
		2.1.2 Hills, valley slopes and plains on non- granitic Palaeozoic rocks	Very High	Low	Moderate	Castlemaine Group hills, Haydens Hill (Bolwarrah).
		2.1.7 Terraces and floodplains	Moderate	Very Low	Moderate	Wilson Reservoir.

Small areas of the Lexton to Ballan section within the Ballarat and Hepburn LGAs are subject to an EMO. The purpose of the EMO is to *"protect areas prone to erosion, landslip or other land degradation processes, by minimising land disturbance and inappropriate development"* (DEECA, 2021). The areas subject to the overlay are generally associated with surface watercourses and areas mapped as the geological unit Nes (scoria deposits), which are positive relief features that represent eruption centre locations. An example of an area subject to the overlay is associated with a watercourse near EMO-CP02 is shown in Figure 6.23, whilst an example of an EMO area associated with a scoria cone near EMO-CP08 is shown in Figure 6.24. No evidence of active erosion was observed at either checkpoint location. The extents of the EMO within the Lexton to Ballan section are illustrated in Figure A.7.2 in Appendix A.

Figure 6.23: EMO associated with creek, no active erosion, taken at EMO-CP02 (Source: Jacobs, 2022)

Figure 6.24: EMO area associated with eruption point (Scoria cone, surrounded by flat plains of the Newer Volcanic Group basalt), looking north from EMO-CP08 (Source: Jacobs, 2022)

Observations of localised soil erosion were observed at EMO-CP05, as shown below in Figure 6.25 and Figure 6.26. Active erosion appeared to be relatively limited, and this is reflected by the susceptibility mapping of low erosion and gullying susceptibility in this area; however, these soils may be susceptible to erosion if exposed. Areas of ridges, hills and valley slopes are mapped as moderate and very high susceptibility to gully erosion, as described in Table 6.10. Many of these areas were often difficult to access due to hilly, steep terrain or private land access requirements, thus they were not observed during site walkover. The gully erosion susceptibility of the Lexton to Ballan section based on the Geomorphology of Victoria dataset is shown in Figure A.4.2 in Appendix A. Overall, the gully erosion susceptibility is mapped as low over the majority of the Lexton to Ballan section, which is consistent with the conditions observed on site.

Figure 6.25: Historical erosion near creek, exposed soil could be susceptible to erosion EMO-CP05 (Source: Jacobs, 2022)

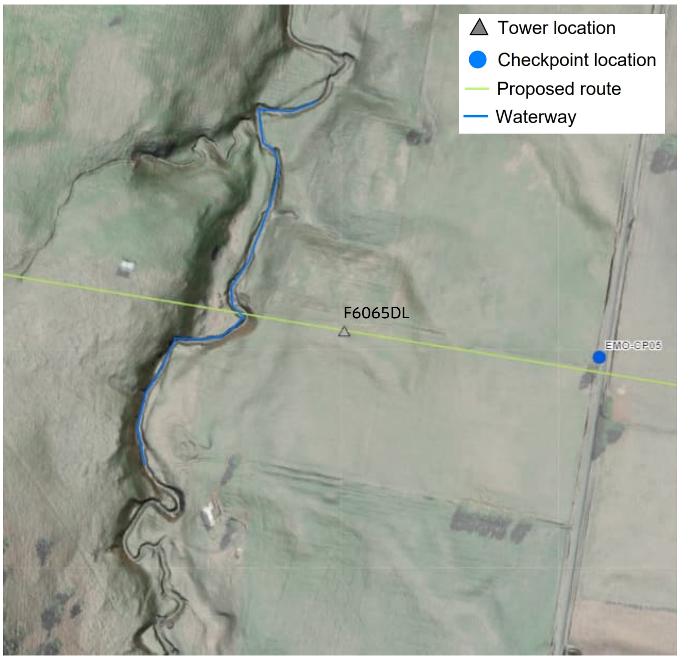

Figure 6.26: Mapped area of erosion susceptibility associated with existing creek west of EMO-CP05 with LiDAR DEM (Source: Jacobs, 2024)

Only minor land instability was observed within the Lexton to Ballan section and was generally observed on creek banks where creeks have incised into the underlying basalt rock. An example includes minor soil creep which was observed on the sides of a creek valley at EMO-CP07 which is likely due to natural erosion of the creek. Site observations and mapping from EMO-CP07 can be seen in Figure 6.27 and Figure 6.28. The Lexton to Ballan section is mapped as having a low to very low landslip susceptibility as described in Table 6.10 and shown on Figure A.5.2 in Appendix A. This susceptibility classification is consistent with observations undertaken on the site walkover.

Figure 6.27: Progressive creep on sides of creek valley, looking east from EMO-CP07 (Source: Jacobs, 2022)

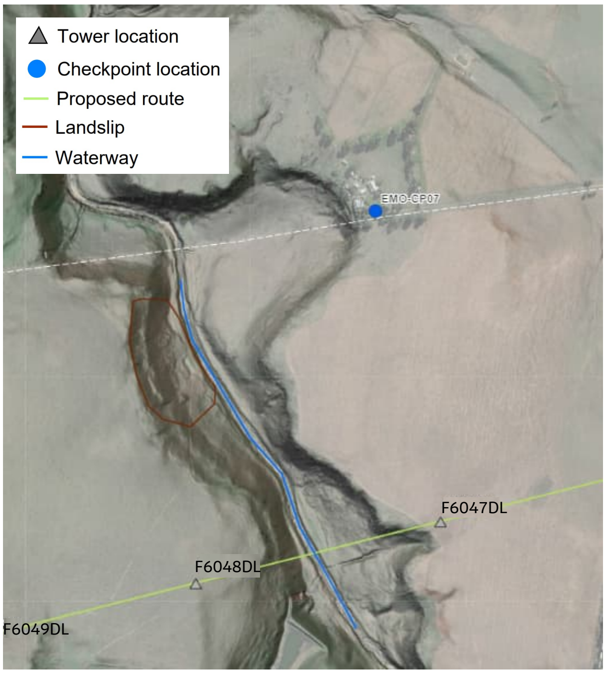

Figure 6.28: Mapped area of slope creep on sides of creek valley near EMO-CP07 with LiDAR DEM (Source: Jacobs, 2024)

Mapped areas of erosion and land in the Lexton to Ballan section based on the LiDAR DEM assessment conducted are presented in Figure A.11 in Appendix A.

6.3.3 Soil types and presence of dispersive soils

A summary of the mapped soil types from Lexton to Ballan is presented in Table 6.11 and is illustrated in Figure A.10.2 in Appendix A. The soil from Lexton to around Kingston has been mapped predominantly as Dermosols, Ferrosols and Kurosols which are typically acidic and well-draining. Minor areas, usually low-lying areas and depressions are mapped as Chromosols and Vertosols which are more sensitive to erosion and cracking/shrink-well behaviour.

From Kingston to Bolwarrah, mapped soil comprises predominantly Ferrosols, which are typically well structured, with a gradual increase in clay down through the profile derived from the weathering of basaltic rock. The soils are acidic at the surface and range from acidic to neutral at depth. A small section of Dermosols and Kurosols is present near Bolwarrah, consistent with the changing geological setting becoming the Ordovician aged Castlemaine Group.

From Bolwarrah to Ballan, mapped soil comprises predominantly Sodosols and Chromosols, soils that typically present texture contrast between the topsoil and subsoil (previously termed duplex). Some minor areas of Kurosol have been mapped, typically in low-lying alluvium channels.

Sodosols typically feature increasing levels of soil sodicity with depth. The presence of Sodosols (sodic soils) is important along the study area from Lexton to Ballan as the clay portion of the soil is sensitive to dispersion. Soil dispersion is the process of clay particles separating from one another upon wetting, resulting in structural decline of the soil and often leading to gullying and tunnel erosion. The risk of dispersion increases for sodic soils where the overlying topsoil is removed or if surface runoff is poorly managed.

Table 6.11: Key soil types – Lexton to Ballan

Area	Major mapped soil type	Geomorphology / landform association	Additional information regarding soil	Potential Hazard associated with soil type
Lexton to Kingston	Grey to brown Dermosols, minor areas of Chromosols, Ferrosols Kurosols, Leptic Rudosols, Vertosols and Tenosols	2.1.1 Ridges, escarpments, mountains on non-granitic Palaeozoic rocks 2.1.6 Eruption points and volcanic plains 2.1.2 Hills, valley slopes and plains on plutonic Palaeozoic rocks 2.1.3 Ridges, escarpments, mountains on granitic Palaeozoic rocks	Information from Schoknecht (1988), indicates a suite of uniform and gradation texture soils. Uniform grey to brown soils (Dermosols) occupy the lower-lying and poorer-drained areas of the volcanic plains. Red to brown gradational soils (Ferrosols) frequently occur on the better-drained rises and colluvial slopes flanking the volcanic hills. Yellow brown duplex soils (Chromosols and Vertosols) are found in depressions or low-lying areas of the plain. Yellow brown texture contrast (Kurosols) and shallow soils (Leptic Rudosols) occur on the slopes and peaks of Mount Bolton and Mount Beckworth. State of Victoria (Agriculture Victoria, 2023) website indicates that soils have developed on these landforms also include Sodosols.	Dermosols are generally stable soils; however, they can exhibit high silt content in areas which can lead to erosion. Ferrosols and Kurosols are known to display high acidity at surface (low pH level) that could potentially corrode construction materials. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour. Although not mapped, sodic soils are also associated with these landforms and might be present. Sodic soils are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed.
Kingston to Bolwarrah	Red Ferrosol (volcanic plains) with minor Dermosols	2.1.6 Eruption points and volcanic plains	In reference to Robinson et al. (2003), red and black strongly structured gradational soils (Ferrosols) dominate this area. According to State of Victoria (Agriculture Victoria, 2023) website, Vertosols are associated with this landform. In addition to Vertosols, sodic brown, yellow and grey texture contrast soils (Sodosols) are also dominant.	Gradation soils (Ferrosols) are likely to display high acidity at surface (low pH level) that could potentially be corrosive. Although not mapped, sodic soils and Vertosols are associated with these landforms and might be present. Sodic soils are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour.
		2.1.7 Terraces and floodplains	Mapped around the Wilson Reservoir. According to State of Victoria (Agriculture Victoria, 2023) website, texture contrast, generally sodic (Sodosols), gradational earths and occasional clay (Vertosols, Dermosols) and sandy soils (Tenosols) are associated with this landform.	
Bolwarrah (Hayden's Hill)	Yellow and brown Dermosol with minor Kurosol	2.1.2 Hills, valley slopes and plains on non- granitic Palaeozoic rocks	According to Robinson et al. (2003), the mapped soils on the area are yellow and brown sodic and strongly sodic mottled texture soils (Sodosols) that occur on the steep and gentle slopes on Palaeozoic sediments. The upper slopes of the hills contain soils with gradational increase in clay with depth (Dermosols) while on lower slopes and colluvial slopes the soil has darker subsoils (pale brown) which are more likely to be texture contrast (Kurosols).	Dermosols are generally stable soils; however, they can exhibit high silt content in areas which can lead to erosion. High to Very High gully erosion susceptibility mapped in these landforms (possibly resulting from dispersion). Kurosols are known to display high acidity at surface (low pH

Area	Major mapped soil type	Geomorphology / landform association	Additional information regarding soil	Potential Hazard associated with soil type
			According to State of Victoria (Agriculture Victoria, 2023) website, red texture contrast soils (Chromosols) that tend to be sodic (Sodosols) in lower topographic positions have developed on hills, valley slopes and plains.	level) that could potentially corrode construction materials. Although not mapped, sodic soils are associated with this landform and might be present. Sodic soils are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed.
Bolwarrah to Ballan	Mottled yellow, grey Sodosols, with Chromosols, Kurosols and minor Ferrosols	2.1.6 Eruption points and volcanic plains	Information from Jeffrey et al. (1979), indicates the presence of mottled yellow, grey sodic duplex (texture contrast) soils (Sodosols) on the volcanic plains. Minor yellow brown Kurosols and brown to black Chromosols found within low-lying alluvium channel and drainage paths. Red gradational or uniform soils (Ferrosols) are associated with the eruption point landforms. According to State of Victoria (Agriculture Victoria, 2023) website, Vertosols are associated with this landform. In addition to Vertosols, sodic brown, yellow and grey texture contrast soils (Sodosols) are also dominant.	Sodic soils are likely to be present that are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Although not generally dispersive, Kurosols and Chromosols can still be susceptible to rill, sheet and stream bank erosion. Kurosols and Ferrosols are known to display high acidity at surface (low pH level) that could potentially corrode construction materials. Although not mapped, Vertosols are associated with this landform and might be present. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour.

Emerson Class Testing conducted at EMO-CP07 within the Lexton to Ballan section on sand topsoil (Dermosols) recorded Emerson Class of 4. This class number indicates the sample tested is slightly to non-dispersive, which is consistent with expected behaviour for these soils (well-draining). The results of Emerson Class testing are summarised in Appendix B, with detailed laboratory certificates shown in Appendix C. Further Emerson Class testing will be required to determine dispersion characteristics of the soils along the Proposed Route during the geotechnical site investigations that will inform the design of Project infrastructure, particularly between Bolwarrah and Ballan.

6.3.4 Saline soils

The Pyrenees, Ballarat, Hepburn and Moorabool LGAs, which includes the study area from Lexton to Ballan, do not have any planning overlays relating to salinity management.

A review of the Victorian salinity provinces indicates that the Lexton to Ballan section is located within the Upper Loddon Volcanic Plains and Upper Moorabool salinity provinces. A summary of each of the salinity provinces within the section is shown below in Table 6.12 and are illustrated in Figure A.9.2 in Appendix A. Recorded salinity areas in both the Upper Loddon Volcanic Plains and Upper Moorabool salinity provinces are shown in Figure 6.17 and Figure 6.18 (DJSIR (formerly DEPI), 2014).

Table 6.12: Summary of Salinity Provinces – Lexton to Ballan (DJSIR (formerly DEPI), 2014)

Salinity province	Catchment management region	Priority status[1]	Province area (ha)	Recorded soil salinity area[2] (ha)	Salinity area description
Upper Loddon Volcanic Plains	North Central	High	97,610	801	Salinity occurs at three distinct areas; Long swamp (near Joyces Creek), Glengower and Smeaton, which are 10-20km to the north of the Proposed Route (see Figure 6.29). Each area is characterised by being a low-lying drainage basin with limited outflow, with likely groundwater discharge coming up from the intermediate scale Groundwater Flow Systems (GFS).
Upper Moorabool	Corangamite	High	114890	206	Mapped salinity occurrence covers only some 200 ha, mainly found in slight depressions in the basalt plains areas to the south of the Proposed Route (see Figure 6.30). While land salinity is of lower significance in this province, the Moorabool River is an important water supply catchment, so brackish groundwater discharging to streams is of concern.

Notes

1. High priority provinces:
   (a) Include (or intersect) the boundaries of significant environmental or cultural assets, high value infrastructure (including urban development), and/or priority biodiversity areas.
   (b) Contain significant salinity occurrences that pose a threat to land productivity, catchment health, downstream assets or water users, and/or high value infrastructure.
   (c) Have reasonable prospects for successful salinity management interventions or treatment options that are considered feasible from both 'practicality' and 'return on investment' points of view.
   Salinity Provinces that do not meet the above criteria are classified as Low priority.
2. Comprises the total geographic area that has been mapped as having, or showing symptoms of, dryland soil salinity at some time (past or present). Retrieved from http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/lwm_salinity-provinces (DJSIR (formerly DEPI), 2014).

No obvious signs of salt scalding or salinity indicator species were observed during the site walkover between Lexton and Ballan. This is consistent with the locations of recorded salinity identified in Table 6.12 being 10 to 20km to the north of the Proposed Route.

Soil salinity testing was conducted at EMO-CP09 on sandy silt of the Newer Volcanic Group residual soil. This test recorded ECe of 281 μS/cm, which indicates that the soil is non-saline (Agriculture Victoria, 2020c). This test constitutes a very small sample size and may not be representative of the broader study area. The results of soil salinity testing conducted in the Lexton to Ballan study area section are summarised in Appendix B, with laboratory test certificates shown in Appendix C.

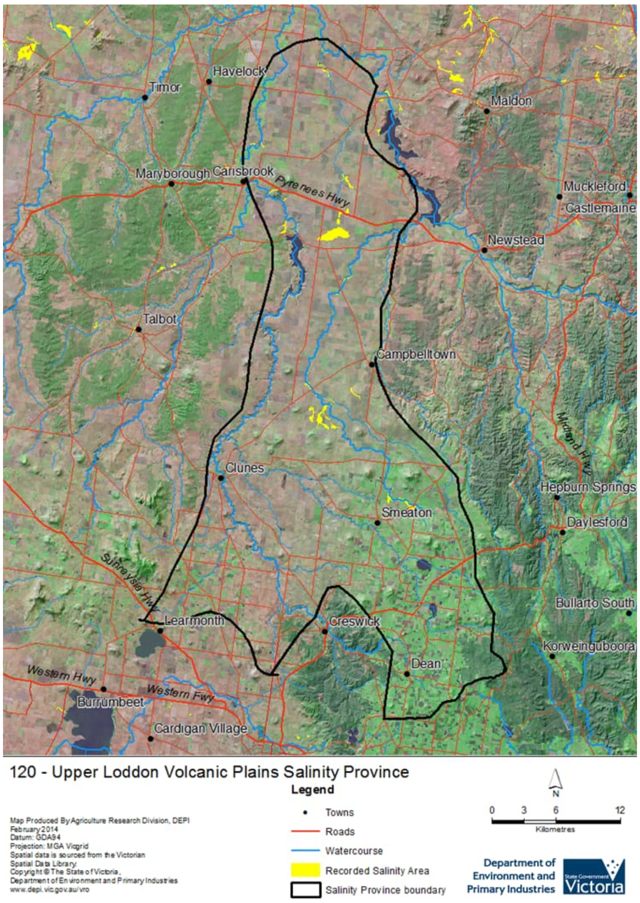

Figure 6.29: Upper Loddon Volcanic Plains Salinity Province with mapped Soil Salinity Areas shown in yellow (Source: DJSIR (formerly DEPI), 2014)

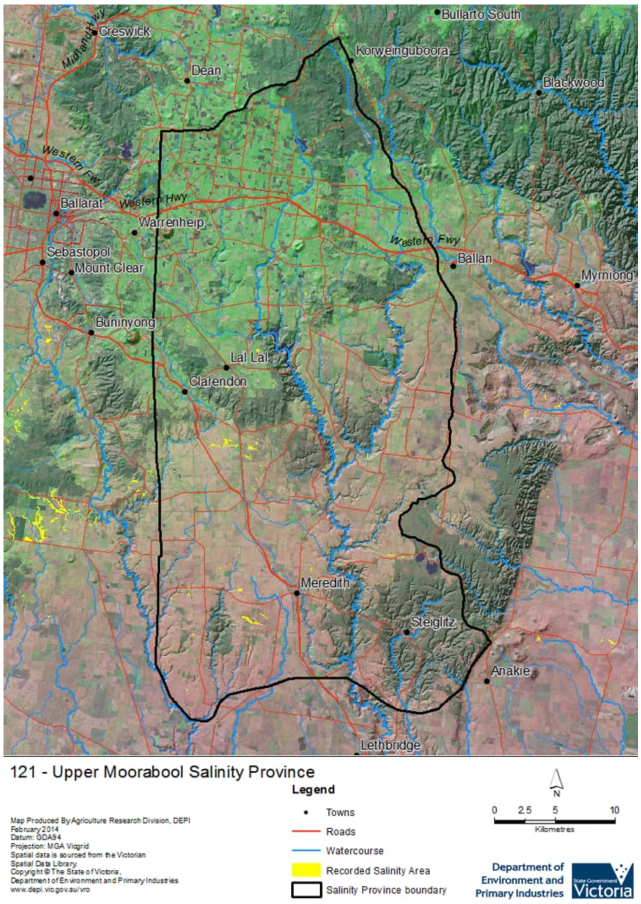

Figure 6.30: Upper Moorabool Salinity Province with mapped Soil Salinity Areas shown in yellow (Source: DJSIR (formerly DEPI), 2014)

6.3.5 Reactive soils

The likelihood for encountering reactive soils in the Lexton to Ballan section is high.

The mapped soil types (refer Figures A.10.2 in Appendix A) indicate that a small area of Vertosols associated with the Newer Volcanic Group is present in the Lexton to Ballan section. As mentioned previously, this soil type is associated with clay-rich soils that shrink and swell in response to moisture change.

There are also large areas of Ferrosols and Sodosols associated with the Newer Volcanic Group in this section. Atterberg Limit testing was undertaken on soil samples from EMO-CP05 and EMO-CP10 within the residual soil of the Newer Volcanic Group. These samples recorded plasticity index (PI) between 9% (EMO-CP05) and 19% (EMO-CP10), which indicates the residual soil of the Newer Volcanic Group in this area displays low to moderate soil reactivity (Holtz & Gibbs, 1956 & Seed et al. 1962). These tests were undertaken on samples from shallow depths (topsoil), and it is expected that the soil reactivity would increase further with depth in the residual soil of the Newer Volcanic Group.

6.3.6 Compressible soils

Soft, compressible soils that may potentially be saturated are likely to be encountered around creeks and rivers. This likelihood is high where recent alluvial deposits (Qa1) have been mapped as shown on Figure A.2.2 in Appendix A. Localised compressible soils that are not shown on Figure A.2.2 in Appendix A may also be present around the creeks and rivers listed in Table 6.8.

6.3.7 Sites of geological significance

The Proposed Route passes close to Mount Beckworth and Hepburn Lagoon, which are classified as having local geological significance. Further details are provided below in Table 6.13. The feature marker for Mount Beckworth (BL39) is shown to be outside the study area; however, the northern boundary of the study area intercepts the lower slopes of Mount Beckworth.

Neither Mount Beckworth nor Hepburn Lagoon are subject to a SLO.

Table 6.13: Sites of geological significance – Lexton to Ballan

Significance level	Feature ID	Name	Description (as provided by GSA)	Feature marker distance from Proposed Route (km)
Local	BL39	Mount Beckworth	Prominent highpoint of granite of Early Devonian age. Twenty-six scoria cones can be discerned from the peak.	1.53 (study area intercepts the lower slopes of Mount Beckworth)
Local	BL45	Hepburn Lagoon	A tuff ring 15m high with a crater 1.2km in diameter, 15 deep and containing an ephemeral lake.	0.43 (edge of lagoon adjacent to study area)

The Lexton to Ballan section includes several SLO areas, which are mainly associated with eruption points. The purpose of these SLO areas is to *"to implement the Municipal Planning Strategy and the Planning Policy Framework, to identify significant landscapes and to conserve and enhance the character of significant landscapes"* (DEECA, 2018). These areas are not listed as geologically significant features, however there is a permit application requirement to develop or carry out works in these areas. The transmission line intersects areas of SLO along the proposed 500kV Proposed Route just south of Mouth Beckworth, which is within the Ballarat Shire LGA; and west of Mount Prospect and east of Newlyn Reservoir, both of which are within the Hepburn Shire LGA. Areas were the Proposed Route passes close to or intersects a SLO are summarised below in Table 6.14.

Table 6.14: Significant landscape overlays – Lexton to Ballan

LGA	PFI	Object ID	Description	Distance from nearest point of SLO to Proposed Route (km)
Ballarat	4151389.0	87686	Eruption Point, Mount Bolton	1.55 (adjacent to study area)
Ballarat	4151388.0	69685	Unknown, near Mount Gap	Intersects Proposed Route
Hepburn	4151692.0	75398	Eruption point, Birch Hill	0.14 (within the study area)
Hepburn	4151697.0	74385	Eruption point, near Mount Prospect	Intersects Proposed Route
Hepburn	4151698.0	78376	Eruption point, near Newlyn Reservoir	Intersects Proposed Route

The location of sites of geological significance and SLO's within the Lexton to Ballan section are illustrated in Figure A.8.2 in Appendix A.

6.4 Ballan to Melton West

6.4.1 Geological setting

The geology from Ballan to Melton West is highly variable along the Proposed Route. Quaternary alluvial units are typically located around surface water features such as Goodman Creek and the Merrimu Reservoir. Quaternary aged alluvium is also present within the active sand quarry to the north of Bacchus Marsh. The alluvial units are commonly incised into the basalt of the Newer Volcanic Group.

As well as the basalt of the Newer Volcanic Group, various Quaternary-Tertiary aged geological units (Darley Gravel and outwash sediments), Tertiary aged alluvial and colluvial deposits (Werribee Formation and White Hills Gravel respectively), Older Volcanics (Pentland Hills Volcanic Group), and Permian aged sedimentary rock unit (Bacchus Marsh Formation) are mapped. Due to the presence of the Rowsley Fault that cuts across the Proposed Route, the Older Volcanics and Werribee Formation outcrop to the surface north of Bacchus Marsh. Underlying all units and outcropping in some parts of the Ballan to Melton West section is the Ordovician aged bedrock (Castlemaine Group and Riddell Sandstone Gisbornian), comprising marine sandstone, siltstone and shale. The major geological units present within the Ballan to Melton West section are listed in Table 6.15.

Table 6.15: Key geological units – Ballan to Melton West

Age	Unit name	Description	Relevant areas where the Proposed Route intersects unit
Quaternary	Alluvial (Qa1), colluvial (Qc1) deposits	Gravel, sand, silt, variably sorted, variably rounded	Myrniong Creek, Lerderderg River (Bacchus Marsh), eastern side of Merrimu Reservoir.
	Quarry waste deposits (Qhq)	Sand, gravel and clay	Small section within Bacchus Marsh quarry.
Quaternary-Tertiary	Darley Gravel (Nxr)	Gravel, moderate to well sorted and rounded	Elevated plateau area above Bacchus Marsh quarries. Sections within quarries. Large flat sections in Coimadai and Melton West between creek valleys.
	Incised alluvial deposits (Na)	Gravel, sand, silt	Western side of Merrimu Reservoir.
	Newer Volcanic Group (Neo)	Neo; basalt flows	Elevated plateaus between valleys incised by watercourses, north of Myrniong and Merrimu Reservoir.
Tertiary	White Hills Gravel (Pxh)	Vein quartz conglomerate, sand, silt and clay; well-rounded pebbles and cobbles of quartz	Slopes of low-lying hills near Pykes Creek Reservoir.
	Werribee Formation (Pxe)	Sand, silt, clay, gravel in variable proportions	Base of hills near Lerderderg River. Low-lying areas of the Bacchus Marsh quarry. On slopes and base of basalt plateau near Merrimu Reservoir.
	Pentland Hills Volcanic Group (Pp)	Basalt with minor tuff	Valleys surrounding eruption point containing Korjamnu Creek and Pykes Creek Reservoir (north of Ballan). Valleyed areas near Myrniong and North Petlands Hills.
Permian	Bacchus Marsh Formation (Pxb)	Sandstone, mudstone, conglomerate	Low-lying areas north west and north of Bacchus Marsh, around Korkuperrimul Creek. Valley containing Goodmans Creek, Darley. Eastern side of Merrimu Reservoir.
Ordovician	Castlemaine Group (Ocl, Occ, Och, Ocb, Ocy)	Marine sandstone, siltstone, shale	Hill range north of Bacchus Marsh. Gullied area south of Merrimu Reservoir containing Coimadai Creek, north Long Forest.
	Riddell Sandstone Gisbornian (Osrg)	Sandstone, black shale, black and grey siltstone	Highly vegetated valley containing the Djerriwarrh Creek on the border of Long Forest and Melton West.

Two geological fault lines intersect the Ballan to Melton West section to the south-east of Glenlofty, as summarised in Table 6.16.

Table 6.16: Geological fault lines – Ballan to Melton West

Named fault line	Observations of fault during walkover	Type	Activity[1]	Description
Greendale Fault	n/a	Thrust	Inactive	The Greendale Fault is approximately 10km long and runs from Greendale in a south-westerly direction parallel to the Coimadai Fault. The fault crosses the study area just west of Deloraine.
Rowsley Fault	No obvious surface expression of fault observed at intersection with Proposed Route.	Thrust	Active	The Rowsley Fault line is a long tectonic fault line that sweeps from Bacchus Marsh in the north to near Anakie in the south, where it peters out to join the valleys of the Moorabool River and Sutherland Creek. The fault line separates the Castlemaine Group to the west and Alluvium units, Bacchus Marsh Formation and Werribee Formation to the east.

Notes

1. Fault activity inferred based on assessment of Geoscience Australia's Neotectonic features online database and lack of visual evidence of recent displacement along fault line.

Figures showing the regional geology and fault lines in the Ballan to Melton West section are presented in Figure A.2.3 in Appendix A.

6.4.2 Geomorphology, erosion and land stability

The section from Ballan to Melton West is characterised by undulating hills and ridgelines in places combined with broad low-lying, flat areas. The topography varies from moderate to steep slopes in hilly areas to gently undulating to flat areas in broad valleys and plains. Examples of typical landscapes observed in this section are shown below in Figure 6.31, Figure 6.32 and Figure 6.33.

Figure 6.31: Castlemaine Group ridgeline, with alluvial flats in foreground associated with Lerderderg River. Rowsley faut line at base of slope. Looking west from EG-CP20 (Source: Jacobs, 2022)

Figure 6.32: Road cut into Permian aged Bacchus Marsh Formation sedimentary rock observed at EG-CP19 (Source: Jacobs, 2022)

Figure 6.33: Road cut into Riddell Sandstone observed at EG-CP23 (Source: Jacobs, 2022)

Mapped geomorphological units, accessed from the Geomorphology of Victoria dataset and based on the Victorian Geomorphology Framework (VGF), are summarised along the Proposed Route in Table 6.17 below. The Tier 3 geomorphological units in the Ballan to Melton West section are shown in Figure A.3.3 in Appendix A.

The Geomorphology of Victoria dataset also indicates susceptibility to gully and wind erosion, and susceptibility to landslide for each of the geomorphological units which are also indicated in Table 6.17.

Table 6.17: Summary of mapped geomorphological units, erosion and landslip susceptibility – Ballan to Melton West.

Geomorphological Units			Erosion/landslide susceptibility			Relevant areas
Tier 1	Tier 2	Tier 3	Gully erosion	Landslide erosion	Wind erosion	
Western Uplands	Dissected Uplands (formerly Midlands)	2.1.6 Eruption points and volcanic plains	Low	Low	Low	Newer Volcanic Group plains with Older Volcanic Group valleys (Petland Hills), from Ballan to Myrniong.
		2.1.2 Hills, valley slopes and plains on non-granitic Palaeozoic rocks	Very High	Low	Moderate	Slopes, steep hills and low-lying areas comprising Bacchus Marsh Formation, Alluvium, Darley Gravel, Castlemaine Group Hills. Contained within east Myrniong, north Bacchus Marsh and Coimadai (including Merrimu Reservoir) areas.
		2.1.1 Ridges, escarpments, mountains on non-granitic Palaeozoic rocks	High	Low	Moderate	Steep slopes, ridges and peak of Castlemaine Group hills to the north of Bacchus Marsh.
Western Plains	Sedimentary Plains	6.2.5 Terraces and floodplains and coastal plains	Moderate	Low	Moderate	Flat plain of Darley Gravel on the border of Long Forest and Melton LGAs.

No areas within both the Moorabool and Melton LGAs, which cover the section of Proposed Route from Ballan to Melton West, are subject to an EMO. The extents of the EMO are illustrated in Figure A.7.3 in Appendix A.

As seen in Table 6.17, High to Very High gully erosion susceptibility areas have been mapped in geomorphological units with steep slopes and incised land (see Table 6.17). Particle size distribution conducted in two areas of alluvium units mapped with Very High gully erosion susceptibility showed that materials contained a high percentage of sand with some silt and clay, which further indicates these soils are likely susceptible to erosion by water and wind (refer to Appendix B and Appendix C for details).

Natural gully erosion on steep slopes was observed in several areas. The gully erosion observed mostly appeared to be inactive where the area was heavily vegetated (EG-CP19, see Figure 6.34), however there were some areas where active erosion was visible in areas where soils had been disturbed (EG-CP20, see Figure 6.35). The main exception in this section was the Bacchus Marsh Quarry site, where no erosion was observed on the slopes of the quarry at EG-CP21. This is likely because the quarry has controls in place to limit erosion and maintain stability of cut slopes, as shown in Figure 6.36.

Figure 6.34: Permian and Castlemaine Group hill with gully erosion, looking east from EG-CP19 (Source: Jacobs, 2022)

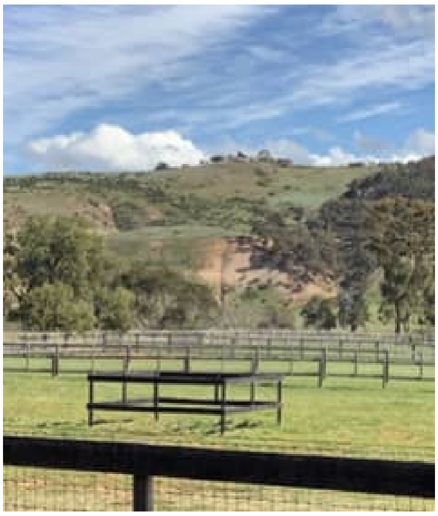

Figure 6.35: Gully erosion observed on slope looking east from EG-CP20 (Bacchus Marsh North) (Source: Jacobs, 2022)

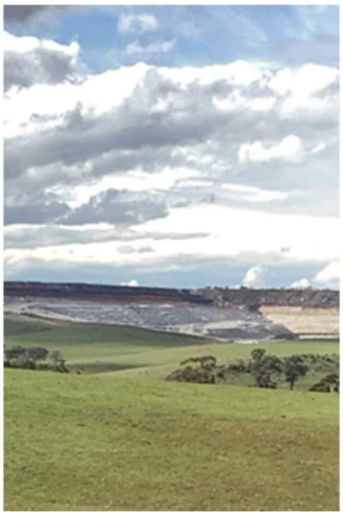

Figure 6.36: Cut slopes at Bacchus Marsh Quarry with exposures of basalt and the Werribee Formation observed from EG-CP21 (Source: Jacobs, 2022)

An example of localised slope instability on the side of a creek valley observed from EG-CP18 is shown in Figure 6.37. An example of localised slope instability was observed at a cut slope in the Riddell Sandstone (Unit 2.1.2 in Table 6.17) near EG-CP23, as shown in Figure 6.38. This indicates that cut slopes within the non-granitic Palaeozoic rocks in this section may be prone to localised failure if appropriate batter slopes and slope stability control measures are not adopted.

A large area of historical earth flow and rotational land slip failures was mapped using the Project LiDAR derived Digital Elevation Model (DEM) close to the Ballan to Melton West section of the Proposed Route. At this location, a Newer Volcanic Group cap overlies the Tertiary aged Pentland Hills Volcanic Group (both classified as Unit 2.1.6 in Table 6.17), which has been incised by the Korjamnunnip Creek. The sides of the creek valley to the west and south of the eruption point display signs of historical instability, with several examples or earth flows and rotational failure evident from the Digital Elevation Model mapping, as shown in Figure 6.39. This area could not be accessed for verification during the site walkover due to land access issues.

The Ballan to Melton West area is mapped as having Low landslip susceptibility, as indicated in Table 6.17. Landslip susceptibility for the Ballan to Melton West section is illustrated in Figure A.5.3 in Appendix A. Whilst this may be applicable for some of the Proposed Route in this area, observations and mapping indicate landslide processes have been active relatively recently on slopes that are close to the Proposed Route, or within geological units over which the Proposed Route will pass.

Figure 6.37: Natural erosion of creek causing instability of creek slopes at EG-CP18 (Source: Jacobs, 2022)

Figure 6.38: Localised slump failure in cut slope in the Riddell Sandstone observed near EG-CP23 (Source: Jacobs, 2022)

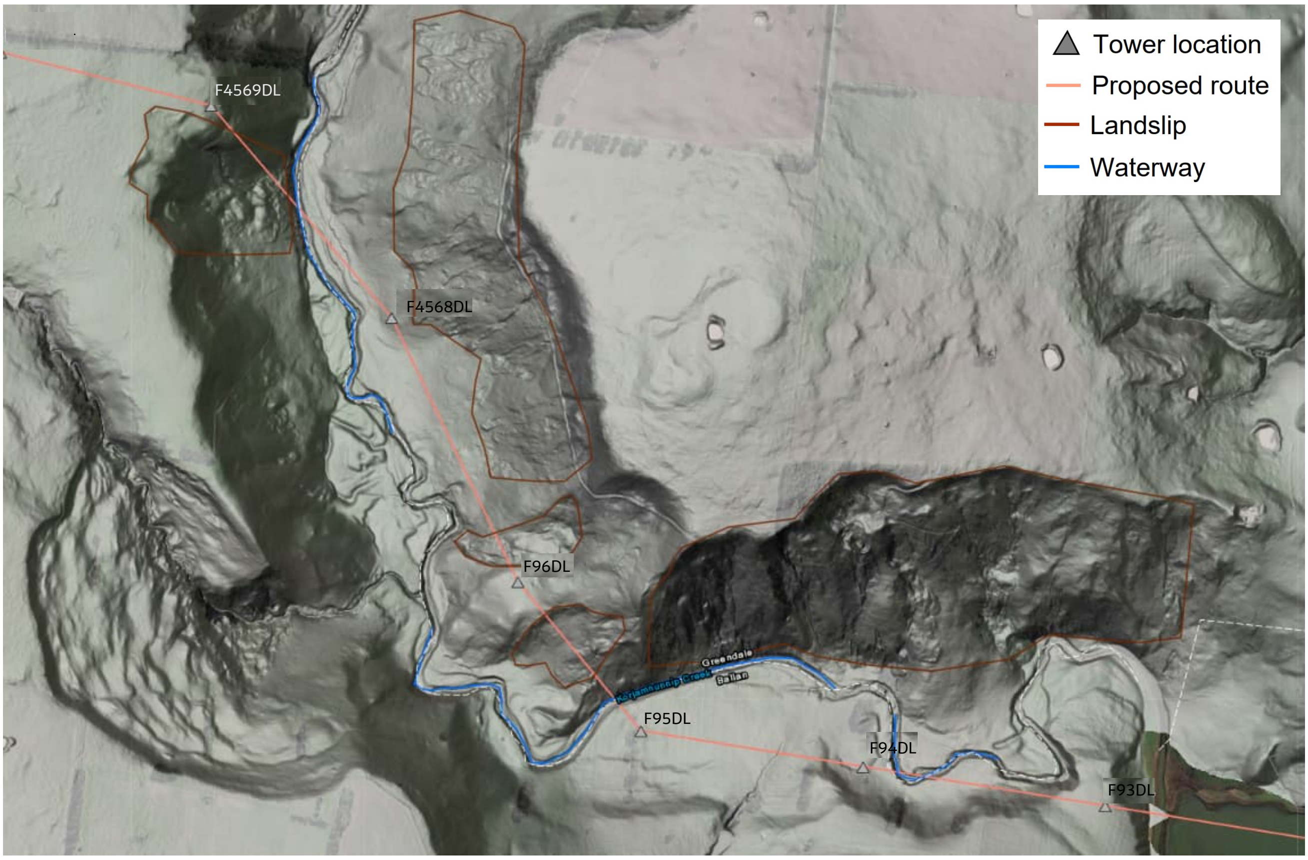

Figure 6.39: Mapped areas of earth flow and rotational land slip failures associated with volcanic eruption point near Pykes Creek Reservoir north of Ballan with LiDAR DEM (Source: Jacobs, 2024)

Mapped areas of erosion and land instability in the Ballan to Melton West section based on the LiDAR DEM assessment conducted are presented in Figure A.11 in Appendix A.

6.4.3 Soil type and presence of dispersive soils

A summary of the mapped soil types for the Ballan to Melton West study area is presented in Table 6.18 and illustrated in Figure A.10.3 in Appendix A. From Ballan to around Myrniong, soils have been mapped as predominately Sodosols with a small section of Vertosols in the valley to the north of Pykes Creek Reservoir. The distribution of these soil types generally reflects the mapped geological units, with Sodosols being the predominant soil type in areas underlain by the Newer Volcanic Group basalt.

A small section from Myrniong to the Lerderderg River has been mapped as Dermosols. This is consistent with the change in geological setting and presence of Ordovician aged Castlemaine Group hills.

From the Lerderderg River to Melton West, soils have been mapped as predominately Sodosols and Chromosols. As noted previously, Sodosols are susceptible to dispersion that may result in structural decline of the soil, often leading to gullying and tunnel erosion.

Widespread occurrences of land degradation, including tunnel erosion, gully erosion, and landslips are present within this section, such as historically in the Parwan Creek valley located near Glenmore approximately 11km south of the Proposed Route. The land degradation at Parwan Creek valley occurred during European settlement and was due to clearing of native vegetation for agricultural use.

Gully erosion is also evident around the Long Forest area to the south of Merrimu Reservoir, which is also associated with the presence of Sodosols. Hence, soils in this section may be especially prone to dispersion and subsequent erosion and land instability if surface water and vegetation cover are not managed appropriately.

Table 6.18: Key soil types – Ballan to Melton West

Area	Major mapped soil type	Geomorphology/ landform association	Additional information regarding soil	Potential Hazard associated with soil type
Ballan to Myrniong Creek	Brown and yellow Sodosols, minor Vertosols, Ferrosols and Kurosols	2.1.6 Eruption points and volcanic plains	Information Jeffrey et al. (1979), indicates the area is dominated by mottled yellow, grey sodic duplex (texture contrast) soils (Sodosols). The steep valley to the north of Pykes Creek Reservoir present uniform texture soils (black Vertosols) on slopes. Minor areas of texture contrast soils (Kurosols) are mapped on banks and underlying creeks. Minor red stony gradational soils (Ferrosols) are associated with the eruption point landforms. State of Victoria (Agriculture Victoria, 2023) website indicates that soils that have developed on this landform also include Vertosols.	Sodic soils are likely to be present that are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Vertosols mapped within valleys may be unstable, as high-water content in the soil contributes to landslip risk. Some potential historical landslip areas have been mapped within this soil type as shown in Figure 6.39 and in Figure A.11 in Appendix A. Kurosols and Ferrosols are known to display high acidity at surface (low pH level) that could potentially corrode construction materials.
Myrniong Creek to the Lerderderg River	Dermosols with minor Chromosols	2.1.6 Eruption points and volcanic plains	According to State of Victoria (Agriculture Victoria, 2023) website, Vertosols are associated with this landform. In addition to Vertosols, sodic brown, yellow and grey texture contrast soils (Sodosols) are also dominant. Ferrosols also occur on volcanic plains and rises in areas of higher	Dermosols are generally stable soils; however, they can exhibit high silt content in areas which can lead to erosion. High to Very High gully erosion susceptibility mapped in these landforms (possibly resulting from dispersion).

Area	Major mapped soil type	Geomorphology/ landform association	Additional information regarding soil	Potential Hazard associated with soil type
			rainfall, and also on numerous volcanic vents. These red soils are well structured and friable, and generally strongly acid throughout with high free iron content.	Although not mapped, sodic soils, Vertosols and Ferrosols are associated with these landforms and might be present. Sodic soils are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour. Ferrosols are known to display high acidity at surface (low pH level) that could potentially corrode construction materials.
		2.1.2 Hills, valley slopes and plains on non-granitic Palaeozoic rocks	According to State of Victoria (Agriculture Victoria, 2023) website, red texture contrast soils (Chromosols) that tend to be sodic (Sodosols) in lower topographic positions have developed on hills, valley slopes and plains.	
		2.1.1 Ridges, escarpments, mountains on non-granitic Palaeozoic rocks	According to State of Victoria (Agriculture Victoria, 2023) website, soils that have developed on these landforms are red texture contrast soils (Chromosols) that may be sodic (Sodosols) especially where rainfall is lower and in lower topographic positions.	
Lerderderg River to Melton West	Sodosols with Chromosols	2.1.2 Hills, valley slopes and plains on non-granitic Palaeozoic rocks	According to State of Victoria (Agriculture Victoria, 2023) website, red texture contrast soils (Chromosols) that tend to be sodic (Sodosols) in lower topographic positions have developed on hills, valley slopes and plains.	Sodic soils are likely to be present that are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Consistent with areas of Very High gully erosion susceptibility mapped in these landforms (possibly resulting from dispersion). Although not mapped, Vertosols and Ferrosols are associated with these landforms and might be present. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour. Ferrosols are known to display high acidity at surface (low pH level) that could potentially corrode construction materials.
		2.1.6 Eruption points and volcanic plains	According to State of Victoria (Agriculture Victoria, 2023) website, Vertosols are associated with this landform. In addition to Vertosols, sodic brown, yellow and grey texture contrast soils (Sodosols) are also dominant. Ferrosols also occur on volcanic plains and rises in areas of higher rainfall, and also on numerous volcanic vents. These red soils are well structured and friable, and generally strongly acid throughout with high free iron content.	
		6.2.5 Terraces and floodplains and coastal plains	According to State of Victoria (Agriculture Victoria, 2023) website, associated soil types include mottled sodic texture contrast soils (Sodosols), grey and black cracking clays (Vertosols) and some dark loams (Dermosols).	

Evidence of erosion possibly resulting from soil dispersion was observed during the site inspection at locations with steep slopes, near creeks and other areas associated with naturally occurring erosion processes. Possible soil dispersion and erosion was observed and mapped on steep hill slopes within the Bacchus Marsh Formation near EG-CP20 as shown below in Figure 6.40 and Figure 6.41. Historical gully erosion of soils in heavily vegetated areas was observed within the Castlemaine Group near EG-CP22 as shown below in Figure 6.42. Natural stream bank erosion was observed in the Riddell Sandstone near EG-CP23 as shown in Figure 6.43.

Figure 6.40: Possible soil dispersion and erosion of exposed soils on steep slopes of Bacchus Marsh Formation observed near EG-CP20 (Source: Jacobs, 2022)

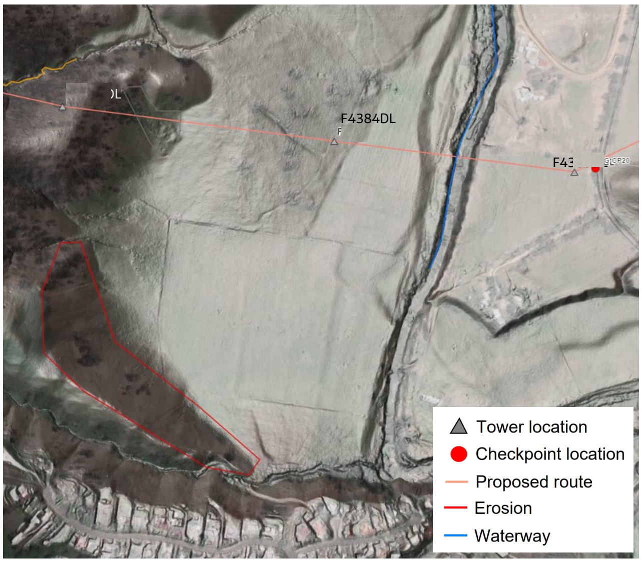

Figure 6.41: Erosion of the side of steep hill slope of Bacchus Marsh Formation near EG-CP20 with LiDAR DEM (Source: Jacobs, 2022)

Figure 6.42: Historical gully erosion in heavily vegetated area near EG-CP22 (Source: Jacobs, 2022)

Figure 6.43: Natural erosion of Creek in Riddell Sandstone observed near EG-CP23 (Source: Jacobs, 2022)

Two Emerson Class dispersion tests were conducted at EG-CP19 and EG-CP23 in the Ballan to Melton West section on silt (Dermosol) and silty gravel (chromosol) samples derived from sedimentary rock units, which both recorded a result of Emerson Class 3. This indicates moderately dispersive soils are present within the Dermosol and chromosol soil types in this section. The results of Emerson Class testing are summarised in Appendix B, with detailed laboratory certificates shown in Appendix C. Additional Emerson Class testing, particularly in areas of Sodosols, will be required to characterise dispersive soils along the Proposed Route during geotechnical site investigations that will be undertaken to inform the Project design.

6.4.4 Saline soils

There are no planning overlays relating to salinity management or salinity provinces within the Ballan to Melton West section. Additionally, no obvious signs of salt scalding or salinity indicator species were observed during the site walkover between Ballan and Melton West.

6.4.5 Reactive soils

The likelihood for encountering reactive soils in the Ballan to Melton West section is high.

The mapped soil types (refer Figures A.10.3 in Appendix A) indicate that a small area of Vertosols associated with the Pentland Hills Volcanic Group are present in the Ballan to Melton West section near Pykes Creek Reservoir. As mentioned previously, this soil type is associated with clay-rich soils that shrink and swell in response to moisture change. The presence of Vertosols in this section is limited, however there is also large areas of Ferrosols and Sodosols associated with the Newer Volcanic Group. No Atterberg Limit testing was conducted in this section. It is expected that the soil properties in this unit would be similar to the Lexton to Ballan section, although this needs to be confirmed by further soil testing during geotechnical site investigations that will be undertaken to inform the Project design.

6.4.6 Compressible soils

Soft, compressible soils that may potentially be saturated are likely to be encountered around creeks and rivers. This likelihood is high were recent alluvial deposits (Qa1) have been mapped as shown on Figure A.2.3 in Appendix A. Localised compressible soils that are not shown on Figure A.2.3 in Appendix A may also be present around the creeks and rivers listed in Table 6.15.

6.4.7 Sites of geological significance

Multiple sites of geological significance are present within the Ballan to Melton West section. Sites of national and international significance are associated with examples of the Permian aged glacial deposits that are present to the east of the Lerderderg River near Bacchus Marsh. Sites of geological significance that are present within the Ballan to Melton West section are listed and described in Table 6.19.

Table 6.19: Sites of geological significance – Ballan to Melton West

Significance level	Feature ID	Name	Description (as provided by GSA)	Distance from Proposed Route (km)
Local	ML278	Pykes Hill	Eruption point of the Quaternary Newer Volcanics basalt on thin Tertiary gravels and sand, rotational landslips.	0.60
Local	ML291	Lerderderg Valley Alluvial Fan	Large steeply sloping alluvial fan extending onto the river terrace. The fan is now inactive and weakly incised.	0.25
International (noted as State in Wakelin Associates, 2017)	ML201	Lerderderg River Permian sequence	River exposure of continuous 145 m section of Permian glacial deposits. Incl: tillite, glacial outwash, ice rafts.	0.20
Local	ML294	Lerderderg River Morven Terrace	The terraces are distinguished by well-preserved scarps 1.5 m high. Exposes gravels, sands & silts of terrace formation	0.18
Local	ML113	Lake Merrimu Cutting	Road cutting exposes Permian glacial sediments. Anticline in Ordovician sediments.	0.32

The Ballan to Melton West section includes a large SLO area, which is associated with steep valleys to the west of Bacchus Marsh. The transmission line Proposed Route intersects the corner of the SLO near EG-CP19, within the Moorabool Shire LGA. Areas where the Proposed Route passes close to or intersects a SLO are summarised below in Table 6.20.

Table 6.20: Significant landscape overlays – Ballan to Melton West

LGA	PFI	Object ID	Description	Distance from route (km)
Moorabool	4151842.0	86403	Unknown, west of Bacchus Marsh.	Intersects Proposed Route

The location of sites of geological significance and SLO's within the Ballan to Melton West section are illustrated in Figure A.8.3 in Appendix A.

6.5 Melton West to Sydenham

6.5.1 Geological setting

The geology is dominated by the Quaternary- Tertiary aged igneous rock unit, comprising olivine basalt flows of the Newer Volcanic Group. The igneous basalt rock unit is variably weathered and is capped by a variable thickness of residual soil. Alluvial deposits are present locally around watercourses that are incised into the basalt flows. The predominant alluvial unit for the area is the Quaternary aged alluvium.

Colluvial deposits are present in low-lying areas near Toolern Creek and other unnamed drainage lines. Historical alluvial deposits are also present comprising the Tertiary aged Darley Gravels associated with the low-lying areas within the Toolern Creek catchment area. The main geological units within the Melton West to Sydenham section are summarised in Table 6.21.

Table 6.21: Geological units – Melton West to Sydenham

Age	Unit name	Description	Relevant areas where the Proposed Route intersects unit
Quaternary	Alluvial deposits (Qa1)	Gravel, sand, silt, variably sorted, variably rounded	Toolern Creek
	Swamp and lake deposits (Qm1)	Carbonaceous mud, silt, clay, minor peat	Low-lying area / potential crater centre to the north-west of Melton West. Low-lying area to the north-east of Mount Kororoit
Quaternary-Tertiary	Darley Gravel (Nxr)	Gravel, sand, silt, moderate to well sorted and rounded	Low-lying area near Kurunjang containing Toolern Creek and other drainage lines
	Newer Volcanic Group (Neo)	Neo; basalt flows	Flat basalt plains incised by watercourses exposing sections of Darley Gravel and depositing alluvium. Multiple eruption points creating isolated steep hills.

Figures showing the regional geology of the section are presented in Figure A.2.4 in Appendix A.

6.5.2 Geomorphology, erosion and land stability

The section from Melton West to Sydenham is characterised by flat plains with low-lying areas associated with watercourses and drainage lines. The topography varies from flat to gently undulating with a steep valley associated with the Kororoit Creek and isolated steep hills associated with eruption points (e.g., Mount Kororoit). Examples of typical landscapes observed in this section are shown below in Figure 6.44 and Figure 6.45.

Figure 6.44: Kororoit Creek incising the Newer Volcanic Group basalt with Mount Kororoit eruption point in the background looking southeast from O-CP02 (Source: Jacobs, 2022).

Figure 6.45: Newer Volcanic Group basalt plains looking south from GSF-CP02 (Source: Jacobs, 2022).

Mapped geomorphological units, accessed from the Geomorphology of Victoria dataset and based on the Victorian Geomorphology Framework (VGF), are summarised along the Proposed Route in Table 6.22 below. The Tier 3 geomorphological units in the Melton West to Sydenham section are shown in Figure A.3.4 in Appendix A.

The Geomorphology of Victoria dataset also indicates susceptibility to gully and wind erosion, and susceptibility to landslide for each of the geomorphological units which are also indicated in Table 6.22.

Table 6.22: Summary of mapped geomorphological units, erosion and landslip susceptibility – Melton West to Sydenham

Geomorphological Units			**Erosion/landslide susceptibility**			**Relevant areas**
Tier 1	**Tier 2**	**Tier 3**	**Gully erosion**	**Landslide erosion**	**Wind erosion**	
Western Plains	Volcanic Plains	6.1.3 Plains with poorly developed drainage and shallow regolith	Low	Very Low	Low	Flat basalt plains of northwest Melton West
	Sedimentary Plains	6.2.5 Terraces and floodplains and coastal plains	Moderate	Low	Moderate	Low-lying valley of Darley Gravel and Alluvium containing Toolern Creek
	Volcanic Plains	6.1.1 Eruption points: maars, scoria cones and lava shields, including associated ash and scoria deposits	Very Low	Low	Very Low	Mount Kororoit
		6.1.2 Stony rises	Very Low	Very Low	Low	Flat basalt plains of northeast Melton West to Sydenham

No areas have been mapped to contain the EMO within the Melton West to Sydenham section, which is located entirely within the City of Melton LGA. The extents of the EMO are illustrated in Figure A.7.4 in Appendix A.

Gully erosion susceptibility is generally mapped as very low and low, however, a small section in the low-lying area containing the Toolern Creek is mapped as moderate. Gully susceptibility for the Melton West to Sydenham section is illustrated in Figure A.4.4 in Appendix A. Basaltic soil of the Newer Volcanic Group and alluvial units in this section may be susceptible to gully erosion during flooding or high rainfall events, especially where soils may have been exposed by construction works. Also, as noted in Section 6.5.3, basaltic soil is sodic and susceptible to dispersion which may lead to tunnel and gully erosion, and removal of topsoil may result in increased susceptibility to gully erosion in areas mapped as very low and low.

As shown in Table 6.22, the Melton West to Sydenham section is mapped as having a Low to Very Low landslip susceptibility. Landslip susceptibility for the section is illustrated in Figure A.5.4 in Appendix A. Localised landslips may occur in areas of steep slopes associated with large creek valleys such as Kororoit Creek. Possible slope creep, localised instability and rock outcrops were observed and mapped near the Kororoit Creek crossing near O-CP02, as shown below in Figure 6.46 and Figure 6.47.

Figure 6.46: Basalt rock outcropping on the southern side of Kororoit Creek valley observed looking south near O-CP02 (Source: Jacobs, 2022)

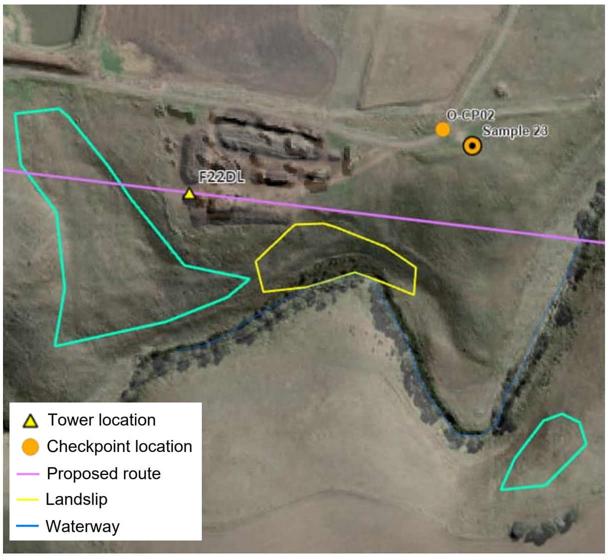

Figure 6.47: Mapped area of possible soil creep on north bank of Kororoit Creek valley near O-CP02 with LiDAR DEM (Source: Jacobs, 2024)

Mapped areas of erosion and land instability in the Melton West to Sydenham section based on the LiDAR DEM assessment conducted are presented in Figure A.11 in Appendix A.

6.5.3 Soil type and presence of dispersive soils

A summary of the mapped soil type for the Melton West to Sydenham study area is presented in Table 6.23 and are illustrated in Figure A.10.4 in Appendix A. The Melton West to Sydenham study area is predominantly mapped on Sodosols. As previously noted, soil sodicity potentially leads to dispersion, degradation of soil structure, and gully and tunnel erosion.

The distribution of these soil types generally reflects the mapped geological units, with Sodosols being the predominant soil type in areas underlain by the Tertiary aged basalt of the Newer Volcanic Group. A small section of Chromosols was mapped in the area associated with the Darley Gravel unit and minor creeks.

Table 6.23: Key soil type properties – Melton to Sydenham

Area	Major mapped soil type	Geomorphology/ landform association	Additional information regarding soil	Potential Hazard associated with soil type
Melton to the Kororoit Creek	Sodosols with minor areas of Chromosols and Ferrosols	6.1.3 Plains with poorly developed drainage and shallow regolith	According to State of Victoria (Agriculture Victoria, 2023) website, associated soil types with this landform are sodic (Sodosols) and non-sodic (Chromosols) texture contrast (moderately deep to deep) soils and some gradational (shallow to moderately deep) soils (Dermosols), and gilgai (mound and rise ground surfaces formed due to clay horizons swelling and shrinking, commonly associated with grey Vertosol soils).	Sodic soils are likely to be present that are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Ferrosols are known to display high acidity at surface (low pH level) that could potentially corrode construction materials. Although not mapped, Vertosols are associated with landform 6.2.5 and might be present. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour.
		6.2.5 Terraces and floodplains and coastal plains	According to State of Victoria (Agriculture Victoria, 2023) website, associated soil types include mottled sodic texture contrast soils (Sodosols), grey and black cracking clays (Vertosols) and some dark loams (Dermosols).	
Kororoit Creek to Sydenham	Red calcareous Sodosols with minor areas of Vertosols	6.1.3 Plains with poorly developed drainage and shallow regolith	According to State of Victoria (Agriculture Victoria, 2023) website, associated soil types with this landform are sodic (Sodosols) and non-sodic (Chromosols) texture contrast (moderately deep to deep) soils and some gradational (shallow to moderately deep) soils (Dermosols), and gilgai (mound and rise ground surfaces formed due to clay horizons swelling and shrinking, commonly associated with grey Vertosol soils).	Sodic soils are likely to be present that are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Although not extensively mapped, Vertosols are associated with these landforms. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour. Although not mapped, Ferrosols are associated with these landforms and might be present. Ferrosols are known to display high acidity at surface (low pH level) that could potentially corrode construction materials.
		6.1.1 Eruption points: maars, scoria cones and lava shields, including associated ash and scoria deposits	According to State of Victoria (Agriculture Victoria, 2023) website, associated soil types include shallow to moderately deep friable (black, red or brown) gradational soils (Dermosols, Ferrosols) often stony.	
		6.1.2 Stony rises	According to State of Victoria (Agriculture Victoria, 2023) website, associated soil types with this landform are shallow dark gradational (Dermosols) and self-mulching (and cracking) clay soils (Vertosols).	

6.5.4 Saline soils

The Melton LGA, which includes the study area from Melton West to Sydenham, does not have any planning overlays relating to salinity management.

A review of the Victorian Salinity Provinces indicates that the Lexton to Ballan section is located partially within the Lancefield-Sunbury salinity province. A summary of this salinity province is shown below in Table 6.24 and is illustrated in Figure A.9.4 in Appendix A. Recorded salinity areas in the Lancefield-Sunbury salinity province are shown in Figure 6.48 (DJSIR (formerly DEPI), 2014).

Table 6.24: Summary of Salinity Provinces – Lexton to Ballan (DJSIR (formerly DEPI), 2014)

Salinity province	Catchment management region	Priority status[1]	Province area (ha)	Recorded soil salinity area[2] (ha)	Salinity area description
Lancefield – Sunbury	Port Phillip and Westernport	Low	129,750	214	Minor areas of recorded soil salinity mainly associated with low lying areas adjacent to existing drainage channels. There is a large area of recorded soil salinity approximately 5km south of the Proposed Route near Kororoit Creek.

Notes

1. High priority provinces:
   (a) Include (or intersect) the boundaries of significant environmental or cultural assets, high value infrastructure (including urban development), and/or priority biodiversity areas.
   (b) Contain significant salinity occurrences that pose a threat to land productivity, catchment health, downstream assets or water users, and/or high value infrastructure.
   (c) Have reasonable prospects for successful salinity management interventions or treatment options that are considered feasible from both ‘practicality’ and ‘return on investment’ points of view.
   Salinity Provinces that do not meet the above criteria are classified as Low priority.
2. Comprises the total geographic area that has been mapped as having, or showing symptoms of, dryland soil salinity at some time (past or present). Retrieved from http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/lwm_salinity-provinces (DJSIR (formerly DEPI), 2014).

No obvious signs of salt scalding or salinity indicator species were observed during the site walkover between Melton West to Sydenham. This is consistent with the locations of recorded salinity identified in Table 6.12 being away from the Proposed Route.

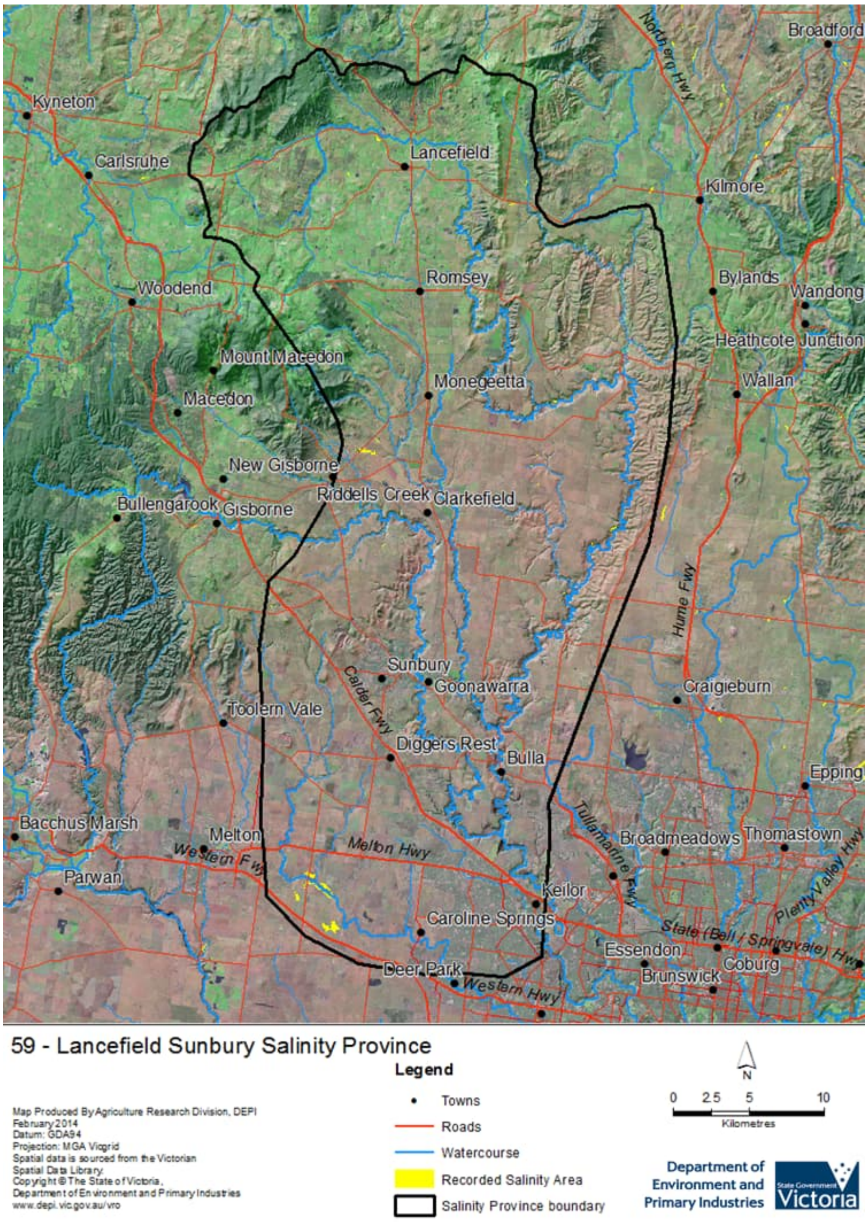

Figure 6.48: Lancefield – Sunbury Salinity Province with mapped Soil Salinity Areas shown in yellow (Source: DJSIR (formerly DEPI), 2014)

6.5.5 Reactive soils

The likelihood for encountering reactive soils in the Melton to Sydenham section is high.

The mapped soil types (refer Figures A.10.4 in Appendix A) indicate that a majority of the Melton to Sydenham section is located in areas of Sodosols. Although Sodosols are not always necessarily associated with large shrink-swell movements, the residual soils of the Newer Volcanic Group are known to be highly to extremely reactive and susceptible to large surface movements as a result of changes in moisture content.

In addition, Vertosols, known to be susceptible to cracking, slickensides and shrink-swell behaviour, are often associated with the landforms featured in the Melton to Sydenham section.

Signs of reactivity in the Newer Volcanic Group residual soils was observed, as shown by the example of shrinkage cracking seen in clay soils near O-CP02 (refer to Figure 6.49). The shrink swell cracking of exposed soils is due to contraction of the clay as a result of reduction in moisture content below soil shrinkage limit. Atterberg testing was undertaken on a high plasticity clay sample from O-CP02. The plasticity index of the residual clay sample at O-CP02 recorded a value of 41% (LL=61%), which indicates the soils in this area display high to very high soil reactivity (Holtz and Gibbs, 1956 and Seed et al. 1962).

Figure 6.49: Shrink swell cracking observed in Newer Volcanics residual clay soil at O-CP02 (Source: Jacobs, 2022)

6.5.6 Compressible soils

Soft, compressible soils that may potentially be saturated are likely to be encountered around creeks and rivers (e.g., Toolern Creek). This likelihood is high where recent alluvial deposits (Qa1) have been mapped as shown on Figure A.2.4 in Appendix A. Localised compressible soils that are not shown on Figure A.2.4 in Appendix A may also be present around the creeks and rivers listed in Table 6.21.

6.5.7 Sites of geological significance

Sites of geological significance present within the Melton West to Sydenham section are listed and described in Table 6.25 and illustrated in Figure A.8.4 in Appendix A.

Table 6.25: Sites of geological significance – Melton to Sydenham

Significance level	Feature ID	Name	Description (as provided by GSA)	Distance from Proposed Route (km)
State	ML66	Mount Kororoit	Breached cone. Predominantly scoria capped by a rocky outcrop of lava and lava agglomerate. Newer Volcanics.	0.32

Mount Kororoit exhibits large areas of rock outcropping on the summit and low slopes. These examples of basalt rock are a major reason as to why the eruption point has been designated as a significant feature. An existing phone and radio tower supplying small power line is present at the top of the feature. Observations of the Mount Kororoit recorded at GSF-CP02, which show examples of the eruption point and basalt rock outcrops can be seen in Figure 6.50 and Figure 6.51 respectively.

Figure 6.50: Mt Kororoit eruption point with phone and radio towers observed looking north from GSF-CP02 (Source: Jacobs, 2022)

Figure 6.51: Newer Volcanic Group basalt outcrop on side of slope at Mt Kororoit observed looking north from GSF-CP02 (Source: Jacobs, 2022)

The Melton West to Sydenham section includes a large SLO area, which is associated with Mount Kororoit. The transmission line Proposed Route intersects the corner of the SLO near GSF-CP02, within the Melton Shire LGA. Areas were the Proposed Route passes close to or intersects a SLO are summarised below in Table 6.26.

Table 6.26: Significant landscape overlays – Melton West to Sydenham

LGA	PFI	Object ID	Description	Distance from Proposed Route (km)
Melton	4252952.0	6265	Eruption point, Mount Kororoit	Intersects Proposed Route

Mount Kororoit is also identified in the Western Plains North Green Wedge Management Plan as a key landform not found elsewhere in the Green Wedge which represents important elements of the natural landscape.

6.6 Terminal stations

6.6.1 Geological setting

The geology at each of the terminal station sites is summarised below and is also illustrated in Figure A.2.0 in Appendix A:

- **Bulgana Terminal Station (BGTS):** The geology at the existing BGTS site features the Tertiary aged colluvium unit of White Hills Gravel (Pxh), comprising vein quartz conglomerate, sand, silt and clay; well-rounded pebbles and cobbles of quartz. The colluvium unit overlies the Cambrian aged Warrack Formation comprising siltstone and sandstone.

  The geology at the site of the new 500kV terminal station near Bulgana features predominantly the Tertiary aged colluvium unit of White Hills Gravel (Pxh), comprising vein quartz conglomerate, sand, silt and clay, well-rounded pebbles and cobbles of quartz. The Quaternary-Tertiary aged alluvial unit of the Shepparton Formation (Nws), comprising fluvial clay, sand, silt, poorly sorted lenticular gravel, is underlying the north-east corner of the site. The colluvium and alluvium units overly the Cambrian aged Warrack Formation, comprising siltstone and sandstone.

- **Elaine Terminal Station (ETS):** The geology at the existing ETS site features the Tertiary aged colluvium unit of White Hills Gravel (Pxh) comprising vein quartz conglomerate, sand, silt and clay; well-rounded pebbles and cobbles of quartz. The southern end of the site is underlain by the Tertiary aged Black Rock Sandstone (Nbb) comprising sand, sandstone, conglomerate, minor sandy limestone and local ironstone (commonly referred to as the Brighton Group soils).
- **Sydenham Terminal Station (SYTS):** The geology at the existing SYTS site comprises basalt of the Quaternary-Tertiary aged Newer Volcanic Group (Neo), which generally comprises high plasticity residual clay overlying variably weathered basalt rock, with the presence of basalt cobbles and boulders (commonly referred to as floaters) within the residual soil. This unit also features extremely weathered basalt at the interface between the residual soil and weathered basalt rock.

6.6.2 Geomorphology, erosion and land stability

The geomorphology at each terminal station varies depending on location.

Conditions at the existing Bulgana Terminal Station site feature terraces and floodplains in the northern and western part of the site and hills, valley slopes and plains on non- granitic Palaeozoic rocks in the southern and eastern part of the site. The new 500kV terminal station near Bulgana features terraces and floodplains.

Conditions at the existing Elaine Terminal Station feature predominantly plateaux and rises of residual Cainozoic landscapes with hills, valley slopes and plains on non- granitic Palaeozoic rocks present just at the north-western corner of the site.

Mapped geomorphological units at each terminal station site, accessed from the Geomorphology of Victoria dataset and based on the Victorian Geomorphology Framework (VGF), are summarised below in Table 6.27. The Tier 3 geomorphological units at each terminal station are shown in Figure A.3.0 in Appendix A.

The Geomorphology of Victoria dataset also indicates susceptibility to gully and wind erosion, and susceptibility to landslide for each of the geomorphological units which are also indicated in Table 6.27.

Table 6.27: Summary of mapped geomorphological units, erosion and landslip susceptibility – Terminal stations

Geomorphological Units			Erosion/landslide susceptibility			Relevant areas
Tier 1	**Tier 2**	**Tier 3**	**Gully erosion**	**Landslide erosion**	**Wind erosion**	
Western Uplands	Dissected Uplands	2.1.2 Hills, valley slopes and plains on non- granitic Palaeozoic rocks	Very High	Low	Moderate	Bulgana Terminal Station (existing site)
		2.1.7. Terraces and floodplains	Moderate	Very Low	Moderate	
		2.1.5 Plateaux and rises of residual Cainozoic landscapes	Low	Low	Low	New 500kV terminal station near Bulgana
		2.1.7. Terraces and floodplains	Moderate	Very Low	Moderate	
		2.1.5 Plateaux and rises of residual Cainozoic landscapes	Low	Low	Low	Elaine Terminal Station
		2.1.2 Hills, valley slopes and plains on non- granitic Palaeozoic rocks	Very High	Low	Moderate	
Western Plains	Volcanic plains	6.1.2 Stony rises	Very Low	Very Low	Low	Sydenham Terminal Station

Very High gully erosion susceptibility areas have been mapped at the existing Bulgana and Elaine Terminal Stations in a geomorphological unit with steep slopes (e.g., hills, valley slopes). Gully susceptibility for each of the terminal station sites is illustrated in Figure A.4.0 in Appendix A. No examples of gully erosion were observed at existing terminal station sites, which is likely due to the sites being levelled during construction with appropriate drainage control measures used to limit erosion.

As shown in Table 6.27, the terminal station sites are mapped as having a Low to Very Low landslip susceptibility. Landslip susceptibility for the section is illustrated in Figure A.5.4 in Appendix A. No evidence of past landslide activity was observed at any of the existing terminal station sites and a majority of these sites are described as flat to gently undulating with limited hills present. However, this does not preclude landslide activity occurring in the future if excavations into steep areas are not managed correctly. It is important that all modifications to existing slopes are designed appropriately to avoid impacting slope stability at both the existing and proposed sites.

6.6.3 Soil type and presence of dispersive soils

A summary of the mapped soil types for the terminal station study areas is presented in Table 6.28 and are illustrated in Figure A.10.0 in Appendix A.

Elaine Terminal Station, the new 500kV terminal station near Bulgana and partly the existing Bulgana Terminal Station sites are mapped on Chromosols. These are texture contrast soils that are non-sodic in free drainage areas. These soils can exhibit soil sodicity in non-free draining areas or depressions. The existing Bulgana Terminal Station is partly mapped on Kandosols. Emerson Class testing was undertaken at the existing Bulgana Terminal Station as part of previous geotechnical site investigations conducted by Statewide Geotechnical (2020). A total of three samples of silty/sandy clay and clayey sand derived from White Hills Gravels (Chromosols and Kandosols), which all recorded Emerson Class 2, which indicates high dispersion potential at this site.

Sydenham Terminal Station is mapped on Sodosols, highly sodic texture contrast soils. As previously noted, soil sodicity potentially leads to dispersion, degradation of soil structure, and gully and tunnel erosion.

The distribution of these soil types generally reflects the mapped geological units, with Ferrosols and Chromosols being the predominant soil types in the gently undulating landscape underlain by the Quaternary-Tertiary aged Newer Volcanic Group basalt. Minor sections of Kandosols and Kurosols have been mapped within the terminal station areas, usually associated with colluvium or alluvium geological units.

Table 6.28: Key soil type properties – Terminal stations

Area	Major mapped soil type	Geomorphology/ landform association	Additional information regarding soil	Potential Hazard associated with soil type
Bulgana Terminal Station (existing site)	Kandosols and Chromosols	2.1.7 Terraces and floodplains	Information from Robinson et al. (2005) and State of Victoria (Agriculture Victoria, 2023) website indicates that soils for this unit range from texture contrast soils, brown, yellow and grey sodic (Sodosols) or red non-sodic (Chromosols) to gradational earths and occasional clay (Vertosols, Dermosols) and sand soils (Tenosols). Within this unit most of the gradational yellow and brown soils (Kandosols) are found.	Although Chromosols are known to be non-sodic in the upper part of the soil profile, the subsurface horizon can occasionally be sodic and disperse after remoulding. Kandosols can be strongly acidic throughout much of the profile in higher rainfall areas that could potentially corrode construction materials. Although not mapped, sodic soils are associated with this landform and might be present. Sodic soils are susceptible to dispersion and

Area	Major mapped soil type	Geomorphology/ landform association	Additional information regarding soil	Potential Hazard associated with soil type
		2.1.2 Hills, valley slopes and plains on non-granitic Palaeozoic rocks	Information from Robinson et al. (2005) and State of Victoria (Agriculture Victoria, 2023) website indicates that red texture contrast soils (Chromosols) that tend to be sodic (Sodosols) in lower topographic positions have developed on these landforms.	are extremely prone to gully and tunnel erosion if subsoils are exposed. Although not mapped Vertosols are associated with landform 2.1.7 and might be present. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour.
New 500kV terminal station near Bulgana	Chromosols	2.1.5 Plateaux and rises of residual Cainozoic landscapes	Information from Robinson et al. (2003) and State of Victoria (Agriculture Victoria, 2023) website, developed on these sediments are a suite of yellow, brown and red texture contrast soils (Sodosols and Chromosols) and red gradational or uniform soils (Dermosols and Kandosols).	Although Chromosols are known to be non-sodic in the upper part of the soil profile, the subsurface horizon can occasionally be sodic and disperse after remoulding. Although not mapped, sodic soils are associated with both landforms and might be present. Sodic soils are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Although not mapped Vertosols are associated with landform 2.1.7 and might be present. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour.
		2.1.7. Terraces and floodplains	Information from Robinson et al. (2005) and State of Victoria (Agriculture Victoria, 2023) website indicates that soils for this unit range from texture contrast soils, brown, yellow and grey sodic (Sodosols) or red non-sodic (Chromosols) to gradational earths and occasional clay (Vertosols, Dermosols) and sand soils (Tenosols). Within this unit most of the gradational yellow and brown soils (Kandosols) are found.	
Elaine Terminal Station	Grey and brown Chromosols with minor Kurosols	2.1.5 Plateaux and rises of residual Cainozoic landscapes	Information from Robinson et al. (2003) and State of Victoria (Agriculture Victoria, 2023) website, developed on these sediments are a suite of yellow, brown and red texture contrast soils (Sodosols and Chromosols) and red gradational or uniform soils (Dermosols and Kandosols).	Although Chromosols are known to be non-sodic in the upper part of the soil profile, the subsurface horizon can occasionally be sodic and disperse after remoulding. Although not mapped, sodic soils are associated with both landforms and might be present. Sodic soils are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Kurosols are known to display high acidity at surface (low pH level) that could potentially corrode construction materials.
		2.1.2 Hills, valley slopes and plains on non-granitic Palaeozoic rocks	According to State of Victoria (Agriculture Victoria, 2023) website, red texture contrast soils (Chromosols) that tend to be sodic (Sodosols) in lower topographic positions have developed on hills, valley slopes and plains.	

Area	Major mapped soil type	Geomorphology/ landform association	Additional information regarding soil	Potential Hazard associated with soil type
Sydenham Terminal Station	Sodosols	6.1.2 Stony rises	According to Jeffrey (1981), the area contains red calcareous sodic duplex soils (Sodosols). This is consistent with the soil type mapping. According to State of Victoria (Agriculture Victoria, 2023) website, associated soil types with this landform are shallow dark gradational (Dermosols) and self-mulching (and cracking) clay soils (Vertosols).	Sodic soils are likely to be present that are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Although not mapped Vertosols are associated with this landform and might be present. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour.

6.6.4 Saline soils

A summary of salinity provinces relating to each terminal station site are shown below in Table 6.29 and are also illustrated in Figure A.9.0 in Appendix A. Most notably, a large area of mapped soil salinity is present to the south of the Elaine Terminal Station site.

Table 6.29: Summary of Salinity Provinces – Terminal stations (DJSIR (formerly DEPI), 2014)

Area	Salinity province	Catchment management region	Priority status[1]	Province area (ha)	Recorded soil salinity area[2] (ha)	Salinity area description
Bulgana Terminal Station (existing site) and the new 500kV terminal station near Bulgana	Elmhurst	Wimmera	High	69,530	137	A number of small salinity discharge sites are scattered within the upland alluvial plains, mainly adjacent to and along drainage lines. These discharge sites are mainly located well away from the terminal station sites to the south of the Wimmera River.
Elaine Terminal Station	Upper Moorabool	Corangamite	High	114,890	206	Salinity is mainly found in slight depressions in the basalt plains areas. There is an area of recorded soil salinity in the basalt plains 2-3km south of the terminal station site.

Area	Salinity province	Catchment management region	Priority status[1]	Province area (ha)	Recorded soil salinity area[2] (ha)	Salinity area description
Sydenham Terminal Station	Lancefield - Sunbury	Port Phillip and Westernport	Low	129,750	214	Approximately 0.2% of the salinity province is salt affected land, which contributes a low salt load to the Lancefield – Sunbury salinity province. There is a large area of recorded soil salinity approximately 5km south of the terminal station near Kororoit Creek.

Notes

1. High priority provinces:
   (a) Include (or intersect) the boundaries of significant environmental or cultural assets, high value infrastructure (including urban development), and/or priority biodiversity areas.
   (b) Contain significant salinity occurrences that pose a threat to land productivity, catchment health, downstream assets or water users, and/or high value infrastructure.
   (c) Have reasonable prospects for successful salinity management interventions or treatment options that are considered feasible from both "practicality" and "return on investment" points of view.
   Salinity Provinces that do not meet the above criteria are classified as Low priority.
2. Comprises the total geographic area that has been mapped as having, or showing symptoms of, dryland soil salinity at some time (past or present). Retrieved from http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/lwm_salinity-provinces (DJSIR (formerly DEPI), 2014).

No obvious visible signs of soil salinity (e.g., salt scalding or salinity indicator species) were observed at any of the terminal station sites during the site walkover, however this does not preclude the possibility of saline soils being present at these sites. Further site-specific testing is required to confirm the presence of saline soils at each site.

6.6.5 Reactive soils

The likelihood for encountering reactive soils at each of the terminal station sites is summarised below in Table 6.30. Clays of the Newer Volcanic Group residual soil are known to range between high to very high soil reactivity.

Atterberg limit testing were conducted by Jacobs (2018) and Statewide Geotechnical (2020) at the existing Bulgana Terminal Station. Atterberg testing recorded plasticity index (PI) values between 12% to 29% on samples of White Hills Gravel and the Warrack Formation. This indicates that soils at the existing Bulgana Terminal Station site display medium to high soil reactivity (Holtz & Gibbs, 1956 & Seed et al. 1962).

Table 6.30: Likelihood for encountering reactive soils – Terminal stations

Area	Major mapped soil type	Geology	Likelihood for encountering reactive soils	Comment
Bulgana Terminal Station (existing site)	Kandosols and Chromosols	White Hills Gravel (-Pxh)	Low	Colluvial soils of the White Hills Gravel are not known to have high soil reactivity. However, reactivity of the colluvial soils is dependent on the parent bedrock or residual soils from which they have been derived.
New 500kV terminal station near Bulgana	Chromosols	White Hills Gravel (-Pxh) Shepparton Formation (Nws)	Low	Colluvial soils of the White Hills Gravel are not known to have high soil reactivity. Alluvial soils of Shepparton Formation are not known to have high soil reactivity. However, reactivity of the colluvial and alluvial soils is dependent on the parent bedrock or residual soils from which they have been derived.
Elaine Terminal Station	Chromosols with minor Kurosols	White Hills Gravel (-Pxh)	Low	Colluvial soils of the White Hills Gravel are not known to have high soil reactivity.
Sydenham Terminal Station	Sodosols	Newer Volcanic Group basalt (Neo)	High	Lab test conducted at O-CP02 approx. 10km west of Sydenham Terminal Station recorded PI=41%, which indicates high to very high soil reactivity (Holtz & Gibbs, 1956 & Seed et al. 1962).

6.6.6 Compressible soils

Based on the available information, it is not expected that large amounts of soft, compressible soils would be present at any of the terminal station sites. Any compressible soils are expected to occur locally around creeks and waterways.

The likelihood of encountering compressible soils is high where recent alluvial deposits (Qa1) have been mapped as shown on Figure A.2.0 in Appendix A.

6.6.7 Sites of geological significance

No sites of geological significance, as determined by the GSA, are present at or close to any of the terminal station sites.

In additions, none of the terminal stations are shown to be close to or within a SLO zone. Sites of geological significance and SLOs in the area are shown in Figure A.8.0 in Appendix A.

6.7 Intermediate laydown areas

6.7.1 Geological setting

The geology at the intermediate laydown areas is summarised below and is also illustrated in Figure A.2.2 in Appendix A:

- **Lexton (Sunraysia Highway):** The geology at the proposed laydown area features the Quaternary-Tertiary aged basalt of the Newer Volcanic Group (Neo), generally comprising high plasticity residual clay overlying variably weathered basalt rock. Basalt cobbles and boulders (commonly referred to as floaters) are often present within the residual soil. This unit also features extremely weathered basalt at the interface between the residual soil and weathered basalt rock.
- **Ballan (Ingliston Road):** The geology at the proposed laydown area features the Quaternary-Tertiary aged basalt of the Newer Volcanic Group (Neo), generally comprising high plasticity residual clay overlying variably weathered basalt rock. Basalt cobbles and boulders (commonly referred to as floaters) are often present within the residual soil. This unit also features extremely weathered basalt at the interface between the residual soil and weathered basalt rock.

6.7.2 Geomorphology, erosion and land stability

The geomorphology at the Lexton and Ballan laydown areas features eruption points and volcanic plains.

Mapped geomorphological units at each of the laydown areas, accessed from the Geomorphology of Victoria dataset and based on the Victorian Geomorphology Framework (VGF), are summarised in Table 6.31 below. The Tier 3 geomorphological units at each terminal station are shown in Figure A.3.2 in Appendix A.

The Geomorphology of Victoria dataset also indicates susceptibility to gully and wind erosion, and susceptibility to landslide for each of the geomorphological units which are also indicated in Table 6.31 below.

Table 6.31: Summary of mapped geomorphological units, erosion and landslip susceptibility – intermediate laydown areas

Geomorphological Units			Erosion/landslide susceptibility			Relevant site
Tier 1	**Tier 2**	**Tier 3**	**Gully erosion**	**Landslide erosion**	**Wind erosion**	
Western Uplands	Dissected Uplands	2.1.6 Eruption points and volcanic plains	Low	Low	Low	Lexton and Ballan intermediate laydown areas

Although Lexton and Ballan laydown areas are mapped as having a low susceptibility to gully erosion, it has been found that residual soils of the Newer Volcanic Group are susceptible to dispersion which may lead to tunnel and gully erosion where soils may be exposed. Gully erosion, associated with drainage pathway, is mapped based on the LiDAR DEM assessment south-east of the Lexton laydown area. Gully susceptibility for the laydown areas is illustrated in Figure A.4.2 and mapped areas of erosion and land instability based on site observations, LiDAR DEM and aerial imagery in Figures A.11.16 and A.11.50 in Appendix A.

Neither laydown area is mapped to contain the EMO, as illustrated in Figure A.7.2 in Appendix A.

As shown in Table 6.31, the intermediate laydown areas are mapped as having a Low landslide susceptibility. Landslip susceptibility for the section is illustrated in Figure A.5.2 in Appendix A. However, this does not preclude landslide activity occurring in the future if excavations into steep areas are not managed correctly. It is important that all modifications to existing slopes are designed appropriately to avoid impacting slope stability at both the existing and proposed sites.

6.7.3 Soil type and presence of dispersive soils

A summary of the mapped soil types for the intermediate laydown areas is presented in Table 6.32 and are illustrated in Figure A.10.2 in Appendix A.

Ballan laydown area is mapped on Sodosols, highly sodic texture contrast soils. As previously noted, soil sodicity potentially leads to dispersion, degradation of soil structure, and gully and tunnel erosion.

The distribution of these soil types generally reflects the mapped geological units, with Sodosols and Chromosols being the predominant soil types in the eruption points and volcanic plains underlain by the Quaternary-Tertiary aged Newer Volcanic Group basalt.

Table 6.32: Key soil type properties – intermediate laydown areas

Area	Major mapped soil type	Geomorphology/ landform association	Additional information regarding soil	Potential Hazard associated with soil type
Lexton and Ballan intermediate laydown areas	Grey and brown Chromosols (Lexton (Sunraysia Highway)) Red and brown Sodosols (Ballan)	1.1.6 Eruption points and volcanic plains	According to State of Victoria (Agriculture Victoria, 2023) website, Vertosols overlie massive bleached subsurface horizons. In addition to Vertosols, sodic brown, yellow and grey texture contrast soils (Sodosols) are also dominant. Ferrosols also occur on volcanic plains and rises in areas of higher rainfall, and also on numerous volcanic vents. These red soils are well structured and friable, and generally strongly acid throughout with high free iron content.	Sodic soils are likely to be present that are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Although not mapped, Vertosols and Ferrosols are associated with these landforms and might be present. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour. Ferrosols are known to display high acidity at surface (low pH level) that could potentially corrode construction materials.

6.7.4 Saline soils

Lexton and Ballan laydown areas are not located within any mapped soil salinity province, are illustrated in Figure A.9.2 in Appendix A.

No obvious visible signs of soil salinity (e.g., salt scalding or salinity indicator species) were observed close to any of the intermediate laydown areas during the site walkover. However, this does not preclude the possibility of saline soils being present at these sites. Further site-specific testing is required to confirm the presence of saline soils at each site.

6.7.5 Reactive soils

The likelihood for encountering reactive soils at each intermediate laydown area is summarised in Table 6.33 below. Clays of the Newer Volcanic Group residual soil are known to range between high to very high soil reactivity.

Table 6.33: Likelihood for encountering reactive soils – intermediate laydown areas

Area	Major mapped soil type	Geology	Likelihood for encountering reactive soils	Comment
Lexton intermediate laydown area	Chromosols	Newer Volcanic Group basalt (Neo)	High	Clays of the Newer Volcanic Group residual soil are known to range between high to very high soil reactivity.
Ballan intermediate laydown area	Sodosols	Newer Volcanic Group basalt (Neo)	High	Clays of the Newer Volcanic Group residual soil are known to range between high to very high soil reactivity.

6.7.6 Compressible soils

Based on the available information, it is not expected that large amounts of soft, compressible soils would be present at any of the intermediate laydown areas. Any compressible soils are expected to occur locally around creeks and waterways.

6.7.7 Sites of geological significance

No sites of geological significance, as determined by the GSA, are present at or close to any of the proposed intermediate laydown areas.

In addition, none of the proposed laydown areas are shown to be close or within SLO zones. Sites of geological significance and SLOs in the area are shown in Figure A.8.2 in Appendix A.

6.8 Distribution line crossovers

6.8.1 Geological setting

The geology at each of the distribution line crossover is summarised in Table 6.34 below and is also illustrated in Figures A.2.1 to A.2.4 in Appendix A.

Table 6.34: Geological units – distribution line crossovers

Age	Unit name	Description	Crossing ID
Quaternary	Alluvial deposits (Qa1)	Gravel, sand, silt, variably sorted, variably rounded	DLIS_53 DLIS_47 DLIS_23 (partly) DLIS_24 (partly) DLIS_16
Quaternary-Tertiary	Darley Gravel (Nxr)	Gravel, sand, silt, moderate to well sorted and rounded	DLIS_4 DLIS_5 (partly) DLIS_9 (partly) DLIS_10 (partly) DLIS_15
	Shepparton Formation (Nws)	Fluvial clay, sand, silt, poorly sorted lenticular gravel	DLIS_62 DLIS_60 DLIS_58 DLIS_55 DLIS_54 DLIS_52

Age	Unit name	Description	Crossing ID
			DLIS_50 DLIS_49
	Incised alluvial deposits (Na)	Gravel, sand, silt	DLIS_46 (partly)
	Newer Volcanic Group (Neo)	Basalt flows. High plasticity residual clay typically overlies variably weathered basalt rock, with the presence of basalt cobbles and boulders (commonly referred to as floaters) within the residual soil	DLIS_45 DLIS_44 DLIS_43 DLIS_42 DLIS_41 DLIS_40 DLIS_39 DLIS_38 DLIS_37 DLIS_36 DLIS_35 DLIS_34 DLIS_33 DLIS_31 DLIS_30 DLIS_29 DLIS_28 DLIS_27 DLIS_26 DLIS_25 DLIS_23 (partly) DLIS_22 DLIS_21 DLIS_13 DLIS_12 DLIS_11 (partly) DLIS_8 DLIS_7 DLIS_6 DLIS_5 (partly) DLIS_3 DLIS_2 DLIS_1
Tertiary	White Hills Gravel (Pxh)	Vein quartz conglomerate, sand, silt and clay; well-rounded pebbles and cobbles of quartz	DLIS_20 (partly) DLIS_24 (partly) DLIS_61 DLIS_19 DLIS_63 DLIS_64 DLIS_46 (partly) DLIS_59
	Werribee Formation (Pxe)	Sand, silt, clay, gravel in variable proportions	DLIS_14 DLIS_11 (partly)
	Pentland Hills Volcanic Group (Pp)	Basalt with minor tuff	DLIS_20 (partly)

Age	Unit name	Description	Crossing ID
			DLIS_17 (partly)
Permian	Bacchus Marsh Formation (Pxb)	Sandstone, mudstone, conglomerate	DLIS_17 (partly) DLIS_18
Devonian	Granite and granodiorite (G371, G372)	Intrusive granite. Variable thicknesses of residual soil have formed from weathering of the granite.	DLIS_51 DLIS_48
Cambrian	St Arnaud Group sedimentary units (Cab, Cap, Caw)	Marine sandstone, siltstone, schist, occasional hornfels	DLIS_56 DLIS_57
	Sedimentary unit (Czg)	Conglomerate, quartz sandstone and siltstone	DLIS_9 (partly) DLIS_10 (partly)
Ordovician-Cambrian	Castlemaine Group sedimentary units (Ocl)	Marine sandstone, siltstone, shale	DLIS_32

Three geological fault lines intersect the Proposed Route close to the proposed distribution line crossovers, as summarised in Table 6.35 below.

Table 6.35: Geological fault lines – distribution line crossovers

Named fault line	Observations of fault during walkover	Type	Activity[1]	Description	Relevant Crossover ID	Distance from proposed crossing (km)
Glendhu Fault	Southern extent of fault approximately 400m north of Proposed Route.	Thrust	Inactive	The Glendhu Fault is approximately 9km long and runs from north of the study area in a north-north-westerly direction parallel to the Landsborough Fault. This fault line is entirely within the Warrack Formation.	DLIS_56	0.65
Landsborough Fault	No obvious surface expression of fault observed at intersection with Proposed Route.	Thrust	Inactive	The Landsborough Fault is approximately 50km long and runs from Mount Cole in a north-north-westerly direction. The fault crosses the study area near Glenlofty. The fault line separates the Warrack Formation to the west and the Pyrenees Formation to the east.	DLIS_55 DLIS_54	0.32 0.25
Rowsley Fault	No obvious surface expression of fault observed at intersection with Proposed Route.	Thrust	Inactive	The Rowsley Fault line is a long tectonic fault line that sweeps from Bacchus Marsh in the north to near Anakie in the south, where it peters out to join the valleys of the Moorabool River and Sutherland Creek. The fault line separates the Castlemaine Group to the west and Alluvium units, Bacchus Marsh Formation and Werribee Formation to the east.	DLIS_16	0.85

Notes

1. Fault activity inferred based on assessment of Geoscience Australia's Neotectonic features online database and lack of visual evidence of recent displacement along fault line.

Figures showing the regional geology and fault lines for the Project Area are presented in Figures A.2.1 to A.2.4 in Appendix A.

6.8.2 Geomorphology, erosion and land stability

The geomorphology at each distribution line crossover varies depending on location. Conditions at the majority of the distribution line crossovers feature eruption points and volcanic plains.

Mapped geomorphological units at each of the distribution line crossovers, accessed from the Geomorphology of Victoria dataset and based on the Victorian Geomorphology Framework (VGF), are summarised in Table 6.36 below. The Tier 3 geomorphological units at each terminal station are shown in Figures A.3.1 to A.3.4 in Appendix A.

The Geomorphology of Victoria dataset also indicates susceptibility to gully and wind erosion, and susceptibility to landslide for each of the geomorphological units which are also indicated in Table 6.36 below.

Table 6.36: Summary of mapped geomorphological units, erosion and landslip susceptibility – distribution line crossovers

Geomorphological Units			Erosion/landslide susceptibility			Relevant Crossover ID
Tier 1	Tier 2	Tier 3	Gully erosion	Landslide erosion	Wind erosion	
Western Uplands	Dissected Uplands	2.1.1 Ridges, escarpments, mountains on non- granitic Palaeozoic rocks	High	Low	Moderate	DLIS_58 DLIS_55 DLIS_49 DLIS_48 DLIS_47 DLIS_46
		2.1.3 Hills, valley slopes and plains on non- granitic Palaeozoic rocks	Very High	Low	Moderate	DLIS_24 DLIS_18 (partly) DLIS_17 (partly) DLIS_16 DLIS_15 DLIS_14 DLIS_11 (partly) DLIS_10 DLIS_9
		2.1.4 Hills, valley slopes and plains on plutonic Palaeozoic rocks	Low	Very Low	Very Low	DLIS_51
		2.1.5 Plateaux and rises of residual Cainozoic landscapes	Low	Low	Low	DLIS_64 DLIS_63 DLIS_62 DLIS_61 (partly) DLIS_59 DLIS_57 DLIS_56
		2.1.6 Eruption points and volcanic plains	Low	Low	Low	DLIS_45 DLIS_44 DLIS_43

Geomorphological Units			Erosion/landslide susceptibility			Relevant Crossover ID
Tier 1	Tier 2	Tier 3	Gully erosion	Landslide erosion	Wind erosion	
						DLIS_42 DLIS_41 DLIS_40 DLIS_39 DLIS_38 DLIS_37 DLIS_36 DLIS_35 DLIS_34 DLIS_33 DLIS_32 DLIS_31 DLIS_30 DLIS_29 DLIS_28 DLIS_27 DLIS_26 DLIS_25 DLIS_23 DLIS_22 DLIS_21 DLIS_20 DLIS_19 DLIS_18 (partly) DLIS_17 (partly) DLIS_13 DLIS_12 DLIS_11 (partly)
		2.1.3 Terraces and floodplains	Moderate	Very Low	Moderate	DLIS_61 (partly) DLIS_60 DLIS_54 DLIS_53 DLIS_52 DLIS_50
Western Plains	Volcanic plains	6.1.2 Stony rises	Very Low	Very Low	Low	DLIS_1
		6.1.3 Plains with poorly developed drainage and shallow regolith	Low	Very Low	Low	DLIS_8 DLIS_7 DLIS_6 DLIS_5 DLIS_4 DLIS_3 DLIS_2

Very High and High gully erosion susceptibility has been mapped at the distribution line crossovers in geomorphological units with steep slopes (hills, valley slopes, ridges, escarpments, mountains), between Bulgana and Lexton. The hills and mountains (Grampians, Pyrenees and Langi Ghiran range) in the Western Uplands along with colluvial granite and sedimentary slopes are prone to tunnel and gully erosion, and sheet and rill erosion especially where cleared (Robinson et al., 2005).

This is consistent with the field observations in Bulgana to Lexton section where several instances of gully erosion were identified, mainly associated with fine grained residual soil and colluvium on steep slopes and creeks in hilly areas. Additionally, several instances of gully erosion are mapped close to the proposed distribution line crossovers in this section. Gully susceptibility for each of the distribution line crossovers is illustrated in Figures A.4.1 to A.4.4 and mapped areas of erosion and land instability based on site observations, LiDAR DEM and aerial imagery in Figures A.11 in Appendix A.

Observations of possible historical landslide activity and soil instability was undertaken during the site walkover. Soil creep was observed and mapped to the west of site walkover checkpoint EG-CP16, as shown in Figure 6.15 and Figure 6.16, approximately 400m west of the proposed crossover ID DLIS_55. Soil creep was observed in two locations, on the hill slope and at the bank of the creek, formed on the sedimentary units of the Pyrenees Formation. A minor soil creep was observed on the sides of a creek valley, incised into the underlying basalt rock, at EMO-CP07, approximately 380m north upstream of the proposed crossover ID DLIS_40. This is likely due to natural erosion of the creek. Site observations and mapping from EMO-CP07 can be seen in Figure 6.27 and Figure 6.28. Localised slope instabilities were also observed near EG-CP18, as shown in Figure 6.37, and near EG-CP23, as shown in Figure 6.38, indicating that cut slopes within the non-granitic Palaeozoic rocks between Ballan and Melton West may be prone to localised failure if appropriate batter slopes and slope stability control measures are not adopted.

As shown in Table 6.36, the distribution line crossovers are mapped as having a Low to Very Low landslip susceptibility. This susceptibility classification is consistent with observations undertaken on the site walkover. Landslip susceptibility is illustrated in Figures A.5.1 to A.5.4 in Appendix A. However, this does not preclude landslide activity occurring in the future if excavations into steep areas are not managed correctly. It is important that all modifications to existing slopes are designed appropriately to avoid impacting slope stability at both the existing and proposed sites.

Distribution line crossover ID DLIS_40, which sits within the Ballarat Shire LGA, is subject to an EMO, associated with a surface watercourse. The extents of the EMO within the study area are illustrated in Figures A.7.1 to A.7.4 in Appendix A.

6.8.3 Soil type and presence of dispersive soils

A summary of the mapped soil types at the each of the distribution line crossovers are presented in Table 6.37: Key soil type properties – distribution line crossovers below and are illustrated in Figures A.10.1 to A.10.4 in Appendix A.

Most of the distribution line crossovers are mapped on either Ferrosols (uniform or gradational soils which are typically acidic and well-draining), Chromosols (texture contrast soils that are non-sodic in free drainage areas but can exhibit soil sodicity in non-free draining areas or depressions) or Sodosols (highly sodic texture contrast soils; soil sodicity potentially leads to dispersion, degradation of soil structure, and gully and tunnel erosion).

The distribution of these soil types generally reflects the mapped geological units, with Ferrosols and Chromosols being the predominant soil types in the gently undulating landscape underlain by the Quaternary-

Tertiary aged Newer Volcanic Group basalt. The presence of Vertosols, also associated with the Newer Volcanic Group basalt, is very limited within the distribution line crossover sites.

Table 6.37: Key soil type properties – distribution line crossovers

Crossover ID	Mapped soil type	Geomorphology / landform association	Additional information regarding soil	Potential Hazard associated with soil type
DLIS_58 DLIS_55 DLIS_49 DLIS_48 DLIS_47 DLIS_46	Predominantly Sodosols, with minor leptic Rudosols and Dermosols	2.1.1 Ridges, escarpments, mountains on non-granitic Palaeozoic rocks	According to State of Victoria (Agriculture Victoria, 2023) website, soils that have developed on these landforms are red texture contrast soils (Chromosols) that may be sodic (Sodosols) especially where rainfall is lower and in lower topographic positions.	Sodic soils are likely to be present that are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed.
DLIS_24 DLIS_16 DLIS_15 DLIS_14 DLIS_11 DLIS_10 DLIS_9	Chromosols and Sodosols	2.1.2 Hills, valley slopes and plains on non- granitic Palaeozoic rocks	According to State of Victoria (Agriculture Victoria, 2023) website, red texture contrast soils (Chromosols) that tend to be sodic (Sodosols) in lower topographic positions have developed on hills, valley slopes and plains.	Sodic soils are likely to be present that are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed.
DLIS_51	Leptic Rudosols	2.1.4 Hills, valley slopes and plains on plutonic Palaeozoic rocks	According to State of Victoria (Agriculture Victoria, 2023) website, sodic yellow texture contrast soils (Sodosols) are common on these granite landscapes.	Dermosols are generally stable soils. Although not mapped, sodic soils are associated with this landform and might be present. Sodic soils are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. They can also be strongly acidic (low pH level) at surface that could potentially corrode construction materials.
DLIS_64 DLIS_63 DLIS_62 DLIS_61 DLIS_59 DLIS_57 DLIS_56	Chromosols	2.1.5 Plateaux and rises of residual Cainozoic landscapes	According to State of Victoria (Agriculture Victoria, 2023) website, developed on these sediments are a suite of yellow, brown and red texture contrast soils (Sodosols and Chromosols) and red gradational or uniform soils (Dermosols and Kandosols).	Although Chromosols are known to be non-sodic in the upper part of the soil profile, the subsurface horizon can occasionally be sodic and disperse after remoulding.
DLIS_45 DLIS_44 DLIS_43 DLIS_42 DLIS_41 DLIS_40 DLIS_39	Predominantly Ferrosols with Sodosols and Dermosols, and minor Chromosols, Kurosols and Vertosols.	2.1.6 Eruption points and volcanic plains	According to State of Victoria (Agriculture Victoria, 2023) website, Vertosols overlie massive bleached subsurface horizons. In addition to Vertosols, sodic brown, yellow and grey texture contrast soils (Sodosols) are also dominant.	Sodic soils are likely to be present that are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Ferrosols and Kurosols are known to display high acidity

Crossover ID	Mapped soil type	Geomorphology / landform association	Additional information regarding soil	Potential Hazard associated with soil type
DLIS_38 DLIS_37 DLIS_36 DLIS_35 DLIS_34 DLIS_33 DLIS_32 DLIS_31 DLIS_30 DLIS_29 DLIS_28 DLIS_27 DLIS_26 DLIS_25 DLIS_23 DLIS_22 DLIS_21 DLIS_20 DLIS_19 DLIS_18 DLIS_17 DLIS_13 DLIS_12			Ferrosols also occur on volcanic plains and rises in areas of higher rainfall, and also on numerous volcanic vents. These red soils are generally strongly acid throughout with high free iron content.	at surface (low pH level) that could potentially corrode construction materials. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour.
DLIS_60 DLIS_54 DLIS_53 DLIS_52 DLIS_50	Predominantly Chromosols with minor Sodosols	2.1.7. Terraces and floodplains	Information from Robinson et al. (2005) and State of Victoria (Agriculture Victoria, 2023) website indicates that soils for this unit range from texture contrast soils, brown, yellow and grey sodic (Sodosols) or red non-sodic (Chromosols) to gradational earths and occasional clay (Vertosols, Dermosols) and sand soils (Tenosols). Within this unit most of the gradational yellow and brown soils (Kandosols) are found.	Although Chromosols are known to be non-sodic in the upper part of the soil profile, the subsurface horizon can occasionally be sodic and disperse after remoulding. Sodic soils are likely to be present that are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed. Although not mapped Vertosols are associated with this landform and might be present. Vertosols are known to be susceptible to cracking, slickensides and shrink-swell behaviour.
DLIS_1	Sodosols	6.1.2 Stony rises	According to State of Victoria (Agriculture Victoria, 2023) website, associated soil types with this landform are shallow dark gradational (Dermosols) and self-mulching (and cracking) clay soils (Vertosols).	Sodic soils are likely to be present that are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed.

Crossover ID	Mapped soil type	Geomorphology / landform association	Additional information regarding soil	Potential Hazard associated with soil type
DLIS_8 DLIS_7 DLIS_6 DLIS_5 DLIS_4 DLIS_3 DLIS_2	Predominantly Sodosols with minor Chromosols	6.1.3 Plains with poorly developed drainage and shallow regolith	According to State of Victoria (Agriculture Victoria, 2023) website, associated soil types with this landform are sodic and non-sodic texture contrast (moderately deep to deep) soils (Sodosols) and some gradational (shallow to moderately deep) soils (Dermosols), and gilgai (mound and rise ground surfaces formed due to clay horizons swelling and shrinking, commonly associated with grey Vertosol soils).	Sodic soils are likely to be present that are susceptible to dispersion and are extremely prone to gully and tunnel erosion if subsoils are exposed.

6.8.4 Saline soils

A summary of salinity provinces relating to the distribution line crossovers are shown below in Table 6.38 and are also illustrated in Figures A.9.1 to A.9.4 in Appendix A.

Table 6.38: Summary of Salinity Provinces – distribution line crossovers (DJSIR (formerly DEPI), 2014)

Crossover	Salinity province	Catchment manageme nt region	Priority status[1]	Province area (ha)	Recorded soil salinity area[2] (ha)	Salinity area description
DLIS_64 DLIS_63 DLIS_62 DLIS_61 DLIS_60 DLIS_59 DLIS_58 DLIS_57 DLIS_56 DLIS_55 DLIS_54 DLIS_53 DLIS_52 DLIS_51	Elmhurst	Wimmera	High	69,530	137	A number of small salinity discharge sites are scattered within the upland alluvial plains, mainly adjacent to and along drainage lines. These discharge sites are mainly located well away from the distribution line crossovers to the south of the Wimmera River.
DLIS_50 DLIS_49 DLIS_48	Amphitheatre	North Central	Low	18,460	95	-

Crossover	Salinity province	Catchment management region	Priority status[1]	Province area (ha)	Recorded soil salinity area[2] (ha)	Salinity area description
DLIS_47 DLIS_46	Lexton	North Central	High	9,910	235	Approximately 2% of the Province is salt affected land, which contributes a high salt load to the Loddon River. Some salinity is expressed as change of-slope, but most is mapped along drainage lines, many of which are deeply eroded.
DLIS_42 DLIS_41 DLIS_40 DLIS_39 DLIS_38 DLIS_37 DLIS_36 DLIS_35 DLIS_34 DLIS_33 DLIS_32 DLIS_31 DLIS_30	Upper Loddon Volcanic Plains	North Central	High	97,610	801	Salinity occurs in areas characterised by low-lying drainage basin with limited outflow, with likely groundwater discharge coming up from the intermediate scale GFSs. Main recorded salinity areas include Long swamp, Glengower and Smeaton, which are to the north of the proposed distribution line crossovers.
DLIS_29 DLIS_28 DLIS_27 DLIS_26 DLIS_25 DLIS_24	Upper Moorabool	Corangamite	High	114,890	206	Salinity is mainly found in slight depressions in the basalt plains areas.
DLIS_3 DLIS_2 DLIS_1	Lancefield - Sunbury	Port Phillip and Westernport	Low	129,750	214	Approximately 0.2% of the salinity province is salt affected land, which contributes a low salt load to the Lancefield – Sunbury salinity province.

Notes

1. High priority provinces:
   (a) Include (or intersect) the boundaries of significant environmental or cultural assets, high value infrastructure (including urban development), and/or priority biodiversity areas.
   (b) Contain significant salinity occurrences that pose a threat to land productivity, catchment health, downstream assets or water users, and/or high value infrastructure.
   (c) Have reasonable prospects for successful salinity management interventions or treatment options that are considered feasible from both "practicality" and "return on investment" points of view.
   Salinity Provinces that do not meet the above criteria are classified as Low priority.
2. Comprises the total geographic area that has been mapped as having, or showing symptoms of, dryland soil salinity at some time (past or present). Retrieved from http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/lwm_salinity-provinces (DJSIR (formerly DEPI), 2014).

Salt scalding, which indicates elevated soil salinity, was observed at EG-CP04 (shown in Figure 6.17). Soil salinity testing was conducted by Jacobs at this checkpoint on silt of the Shepparton Formation. This test recorded electrical conductivity of a saturated soil extract (Ece) of 3960 µS/cm, which indicates that the soil sample is slightly saline (Agriculture Victoria, 2020c).

Soil salinity testing was also conducted at EMO-CP09 on sandy silt of the Newer Volcanic Group. This test recorded Ece of 281 µS/cm, which indicates that the soil is non-saline (Agriculture Victoria, 2020c).

These tests constitute a very small sample size and may not be representative of the broader study area. The results of soil salinity testing conducted in the Lexton to Ballan study area section are summarised in Appendix B, with laboratory test certificates shown in Appendix C.

6.8.5 Reactive soils

The likelihood for encountering reactive soils at each of distribution line crossovers is summarised in Table 6.39 below.

Clays of the Newer Volcanic Group and the Pentland Hills Volcanic Group residual soil are known to range between high to very high soil reactivity.

Table 6.39: Likelihood for encountering reactive soils – distribution line crossovers

Crossover	Major mapped soil type	Geology	Likelihood for encountering reactive soils	Comment
DLIS_53 DLIS_24 (partly)	Chromosols	Alluvial deposits (Qa1)	Low to Medium	Alluvial soils are not known to have high soil reactivity. However, reactivity of the alluvial soils is dependent on the parent bedrock or residual soils from which they have been derived.
DLIS_47 DLIS_16	Sodosols			
DLIS_23 (partly)	Kurosols			
DLIS_10 DLIS_9 DLIS_4	Chromosols	Darley Gravel (Nxr)	Low to Medium	Colluvial soils of the Darley Gravel are not known to have high soil reactivity. However, reactivity of the colluvial soils is dependent on the parent bedrock or residual soils from which they have been derived.
DLIS_15 DLIS_5 (partly)	Sodosols			
DLIS_62 DLIS_60 DLIS_57 DLIS_56 DLIS_54 DLIS_52	Chromosols	Shepparton Formation (Nws)	Low to Medium	Alluvial soils are not known to have high soil reactivity. However, reactivity of the alluvial soils is dependent on the parent bedrock or residual soils from which they have been derived.
DLIS_50 DLIS_49	Sodosols			
DLIS_59 DLIS_58 DLIS_55	Rudosols			

Crossover	Major mapped soil type	Geology	Likelihood for encountering reactive soils	Comment
DLIS_45	Chromosols	Newer Volcanic Group (Neo)	High	Clays of the Newer Volcanic Group residual soil are known to range between high to very high soil reactivity. Crossing ID DLIS_39 is mapped on Vertosols, clay-rich soils that shrink and swell in response to moisture change.
DLIS_22 DLIS_21 DLIS_13 DLIS_12 DLIS_11 (partly) DLIS_8 DLIS_7 DLIS_6 DLIS_5 (partly) DLIS_3 DLIS_2 DLIS_1	Sodosols			
DLIS_43 DLIS_42 DLIS_40 DLIS_38 DLIS_37 DLIS_17 (partly)	Dermosols			
DLIS_41 DLIS_36 DLIS_35 DLIS_34 DLIS_33 DLIS_31 DLIS_30 DLIS_29 DLIS_28 DLIS_27 DLIS_26 DLIS_25	Ferrosols			
DLSI_44 DLIS_39	Vertosols			
DLIS_23	Kurosols			
DLIS_64 DLIS_63 DLIS_61 DLIS_24 (partly) DLIS_20 (partly)	Chromosols	White Hills Gravel (Pxh)	Low	Colluvial soils of the White Hills Gravel are not known to have high soil reactivity.
DLIS_46 DLIS_19	Sodosols			
DLIS_14 DLIS_11 (partly)	Sodosols	Werribee Formation (Pxe)		
DLIS_20 (partly)	Sodosols		High	

Crossover	Major mapped soil type	Geology	Likelihood for encountering reactive soils	Comment
DLIS_18	Dermosols	Pentland Hills Volcanic Group (Pp)		Clays of the Pentland Hills Volcanic Group residual soil are known to range between high to very high soil reactivity.
DLIS_17 (partly)	Dermosols	Bacchus Marsh Formation (Pxb)		
DLIS_48	Sodosols	Granite and granodiorite (G371, G372)		
DLIS_51	Rudosols			
DLIS_32	Ferrosols	Castlemaine Group sedimentary units (Ocl)		

6.8.6 Compressible soils

Soft, compressible soils that may potentially be saturated are likely to be encountered at the distribution line crossovers mapped on recent alluvial deposits (Qa1) as shown in Figures A.2.1 to A.2.4 in Appendix A. Any compressible soils are expected to occur locally around creeks and waterways.

6.8.7 Sites of geological significance

Sites of geological significance present at or close to any of the distribution line crossovers are listed and described in Table 6.40 and illustrated in Figures A.8.1 to A.8.4 in Appendix A.

Table 6.40: Sites of geological significance – distribution line crossovers

Significance level	Feature ID	Name	Description (as provided by GSA)	Crossing ID	Distance from proposed crossing (km)
Local (noted as Regional in Wakelin Associates, 2017)	BL120	Fault – high strain zone (Landsborough Fault)	Road cutting exposure of structural geology and sedimentary structures. Dominant structural element in these rocks is the s1 cleavage which parallels the west-dipping fault.	DLIS_55	0.65
Local	ML291	Lerderderg Valley Alluvial Fan	Large steeply sloping alluvial fan extending onto the river terrace. The fan is now inactive and weakly incised.	DLIS_16	0.45
Local	ML294	Lerderderg River Morven Terrace	The terraces are distinguished by well-preserved scarps 1.5 m high. Exposes gravels, sands & silts of terrace formation	DLIS_16	0.07

Significance level	Feature ID	Name	Description (as provided by GSA)	Crossing ID	Distance from proposed crossing (km)
International (noted as State in Wakelin Associates, 2017)	ML201	Lerderderg River Permian sequence	River exposure of continuous 145 m section of Permian glacial deposits. Incl: tillite, glacial outwash, ice rafts.	DLIS_16	0.15
State	ML66	Mount Kororoit	Breached cone. Predominantly scoria capped by a rocky outcrop of lava and lava agglomerate. Newer Volcanics.	DLIS_2	0.69

Several distribution line crossovers are located within or close to SLO areas. These are summarised in Table 6.41 below.

Table 6.41: Significant landscape overlays – distribution line crossovers

LGA	PFI	Object ID	Description	Crossing ID	Distance from nearest point of SLO to distribution line crossover (km)
Hepburn	4151698.0	78373	Eruption point, near Newlyn Reservoir	DLIS_32	0.16
Moorabool	4151842.0	86403	Unknown, west of Bacchus Marsh.	DLIS_17	Intersects
Melton	4252952.0	78380	Eruption point, Mount Kororoit	DLIS_2	Intersects

7. Construction impact assessment

7.1 Key issues

The potential to impact geology and soils is largely related to the disturbance of soil and rock resulting from:

- Site preparation and earthworks activities
- Construction of foundations for transmission towers and terminal stations
- Construction of temporary and permanent access tracks
- Construction of temporary tower assembly areas to facilitate transmission tower construction
- Construction of stringing pads
- Construction of temporary laydown areas and workforce accommodation facilities
- Construction of distribution line crossovers.

Some of the activities that may not be managed as part of standard construction practices and have been considered as part of the impact assessment are summarised below:

- **Soil erosion and dispersive soils:** Encountering and disturbing dispersive soil and/or erosive soil during construction, including areas subject to Erosion Management Overlay
- **Slope instability:** Construction of transmission tower foundations and earthworks for access tracks, temporary hardstands and stringing pads on slopes of hills and ridgelines causing slope instability
- **Compressible soil:** Constructing on compressible soils along the Proposed Route and at the proposed terminal station locations. This is expected to be relevant around creek and rivers where recent alluvial deposits are mapped
- **Reactive clay soil:** Disturbing and/or constructing on reactive soils (soils that exhibit shrink-swell behaviour that results in movement of the ground surface). This is particularly relevant to Vertosols that are mapped along the Proposed Route and residual clay soil that will be encountered on top of basalt rock of the Newer Volcanic Group. Residual clay soil can also be sodic, meaning it is susceptible to dispersion and erosion as well as being reactive
- **Saline soil:** Disturbing saline soils during earthworks related to temporary hardstand, foundation and access road construction
- **Geologically significant sites:** Damage or restriction to access of geologically significant sites that are on or close to the Proposed Route.

An assessment of the above impacts and relevant mitigation strategies is described in the following sections.

7.2 Impact assessment

An assessment of the significance of the pre-mitigated impacts is presented in Table 7.1.

Table 7.1: Construction pre-mitigated impact assessment – Geology and soils

Key issue	Impact pathway	Relevant sections of study area that may be impacted	Significance of pre-mitigated impact in relevant sections of the study area	Justification for rating of pre-mitigated impacts
Soil erosion and dispersive soils Encountering and disturbing dispersive soil and/or erosive soil during construction (including areas subject to Erosion Management Overlay)	The Project will involve topsoil stripping and removal of some vegetation for construction of access roads, temporary hardstands, stringing pads, temporary laydown areas and distribution line crossovers. Observations undertaken during the walkover and soil laboratory testing indicates the presence of dispersive and erosive soil along much of the study area. Failure to put control measures into place to control erosion during construction and to re-instate areas (with sufficient time allowance for establishment of grass) where soil has been exposed may result in loss of soil material from disturbed areas and sedimentation of waterways and adjacent land. Excessive erosion and scouring at the toe of existing slopes on hillsides and ridgelines may result in undermining of slopes and result in instability. In-situ dispersive soils are prone to waterlogging that can cause issues with trafficking of vehicles and impact the surrounding environment if not properly managed. Re-use of soil prone to dispersion for earthworks (i.e., access track embankments) will also need to be managed as the soil may be susceptible to erosion and gullying, impacting earthworks integrity and leading to sedimentation of waterways and adjacent land. Design options and measures implemented during construction may begin to display erosion over the post	**Bulgana to Lexton:** ▪ Presence of potentially erosive soils on hills and ridgelines of Pyrenees Formation ▪ Potentially erodible granite derived colluvium in fans at base of granite hills. **Lexton to Ballan:** ▪ Presence of potentially erosive soils on hills and ridgelines of Castlemaine Group derived hills, Haydens Hill (Bolwarrah) ▪ Sodic (dispersive) soils from Bolwarrah to Ballan ▪ Areas subject to Erosion Management Overlay in Ballarat and Hepburn LGAs. **Ballan to Melton West:** ▪ Presence of potentially erosive soils along most of the Proposed Route on hills, ridgelines, valley side slopes and also alluvial flats (Lerderderg River). **Melton West to Sydenham:** ▪ Sodic (dispersive) soils along most of Proposed Route. **Terminal station locations:** ▪ Bulgana (existing and the new 500kV terminal station near Bulgana) ▪ Elaine ▪ Sydenham. **Intermediate laydown areas and workforce accommodation facilities:** ▪ Ballan	Major	Pre-mitigation impacts of erosion and/or dispersion assessed to potentially impact landscape, environment, existing land use and assets within and beyond the Project Land boundary and also potentially over a long-term basis.

Key issue	Impact pathway	Relevant sections of study area that may be impacted	Significance of pre-mitigated impact in relevant sections of the study area	Justification for rating of pre-mitigated impacts
	construction period and over the life of the Project, in the event that the implemented measures do not stabilise correctly or perform as expected. Examples of Project infrastructure that may exhibit erosion post construction include: ▪ Permanent access tracks ▪ Battered or engineered slopes ▪ Tower footings Permanent erosion control measures installed during construction, such as drainage diversions and outlet structures, may become blocked over time, causing the control measures to become ineffective in preventing erosion over the operational stage.	**Distribution line crossovers:** ▪ DLIS_1, DLIS_2, DLIS_3, DLIS_5, DLIS_6, DLIS_7, DLIS_8, DLIS_9, DLIS_10, DLS_11, DLIS_12, DLIS_13, DLIS_14, DLIS_15, DLIS_16, DLIS_17, DLIS_18, DLIS_24, DLIS_46, DLIS_47, DLIS_48, DLIS_49, DLIS_50, DLIS_52, DLIS_53, DLIS_54, DLIS_55, DLIS_58, DLIS_60, DLIS_61		
Slope instability Construction and earthworks activities causing slope instability on slopes of hills and ridgelines	The Project will include construction of access roads, laydown areas, distribution line crossovers, temporary hardstands, foundations for transmission towers on or close to slopes of eruption points, hills and ridgelines. Observations of existing hill slopes during the walkover indicated most hill slopes are stable in their current state, however earthworks during construction involving cut operations that remove slope toe support or add surcharge to existing slopes may cause destabilisation. This includes potential re-mobilisation of old landslides that have been mapped in some locations along the route. Slope instability may also result from inadequate temporary and permanent slope and batter design.	**Bulgana to Lexton:** ▪ Hills and ridgelines of Pyrenees Formation. **Lexton to Ballan:** ▪ Hills and ridgelines of Castlemaine Group hills, Haydens Hill (Bolwarrah). **Ballan to Melton West:** ▪ Most of Proposed Route on hills, ridgelines, valley side slopes, in particular the valley side slopes around Pykes Creek. **Melton West to Sydenham:** ▪ Valley side slopes at Kororoit Creek. **Distribution line crossovers:** ▪ DLIS_14, DLIS_16, DLIS_17, DLIS_18, DLIS_48, DLIS_49, DLIS_53, DLIS_55, DLIS_58, DLIS_43	Major	Pre-mitigation impacts of slope instability assessed to be major, as uncontrolled earthworks on slopes can potentially result in slope instability, that may impact landscape, environment, existing land-use and assets within and beyond the Project Land boundary and also potentially over a long-term basis.

Key issue	Impact pathway	Relevant sections of study area that may be impacted	Significance of pre-mitigated impact in relevant sections of the study area	Justification for rating of pre-mitigated impacts
	Slope instability can result in large scale mass movement of soil and rock material downslope that can result in damage to vegetation, land use (farmland), landforms and infrastructure and buildings.			
Compressible soil Disturbing and/or constructing on compressible soils around water courses, particularly where recent alluvial deposits have been mapped	Soft, compressible and potentially saturated soils may be encountered around water courses, particularly where recent alluvial sediments have been mapped. Excavation, vehicle movement and construction of structures in these locations have the potential to result in settlement and/or land instability due to inadequate bearing capacity of soils during construction. In addition, soft, compressible material may be unsuitable for re-use for fill material without treatment and may require disposal off site.	**Bulgana to Lexton:** ▪ Recent alluvium (Qa1) deposits mapped around the Wimmera River and minor creek along Beaufort-Lexton Road. **Lexton to Ballan:** ▪ Recent alluvium (Qa1) deposits mapped to the east of Hepburn Lagoon and around Mount Greencock Creek, Rocky Lead Creek, Pinchgut Creek and the Moorabool and Werribee River. Small sections of swamp and lake deposits (Qm1) are mapped in depressions to the north-west of Waubra and north-east of Glendonald. **Ballan to Melton West:** ▪ Recent alluvium (Qa1) deposits mapped around the northern extent of Pykes Creek Reservoir and along Myrniong Creek, Lerderderg River, Goodmans Creek and underlying the Merrimu Reservoir. **Melton West to Sydenham:** ▪ Recent alluvium (Qa1) deposits mapped around Toolern Creek and a small section of swamp and lake deposits (Qm1) in a depression to the north-west of MacPherson Park. **Distribution line crossovers:** ▪ DLIS_53, DLIS_47, DLIS_24 (partly), DLIS_23 (partly) and DLIS_16	Moderate	Pre-mitigation impacts of compressible soils assessed to have the potential to result in settlement and/or land instability, potentially impacting landscape, environment, existing land-use and assets within the Project Land boundary and also potentially on an ongoing basis.
Reactive clay soil Disturbing and/or constructing on	The integrity of access roads, laydown areas, temporary hardstands constructed on reactive soils may be impacted due to ground surface movement caused by shrink-swell	**Lexton to Ballan, Ballan to Melton West and Melton West to Sydenham:** ▪ Areas of residual clay soil of the Newer Volcanic Group (extending intermittently from Lexton to Sydenham)	Moderate	Pre-mitigation impacts of reactive clay soils assessed to potentially impact landscape,

Key issue	Impact pathway	Relevant sections of study area that may be impacted	Significance of pre-mitigated impact in relevant sections of the study area	Justification for rating of pre-mitigated impacts
reactive soils (soils that exhibit shrink-swell behaviour that results in movement of the ground surface), particularly high plasticity residual clay soil that will be encountered on top of basalt rock of the Newer Volcanic Group	behaviour of the soil, leading to reduced trafficability, erosion and soil instability impacting land use and assets. Reactive clay soils when exposed and stripped of topsoil may also become difficult to traffic in wet weather and may result in enhanced erosion. Reactive clay may be unsuitable for re-use for fill material without treatment and may require disposal off site. Inadequate investigation and design of permanent access roads and shallow foundations constructed on reactive soils may impact the integrity of the structures due to ground surface movement caused by shrink-swell behaviour, leading to reduced trafficability, erosion and soil instability impacting land use and assets. Suitable permanent design measures must include appropriate design of permanent drainage to control moisture within the reactive clay soil.	▪ Areas mapped as Vertosols. **Terminal stations:** ▪ Sydenham **Intermediate laydown areas and workforce accommodation facilities:** ▪ Ballan **Distribution line crossovers:** ▪ DLIS_1, DLIS_2, DLIS_3, DLIS_5 (partly), DLIS_6, DLIS_7, DLIS_8, DLIS_11 (partly), DLIS_12, DLIS_13, DLIS_17 (partly), DLIS_18, DLIS_20 (partly), DLIS_21, DLIS_22, DLIS_23, DLIS_25, DLIS_26, DLIS_27, DLIS_28, DLIS_29, DLIS_30, DLIS_31, DLIS_33, DLIS_34,DLIS_35, DLIS_36, DLIS_37, DLIS_38, DLIS_39, DLIS_40, DLIS_41, DLIS_42, DLIS_43, DLSI_44, DLIS_45.		environment, existing land-use and assets within the Project Land boundary and also potentially on an ongoing basis.
Saline soil Disturbing and/or constructing on saline soils during earthworks related to hardstand, foundation and access road construction	Disturbance and/or stockpiling of saline soils during construction or use of saline soils as fill material for earthworks, may result in runoff having increased salinity concentration during wet weather, potentially impacting watercourses or existing drainage systems. Saline soil may cause corrosion to buried concrete structures such as piled foundations for transmission towers. Inadequate investigation and design to take account of the presence of corrosive soils may impact the integrity and stability of structures.	**Bulgana to Lexton, Lexton to Ballan, Ballan to Melton West and Melton West to Sydenham:** ▪ Areas subject to being covered by salinity provinces. Observations of saline soil were made between Bulgana and Lexton. **Terminal stations:** ▪ Elaine **Distribution line crossovers:** ▪ DLIS_58	Moderate	Pre-mitigation impacts of saline soils assessed to potentially impact landscape, environment, existing land-use and assets within the Project Land boundary and also potentially on an ongoing basis.

Key issue	Impact pathway	Relevant sections of study area that may be impacted	Significance of pre-mitigated impact in relevant sections of the study area	Justification for rating of pre-mitigated impacts
Geologically significant sites Damage or restriction to access of geologically significant sites that are on or close to the route	Construction causing damage of or prohibiting access to geologically significant sites.	**Bulgana to Lexton:** ▪ Proposed Route runs along foothills of Mount Direction Rooftop Pendant Remnant (BL123) ▪ Landsborough Fault – road cutting exposure of structural geology and sedimentary structures approximately 0.06km from Proposed Route (BL120). **Lexton to Ballan:** ▪ Hepburn Lagoon (BL45) bounded by Proposed Route ▪ Proposed Route passes through potential eruption point near Mount Gap (SLO)[1], eruption point near Mount Prospect (SLO)[1] and eruption point near Newlyn Reservoir (SLO)[1] ▪ Eruption point near Mount Bolton (SLO)[1] adjacent to the study area and eruption point near Birch Hill (SLO)[1] within the study area. **Ballan to Melton West:** ▪ Lerderderg River Permian sequence (ML201), Lerderderg River Morven Terrace (ML294) and Lerderderg Valley Alluvial Fan (ML291) approximately 0.2km from the Proposed Route ▪ Proposed Route passes through steep hills west of Bacchus Marsh (SLO)[1]. **Melton West to Sydenham** ▪ Proposed Route passes through eruption point near Mount Kororoit (SLO)[1]. **Distribution line crossovers:** ▪ Lerderderg River Permian sequence (ML201) and Lerderderg River Morven Terrace (ML294) approximately 0.1km from the distribution line crossover ID DLIS_16	Moderate	Potential to cause permanent damage to features due to construction within Proposed Route.

Key issue	Impact pathway	Relevant sections of study area that may be impacted	Significance of pre-mitigated impact in relevant sections of the study area	Justification for rating of pre-mitigated impacts
		▪ Distribution line crossover ID DLIS_17 on the boundary of steep hills west of Bacchus Marsh (SLO)[1] and DLIS_2 within eruption point near Mount Kororoit (SLO)[1].		
		Lexton to Ballan: ▪ Mount Beckworth (BL39)- edge of the hill over 0.25 km away from Proposed Route. **Ballan to Melton West:** ▪ Pykes Hill (ML278) over 0.5 km away from Proposed Route ▪ Proposed Route around Lake Merrimu (ML133) cutting on main road. **Melton West to Sydenham:** ▪ Mount Kororoit (ML66) over 0.3 km away from Proposed Route. **Distribution line crossovers:** ▪ Landsborough Fault – approximately 0.65 km away from the distribution line crossover ID DLIS_55 ▪ Mount Kororoit (ML66)- approximately 0.70km away from the distribution line crossover ID DLIS_2 ▪ Eruption point, near Newlyn Reservoir (SLO)[1]- approximately 0.15km away from the distribution line crossover ID DLIS_32.	Minor	Potential localised disruption to access of features

Notes

1. Sites are not identified as geologically significant sites; however, they are covered by a SLO.

7.2.1 Laydown areas and workforce accommodation facilities

As per the draft Incorporated Document, the establishment of laydown areas can be carried out as preparatory works, and as such EPRs do not apply. EPRs however do apply to the use of the laydown areas during the Project construction stage. The construction of the workforce accommodation facilities will also be subject to conditions of the draft Incorporated Document, which includes the preparation of a Construction Environmental Management Plan with procedures to identify, manage and monitor environmental risks. The use of the workforce accommodation facility will be subject to the EPRs. As such, the residual impacts are considered to be negligible.

The use of the laydown areas throughout the construction stage is not expected to cause any significant impacts to geology and soils, with the adoption of mitigation measures identified in Table 7.2 which are reflected in the EPRs and draft Incorporated Document conditions as required. The significance of impacts would be considered negligible.

7.3 Mitigation of impacts

Soil, geology and landform impacts during construction will be mitigated through:

- Planning and geotechnical site investigations undertaken prior to construction to inform temporary and permanent works design
- Sufficient level of temporary works design undertaken by the contractor to mitigate potential soil, geology and landform impacts during construction, combined with additional geotechnical site investigation by the contractor undertaking construction (if deemed necessary)
- Development of and adherence to a CEMP (required by the Project EPR EM2) for the Project by the Principal Contractor that will include an Erosion and Sediment Control Management Plan and final conditions report as baseline records for maintenance during operation.

Specific controls to mitigate key issues identified from the impact assessment are outlined in Table 7.2, including discussion about how residual impacts will be limited during construction by each of the mitigation measures.

Table 7.2: Key issues and specific recommended Project controls identified for construction impact assessment – Geology and soils

Key issue	Recommended Project controls to mitigate impacts[1]	Effectiveness of recommended control measures
Soil erosion and dispersive soils	▪ Avoidance - Appropriate design and placement of transmission towers within the tower assembly area to avoid or minimise disturbance in areas subject to the EMO and areas of soil characterised as dispersive or susceptible to erosion as far as reasonably practicable. ▪ Engineering controls - Undertake appropriate geomorphological assessment and geotechnical site investigations to further characterise the presence of dispersive and erodible soils along the Proposed Route. Investigations should be undertaken before detailed design. - The presence of dispersive and erodible soils should be considered for temporary and permanent works design. - When dispersive soils are exposed in earthworks or used for fill, tunnel erosion may occur. Potentially adverse impacts may be limited thorough the use of soil additives such as gypsum. Gypsum rates / lime stabilisation rates depend on site-specific conditions and are to be determined during construction. - During construction topsoil stripping should be restricted as much as practicable in areas of dispersive or erodible soil. - Design to minimise earthworks on slopes much as practically possible. - Implement design options and measures to limit erosion during construction in accordance with IECAA Best Practice Erosion and Sediment Control (2008), including: - Drainage control to manage water ingress into dispersive soils and limit soil erosion, such as: > Flow diversions > Slope drainage > Outlet and velocity control structures	▪ Depending on the Project requirements, where possible, placement of towers outside of EMO areas and areas characterised as comprising dispersive or erosive soil would reduce the administrative and design requirements of the Project. This would also reduce the likelihood that areas either prone to erosion or currently well managed with active erosion control measures in place are impacted by Project activities. ▪ Undertaking appropriate geomorphological assessment and geotechnical site investigations would provide critical information to inform the design and enable further characterisation of soil erosion and dispersivity along the Proposed Route. ▪ Design minimising earthworks on slopes would limit the amount of soil disturbance in areas most susceptible to soil erosion. ▪ Implementing design measures during construction to limit erosion would mean that where areas have been identified that may be prone to erosion, such as steep slope or large areas of disturbed soils, that appropriate measures are put in place to minimise or eliminate erosion from occurring. ▪ Due to the scale of the Project, both the proposed design measures and advice on application erosion controls would need to be covered in detail as part of the Erosion and Sediment Control Management Plan as part of the CEMP, with regular audits recommended to monitor compliance. The CEMP should also include details of remediation requirements in the event of an unexpected disturbance that has not been controlled appropriately with other measures. ▪ Installation of temporary and permanent drainage control measures would reduce or eliminate erosion impacts during the construction of the Project, especially in erosion prone areas that have been altered as a result of transmission towers. ▪ Reinstatement of disturbed areas immediately after construction would increase the likelihood of soils return to their initial condition. Measures including topsoiling or revegetation would reduce the duration of soil erosion impacts. ▪ Allowance for regular post construction inspections of implemented design options and measures as part of the CEMP and AusNet’s operational procedures would reduce the magnitude of this impact by ensuring that the erosion control systems are performing as expected and allow for any remediation or maintenance to be performed promptly, before large scale erosion occurs if an area does not stabilise as expected.

Key issue	Recommended Project controls to mitigate impacts[1]	Effectiveness of recommended control measures
	> Access track drainage > Waterway crossings. - Erosion control: > Soil stabilisation and protection (including gypsum/lime stabilisation) > Mulching > Erosion control blankets and soil binding sprays > Control of soil erosion on slopes > Dust control > Stabilisation of drainage channels and watercourses. - Sediment control to minimise impacts on nearby watercourses: > Berms > Filter fences or socks > Rock filters > Sediment traps > De-watering techniques. - Stockpile management: > Stockpile covers > Down-slope sediment control. - Design permanent drainage control measures as required in accordance with IECAA Best Practice Erosion and Sediment Control (2008) including measures listed above. ▪ Administrative controls - Develop and implement Erosion and Sediment Control Management Plan as part of the CEMP, including inspection requirements for erosion prone areas. - Appropriate reinstatement of disturbed areas is conducted following completion of construction stage. - Allowance for regular ongoing inspections where design options and measures have been implemented to limit erosion or where soils may have been disturbed following construction. The ongoing inspection requirements shall be included in	▪ During operation, ongoing management and maintenance of permanent drainage control measures would reduce the magnitude of soil erosion impacts by ensuring the continued function of these assets is maintained.

Key issue	Recommended Project controls to mitigate impacts[1]	Effectiveness of recommended control measures
	the CEMP and AusNet's operational procedures. This plan shall also include details of remediation requirements based on the results of inspections. ▪ Include requirements for ongoing maintenance of permanent erosion control measures as part of the CEMP and AusNet's operational procedures.	
Slope instability	▪ Avoidance - Design and placement of transmission towers within the tower assembly area to avoid existing landslides or areas susceptible to landslides as far as reasonably practical. ▪ Engineering controls - Undertake appropriate geomorphological assessment, landslip hazard assessment and geotechnical site investigations to characterise existing landslides and slopes, and to inform the design of Project infrastructure to be located on slopes. - Design to minimise cut earthworks on slopes as much as practically possible. - Design temporary and permanent cuts and final batter slopes to mitigate potential impacts on surrounding land. As per the AGS GeoGuides for Slope Management LR1-LR11 (AGS, 2007e), possible design options and measures may include: - Soil slopes: > Appropriate batter slopes > Engineered structural elements such as geo-grids, soil nails, or retaining walls > Drainage and surface protection > Re-vegetation. - Rock slopes: > Slope trimming > Bolting or anchoring > Rockfall protection > Drainage and surface protection (surface or deep).	▪ Locating transmission towers away from identified landslides or areas susceptible to landslides would reduce the design and construction safety management measures required. This would significantly reduce the magnitude of impacts, reducing the likelihood of landslip activity and avoiding requirements for slope improvement or remediation during the construction and operation stage. ▪ Undertaking geomorphological assessment, landslide hazard assessment and geotechnical site investigations would provide information to characterise areas of landslide hazard and slopes potentially susceptible to instability. The assessments and investigations will also provide important information to inform temporary and permanent design and will reduce the magnitude of slope instability impacts by allowing for design of appropriate slope stability. ▪ Designing to minimise cut earthworks would mean avoiding augmenting existing slopes and maintaining the current slope angles. This would reduce the magnitude of slope instability impacts, whilst also reducing the amount of control measures required. ▪ Designing temporary and permanent cuts with appropriate batter slope angles would reduce impacts on surrounding land, including: - Reducing likelihood of slope instability impacting surrounding land - Increasing speed of re-vegetation on slope

Key issue	Recommended Project controls to mitigate impacts[1]	Effectiveness of recommended control measures
	▪ Administrative - Construction works on slope should be undertaken in accordance with good hillside construction practice as outlined in AGS GeoGuide for slope management LR8 (Hillside construction practice) (AGS, 2007e) to manage slope instability impacts. - CEMP to include inspection requirements during construction for existing landslides or slopes susceptible to landslides that might be impacted by the Project activities.	

Compressible soil	▪ Avoidance
	- Design and placement of transmission towers within the tower assembly area to avoid areas of compressible soil as far as reasonably practical.
	▪ Engineering controls
	- Undertake appropriate geomorphological assessment and geotechnical site investigations to inform the detailed design stage to identify areas of soft, compressible soil along the Proposed Route (anticipated predominantly in areas mapped as recent alluvium around creek and rivers that cut across the Proposed Route).
	- Design appropriate temporary and permanent earthworks and subgrade treatment as required to prevent excessive settlement or failure of access road, temporary hardstanding, piling and crane platforms. Possible design options and measures may include:
	  - Temporary fill platforms
	  - Dig and replace subgrade
	  - Geofabric
	  - Bog mats
	  - Pre-loading with fill material
	  - Vertical drains
	  - Lime stabilisation
	  - Deep soil mixing
		▪ Depending on the Project requirements, where possible, locating transmission towers away from soft, compressible soils would reduce the impact of excessive settlement and poor bearing capacity of structures. This would reduce the magnitude of settlement impacts by reducing the likelihood of tower failure impacting the surrounding land, whilst also avoiding the need for ground improvement and potential for differential settlement and remediation of adjacent structures by avoiding these areas.
		▪ Undertaking geomorphological assessment and geotechnical site investigations would allow characterisation of areas of soft, compressible soils and development of strength and compressibility parameters for design. This would reduce the magnitude and extent of the impact of soft soils through accurate mapping and allow for appropriate design measures to be implemented, such as subgrade treatment.
		▪ Design of appropriate temporary and permanent earthworks and subgrade treatment would reduce the magnitude of impacts by reducing settlement of permanent structures and avoiding failure of access roads, temporary hardstands, piling platforms and stringing pads.

Key issue	Recommended Project controls to mitigate impacts[1]	Effectiveness of recommended control measures
	- Engineered structural elements such as geogrids, controlled modulus concrete (CMC) columns, piled foundations.	
Reactive clay soil	▪ Engineering controls - Undertake appropriate geomorphological assessment and geotechnical site investigations to inform the detailed design stage to identify areas of reactive soil along the Proposed Route (anticipated to comprise residual clay soil overlying basalt rock of the Newer Volcanic Group). - Design temporary and permanent earthworks, drainage diversion and access roads, and provide subgrade treatment or treatment of reactive soil for re-use (if required), for the integrity of access roads and temporary hardstands. Possible design options and measures may include: - Dig and replace subgrade - Lime stabilisation - Geogrids - Drainage and surface protection - Design of tower foundations to accommodate the potential for shrinkage cracking and negative skin friction effects in reactive soils, including site classification and estimation of characteristic surface movement (ys) based on AS2870-2011.	▪ Undertaking appropriate geomorphological assessment and geotechnical site investigations to identify reactive soils would allow for soils to be accurately mapped and soil reactivity to be classified. This would reduce the magnitude of the impact by allowing accurate characterisation of these soils to inform the Project design. ▪ Design of temporary and permanent earthworks, drainage diversions, access roads, subgrade treatment and treatment of reactive soil for re-use would reduce the magnitude of this impact by ensuring integrity of access roads and temporary hardstands are not compromised.
Saline soil	▪ Engineering controls - Undertake appropriate geomorphological assessment and geotechnical site investigations to inform the detailed design stage to identify areas of saline soil along the Proposed Route (including assessment of saline and corrosive soils for transmission tower locations within saline provinces). - Design permanent works (including appropriate concrete cover for foundations) achieve appropriate level of durability over the design life of the Project so the integrity of concrete structures is not impacted, with reference to appropriate standards (e.g., AS2159-2009). ▪ Administrative controls - Principal Contractor to develop and implement an Erosion and Sediment Control and Stormwater Quality Management Plan as part of the CEMP, including	▪ Undertaking appropriate geomorphological assessment and geotechnical site investigations would reduce the magnitude of this impact by accurately determining the presence of and degree of salinity levels present across the Project Land, allowing for location specific application of control measures. ▪ Design of permanent works with appropriate concrete cover (durability) would reduce the magnitude of the impact by ensuring that concrete cover is not reduced significantly over the design life of the structures. ▪ Measures to control saline runoff in locations where saline soil is disturbed and/or stockpiled during construction works would reduce Project impacts by avoiding sedimentation of saline soils over large areas of vegetation and into waterways. This impact would be managed effectively as part of the CEMP control measures, which would include measures for identification and management of saline soils.

Key issue	Recommended Project controls to mitigate impacts[1]	Effectiveness of recommended control measures
	measures to control and manage saline runoff in locations where saline soil is disturbed and/or stockpiled during construction works.	
Geologically Significant Sites	▪ Avoidance - Appropriate design and placement of transmission towers within the tower assembly area to avoid Geologically Significant Sites as much as practically possible in order to: - Avoid disturbance to sites - Avoid restriction of access to sites. ▪ Administrative controls - Principal Contractor to develop and implement an access controls and measures to maintain access (where sites are currently accessible by the general public) to Geologically Significant Sites as part of the CEMP. This may include: - Minimum access requirements during construction - Site access maps for public access points.	▪ Depending on the Project requirements, where possible, appropriate placement of transmission towers to avoid Geologically Significant Sites would reduce the magnitude of this impact by not directly impacting on these sites. This would eliminate the impact of restricting access and minimise the visual impact of the transmission towers on these sites. ▪ During construction, the magnitude of this impact would be reduced by implementing access controls to allow access to sites. Implementing this as part of the CEMP displays a commitment to maintaining the value of these sites and maintaining access to patrons who wish to view the sites.

Notes

1. Mitigation measures listed in order of effectiveness from highest to lowest. Avoidance - Engineering Controls - Administrative Controls.

7.4 Residual impacts

An assessment of the significance of the residual impacts resulting from construction activities are presented in Table 7.3, assuming successful implementation of the mitigation measures described in Section 7.2.1.

Table 7.3: Construction residual impact assessment – Geology and soils

Key issue	Relevant sections of study area that may be impacted	Significance of pre-mitigated impact in relevant sections of the study area	Significance of residual impact in relevant areas of the study section
Soil erosion and dispersive soils Encountering and disturbing dispersive soil and/or erosive soil during construction (including areas subject to Erosion Management Overlay)	**Bulgana to Lexton:** ▪ Presence of potentially erosive soils on hills and ridgelines of Pyrenees Formation ▪ Potentially erodible granite derived colluvium in fans at base of granite hills. **Lexton to Ballan:** ▪ Presence of potentially erosive soils on hills and ridgelines of Castlemaine Group derived hills, Haydens Hill (Bolwarrah) ▪ Sodic (dispersive) soils from Bolwarrah to Ballan ▪ Areas subject to Erosion Management Overlay in Ballarat and Hepburn LGAs. **Ballan to Melton West:** ▪ Presence of potentially erosive soils along most of Proposed Route on hills, ridgelines, valley side slopes and also alluvial flats (Lerderderg River). **Melton West to Sydenham:** ▪ Sodic (dispersive) soils along most of the Proposed Route. **Terminal station locations** ▪ Bulgana (existing and the new 500kV terminal station near Bulgana) ▪ Elaine ▪ Sydenham. **Intermediate laydown areas:** ▪ Ballan **Distribution line crossovers:** ▪ DLIS_1, DLIS_2, DLIS_3, DLIS_5, DLIS_6, DLIS_7, DLIS_9, DLIS_10, DLIS_11, DLIS_12, DLIS_13, DLIS_14, DLIS_15, DLIS_16, DLIS_17, DLIS_18, DLIS_19, DLIS_20, DLIS-21, DLIS_22, DLIS_24, DLIS_39, DLIS_46, DLIS_47, DLIS_48, DLIS_49, DLIS_50, DLIS_52, DLIS_53, DLIS_55, DLIS_58, DLIS_60	Major	Minor
Slope instability Construction and earthworks activities causing slope instability on slopes of hills and ridgelines	**Bulgana to Lexton:** ▪ Hills and ridgelines of Pyrenees Formation. **Lexton to Ballan:** ▪ Hills and ridgelines of Castlemaine Group derived hills, Haydens Hill (Bolwarrah). **Ballan to Melton West:**	Major	Minor

Key issue	Relevant sections of study area that may be impacted	Significance of pre-mitigated impact in relevant sections of the study area	Significance of residual impact in relevant areas of the study section
	▪ Most of Proposed Route on hills, ridgelines, valley side slopes, in particular the valley side slopes around Pykes Creek. **Melton West to Sydenham:** ▪ Valley side slopes at Kororoit Creek. **Distribution line crossovers:** ▪ DLIS_14, DLIS_17, DLIS_48, DLIS_49, DLIS_53, DLIS_55, DLIS_58, DLIS_43		
Compressible soil Disturbing and/or constructing on compressible soils around water courses, particularly where recent alluvial deposits have been mapped	**Bulgana to Lexton:** ▪ Recent alluvium (Qa1) deposits mapped around the Wimmera River and minor creek along Beaufort-Lexton Road. **Lexton to Ballan** ▪ Recent alluvium (Qa1) deposits mapped to the east of Hepburn Lagoon and around Mount Greencock Creek, Rocky Lead Creek, Pinchgut Creek and the Moorabool and Werribee River. Small sections of swamp and lake deposits (Qm1) are mapped in depressions to the north-west of Waubra and north-east of Glendonald. **Ballan to Melton West** ▪ Recent alluvium (Qa1) deposits mapped around the northern extent of Pykes Creek Reservoir and along Myrniong Creek, Lerderderg River, Goodmans Creek and underlying the Merrimu Reservoir. **Melton West to Sydenham** ▪ Recent alluvium (Qa1) deposits mapped around Toolern Creek and a small section of swamp and lake deposits (Qm1) in a depression to the north-west of MacPherson Park. **Distribution line crossovers:** ▪ CAB_JUN22_056, CAB_JUN22_047, CAB_JUL22_025, CAB_JUL22_015	Moderate	Negligible
Reactive clay soil Disturbing and/or constructing on reactive soils (soils that exhibit shrink-swell behaviour that results in movement of the ground surface), particularly high plasticity residual clay soil that will be encountered on top of basalt rock of the Newer Volcanic Group	**Lexton to Ballan, Ballan to Melton West and Melton West to Sydenham:** ▪ Areas of residual clay soil of the Newer Volcanic Group (extending intermittently from Lexton to Sydenham) ▪ Areas mapped as Vertosols. **Terminal stations:** ▪ Sydenham **Intermediate laydown areas:** ▪ Lexton ▪ Ballan **Distribution line crossovers:** ▪ DLIS_45, DLIS_1, DLIS_2, DLIS_3, DLIS_6, DLIS_7, DLIS_12, DLIS_13, DLIS_16, DLIS_20, DLIS_21, DLIS_22, DLIS_23, DLIS_23, DLIS_25, DLIS_26, DLIS_27, DLIS_28, DLIS_29, DLIS_30, DLIS_31,	Moderate	Negligible

Key issue	Relevant sections of study area that may be impacted	Significance of pre-mitigated impact in relevant sections of the study area	Significance of residual impact in relevant areas of the study section
	DLIS_36, DLIS_36, DLIS_38, DLIS_39, DLIS_40, DLIS_41, DLIS_42, DLIS_33, DLIS_34, DLIS_43		
Saline soil Disturbing and/or constructing on saline soils during earthworks related to hardstand, foundation and access road construction	**Bulgana to Lexton, Lexton to Ballan, Ballan to Melton West and Melton West to Sydenham:** ▪ Areas subject to being covered by salinity provinces, however, observations of saline soil were made between Bulgana and Lexton. **Terminal stations:** ▪ Elaine **Distribution line crossovers:** ▪ DLIS_58	Moderate	Negligible
Geologically significant sites Damage or restriction to access of geologically significant sites that are on or close to the Proposed Route	**Bulgana to Lexton:** ▪ Proposed Route runs along foothills of Mount Direction Rooftop Pendant Remnant (BL123) ▪ Landsborough Fault – road cutting exposure of structural geology and sedimentary structures approximately 0.06km from Proposed Route (BL120). **Lexton to Ballan:** ▪ Hepburn Lagoon (BL45) bounded by Proposed Route ▪ Proposed Route passes through potential eruption point near Mount Gap (SLO)[1], eruption point near Mount Prospect (SLO)[1] and eruption point near Newlyn Reservoir (SLO)[1] ▪ Eruption point near Mount Bolton (SLO)[1] adjacent to the study area and eruption point near Birch Hill (SLO)[1] within the study area. **Ballan to Melton West:** ▪ Lerderderg River Permian sequence (ML201), Lerderderg River Morven Terrace (ML294) and Lerderderg Valley Alluvial Fan (ML291) approximately 0.2km from the Proposed Route ▪ Proposed Route passes through steep hills west of Bacchus Marsh (SLO)[1]. **Melton West to Sydenham:** ▪ Proposed Route passes through eruption point near Mount Kororoit (SLO)[1]. **Distribution line crossovers:** ▪ Lerderderg River Permian sequence (ML201) and Lerderderg River Morven Terrace (ML294) approximately 0.1km from the distribution line crossover ID DLIS_16. ▪ Distribution line crossover ID DLIS_16 on the boundary of steep hills west of Bacchus Marsh (SLO)[1] and DLIS_2 within eruption point near Mount Kororoit (SLO)[1].	Moderate	Negligible

Key issue	Relevant sections of study area that may be impacted	Significance of pre-mitigated impact in relevant sections of the study area	Significance of residual impact in relevant areas of the study section
	Lexton to Ballan: ▪ Mount Beckworth (BL39)- edge of the hill over 0.25 km away from Proposed Route. **Ballan to Melton West:** ▪ Pykes Hill (ML278) over 0.5 km away from Proposed Route ▪ Lake Merrimu (ML133) cutting on main road. **Melton West to Sydenham:** ▪ Mount Kororoit (ML66) over 0.3 km away from Proposed Route. **Distribution line crossovers:** ▪ Landsborough Fault – approximately 0.65 km away from the distribution line crossover ID DLIS_55 ▪ Mount Kororoit (ML66)- approximately 0.70km away from the distribution line crossover ID DLIS_2 ▪ Eruption point, near Newlyn Reservoir (SLO)[1]- approximately 0.16km away from the distribution line crossover ID DLIS_32.	Minor	Negligible

Notes

1. Sites are not identified as geologically significant sites; however, they are covered by a SLO.

The level of certainty of the mitigation strategies being effective is considered high. Measures specific to the soil and rock conditions (i.e., erosive, dispersive or compressible soils and construction on slopes) have been successfully implemented in similar projects in a range of environments through comprehensive geotechnical investigation programmes, careful consideration during the geotechnical detailed design and construction management. In addition, regular inspections of the Project infrastructure in erosion prone areas susceptible to landslides would be required as identified in EPR GSL3 (Refer to Table 11.1).

The overall significance of residual impacts after implementation of recommended control measures in Section 7.2.1 is therefore considered to be minor to negligible.

8. Operations impact assessment

8.1 Key issues

The Project activities that have potential to impact geology and soils during operational life of the Project include:

- **Geologically significant sites:** Restriction to access of geologically significant sites that are on or close to the Proposed Route during, for example, maintenance undertaken during the operational stage.

The operation and maintenance of the transmission line and easement will include inspections (by vehicle or drone/LiDAR), vegetation removal and physical repairs/maintenance. These activities may require the use of light or heavy vehicles, which in turn may require the closure of roads. This may require restriction of access to geologically significant sites that are on or close to the Proposed Route. The type of activity will vary in duration and it is possible for access to geologically significant sites to be restricted for periods of hours or days.

An assessment of the above impact and relevant mitigation strategies have been described in the following sections.

8.2 Impact assessment

An assessment of the significance of the impact is presented in Table 8.1.

Table 8.1: Operation pre-mitigated impact assessment – Geology and soils

Key issue	Impact pathway	Relevant sections of study area that may be impacted	Significance of pre-mitigated impact in relevant sections of the study area	Justification for rating of pre-mitigated impacts
Geologically significant sites Restriction to access of geologically significant sites during operation that are on or close to the Proposed Route	Maintenance operations prohibiting access to geologically significant sites. The transmission line and easement will require inspections (by vehicle or drone/LiDAR), vegetation removal and physical repairs/maintenance. These activities may require the use of light or heavy vehicles, which in turn may require the closure of roads, thus potentially restricting access.	**Bulgana to Lexton:** ▪ Landsborough Fault road cutting (BL120) ▪ Mount Direction Roof Pendant Remnant, (BL123). **Lexton to Ballan:** ▪ Mount Beckworth (BL39) ▪ Hepburn Lagoon (BL45) ▪ Potential eruption point near Mount Gap (SLO), eruption point near Mount Prospect (SLO), eruption point near Newlyn Reservoir (SLO)[1] ▪ Eruption point near Mount Bolton (SLO)[1] adjacent to the study area and eruption point near Birch Hill (SLO)[1] within the study area. **Ballan to Melton West:** ▪ Lerderderg River Morven Terrace (ML294), Lerderderg River Permian sequence (ML201), Lerderderg Valley Alluvial Fan (ML291) ▪ Pykes Hill (ML278) ▪ Lake Merrimu road cutting (ML113) ▪ Steep hills west of Bacchus Marsh (SLO)[1]. **Melton West to Sydenham:** ▪ Mount Kororoit (ML66) ▪ Eruption point near Mount Kororoit (SLO)[1].	Minor	Potential localised disruption to access of features

Notes

1. Sites are not identified as geologically significant sites; however, they are covered by a SLO.

8.3 Mitigation of impacts

Soil, geology and landform impacts during operation will be mitigated through specific controls outlined in Table 8.2, including discussion about how residual impacts will be limited during operation by the identified mitigation strategies.

Table 8.2: Key issues and specific Project controls identified for operation impact assessment – Geology and soils

Key issues	Recommended Project controls to mitigate impacts[1]	Effectiveness of recommended control measures
Geologically significant sites	▪ Administrative controls - AusNet should develop and implement access controls and measures to maintain access (where sites are currently accessible by the general public) to Geologically Significant Sites as part of AusNet's operational procedures. This may include: - Minimum access requirements during operation - Site access maps for public access points.	▪ Development of access controls and measures to maintain access to Geologically Significant Sites during operation would reduce the magnitude of this impact by maintaining access to these sites for public viewing.

Notes

1. Mitigation measures listed in order of effectiveness from highest to lowest. Avoidance - Engineering Controls - Administrative Controls.

8.4 Residual impacts

An assessment of the significance of the residual impacts resulting from operations activities are presented in Table 7.3.

Table 8.3: Operations residual impact assessment – Geology and soils

Key issues	Relevant sections of study area that may be impacted	Significance of pre-mitigated impact in relevant sections of the study area	Significance of residual impact in relevant areas of the study section
Geologically significant sites Restriction to access of geologically significant sites during operation that are on or close to the Proposed Route.	**Bulgana to Lexton:** ▪ Landsborough Fault road cutting (BL120) ▪ Mount Direction Roof Pendant Remnant, (BL123). **Lexton to Ballan:** ▪ Mount Beckworth (BL39) ▪ Hepburn Lagoon (BL45) ▪ Potential eruption point near Mount Gap (SLO), eruption point near Mount Prospect (SLO), eruption point near Newlyn Reservoir (SLO)[1] ▪ Eruption point near Mount Bolton (SLO)[1] adjacent to the study area and eruption point near Birch Hill (SLO)[1] within the study area. **Ballan to Melton West:** ▪ Lerderderg River Morven Terrace (ML294), Lerderderg River Permian sequence (ML201), Lerderderg Valley Alluvial Fan (ML291) ▪ Pykes Hill (ML278)	Minor	Negligible

Key issues	Relevant sections of study area that may be impacted	Significance of pre-mitigated impact in relevant sections of the study area	Significance of residual impact in relevant areas of the study section
	▪ Lake Merrimu road cutting (ML113) ▪ Steep hills west of Bacchus Marsh (SLO)[1]. **Melton West to Sydenham:** ▪ Mount Kororoit (ML66) ▪ Eruption point near Mount Kororoit (SLO)[1].		

Notes

1. Sites are not identified as geologically significant sites; however, they are covered by a SLO.

The level of certainty of the mitigation strategies being effective is considered high, as maintaining access to publicly accessible Geologically Significant Sites during operation would be required as per EPR GSL4 (Refer to Table 11.1).

With the implementation of the management and mitigation measures described in Section 8.3, residual impacts resulting from Project operational activities that have potential to impact soils and landforms are negligible.

9. Decommissioning impact assessment

The key issues and impacts from decommissioning will be similar as for the construction. The potential to impact geology and soils is largely related to the disturbance of soil and rock resulting from the following activities:

- Site preparation and earthworks activities for construction of temporary access roads
- Decommissioning, demolition of foundations for transmission towers and terminal stations
- Decommissioning of temporary and permanent access tracks
- Reinstatement of temporary laydown areas
- Construction of temporary hardstands to facilitate transmission tower decommissioning
- Reinstatement and revegetation of the transmission tower Proposed Route and terminal station locations.

The key issues from decommissioning activities that have potential to impact geology and soils are the same as for construction, but essentially reversed with some temporary construction required to facilitate demolition. The significance of impacts for activities that may impact geology and soils was ranked as negligible. The control measures that will be employed for construction that limit the significance of impacts and reduce residual impacts, as summarised in Section 7.2.1, will be the same for decommissioning. Relevant mitigation measures to manage any potential impacts to geology and soils associated with decommissioning would be developed and implemented via the Decommissioning Management Plan (EPR EM11).

10. Cumulative impacts

A cumulative impact assessment considers the impacts of a project together with the impacts of other relevant projects that may interact spatially and temporally to change the level of impact on environmental, social or cultural values. **EES Chapter 4: EES assessment framework and approach** identifies relevant future projects that are proportionate to the scale and potential significance of the impacts of Western Renewables Link Project (WRL); that have sufficient information publicly available in an EES or an environmental approvals application; and that have a spatial and temporal relationship to the Western Renewables Link. Cumulative impacts may occur when incremental, successive and combined effects of actions or projects are added to other proposed actions or projects.

Cumulative geology and soils impacts may arise from the interaction of construction, operational and decommissioning activities of WRL, and other developments, activities, land uses and projects in the area, both current and future. When considered in isolation, specific WRL impacts may be considered manageable. These manageable impacts may, however, be more substantial, when the impact of multiple projects on the same receptors are considered.

Of the 23 shortlisted projects identified in **EES Chapter 4: EES assessment framework and approach**, the following have been considered as potentially relevant to geology and soils:

- Akaysha (Elaine) Battery Energy Storage System (BESS)
- Elaine Solar Farm
- Lerderderg River Nature Trail
- Melbourne Renewable Energy Hub, Plumpton, Victoria
- Merrimu Precinct Structure Plan (PSP)/Bacchus Marsh Urban Growth Framework
- Nyaninyuk Wind Farm
- Outer Metropolitan Ring Road/E6 (OMR)
- Sydenham Terminal Station Rebuild
- Toolern Vale Solar Farm
- Victoria to New South Wales Interconnector West (VNI West)
- Western Irrigation Network (WIN) Scheme – Recycled Water Supply Infrastructure Project

These 11 projects were identified on the basis of 1) their close proximity to the Project and thus their potential to cause cumulative geology and soils impacts (if both projects are not effectively managed); 2) their projected timings such that they may overlap with the Project; and 3) the nature of project which could lead to cumulative effects. Further detail of the potential cumulative geology and soil impacts is provided in Table 10.1.

Table 10.1: Relevant future projects with the potential for cumulative geology and soils impacts

Project	Reason Project presents the potential for cumulative geology and soils impacts
Akaysha (Elaine) Battery Energy Storage System (BESS)	This project is located at 225 Elaine-Blue Bridge Road, Elaine, approximately 25km from of the Project Land. However, it is adjacent to Elaine Terminal Station which will be upgraded as part of the Project. As such, potential impacts are expected to have a spatial relationship with Western Renewables Link. Construction risks such as erosion or overlapping temporary earthworks of either project has been considered as a potential cumulative impact. Construction related risks can however be primarily mitigated and controlled with the proposed EPRs for Western Renewables Link: EPR GSL1, EPR GSL2 and GSL3, as outlined in Table 11.1.

Project	Reason Project presents the potential for cumulative geology and soils impacts
Elaine Solar Farm	This project involves the construction of a substation on property neighbouring the Elaine Terminal Station. As such, it has a spatial relationship with Western Renewables Link. Construction risks such as erosion or overlapping temporary earthworks of either project has been considered as a potential cumulative impact. Construction related risks can however be primarily mitigated and controlled with the proposed EPRs for Western Renewables Link: EPR GSL1, EPR GSL2 and GSL3, as outlined in Table 11.1.
Lerderderg River Nature Trail	The project is located within the Project Land of Western Renewables Link and therefore has a spatial relationship. Construction of the new 5km trail has the potential to impact geology and soils adjacent to the Project infrastructure. Construction risks such as erosion or overlapping temporary earthworks of either project has been considered as a potential cumulative impact. Construction related risks can however be primarily mitigated and controlled with the proposed EPRs for Western Renewables Link: EPR GSL1, EPR GSL2 and GSL3, as outlined in Table 11.1.
Melbourne Renewable Energy Hub, Plumpton, Victoria	This project is located at 77-347 Holden Rd, Plumpton, and is within and directly adjacent to Project Land. As such, potential impacts are expected to have a spatial relationship with Western Renewables Link. Construction risks such as erosion or overlapping temporary earthworks of either project has been considered as a potential cumulative impact. Construction related risks can however be primarily mitigated and controlled with the proposed EPRs for Western Renewables Link: EPR GSL1, EPR GSL2 and GSL3, as outlined in Table 11.1.
Merrimu Precinct Structure Plan (PSP)/Bacchus Marsh Urban Growth Framework	This northern-most section of this project intersects with Project Land in Merrimu. As such, it has a spatial relationship with Western Renewables Link. Construction risks such as erosion or overlapping temporary earthworks of either project has been considered as a potential cumulative impact. Construction related risks can however be primarily mitigated and controlled with the proposed EPRs for Western Renewables Link: EPR GSL1, EPR GSL2 and GSL3, as outlined in Table 11.1.
Nyaninyuk Wind Farm	This project is located between Ecansford, Clunes and Waubra and intersects with Western Renewables Link. As such, it has a spatial relationship with Western Renewables Link. Construction risks such as erosion or overlapping temporary earthworks of either project has been considered as a potential cumulative impact. Construction related risks can however be primarily mitigated and controlled with the proposed EPRs for Western Renewables Link: EPR GSL1, EPR GSL2 and GSL3, as outlined in Table 11.1.
Outer Metropolitan Ring Road/E6 (OMR)	This project is located within the eastern end of Project Land. As such, it has a spatial relationship with Western Renewables Link. Construction risks such as erosion or overlapping temporary earthworks of either project has been considered as a potential cumulative impact. Construction related risks can however be primarily mitigated and controlled with the proposed EPRs for Western Renewables Link: EPR GSL1, EPR GSL2 and GSL3, as outlined in Table 11.1.
Sydenham Terminal Station Rebuild	This project is located within the eastern end Western Renewables Link Project Land in Plumpton. As such, it has a spatial relationship with Western Renewables Link. Construction risks such as erosion or overlapping temporary earthworks of either project has been considered as a potential cumulative impact. Construction related risks can however be primarily mitigated and controlled with the proposed EPRs for Western Renewables Link: EPR GSL1, EPR GSL2 and GSL3, as outlined in Table 11.1.
Toolern Vale Solar Farm	This project is located at 1375-1415 Holden Rd, Toolern Vale, and is directly adjacent to Project Land. As such, potential impacts are expected to have a spatial relationship with Western Renewables Link. Construction risks such as erosion or overlapping temporary earthworks of either project has been considered as a potential cumulative impact. Construction related risks can however be primarily mitigated and controlled with the proposed EPRs for Western Renewables Link: EPR GSL1, EPR GSL2 and GSL3, as outlined in Table 11.1.

Project	Reason Project presents the potential for cumulative geology and soils impacts
VNI West	This preferred option for this project connects with Western Renewables Link at Bulgana. As such, it has a spatial relationship with Western Renewables Link. Construction risks such as erosion or overlapping temporary earthworks of either project has been considered as a potential cumulative impact. Construction related risks can however be primarily mitigated and controlled with the proposed EPRs for Western Renewables Link: EPR GSL1, EPR GSL2 and GSL3, as outlined in Table 11.1.
Western Irrigation Network (WIN) Scheme – Recycled Water Supply Infrastructure Project	This is a large-scale project, that intersects with Project Land between Bacchus Marsh, Melton, and Sunbury. As such, it has a spatial relationship with Western Renewables Link. Construction risks such as erosion or overlapping temporary earthworks of either project has been considered as a potential cumulative impact. Construction related risks can however be primarily mitigated and controlled with the proposed EPRs for Western Renewables Link: EPR GSL1, EPR GSL2 and GSL3, as outlined in Table 11.1.

Although the potential for cumulative geology and soils effects would depend on the timings and sequencing of the Project and the other projects listed in Table 10.1, no significant adverse cumulative impacts are expected. The cumulative impacts of the above projects can be managed effectively through avoidance, engineering and administrative controls and, therefore, the potential for significantly adverse cumulative impact is considered to be negligible.

11. Environmental Performance Requirements

Environmental Performance Requirements (EPRs) set out the environmental outcomes to be achieved through the implementation of mitigation measures during construction, operation and decommissioning. While some EPRs are performance based to allow flexibility in how they will be achieved, others include more prescriptive measures that must be implemented. Compliance with EPRs will be required as a condition of the Project's approval.

To meet the EES evaluation objective of avoid, reduce or limit impacts on geology, soils and environment resulting from construction, operation and decommissioning of the Project, the EPRs outlined in Table 11.1 are recommended.

Table 11.1: Geology and Soils Environmental Performance Requirements

EPR code	Environmental Performance Requirements	Project component	Stage
GSL1	**Develop and implement a pre-construction Site Investigation Plan to inform detailed design** 1. Prior to the commencement of construction works, develop and implement a pre-construction Site Investigation Plan for geotechnical site investigations to inform detailed design. The plan must be developed in accordance with AS 1726-2017 and include the locations, number, and type of geotechnical site investigations to determine the sub-surface conditions and soil/rock characteristics, and to characterise and assess the nature of the soils, including compressible, reactive, erosive/dispersive and saline soils. 2. Detailed design of the Project must consider the findings of the geotechnical site investigations, with design measures to be incorporated as far as reasonably practicable to reduce the potential for erosion and sedimentation (including considering appropriate surface drainage and existing topography of land), and impact to geologically significant sites. Detailed design must consider: a. Earthworks design must be undertaken in accordance with AS 3798-2007. b. Landslide risk and slope stability must be assessed in accordance with AGS Practice Note Guidelines (AGS, 2007c). Mitigation measures and practices must be developed with reference to AGS GeoGuide LR8 (AGS, 2007e). c. Foundation design must be undertaken in accordance with AS/NZS 7000-2016 with reference to the handbook HB331:2020, AS2159-2009 and AS5100.3:2017 as applicable.	Transmission tower and terminal station foundations Permanent earthworks and slope design Permanent erosion control measures Permanent access track design Temporary works required for construction.	Design
GSL2	**Develop and implement a Sediment and Erosion Control Management Plan** 1. Develop and implement a Sediment and Erosion Control Management Plan as part of the Construction Environmental Management Plan (CEMP) (EPR EM2). 2. The Sediment and Erosion Control Management Plan must incorporate drainage, erosion and sediment control measures and stockpile management from industry guidelines, including IECAA Best Practice Erosion and Sediment Control, 2008 and EPA Victoria Publication No. 1834.1: Civil construction, building and demolition guide. It must include measures to: a. Minimise clearance of vegetation and retain existing vegetation wherever possible, particularly along drainage lines and waterways, steep slopes and areas with unstable soils.	Temporary earthworks during construction.	Construction

EPR code	Environmental Performance Requirements	Project component	Stage
	b. Stabilise exposed soil where applicable with the appropriate structural materials and media for the construction activities (e.g., stabilisation matting, rock armour or vegetation). c. Manage vehicle movement to designated roads and access areas, and use dust-suppression measures where practicable. d. Where required, reinstate vegetation as soon as works in an area have finished (staged reinstatement). Maintain erosion controls until vegetation is established (as per EPR GSL3). e. Install sediment control measures around stockpiles to contain sediment. f. If required, treat in situ and site won dispersive or reactive soils prior to construction to improve the performance. g. Any imported material should be tested for dispersive/reactive soil behaviour prior to use in construction in accordance with AS 3798-2007 and the Project earthwork specification. h. Maintain existing erosion management controls within existing biodiversity corridors and reinstate if damaged.		
GSL3	**Identify and remediate erosion and land stability issues** 1. Develop and implement an inspection and maintenance schedule as part of the Construction Environmental Management Plan (CEMP) (EPR EM2) and AusNet's operational procedures to inform adaptive management and/or measures to maintain integrity of infrastructure during and post construction. The schedule will include: a. Minimum ongoing inspection and monitoring requirements, including frequency, timing and locations. b. Requirements for ongoing maintenance of permanent erosion control measures (e.g., vegetation). c. Remediation requirements for areas that have experienced unexpected disturbance that have not been controlled appropriately with other measures.	All Project components, particularly those located in identified erosion prone areas, existing landslides or slopes susceptible to landslides.	Construction, Operation
GSL4	**Maintain current public access to geologically significant sites** 1. Develop and implement access controls and measures as part of the Construction Environmental Management Plan (CEMP) (EPR EM2) and AusNet's operational procedures to maintain safe access (where sites are currently accessible by the general public) to geologically significant sites during construction and operation. 2. Geologically significant sites include the following locations: a. Bulgana to Lexton: i. Landsborough Fault road cutting (BL120) ii. Mount Direction Roof Pendant Remnant, (BL123). b. Lexton to Ballan: i. Mount Beckworth (BL39) ii. Hepburn Lagoon (BL45) iii. Potential eruption point near Mount Gap (SLO), eruption point near Mount Prospect (SLO), eruption point near Newlyn Reservoir (SLO)[1] iv. Eruption point near Mount Bolton (SLO)[1] adjacent to the study area and eruption point near Birch Hill (SLO)[1] within the study area. c. Ballan to Melton West:	All Project components.	Construction, Operation

EPR code	Environmental Performance Requirements	Project component	Stage
	i. Lerderderg River Morven Terrace (ML294), Lerderderg River Permian sequence (ML201), Lerderderg Valley Alluvial Fan (ML291) ii. Pykes Hill (ML278) iii. Lake Merrimu road cutting (ML113) iv. Steep hills west of Bacchus Marsh (SLO)[1]. d. Melton West to Sydenham: i. Mount Kororoit (ML66) ii. Eruption point near Mount Kororoit (SLO)[1]. e. Distribution line crossovers: i. Landsborough Fault road cutting (BL120) ii. Lerderderg River Permian sequence (ML201) and Lerderderg River Morven Terrace (ML294) iii. Mount Kororoit (ML66) iv. Eruption point, near Newlyn Reservoir (SLO)[1] v. Steep hills west of Bacchus Marsh (SLO)[1] vi. Eruption point near Mount Kororoit (SLO)[1].		

Notes

1. Sites are not identified as geologically significant sites however they are covered by a SLO.

In addition to the EPRs recommended specific to geology and soils, the other EPR is listed in the table below for reference.

Table 11.2: Additional EPRs related to geology and soils

EPR code	Environmental Performance Requirements	Project component	Stage
EM2	**Develop and implement a Construction Environmental Management Plan** 1. Prior to the commencement of construction, develop and implement a Construction Environmental Management Plan (CEMP) with associated subplans as required by relevant EPRs in accordance with the Environmental Management Framework to manage the environmental impacts associated with construction in accordance with the mitigation hierarchy. 2. The CEMP must be developed in consultation with relevant stakeholders as required by relevant EPRs, reviewed by AusNet, and reviewed and verified by the Independent Environmental Auditor (IEA) for compliance with the EPRs prior to the commencement of construction. 3. The CEMP subplans must address applicable EPRs including those relevant to surface water, groundwater, geology and soils, contaminated land, biodiversity, air, noise, historical heritage, bushfire protocols, weed and pest management. 4. The CEMP and its subplans must comply with the EPRs and relevant environmental legislation, and performance must be reported to AusNet and relevant government agencies as appropriate.	All	Construction
EM11	**Develop and implement a Decommissioning Management Plan** 1. Prior to commencement of decommissioning, develop and implement a Decommissioning Management Plan detailing mitigation measures required to manage the environmental impacts associated with	All	Decommissioning

EPR code	Environmental Performance Requirements	Project component	Stage
	decommissioning and seek to minimise the risk of harm to human health or the environment of all activities associated with decommissioning 2. Management and mitigation measures shall be consistent with environmental management strategies, practices, and technologies current at the time and shall include, but not be limited to measures for communications and stakeholder engagement, environmental protection measures, waste management and recycling, emergency response and measures to minimise disturbance to agriculture, recreation and other enterprises.		

12. Conclusion

The Project has potential to cause impacts to geology and soils if construction and earthworks are not planned and managed with respect to the geological conditions encountered, relevant legislation and guidelines, appropriate mitigation measures and the application of EPRs outlined in Section 11. This report considers the existing conditions relating to geology and soils in the study area and how they relate to the Project in order to minimise potential impacts to geology and soils during all Project stages and provide appropriate controls. The impacts identified in respect of geology and soils arising from the Project are presented in the following sections.

12.1 Existing conditions

Existing conditions relating to geology and soils have been described for the study area based on four separate sections, which have been defined based on distinctive geological and geomorphological conditions. A summary of existing conditions within each of these four sections, as well as a separate summary for the terminal station sites and the intermediate laydown areas is presented below:

- **Bulgana to Lexton**
  - Situated within the Western Uplands geomorphic province, this section is characterised by undulating hills and ridges formed by sedimentary rock units intersected by valleys filled with narrow creek valleys and broad low-lying areas.
  - Several instances of gully erosion were identified in this section, mainly associated with fine grained residual soil and colluvium on steep slopes and creeks in hilly areas. Minor localised instability was also observed on steep hill and valley slopes in the form of hummocky terrain and soil creep. Observations are consistent with Department of Energy, Environment and Climate Action (DEECA) erosion and landslide susceptibility mapping, which indicates generally high susceptibility to erosion in hilly areas and ridgelines, and low susceptibility to landslides.
  - Dispersive soils are likely to be present in this section, as indicated by mapped soil types (Sodosols, which are known to be dispersive) and supported by the results of geotechnical laboratory testing.
  - Possible soil salinity was indicated by the presence of bare patches of soil in some areas. Limited soil salinity testing indicated that soils are slightly/moderately saline to non-saline.
  - Reactive soils are unlikely to be encountered in this section.
  - Compressible soils are likely to be encountered around creeks and rivers where the Quaternary aged alluvial deposits (Qa1) have been mapped.
  - One site of geological significance was identified in this section, associated with a granite hill named Mount Direction.
- **Lexton to Ballan**
  - Situated within the Western Uplands geomorphic province, this section is characterised by gently undulating hills formed by the Quaternary-Tertiary aged lava flows with isolated steep hills associated with local volcanic eruption points.
  - Several areas in this section are subject to Erosion Management Overlay (EMO) mapping developed under Clause 44.01 (last updated 6 September 2021) of the Victoria Planning Provisions and displayed on relevant planning scheme mapping, which are mainly associated with surface watercourses and scoria deposits (eruption points).
  - Limited examples of soil gully erosion were identified and where these instances occurred, they are generally associated with areas of steep slopes and around existing creeks. Observations are consistent with DEECA erosion mapping, which indicates low susceptibility to erosion on the gently undulating volcanic landscape.

- Localised minor land instability was observed in this section, mainly occurring where creek banks have incised the underlying basalt rock resulting in some soil creep. Observations are consistent with DEECA landslide susceptibility mapping, which indicates low susceptibility to landslides in this section.
- Soil types are mapped as predominantly Dermosols, Ferrosols and Kurosols from Lexton to Kingston, Ferrosols from Kingston to Bolwarrah and Sodosols and Chromosols from Bolwarrah to Ballan.
- Dispersion testing was conducted on a single sample which returned Emerson Class 4, which indicates this sample was slightly to non-dispersive. Further Emerson testing is required to determine dispersion characteristics in this section, particularly between Bolwarrah and Ballan where Sodosols have been mapped.
- This section is situated within the Upper Loddon Volcanic Plains and Upper Moorabool salinity provinces. No obvious signs of soil salinity were observed in this section or indicated in reference materials reviewed. One soil salinity test conducted within this section indicated that the soil is non-saline.
- The likelihood for encountering reactive soils is high, with mapped areas of Vertosols present, as well as large areas of residual soils of the Newer Volcanic Group, both of which are prone to shrink-swell behaviour. Atterberg testing conducted indicated samples of the Newer Volcanic Group residual soils obtained from shallow depths displayed low to moderate soil reactivity.
- Compressible soils are likely to be encountered around creeks and rivers where the Quaternary aged alluvial deposits (Qa1) have been mapped.
- Two sites of geological significance were identified in this section, Hepburn Lagoon and Kangaroo Hills. Additionally, this section contains several volcanic eruption points that are subject to the SLO in the relevant planning scheme, which are close to and intersecting the study area.

▪ **Ballan to Melton West**

  - Situated within the Western Uplands and Western Plains geomorphic provinces, characterised by undulating hills with steep hills ranges formed by sedimentary rock units with broad low-lying areas dominated by alluvium units.
  - Several examples of active and inactive gully erosion were identified, mainly associated with steep slopes. This is consistent with DEECA erosion susceptibility mapping, that indicates the section has a high susceptibility to gully erosion on hills and ridgelines.
  - The Ballan to Melton West section is mapped as having Low landslip susceptibility, and whilst this may be applicable for some of the Proposed Route in this area, observations and mapping indicate landslide processes have been active relatively recently on slopes that are close to the study area, or within geological units that are in the study area.
  - Soil types are mapped as predominately Sodosols with a small section of Vertosols between Ballan and Myrniong, Dermosols from Myrniong to the Lerderderg River and Sodosols and Chromosols from Lerderderg River to Melton West.
  - Evidence of erosion possibly resulting from soil dispersion was observed. Dispersion testing conducted on two samples recorded Emerson Class 3, which indicates moderately dispersive soils are present.
  - No signs of soil salinity were observed in this section.
  - The likelihood for encountering reactive soils is high, with mapped areas of Vertosols and the presence of the Pentland Hills Volcanic Group and the Newer Volcanic Group units.
  - Compressible soils are likely to be encountered around creeks and rivers where the Quaternary aged alluvial deposits (Qa1) have been mapped.
  - Two sites of geological significance were identified near Bacchus Marsh that range from national to international significance, which include the Permian aged glacigene sediments and exposures of the Permian aged glacial deposits.

- **Melton West to Sydenham**
  - Situated within the Western Plains geomorphic province, characterised by flat Tertiary aged Volcanic plains with low-lying areas associated with watercourse and drainage lines.
  - Limited areas of gully erosion are present within this section however, it was found that residual soils of the Newer Volcanic Group are susceptible to dispersion which may lead to tunnel and gully erosion where soils may be exposed. This is consistent with DEECA erosion susceptibility mapping in this section, that indicates low susceptibility to erosion.
  - Localised land instability and rock outcropping were observed on steep valley slopes of Kororoit Creek.
  - Soil types are predominantly described as Sodosols between Melton West to Sydenham, which indicates soils are prone to dispersion and subsequent erosion.
  - No obvious signs of soil salinity were observed in this section, however a large are of recorded soil salinity is present near Kororoit Creek 5km south of the Proposed Route.
  - The likelihood for encountering reactive soils is high, with a majority of the section mapped as the Newer Volcanic Group basalt. Shrinkage cracking was observed in residual soils in this section and Atterberg limit testing on one sample indicated high to very high soil reactivity.
  - Compressible soils are likely to be encountered around creeks and rivers (e.g., Toolern Creek) where the Quaternary aged alluvial deposits (Qa1) have been mapped.
  - One site of geological significance was identified, which is Mount Kororoit, that is described as a breached cone of basalt with lava outcrops. This feature, which is located within the Melton LGA, is covered by the SLO in the relevant planning scheme. Mount Kororoit is also a key landform identified in the 'Western Plains North Green Wedge Management Plan'.
- **Terminal stations**
  - Located within both the Western Uplands and Western Plains geomorphic provinces, the geomorphic conditions at the terminal station sites include:
    - Terraces and floodplains with hills, valley slopes and plains composed of the Palaeozoic aged sedimentary rock units (existing Bulgana Terminal Station)
    - Terraces and floodplains with plateaux and rises of residual Cainozoic age landscapes (new 500 kV terminal station near Bulgana)
    - Predominantly plateaux and rises of residual Cainozoic age landscapes with hills, valley slopes and plains composed of the Palaeozoic age rock units (Elaine Terminal Station)
    - Stony rises of the volcanic plains (Sydenham Terminal Station).
  - No erosion at existing terminal station sites was observed, likely due to the sites being levelled during construction and active erosion control measures put in place (e.g., drainage and hardstands).
  - The terminal station sites are mapped as having a Low to Very Low landslip susceptibility and no evidence of past landslide activity was observed at any of the existing terminal station sites.
  - Mapped soil types at terminal station locations include:
    - Kandosols and Chromosols at the existing Bulgana Terminal Station
    - Chromosols at the new 500kV terminal station near Bulgana
    - Chromosols with minor Kurosols at the Elaine Terminal Station
    - Sodosols at the Sydenham Terminal Station.
  - No visible signs of soil salinity were observed at the terminal station sites; however, areas of recorded soil salinity are indicated within 2 to 3km of Elaine Terminal Station.
  - The likelihood of encountering reactive soils is high where terminal stations are located in areas underlain by the Newer Volcanic Group basalt (Sydenham Terminal Station). At other sites, where this

unit is not present the likelihood of encountering reactive soils is low (the existing Bulgana and Elaine Terminal Stations and the new 500kV terminal station near Bulgana).

- No sites of geological significance are present at any of the terminal station sites. In addition, none of the terminal stations are shown to be close to or within a zone.

▪ **Intermediate laydown areas**
  - Located within the Western Uplands geomorphic province, the geomorphic conditions at the (temporary) intermediate laydown areas include eruption points and volcanic plains of Quaternary-Tertiary lava flows.
  - Although Lexton and Ballan laydown areas are mapped as having a low gully erosion susceptibility, it has been found that residual soils of the Newer Volcanic Group are susceptible to dispersion which may lead to tunnel and gully erosion where soils may be exposed.
  - The intermediate laydown areas are mapped as having a Low landslip susceptibility, consistent with observations undertaken on the site walkover.
  - Mapped soil types at intermediate laydown areas include:
    - Chromosols at the Lexton laydown area
    - Sodosols at the Ballan laydown area.
  - Dispersive soils are likely to be present at the Ballan laydown area, which is mapped on Sodosols, known to be dispersive.
  - Both intermediate laydown areas are located in areas underlain by the Newer Volcanic Group basalt so the likelihood of encountering reactive soils is high.
  - Large amounts of compressible soils are unlikely to be present at both intermediate laydown areas.
  - No sites of geological significance are present at both the intermediate laydown areas. In addition, neither are shown to be close to or within a SLO zone.

▪ **Distribution line crossovers**
  - The geomorphology at each distribution line crossover varies depending on the location. Conditions at the majority of the distribution line crossovers feature eruption points and volcanic plains of Quaternary-Tertiary lava flows.
  - The susceptibility to gully erosion varies depending on the location. High gully susceptibility is mapped at distribution line crossovers in geomorphological units with steep slopes (hills, valley slopes, ridges, escarpments, mountains), between Bulgana and Lexton. Additionally, several instances of gully erosion are mapped close to the proposed distribution line crossovers in this section.
  - The distribution line crossovers are mapped as having a Low to Very Low landslip susceptibility, consistent with observations undertaken on the site walkover.
  - Majority of the distribution line crossovers are mapped on either Ferrosols, Chromosols or Sodosols with some of the crossings mapped on Rudosols, Dermosols, Kurosols and Vertosols. Dispersive soils are likely to be present where distribution line crossovers are mapped on Sodosols, which are known to be dispersive.
  - The likelihood of encountering reactive soils is high where the distribution line crossovers are located in areas of either the Newer Volcanic Group or Pentland Hills Volcanic Group basalt. At other sites, where these units are not present the likelihood of encountering reactive soils is low.
  - Soft, compressible soils that may potentially be saturated are likely to be encountered at the distribution line crossovers mapped on recent alluvial deposits (Qa1). Compressible soils are also expected to occur locally around creeks and waterways.
  - Three sites of geological significance were identified at or close to the distribution line crossovers, named Landsborough Fault, Lerderderg River Morven Terrace and Lerderderg River Permian sequence.

Additionally, several distribution line crossovers are located within or close to SLO areas, associated with eruption points and steep valleys to the west of Bacchus Marsh.

12.2 Construction impact assessment

The Project has the potential to impact geology and soils during construction as a result of disturbance of soil and rock during site preparation, foundation construction, construction of temporary and permanent access tracks, construction of hardstands, construction of stringing pads and bulk earthworks for terminal station construction.

A number of key issues were identified, which included:

- Encountering and disturbing dispersive soil and/or erosive soils
- Construction activities causing slope instability
- Constructing on compressible soils
- Disturbing and/or constructing on reactive soils
- Disturbing saline soils during earthworks
- Damage or restriction to access of geologically significant sites.

The construction impact assessment found that after appropriate mitigation measure are applied, the significance of construction impacts arising from the above issues after application of controls are negligible, because impacts can be managed effectively through avoidance, engineering and administrative controls. By committing to ongoing inspections and maintenance of the implemented design options and measures, this will minimise potential impacts and provide effective management for the life of the Project.

In response to the EES scoping requirements, specific controls to mitigate each of the key issues identified as part of the construction impact assessment were identified in Section 7.2.1. Specific controls recommended include further geomorphological assessment and geotechnical site investigations and development of issue specific controls as part of the CEMP. The residual impacts as a result of construction are minor to negligible if the mitigation measures outlined in Section 7.2.1 and EPRs outlined in Section 11 are followed. Justification for the assessment of residual impacts is outlined in Section 7.4.

The assessment has shown that the construction stage of the Project can be managed such that the objective of limiting the adverse impacts of the Project on soil stability and erosion can be met.

12.3 Operational impact assessment

The Project has the potential to restrict access of geologically significant sites during operation and maintenance activities.

The operational impact assessment found that after appropriate mitigation measures are applied, the significance of operational impacts arising from the above issues after application of controls are negligible.

In response to the EES objectives, specific controls to mitigate each of the key issues identified as part of the operational impact assessment were identified in Section 8.3. Specific controls include ensuring continued access to Geologically Significant Sites (where sites are currently accessible by the general public) over the operational stage. The residual impacts as a result of operation are negligible if the mitigation measures outlined in Section 8.3 EPRs outlined in Section 11 are followed. Justification for the assessment of residual impacts is outlined in Section 8.4.

The assessment has shown that the operational stage of the Project can be managed such that the objective of limiting the adverse impacts of the Project on geology can be met.

12.4 Decommissioning impact assessment

The Project has the potential to impact geology and soils during operation as a result of disturbance of soil and rock during decommissioning activities. Several activities were identified with the potential to result in similar issues and impacts to construction, as summarised in Section 12.1. These activities include:

- Site preparation and earthworks activities for construction and decommissioning of temporary access roads
- Decommissioning, demolition of foundations for transmission towers and terminal stations
- Decommissioning of temporary and permanent access tracks
- Reinstatement of temporary laydown areas
- Construction of temporary hardstands to facilitate transmission tower decommissioning
- Reinstatement and revegetation of the transmission tower, Proposed Route and terminal station locations.

The key issues and impacts for decommissioning are anticipated to be the same as construction with some temporary construction required to facilitate demolition. The impacts during decommissioning following implementation of control measures are therefore considered to be negligible.

12.5 Environmental Performance Requirements

Four Environmental Performance Requirements (EPRs) have been recommended in order to meet the EES evaluation objective. These include:

- **GSL1:** Develop and implement a pre-construction Site Investigation Plan for geotechnical site investigations to inform detailed design. The plan must consider the findings of the geotechnical site investigations, with detailed design undertaken in accordance with relevant standards and incorporating appropriate design measures as reasonably practicable to reduce the potential for erosion and sedimentation, and impact to geologically significant sites.
- **GSL2:** Develop and implement a Sediment and Erosion Control Management Plan as part of the Construction Environmental Management Plan (CEMP) (EPR EM2) which details measures to minimise vegetation clearance, stabilise exposed soils where applicable, manage vehicle movement, reinstate vegetation, install sediment controls and treat dispersive or reactive soils.
- **GSL3:** Develop and implement an inspection and maintenance as part of the Construction Environmental Management Plan (CEMP) (EPR EM2) and AusNet's operational procedures to inform adaptive management to maintain integrity of infrastructure during and post construction. The schedule will detail requirements for ongoing inspections, maintenance of permanent erosion management controls and remediation requirements for areas subject to unexpected disturbance.
- **GSL4:** Develop and implement access controls and measures as part of the Construction Environmental Management Plan (CEMP) (EPR EM2) and AusNet's operational procedures to maintain safe access (where sites are currently accessible by the general public) to geologically significant sites during construction and operation.

Other EPRs relevant to the Geology and Soils Impact Assessment include:

- **EM2:** Developing and implementing a Construction Environmental Management Plan to manage the environmental impacts associated with construction in accordance with the mitigation hierarchy.
- **EM11:** Developing and implementing a Decommissioning Management Plan to mitigate potential impacts during the decommissioning stage of the Project.

12.6 Residual impacts

The Project is not expected to significantly impact geology and soils during its construction, operation and decommissioning. Specific controls and mitigation strategies will be implemented to address potential impacts associated with slope instability, erosion, disturbance of compressible, reactive or saline soils as well as success to geologically significant sites. After these measures are applied, the significance of the Project's residual impacts to geology and soils has been assessed as minor to negligible and any unexpected impact to geology and soils will be anticipated to be short term and localised and promptly remediated to reduce the extent and magnitude of the impact. This means that the Project meets the requirements of the General Environmental Duty in relation to geology and soils.

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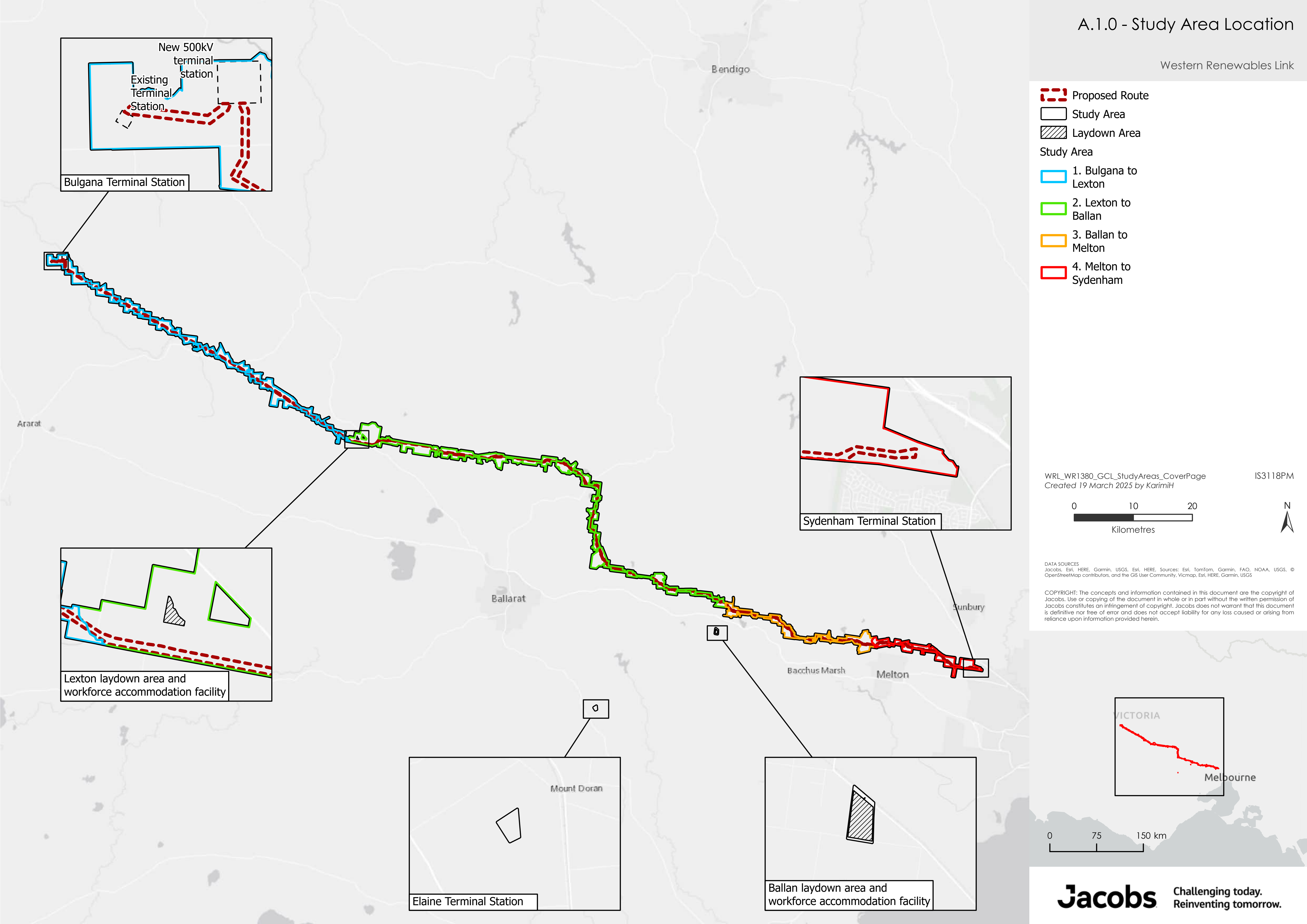

A.1.0 - Study Area Location
Western Renewables Link
Proposed Route
Study Area
Laydown Area
Study Area
1. Bulgana to Lexton
2. Lexton to Ballan
3. Ballan to Melton
4. Melton to Sydenham
New 500kV terminal station
Existing Terminal Station
Bulgana Terminal Station
Lexton laydown area and workforce accommodation facility
Sydenham Terminal Station
Elaine Terminal Station
Mount Doran
Ballan laydown area and workforce accommodation facility
Bendigo
Ararat
Ballarat
Sunbury
Bacchus Marsh
Melton
VICTORIA
Melbourne
0
75
150 km
WRL_WR1380_GCL_StudyAreas_CoverPage
Created 19 March 2025 by KarimiH
IS3118PM
0
10
20
Kilometres
N
DATA SOURCES
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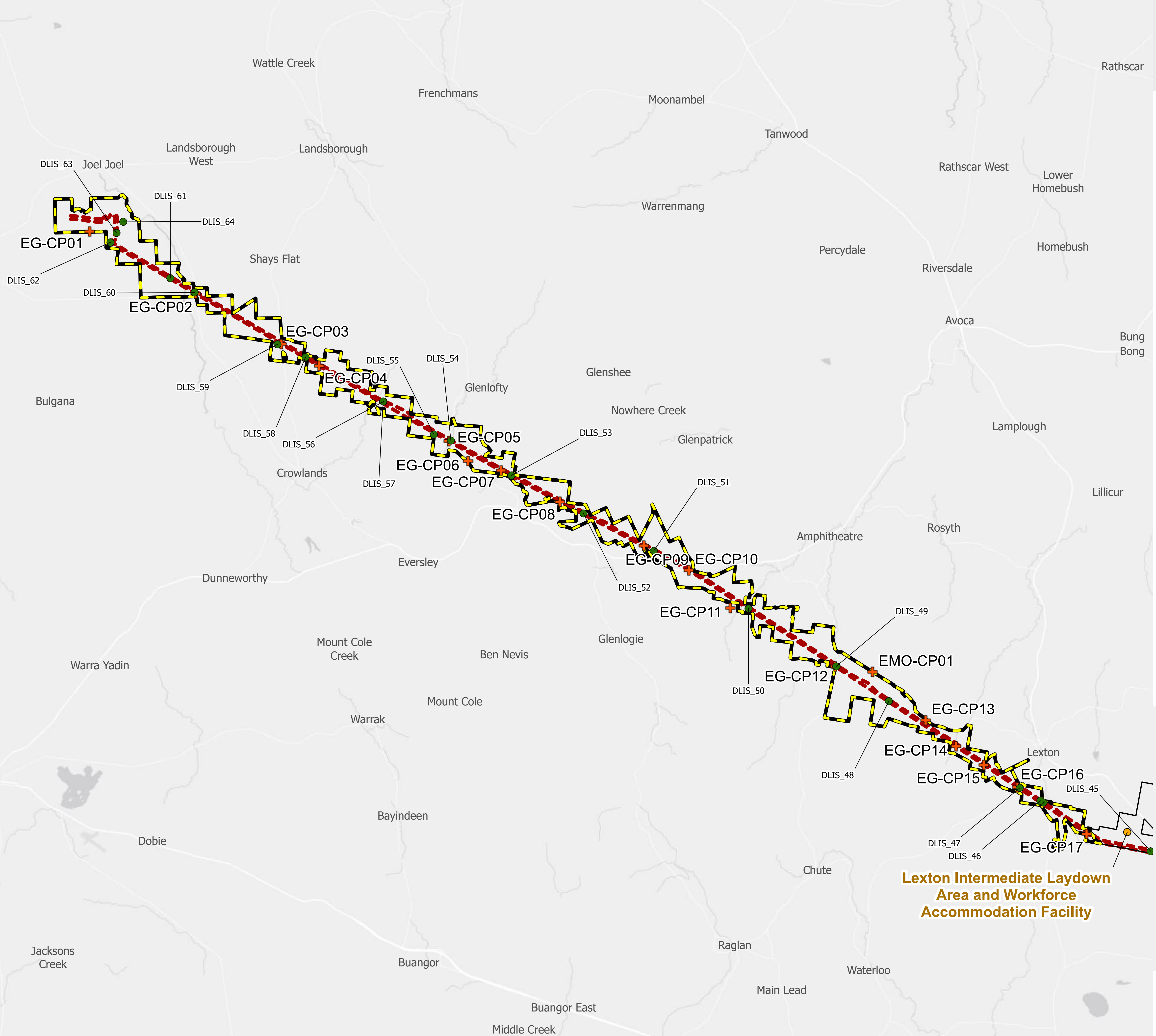
A.1.1 - Checkpoint Locations

Western Renewables Link

- Bulgana to Lexton Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings
- Checkpoint



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Kilometres

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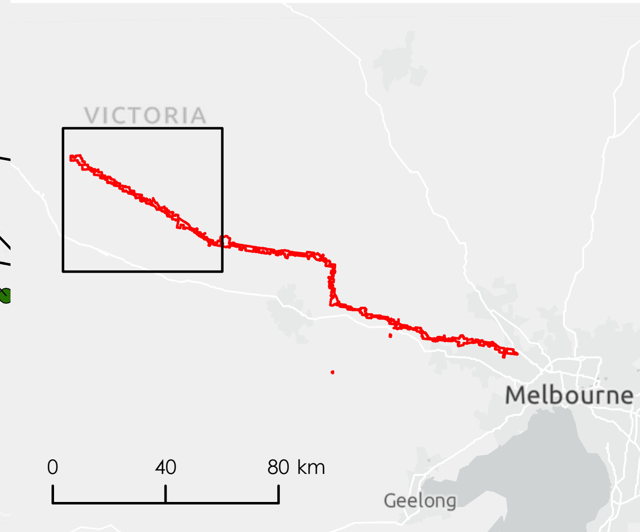

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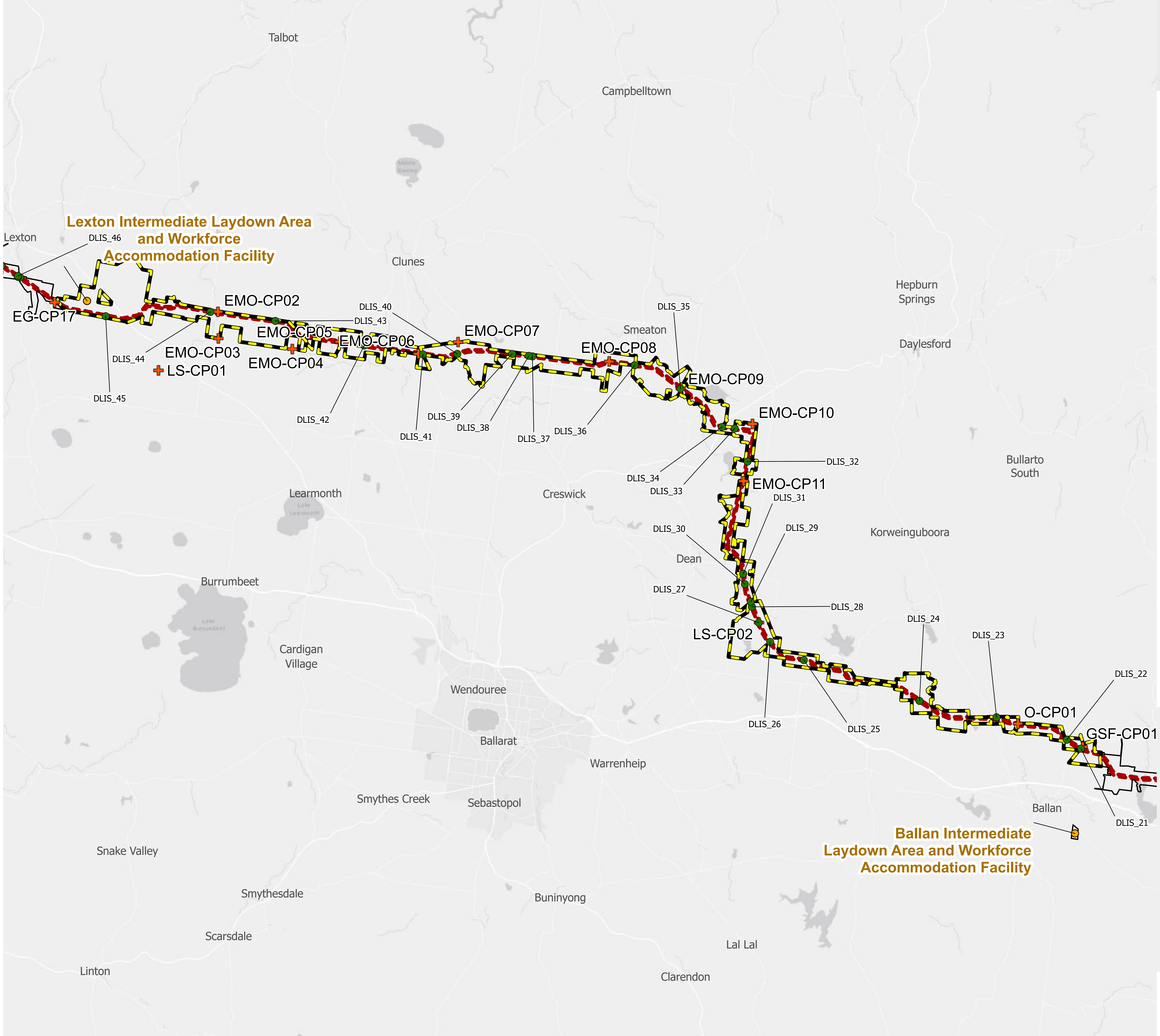
A.1.2 - Checkpoint Locations

Western Renewables Link



- Lexton to Ballan Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings
- Checkpoint

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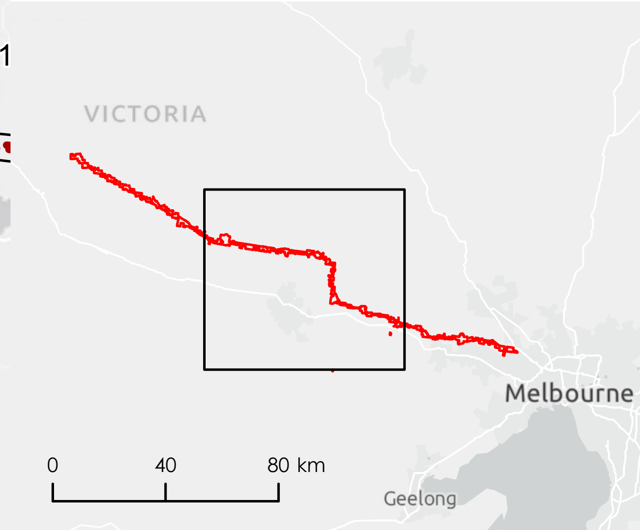

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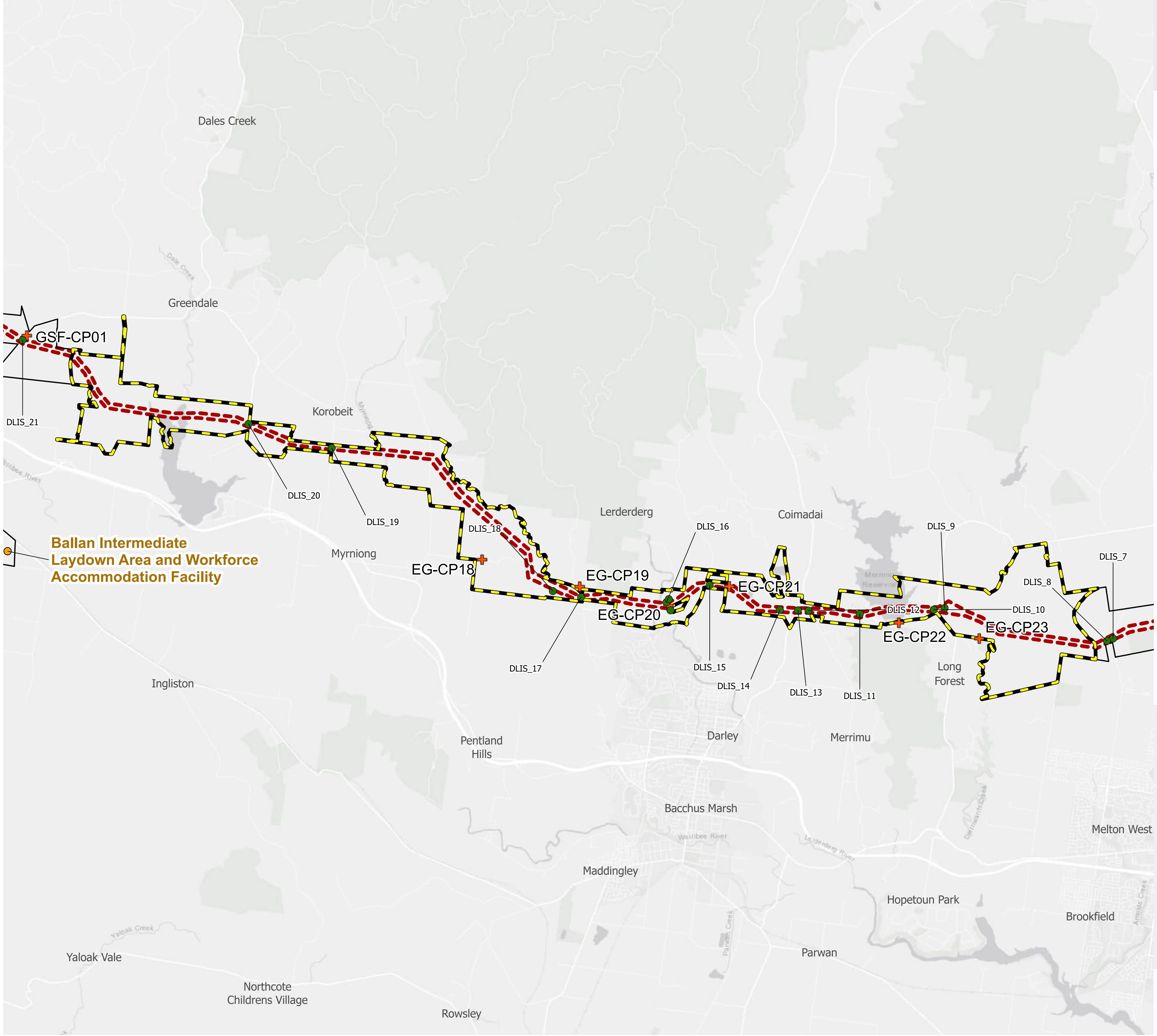
A.1.3 - Checkpoint Locations

Western Renewables Link

Ballan to Melton Study Area
Proposed Route
Project Land
Laydown Area and Workforce Accommodation Facility
Distribution Line - Crossings
Checkpoint



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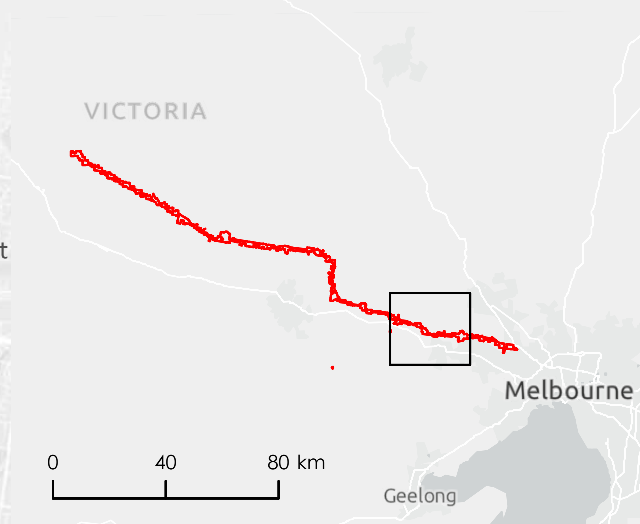

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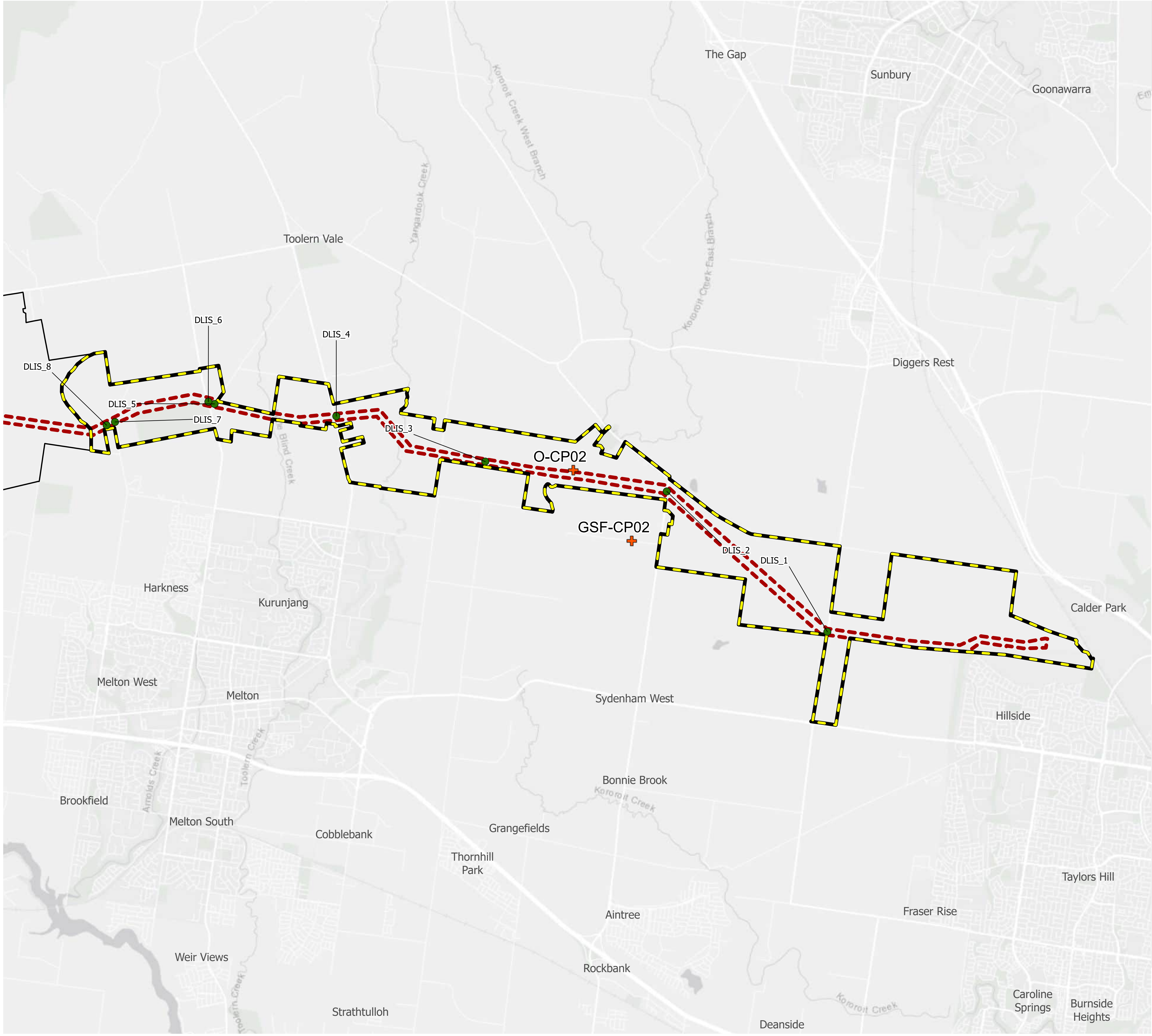
A.1.4 - Checkpoint Locations

Western Renewables Link

- Melton to Sydenham Study Area
- Proposed Route
- Project Land
- Distribution Line - Crossings
- Checkpoint



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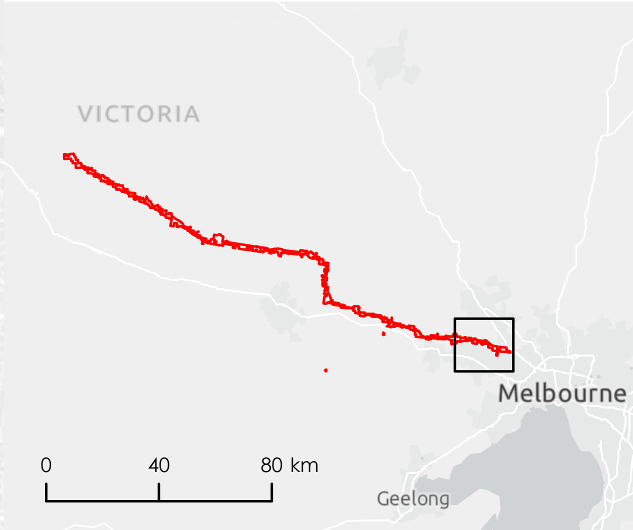

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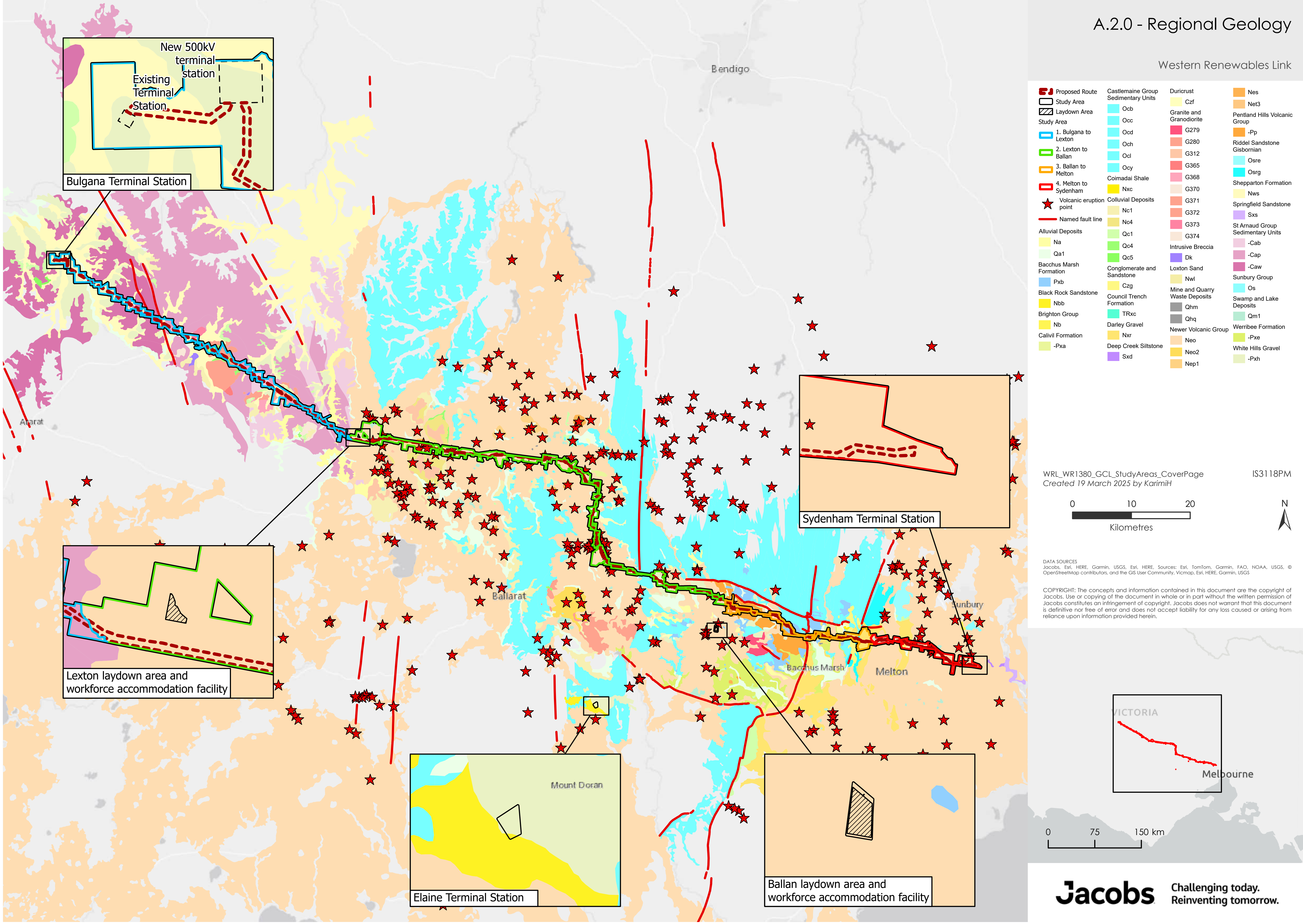
A.2.0 - Regional Geology
Western Renewables Link
Proposed Route
Study Area
Laydown Area
Study Area
1. Bulgana to Lexton
2. Lexton to Ballan
3. Ballan to Melton
4. Melton to Sydenham
Volcanic eruption point
Named fault line
Alluvial Deposits
Na
Qa1
Bacchus Marsh Formation
Pxb
Black Rock Sandstone
Nbb
Brighton Group
Nb
Calivil Formation
-Pxa
Castlemaine Group Sedimentary Units
Ocb
Occ
Ocd
Och
Ocl
Ocy
Coimadai Shale
Nxc
Colluvial Deposits
Nc1
Nc4
Qc1
Qc4
Qc5
Conglomerate and Sandstone
Czg
Council Trench Formation
TRxc
Darley Gravel
Nxr
Deep Creek Siltstone
Sxd
Duricrust
Czf
Granite and Granodiorite
G279
G280
G312
G365
G368
G370
G371
G372
G373
G374
Intrusive Breccia
Dk
Loxton Sand
Nwl
Mine and Quarry Waste Deposits
Qhm
Qhq
Newer Volcanic Group
Neo
Neo2
Nep1
Nes
Net3
Pentland Hills Volcanic Group
-Pp
Riddel Sandstone Gisbornian
Osre
Osrg
Shepparton Formation
Nws
Springfield Sandstone
Sxs
St Arnaud Group Sedimentary Units
-Cab
-Cap
-Caw
Sunbury Group
Os
Swamp and Lake Deposits
Qm1
Werribee Formation
-Pxe
White Hills Gravel
-Pxh
New 500kV terminal station
Existing Terminal Station
Bulgana Terminal Station
Bendigo
Ararat
Ballarat
Bacchus Marsh
Melton
Sunbury
Lexton laydown area and workforce accommodation facility
Sydenham Terminal Station
Mount Doran
Elaine Terminal Station
Ballan laydown area and workforce accommodation facility
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Melbourne
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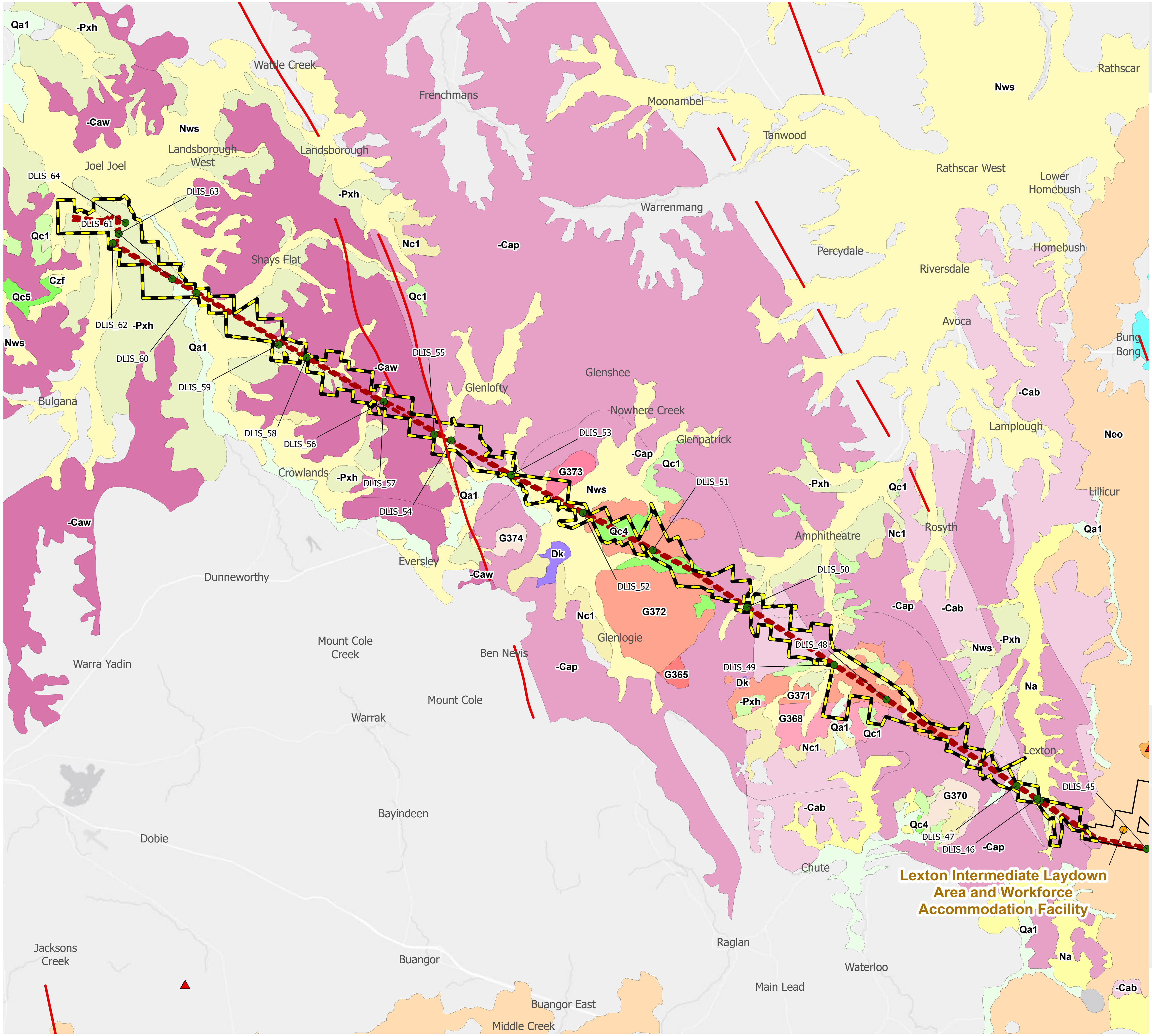
A.2.1 - Regional Geology

Western Renewables Link



- Bulgana to Lexton Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings
- Volcanic eruption point
- Named fault line

Geological Units

Alluvial Deposits
- Na
- Qa1

Castlemaine Group Sedimentary Units
- Ocl

Colluvial Deposits
- Nc1
- Qc1
- Qc4
- Qc5

Duricrust
- Czf

Granite and Granodiorite
- G365
- G368
- G370
- G371
- G372
- G373
- G374

Intrusive Breccia
- Dk

Newer Volcanic Group
- Neo
- Nes

Shepparton Formation
- Nws

St Arnaud Group Sedimentary Units
- -Cab
- -Cap
- -Caw

White Hills Gravel
- -Pxh

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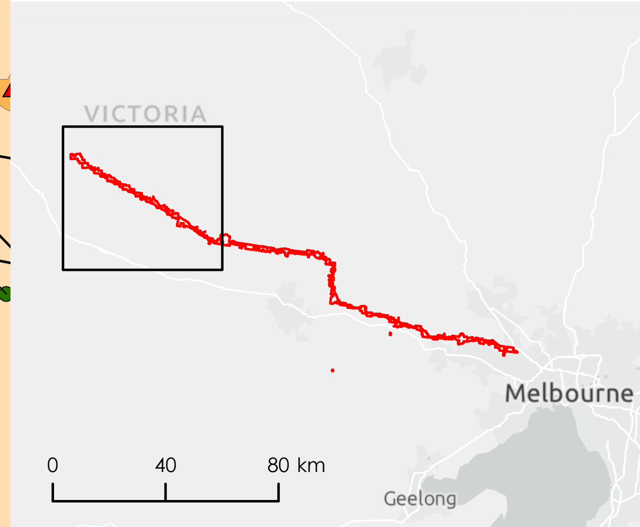

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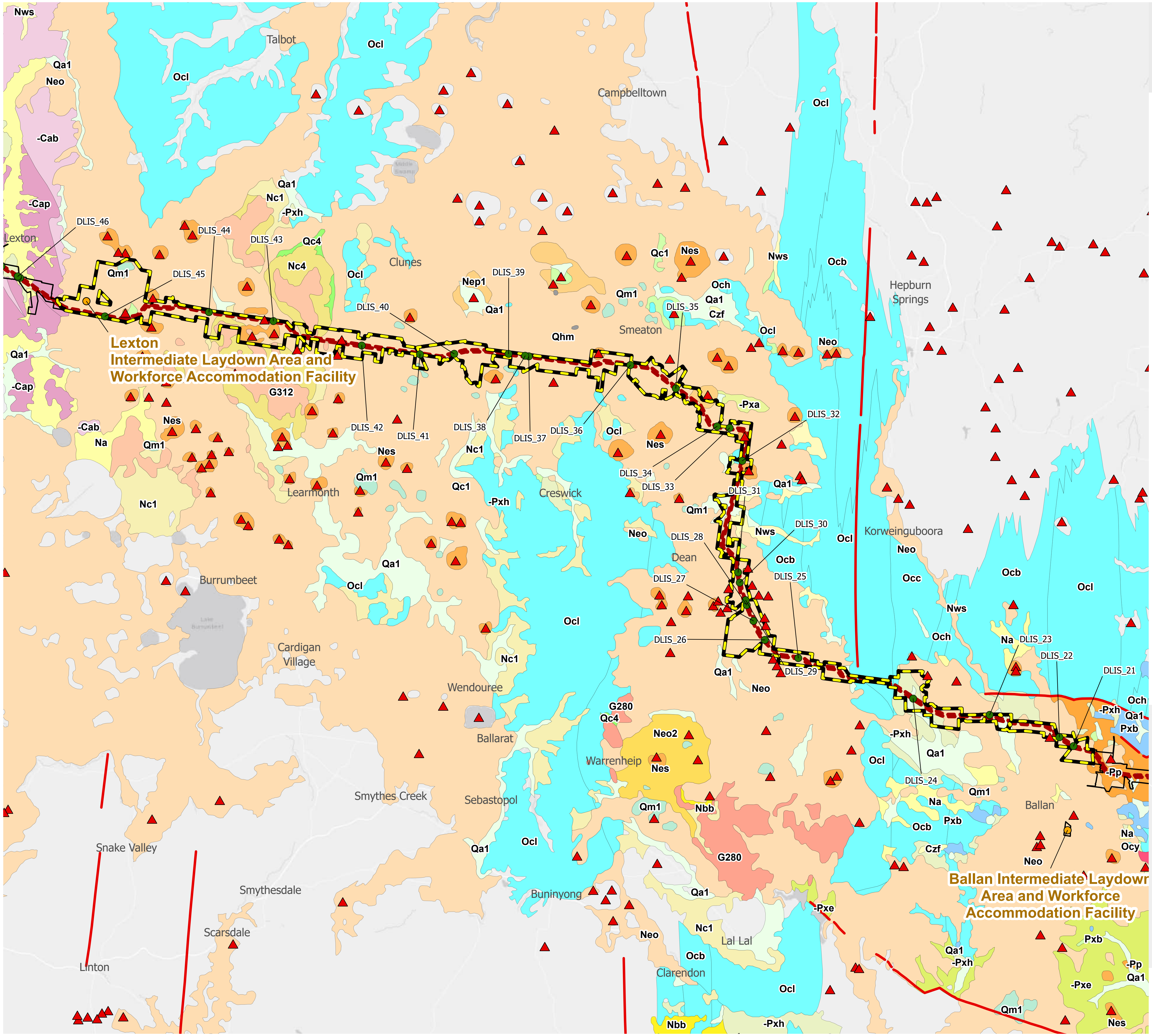
A.2.2 - Regional Geology

Western Renewables Link



- Lexton to Ballan Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings
- Volcanic eruption point
- Named fault line

Geological Units

Alluvial Deposits
- Na
- Qa1

Bacchus Marsh Formation
- Pxb

Black Rock Sandstone
- Nbb

Calivil Formation
- -Pxa

Castlemaine Group Sedimentary Units
- Ocb
- Occ
- Och
- Ocl
- Ocy

Colluvial Deposits
- Nc1
- Nc4
- Qc1
- Qc4

Duricrust
- Czf

Granite and Granodiorite
- G279
- G280
- G312

Mine and Quarry Waste Deposits
- Qhm

Newer Volcanic Group
- Neo
- Neo2
- Nep1
- Nes
- Net3

Pentland Hills Volcanic Group
- -Pp

Shepparton Formation
- Nws

St Arnaud Group Sedimentary Units
- -Cab
- -Cap

Swamp and Lake Deposits
- Qm1

Werribee Formation
- -Pxe

White Hills Gravel
- -Pxh

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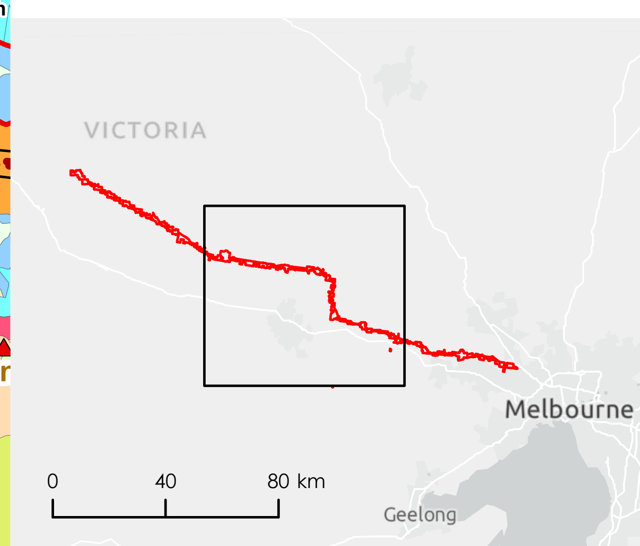

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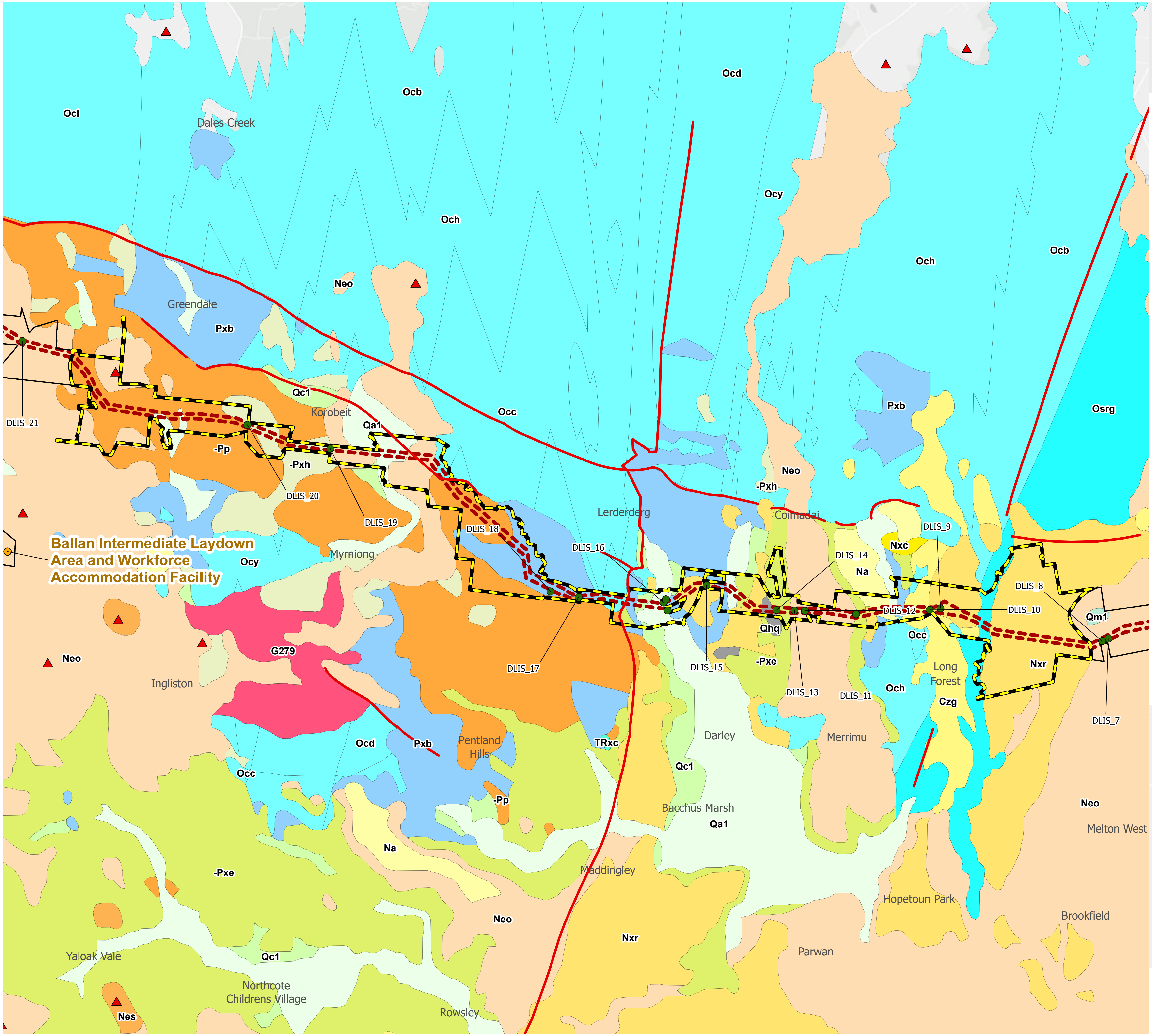
A.2.3 - Regional Geology

Western Renewables Link



- Ballan to Melton Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings
- Volcanic eruption point
- Named fault line

Geological Units

Alluvial Deposits
- Na
- Qa1

Bacchus Marsh Formation
- Pxb

Castlemaine Group Sedimentary Units
- Ocb
- Occ
- Ocd
- Och
- Ocl
- Ocy

Coimadai Shale
- Nxc

Colluvial Deposits
- Qc1

Conglomerate and Sandstone
- Czg

Council Trench Formation
- TRxc

Darley Gravel
- Nxr

Granite and Granodiorite
- G279

Mine and Quarry Waste Deposits
- Qhq

Newer Volcanic Group
- Neo
- Nes

Pentland Hills Volcanic Group
- -Pp

Riddel Sandstone Gisbornian
- Osrg

Swamp and Lake Deposits
- Qm1

Werribee Formation
- -Pxe

White Hills Gravel
- -Pxh

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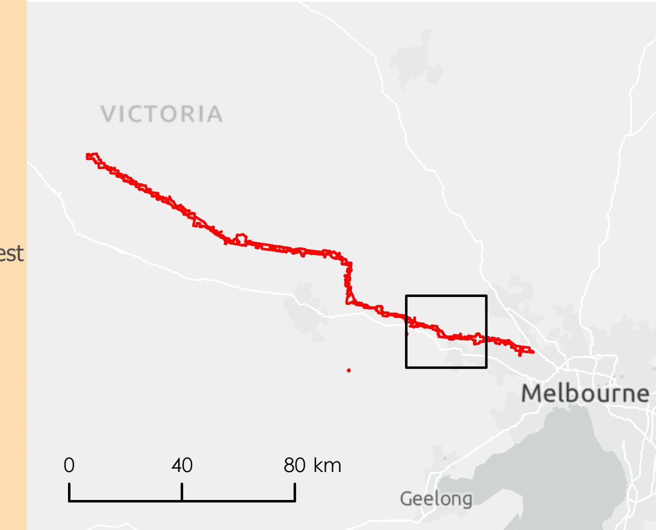

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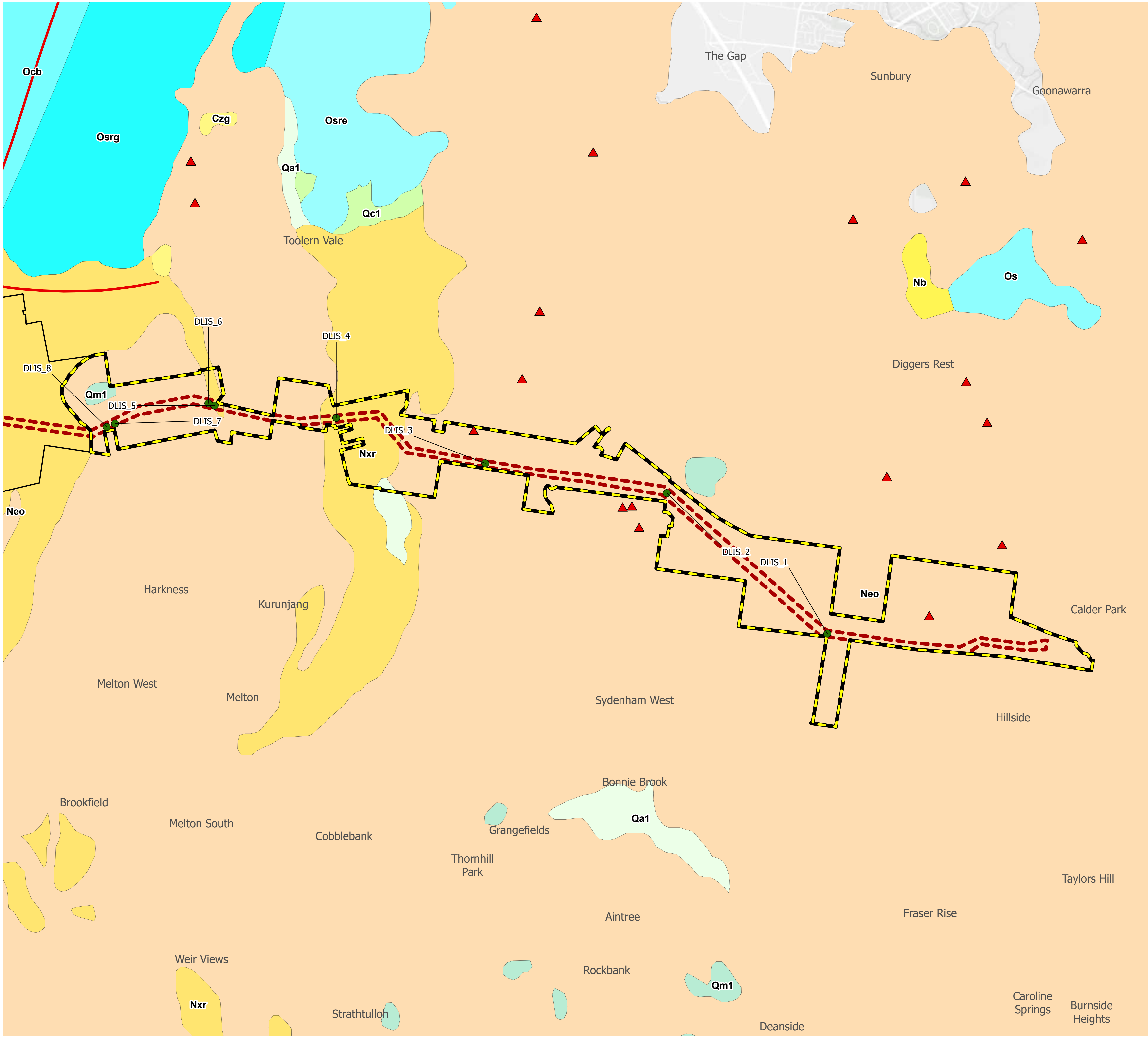
A.2.4 - Regional Geology

Western Renewables Link



Melton to Sydenham Study Area
Proposed Route
Project Land
Distribution Line - Crossings
Volcanic eruption point
Named fault line

Geological Units

Alluvial Deposits
Qa1

Brighton Group
Nb

Castlemaine Group Sedimentary Units
Ocb

Colluvial Deposits
Qc1

Conglomerate and Sandstone
Czg

Darley Gravel
Nxr

Newer Volcanic Group
Neo

Riddel Sandstone Gisbornian
Osre
Osrg

Sunbury Group
Os

Swamp and Lake Deposits
Qm1

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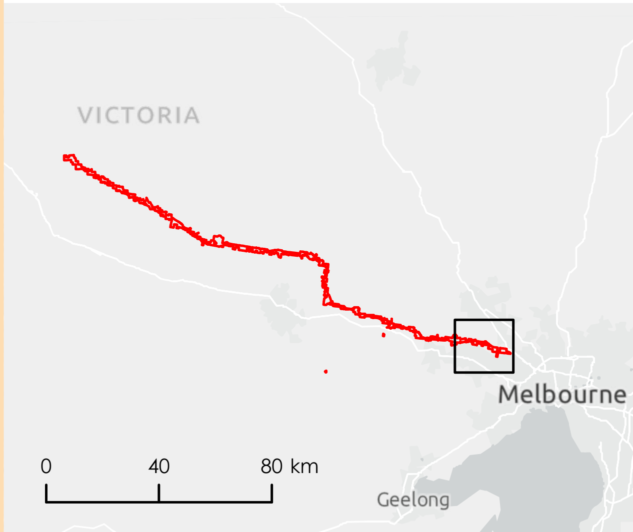

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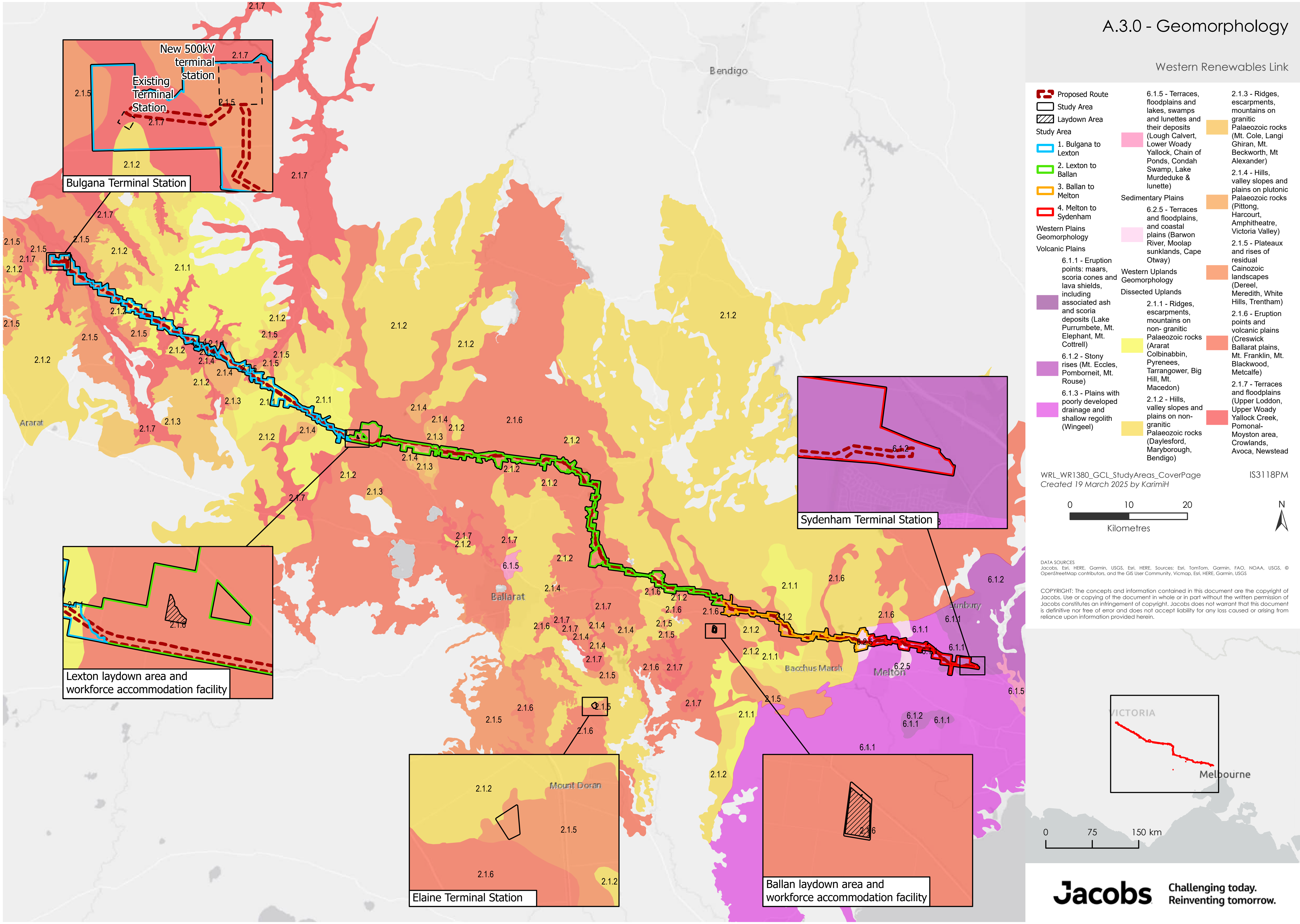
A.3.0 - Geomorphology
Western Renewables Link
Proposed Route
Study Area
Laydown Area
Study Area
1. Bulgana to Lexton
2. Lexton to Ballan
3. Ballan to Melton
4. Melton to Sydenham
Western Plains Geomorphology
Volcanic Plains
6.1.1 - Eruption points: maars, scoria cones and lava shields, including associated ash and scoria deposits (Lake Purrumbete, Mt. Elephant, Mt. Cottrell)
6.1.2 - Stony rises (Mt. Eccles, Pomborneit, Mt. Rouse)
6.1.3 - Plains with poorly developed drainage and shallow regolith (Wingeel)
6.1.5 - Terraces, floodplains and lakes, swamps and lunettes and their deposits (Lough Calvert, Lower Woady Yallock, Chain of Ponds, Condah Swamp, Lake Murdeduke & lunette)
Sedimentary Plains
6.2.5 - Terraces and floodplains, and coastal plains (Barwon River, Moolap sunklands, Cape Otway)
Western Uplands Geomorphology
Dissected Uplands
2.1.1 - Ridges, escarpments, mountains on non- granitic Palaeozoic rocks (Ararat Colbinabbin, Pyrenees, Tarrangower, Big Hill, Mt. Macedon)
2.1.2 - Hills, valley slopes and plains on non-granitic Palaeozoic rocks (Daylesford, Maryborough, Bendigo)
2.1.3 - Ridges, escarpments, mountains on granitic Palaeozoic rocks (Mt. Cole, Langi Ghiran, Mt. Beckworth, Mt Alexander)
2.1.4 - Hills, valley slopes and plains on plutonic Palaeozoic rocks (Pittong, Harcourt, Amphitheatre, Victoria Valley)
2.1.5 - Plateaux and rises of residual Cainozoic landscapes (Dereel, Meredith, White Hills, Trentham)
2.1.6 - Eruption points and volcanic plains (Creswick Ballarat plains, Mt. Franklin, Mt. Blackwood, Metcalfe)
2.1.7 - Terraces and floodplains (Upper Loddon, Upper Woady Yallock Creek, Pomonal-Moyston area, Crowlands, Avoca, Newstead
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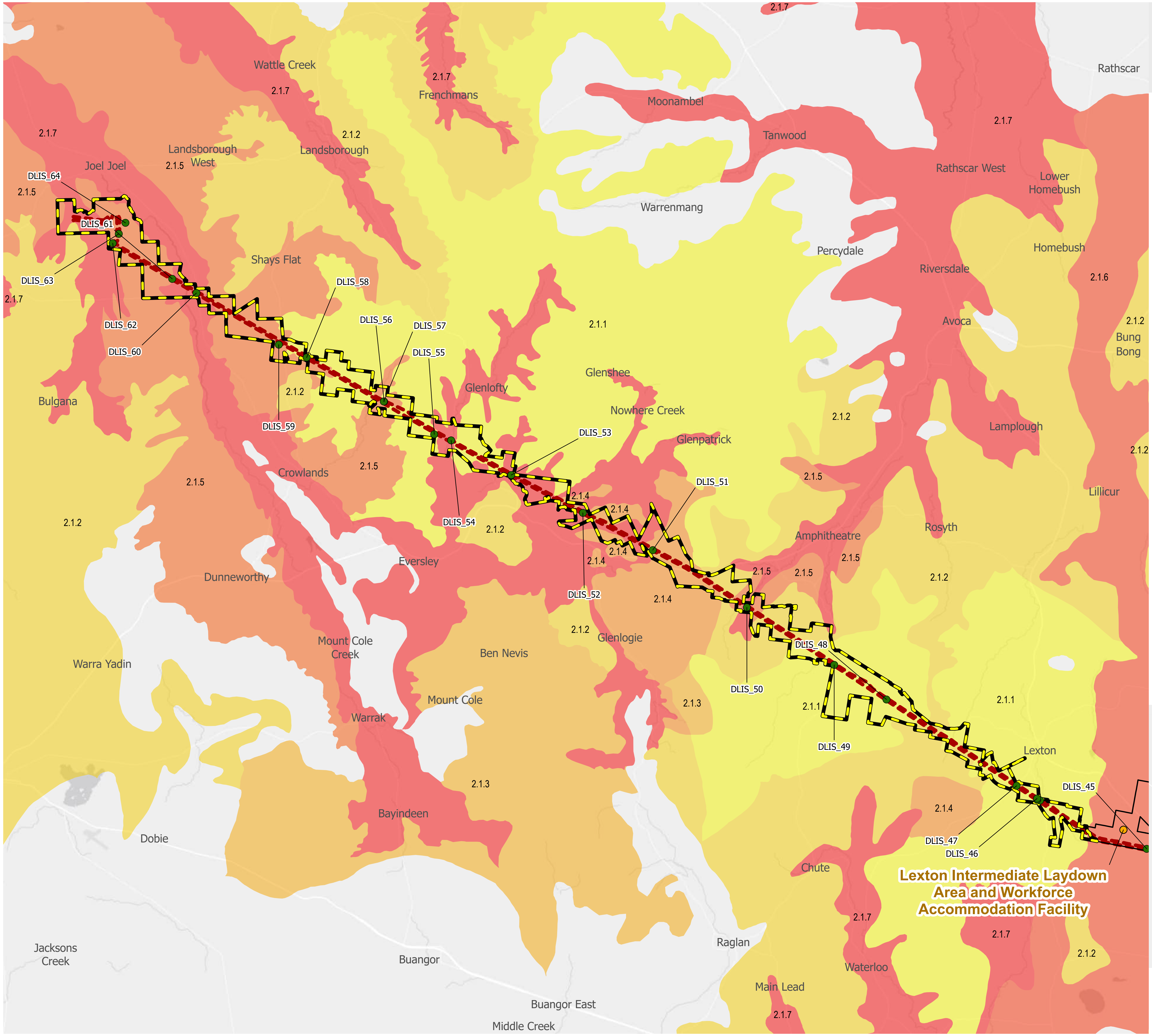
Bulgana Terminal Station
New 500kV terminal station
Existing Terminal Station
Lexton laydown area and workforce accommodation facility
Elaine Terminal Station
Mount Doran
Ballan laydown area and workforce accommodation facility
Sydenham Terminal Station
Bendigo
Ararat
Ballarat
Bacchus Marsh
Melton
Sunbury

A.3.1 - Geomorphology

Western Renewables Link



- Bulgana to Lexton Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings

Western Uplands - Dissected Uplands

- 2.1.1 - Ridges, escarpments, mountains on non- granitic Palaeozoic rocks (Ararat Colbinabbin, Pyrenees, Tarrangower, Big Hill, Mt. Macedon)
- 2.1.2 - Hills, valley slopes and plains on non-granitic Palaeozoic rocks (Daylesford, Maryborough, Bendigo)
- 2.1.3 - Ridges, escarpments, mountains on granitic Palaeozoic rocks (Mt. Cole, Langi Ghiran, Mt. Beckworth, Mt Alexander)
- 2.1.4 - Hills, valley slopes and plains on plutonic Palaeozoic rocks (Pittong, Harcourt, Amphitheatre, Victoria Valley)
- 2.1.5 - Plateaux and rises of residual Cainozoic landscapes (Dereel, Meredith, White Hills, Trentham)
- 2.1.6 - Eruption points and volcanic plains (Creswick Ballarat plains, Mt. Franklin, Mt. Blackwood, Metcalfe)
- 2.1.7 - Terraces and floodplains (Upper Loddon, Upper Woady Yallock Creek, Pomonal-Moyston area, Crowlands, Avoca, Newstead

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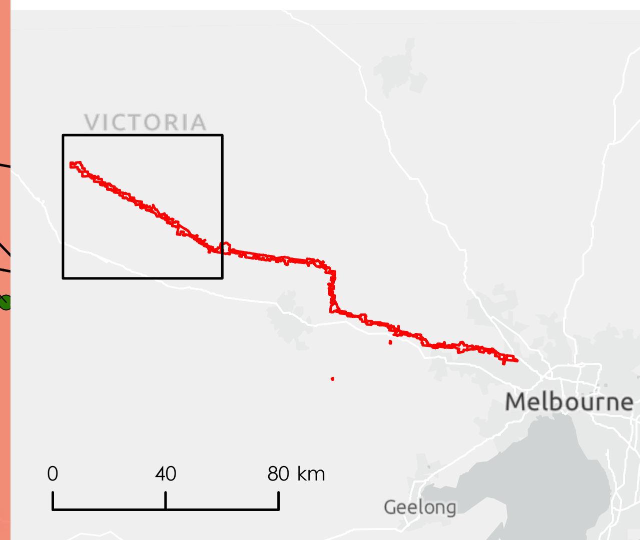

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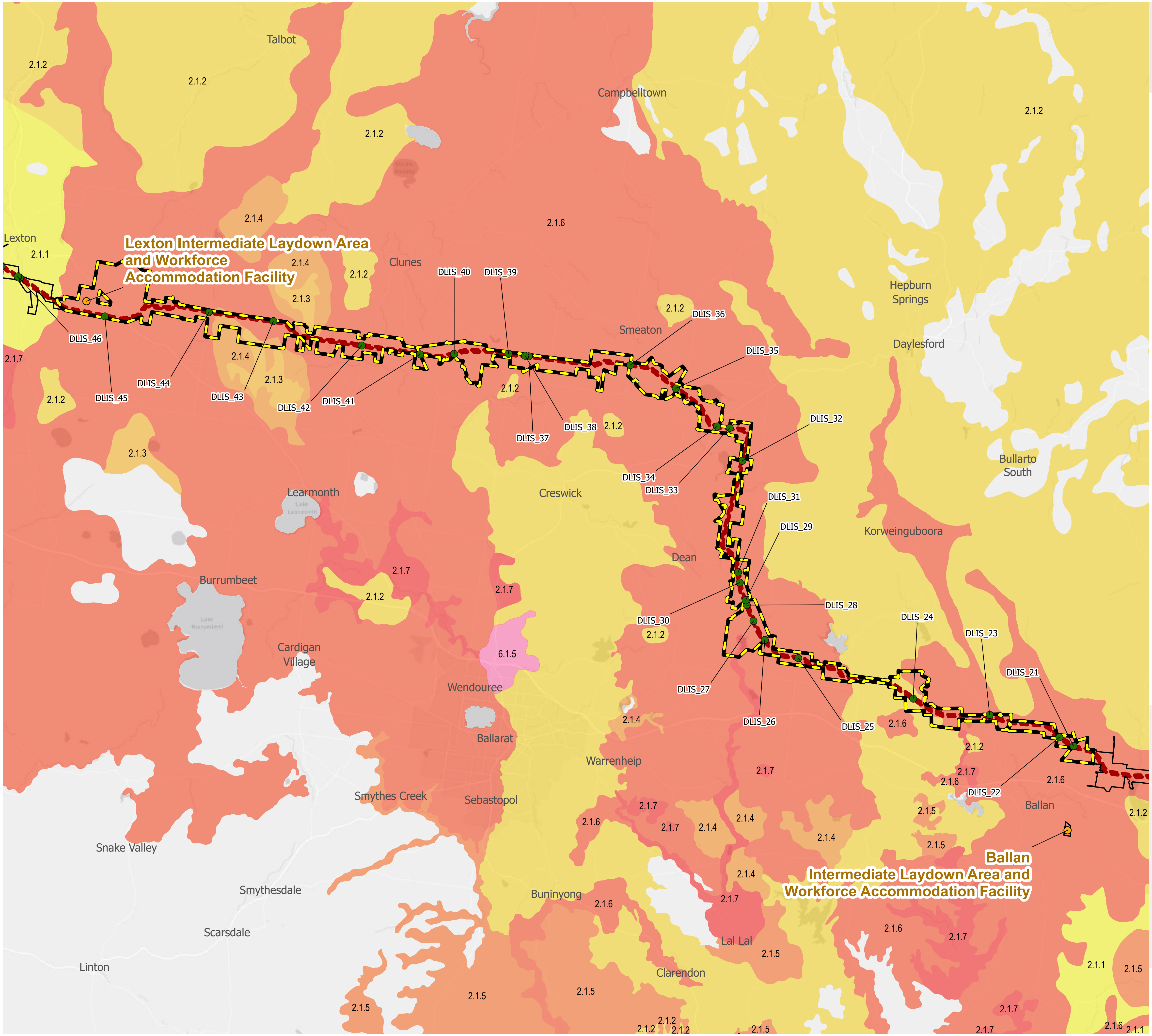
A.3.2 - Geomorphology

Western Renewables Link



- Lexton to Ballan Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings

Western Plains Geomorphology - Volcanic Plains

- 6.1.5 - Terraces, floodplains and lakes, swamps and lunettes and their deposits (Lough Calvert, Lower Woady Yallock, Chain of Ponds, Condah Swamp, Lake Murdeduke & lunette)

Western Uplands - Dissected Uplands

- 2.1.1 - Ridges, escarpments, mountains on non- granitic Palaeozoic rocks (Ararat Colbinabbin, Pyrenees, Tarrangower, Big Hill, Mt. Macedon)
- 2.1.2 - Hills, valley slopes and plains on non-granitic Palaeozoic rocks (Daylesford, Maryborough, Bendigo)
- 2.1.3 - Ridges, escarpments, mountains on granitic Palaeozoic rocks (Mt. Cole, Langi Ghiran, Mt. Beckworth, Mt Alexander)
- 2.1.4 - Hills, valley slopes and plains on plutonic Palaeozoic rocks (Pittong, Harcourt, Amphitheatre, Victoria Valley)
- 2.1.5 - Plateaux and rises of residual Cainozoic landscapes (Dereel, Meredith, White Hills, Trenthams)
- 2.1.6 - Eruption points and volcanic plains (Creswick Ballarat plains, Mt. Franklin, Mt. Blackwood, Metcalfe)
- 2.1.7 - Terraces and floodplains (Upper Loddon, Upper Woady Yallock Creek, Pomonal-Moyston area, Crowlands, Avoca, Newstead

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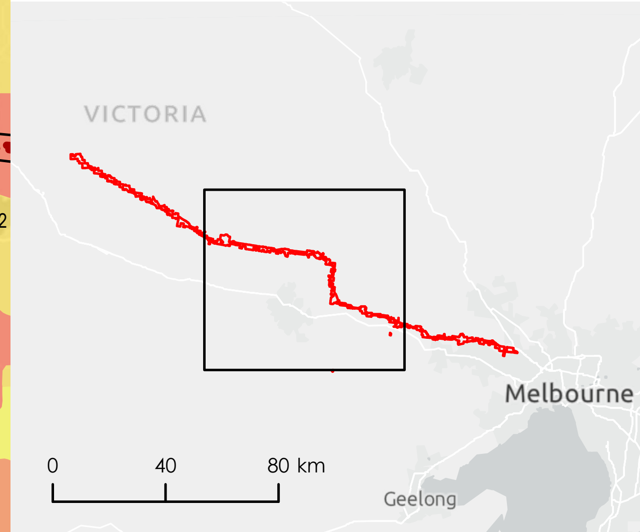

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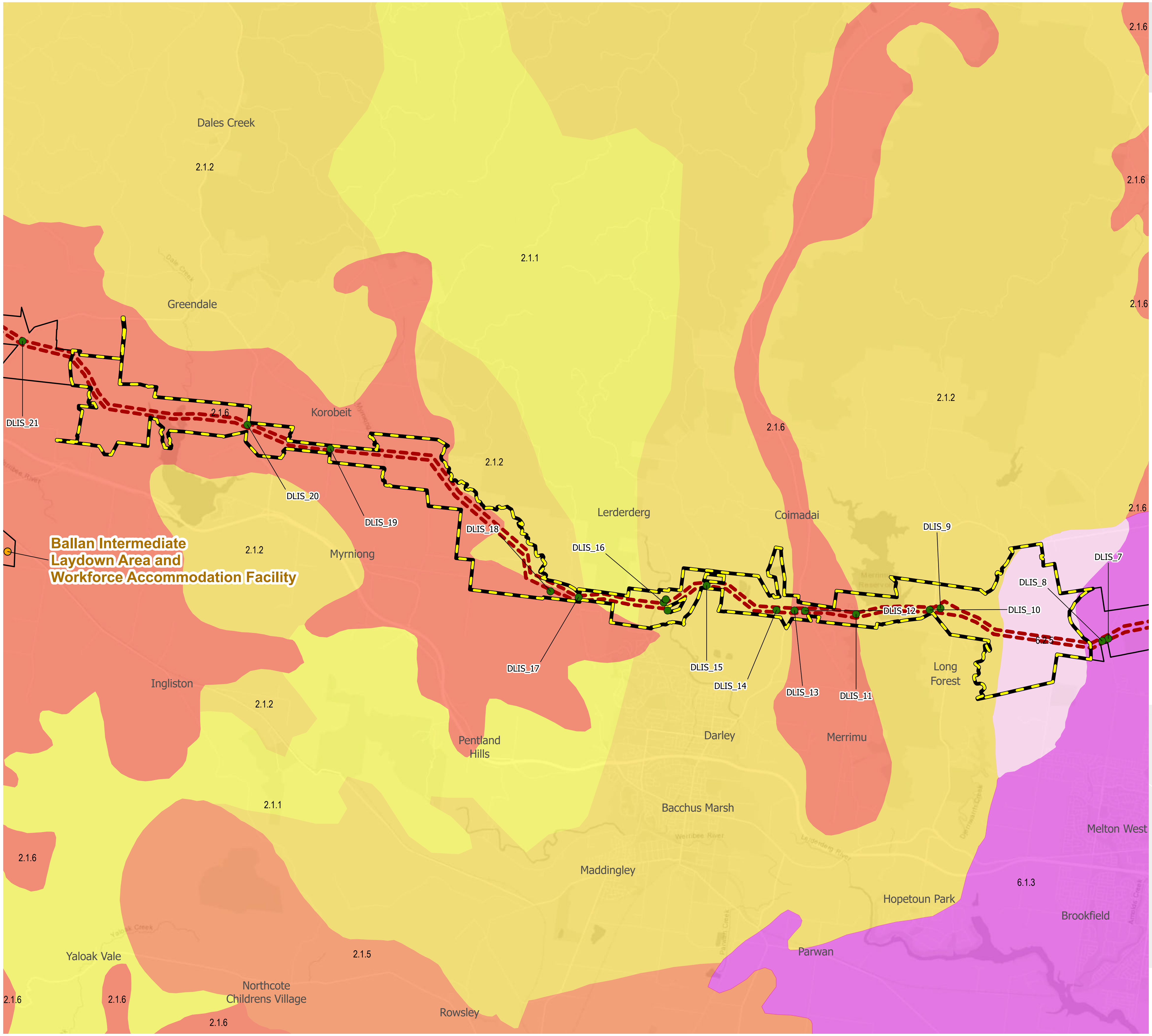
A.3.3 - Geomorphology

Western Renewables Link



- Ballan to Melton Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings

Western Plains Geomorphology - Volcanic Plains

- 6.1.3 - Plains with poorly developed drainage and shallow regolith (Wingeel)

Western Plains Geomorphology - Sedimentary Plains

- 6.2.5 - Terraces and floodplains, and coastal plains (Barwon River, Moolap sunklands, Cape Otway)

Western Uplands - Dissected Uplands

- 2.1.1 - Ridges, escarpments, mountains on non- granitic Palaeozoic rocks (Ararat Colbinabbin, Pyrenees, Tarrangower, Big Hill, Mt. Macedon)
- 2.1.2 - Hills, valley slopes and plains on non-granitic Palaeozoic rocks (Daylesford, Maryborough, Bendigo)
- 2.1.5 - Plateaux and rises of residual Cainozoic landscapes (Dereel, Meredith, White Hills, Trentham)
- 2.1.6 - Eruption points and volcanic plains (Creswick Ballarat plains, Mt. Franklin, Mt. Blackwood, Metcalfe)

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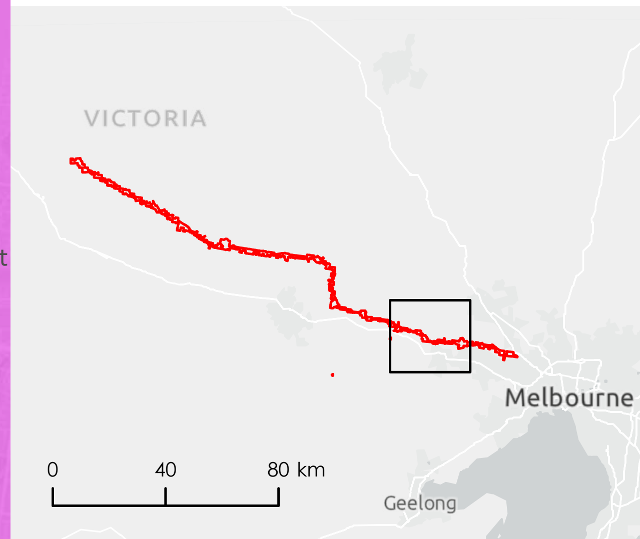

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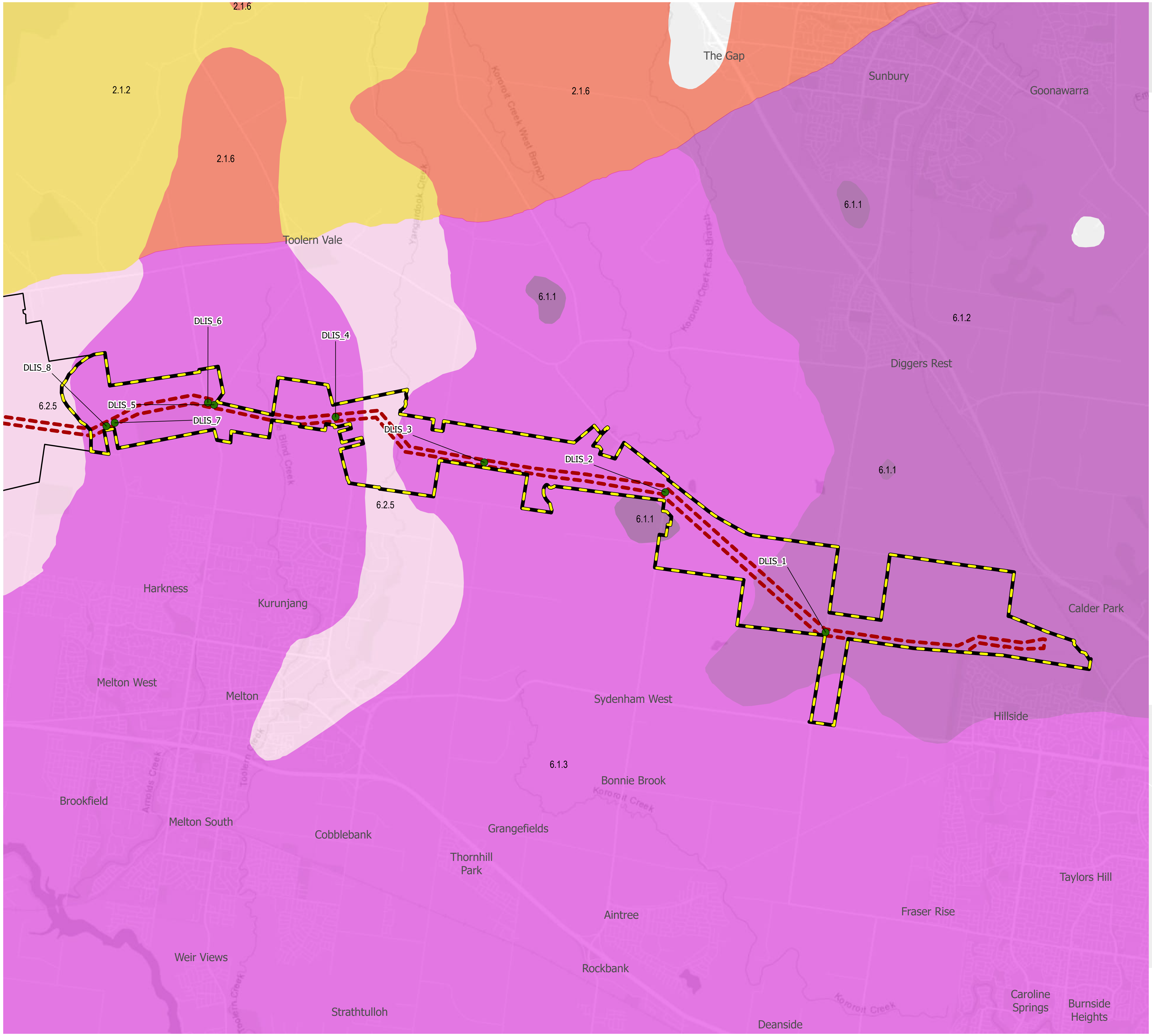
A.3.4 - Geomorphology

Western Renewables Link



- Melton to Sydenham Study Area
- Proposed Route
- Project Land
- Distribution Line - Crossings

Western Plains Geomorphology - Volcanic Plains

- 6.1.1 - Eruption points: maars, scoria cones and lava shields, including associated ash and scoria deposits (Lake Purrumbete, Mt. Elephant, Mt. Cottrell)
- 6.1.2 - Stony rises (Mt. Eccles, Pomborneit, Mt. Rouse)
- 6.1.3 - Plains with poorly developed drainage and shallow regolith (Wingeel)

Western Plains Geomorphology - Sedimentary Plains

- 6.2.5 - Terraces and floodplains, and coastal plains (Barwon River, Moolap sunklands, Cape Otway)

Western Uplands - Dissected Uplands

- 2.1.2 - Hills, valley slopes and plains on non-granitic Palaeozoic rocks (Daylesford, Maryborough, Bendigo)
- 2.1.6 - Eruption points and volcanic plains (Creswick Ballarat plains, Mt. Franklin, Mt. Blackwood, Metcalfe)

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0 1.5 3
Kilometres
N

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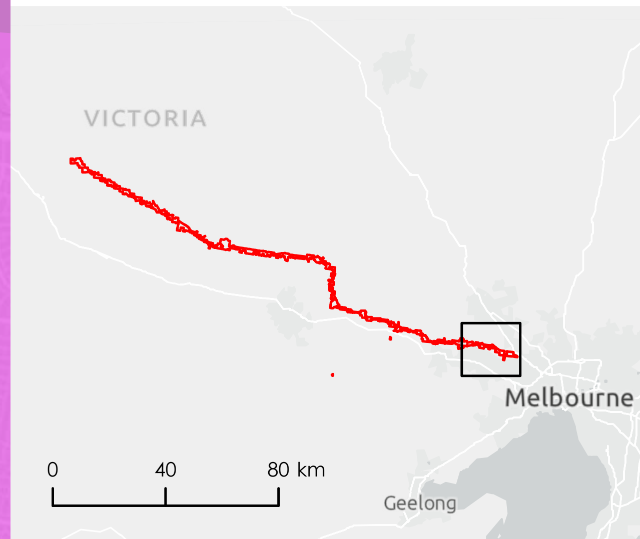

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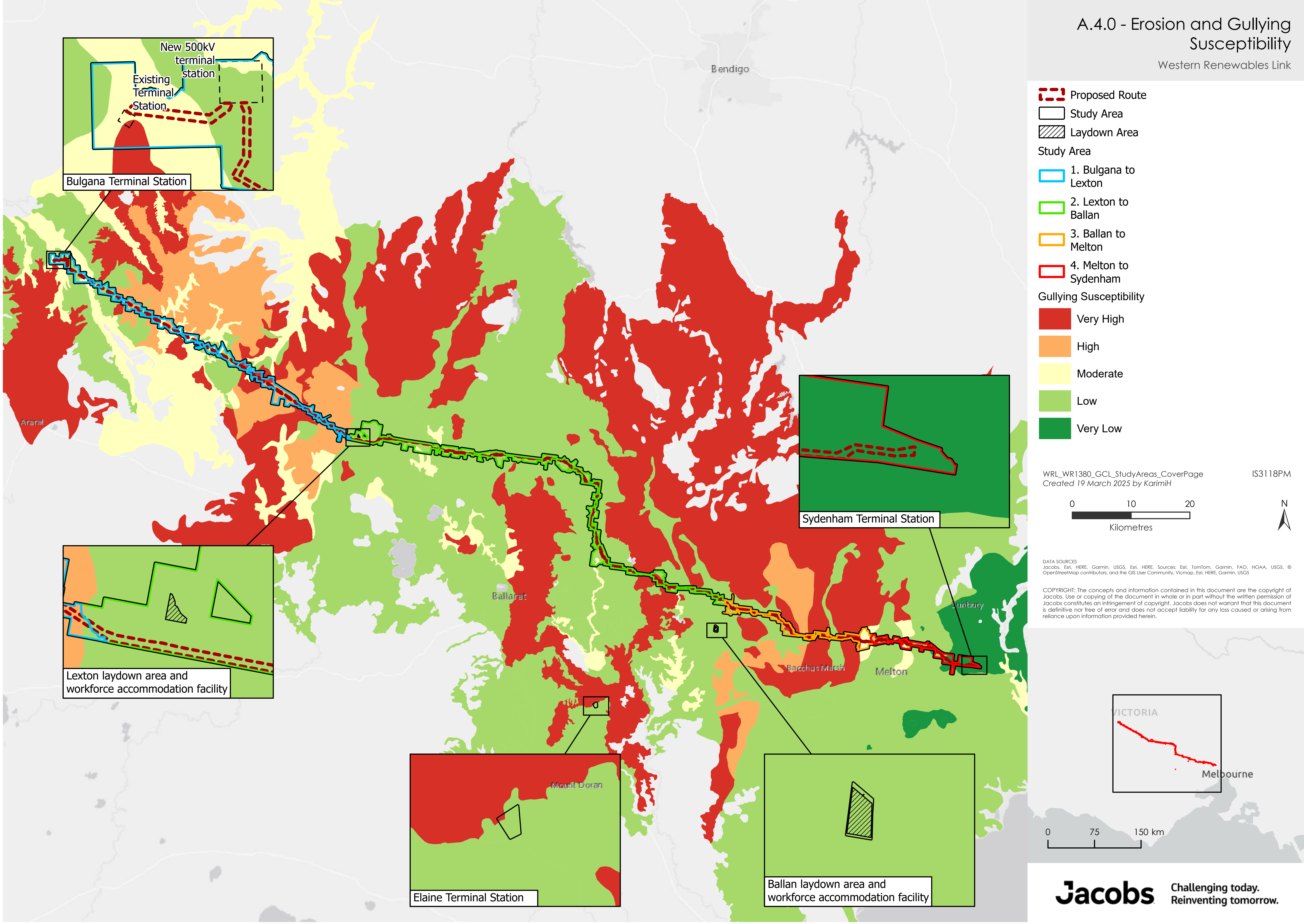
A.4.0 - Erosion and Gullying Susceptibility

Western Renewables Link



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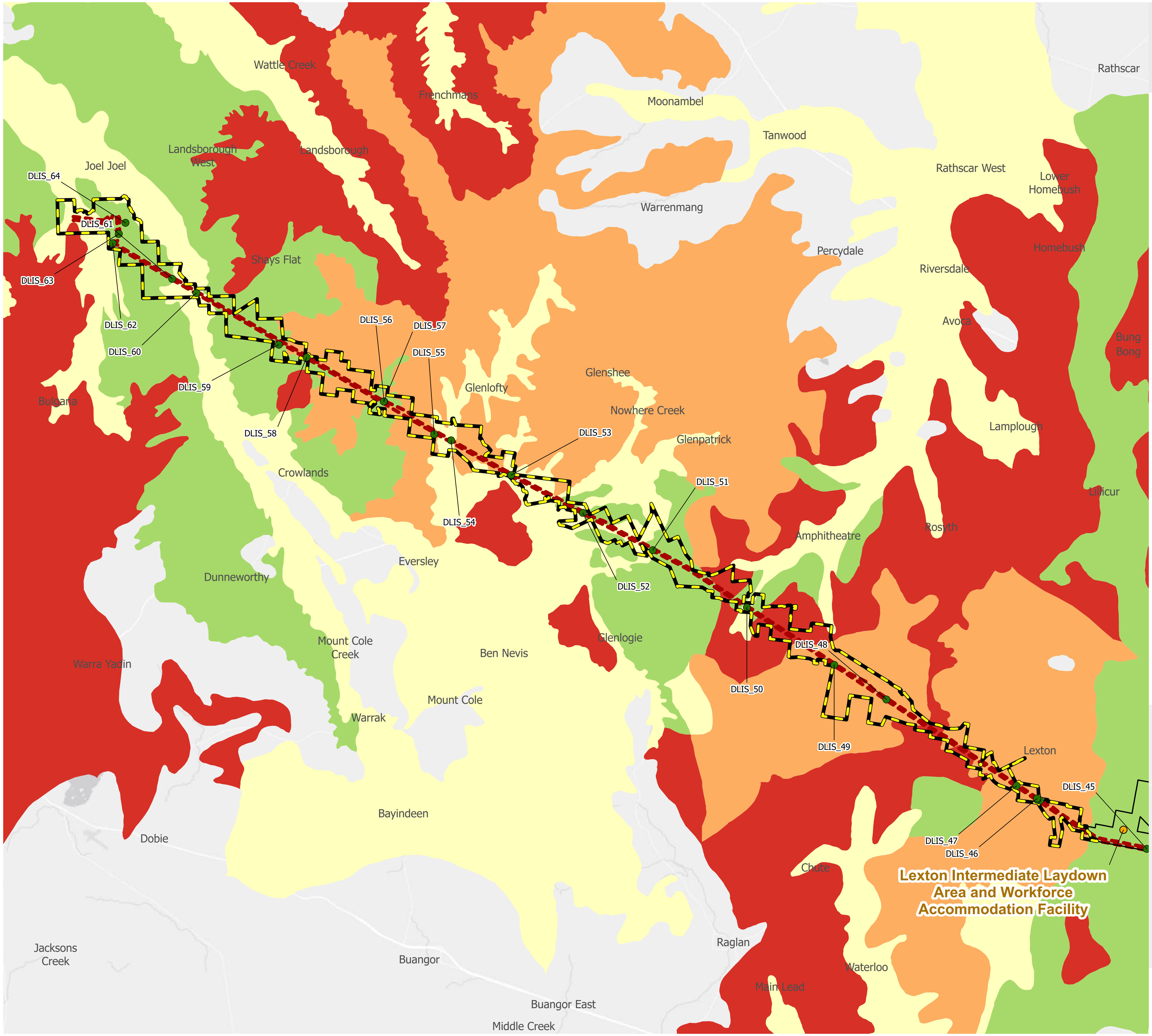
A.4.1 - Erosion and Gullying Susceptibility

Western Renewables Link



- Bulgana to Lexton Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings

Gullying Susceptibility

- Very High
- High
- Moderate
- Low

WRL_WR1380_GCL_StudyAreas

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Kilometres

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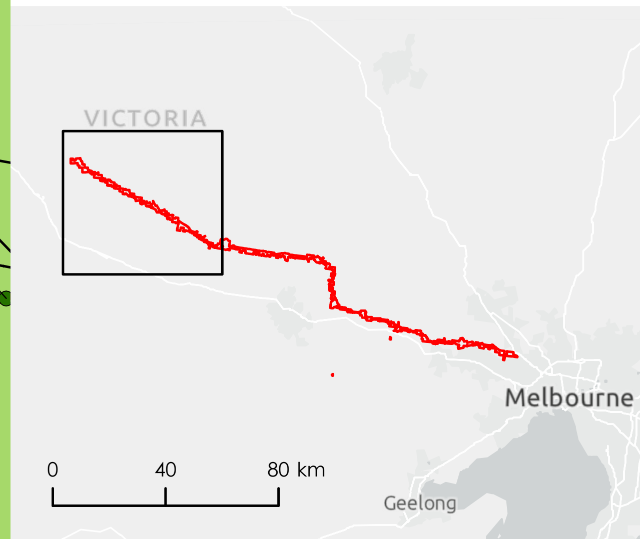

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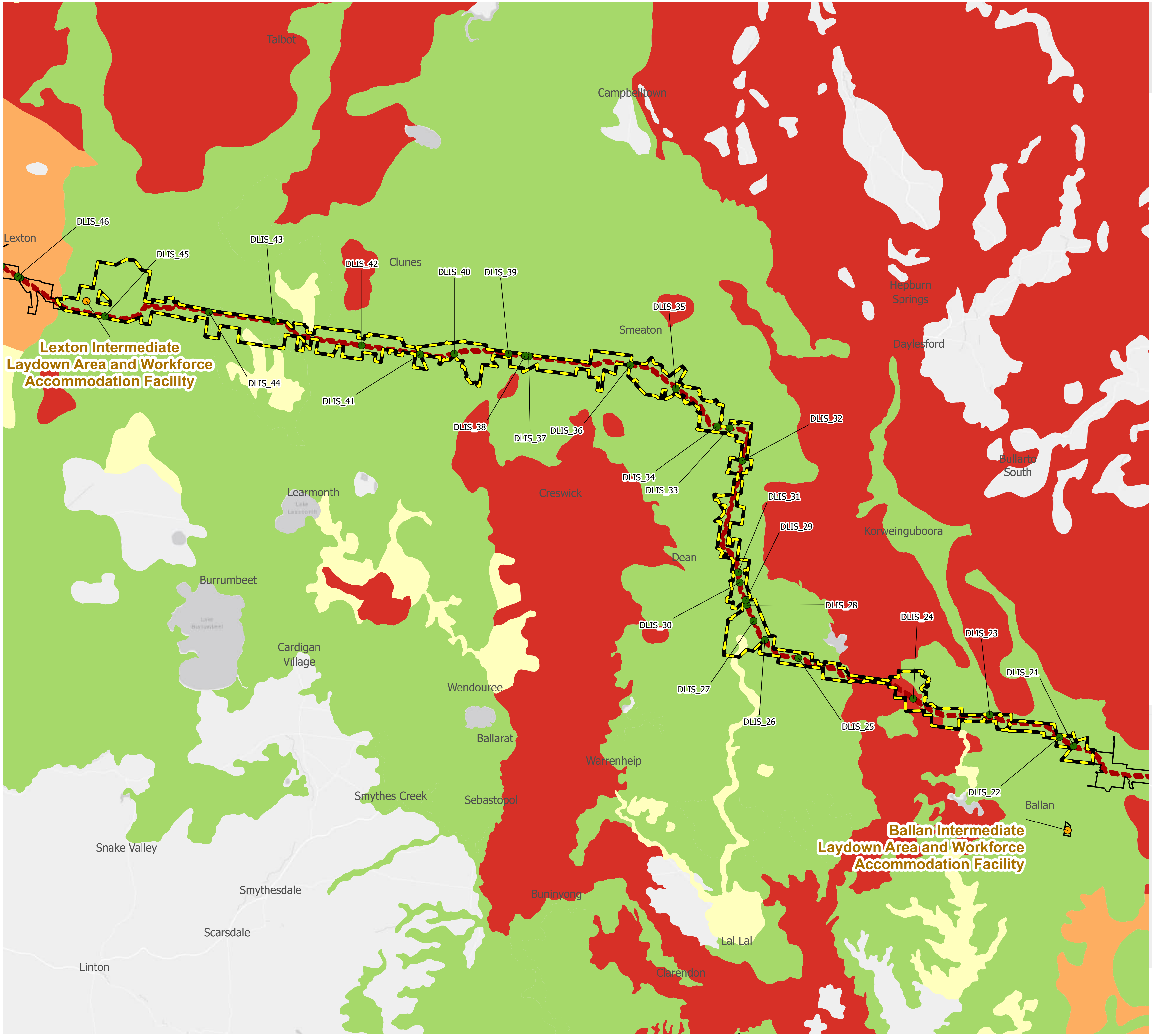
A.4.2 - Erosion and Gullying Susceptibility

Western Renewables Link



Lexton to Ballan Study Area
Proposed Route
Project Land
Laydown Area and Workforce Accommodation Facility
Distribution Line - Crossings

Gullying Susceptibility

Very High
High
Moderate
Low

WRL_WR1380_GCL_StudyAreas
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Kilometres

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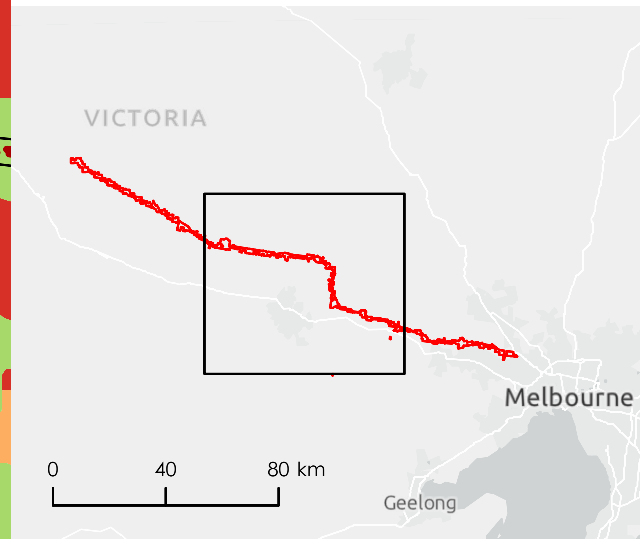

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A.4.3 - Erosion and Gullying Susceptibility

Western Renewables Link

- Ballan to Melton Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings

Gullying Susceptibility

- Very High
- High
- Moderate
- Low

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Kilometres

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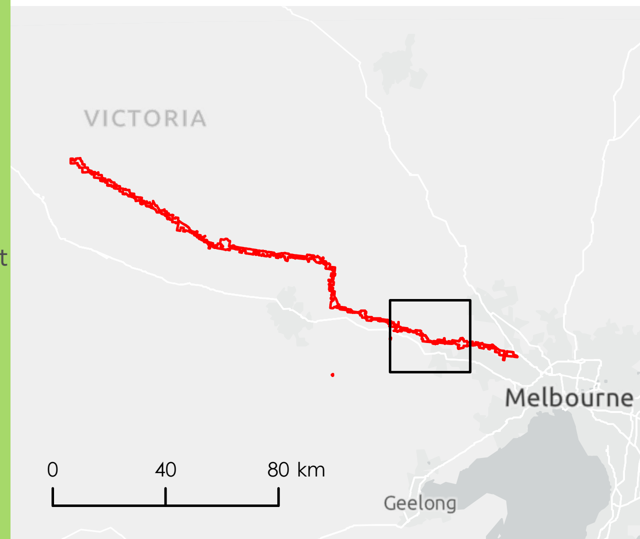

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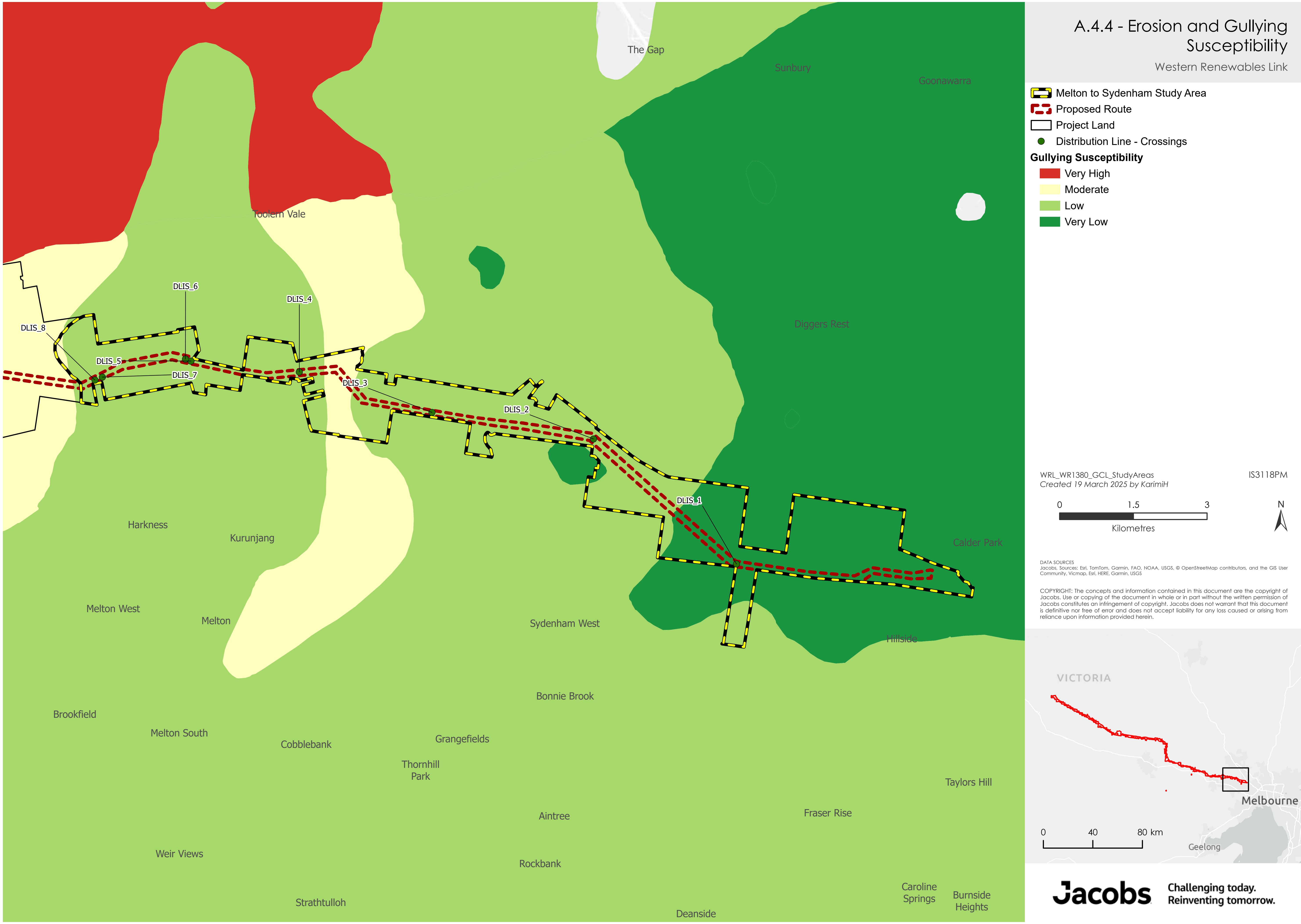

A.4.4 - Erosion and Gullying Susceptibility
Western Renewables Link
Melton to Sydenham Study Area
Proposed Route
Project Land
Distribution Line - Crossings
Gullying Susceptibility
Very High
Moderate
Low
Very Low
WRL_WR1380_GCL_StudyAreas
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Kilometres
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The Gap
Sunbury
Goonawarra
Toolern Vale
Diggers Rest
DLIS_6
DLIS_4
DLIS_8
DLIS_5
DLIS_7
DLIS_3
DLIS_2
DLIS_1
Calder Park
Harkness
Kurunjang
Melton West
Melton
Sydenham West
Hillside
Bonnie Brook
Brookfield
Melton South
Cobblebank
Grangefields
Thornhill Park
Taylors Hill
Aintree
Fraser Rise
Weir Views
Rockbank
Caroline Springs
Burnside Heights
Strathtulloh
Deanside
VICTORIA
Melbourne
Geelong
0
40
80 km
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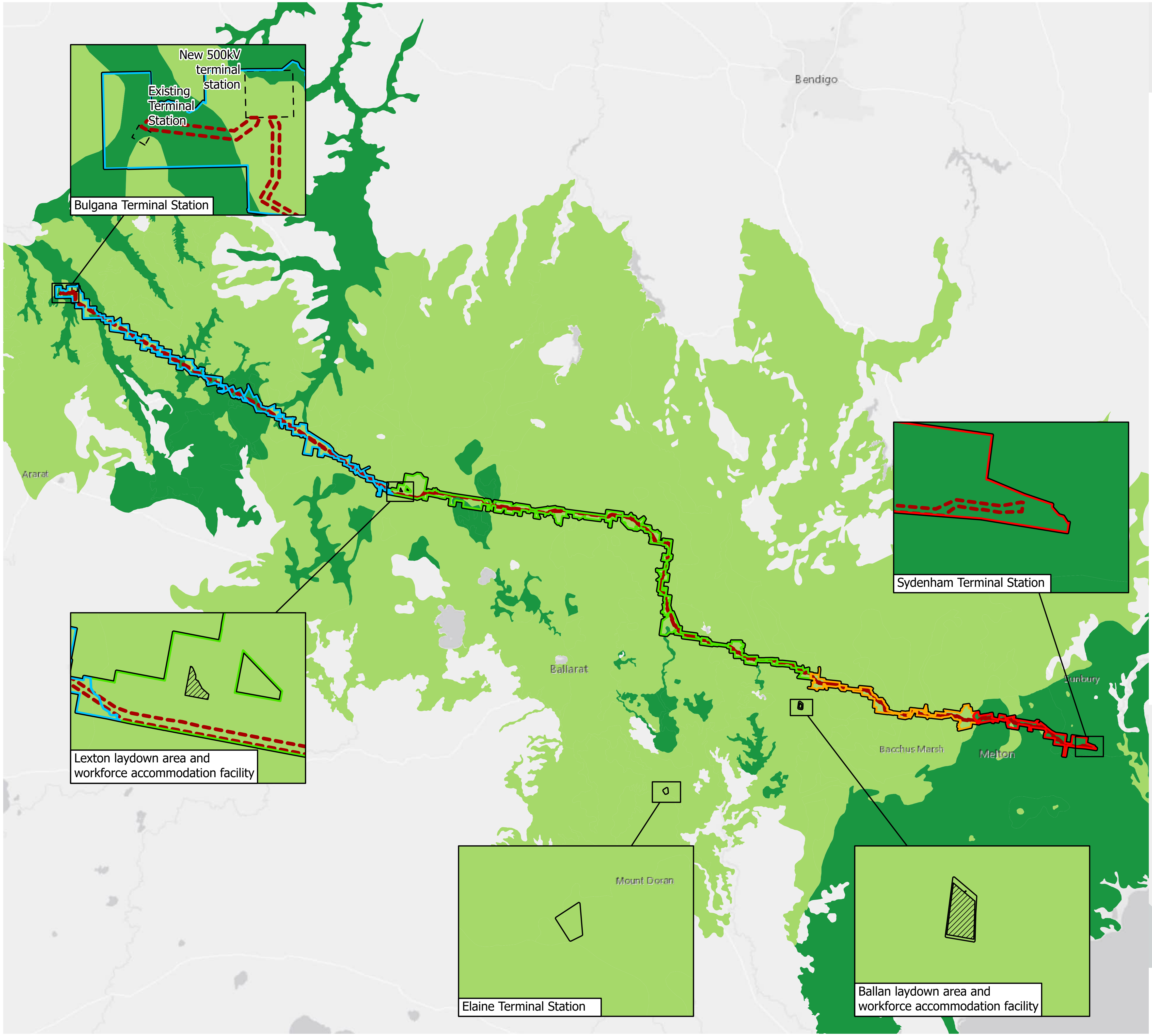
A.5.0 - Landslide Susceptibility

Western Renewables Link



Proposed Route
Study Area
Laydown Area

Study Area
1. Bulgana to Lexton
2. Lexton to Ballan
3. Ballan to Melton
4. Melton to Sydenham

Landslide Susceptibility
Low
Very Low

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Kilometres

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A.5.1 - Landslide Susceptibility

Western Renewables Link

Bulgana to Lexton Study Area
Proposed Route
Project Land
Laydown Area and Workforce Accommodation Facility
Distribution Line - Crossings

Landslide Susceptibility

Low
Very Low

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Kilometres

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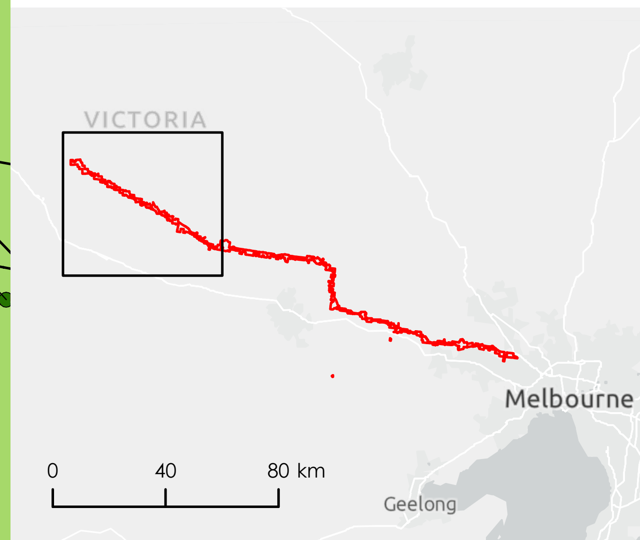

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A.5.2 - Landslide Susceptibility

Western Renewables Link

Lexton to Ballan Study Area
Proposed Route
Project Land
Laydown Area and Workforce Accommodation Facility
Distribution Line - Crossings

Landslide Susceptibility

Low
Very Low

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Kilometres

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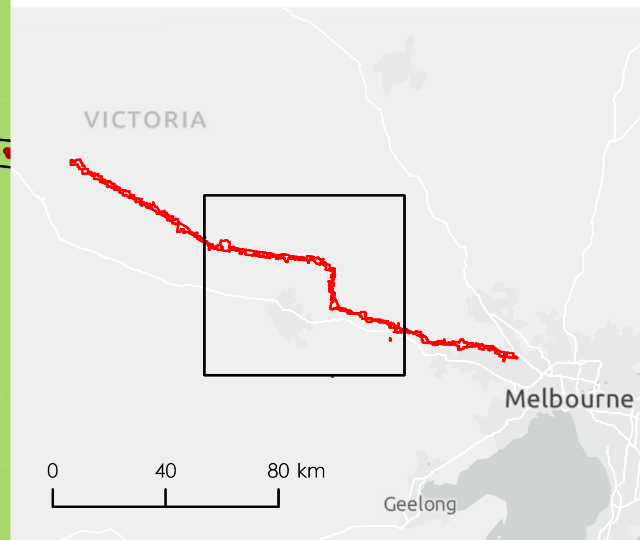

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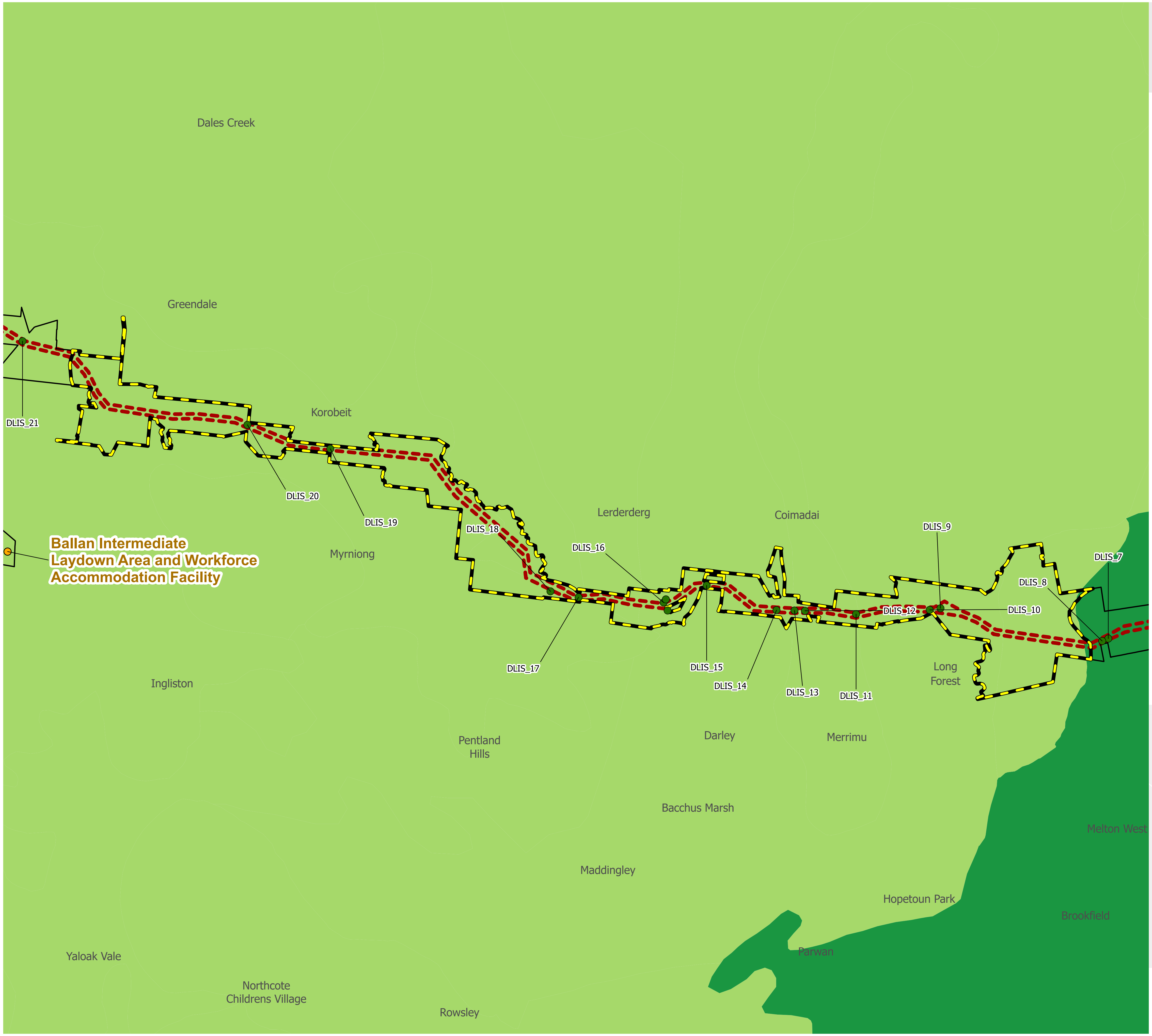
A.5.3 - Landslide Susceptibility

Western Renewables Link



Ballan to Melton Study Area
Proposed Route
Project Land
Laydown Area and Workforce Accommodation Facility
Distribution Line - Crossings

Landslide Susceptibility

Low
Very Low

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Kilometres
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A.5.4 - Landslide Susceptibility

Western Renewables Link

- Melton to Sydenham Study Area
- Proposed Route
- Project Land
- Distribution Line - Crossings

Landslide Susceptibility

- Low
- Very Low

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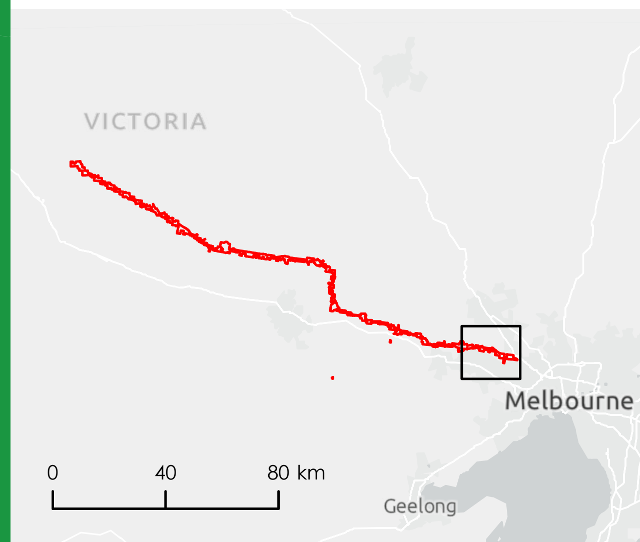

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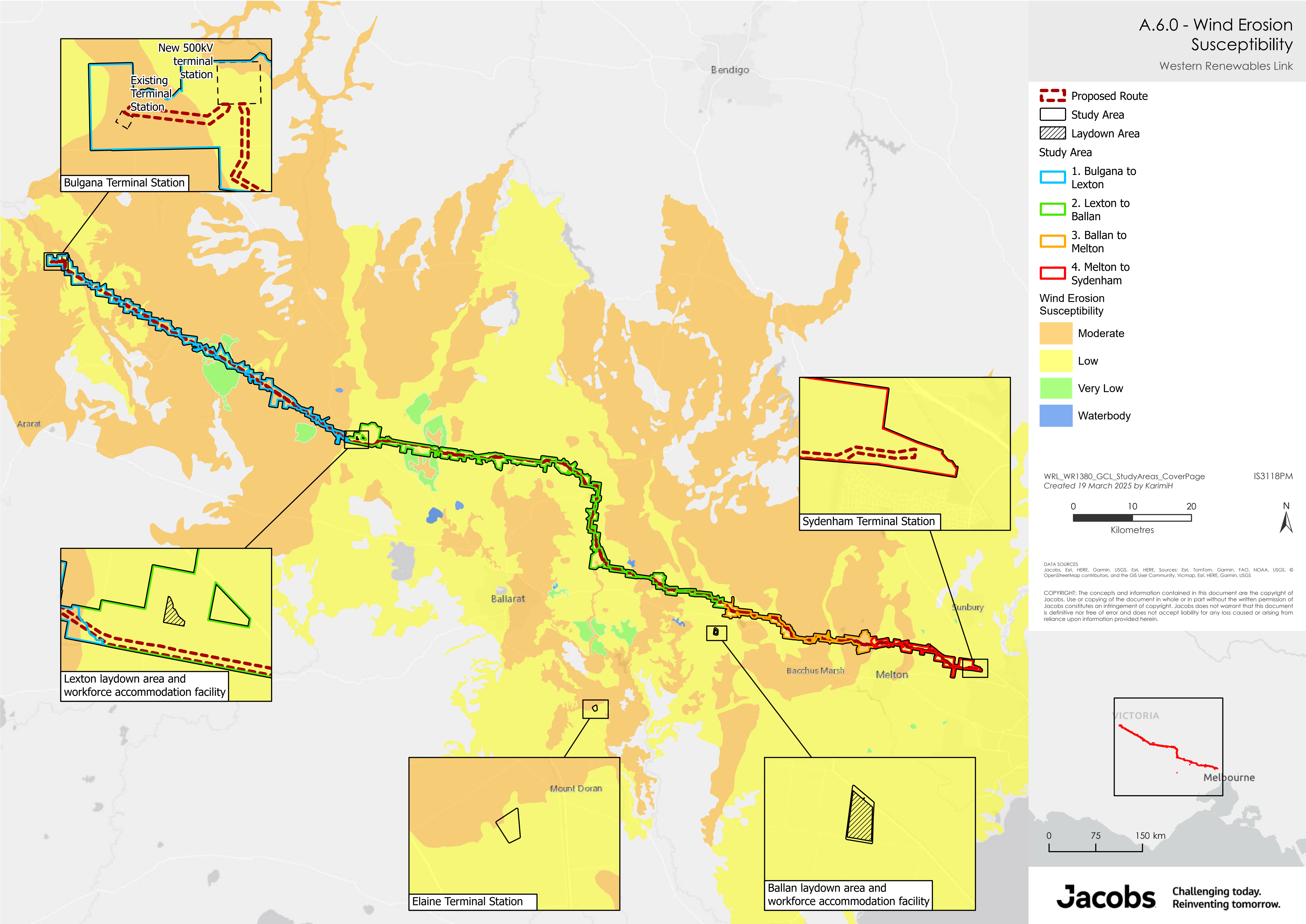

A.6.0 - Wind Erosion Susceptibility
Western Renewables Link
Proposed Route
Study Area
Laydown Area
Study Area
1. Bulgana to Lexton
2. Lexton to Ballan
3. Ballan to Melton
4. Melton to Sydenham
Wind Erosion Susceptibility
Moderate
Low
Very Low
Waterbody
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0
10
20
Kilometres
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VICTORIA
Melbourne
0
75
150 km
Bendigo
Ararat
Ballarat
Sunbury
Bacchus Marsh
Melton
New 500kV terminal station
Existing Terminal Station
Bulgana Terminal Station
Lexton laydown area and workforce accommodation facility
Sydenham Terminal Station
Mount Doran
Elaine Terminal Station
Ballan laydown area and workforce accommodation facility

A.6.1 - Wind Erosion Susceptibility

Western Renewables Link

Bulgana to Lexton Study Area
Proposed Route
Project Land
Laydown Area and Workforce Accommodation Facility
Distribution Line - Crossings

Wind Erosion Susceptibility

Moderate
Low
Very Low
Waterbody

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Kilometres

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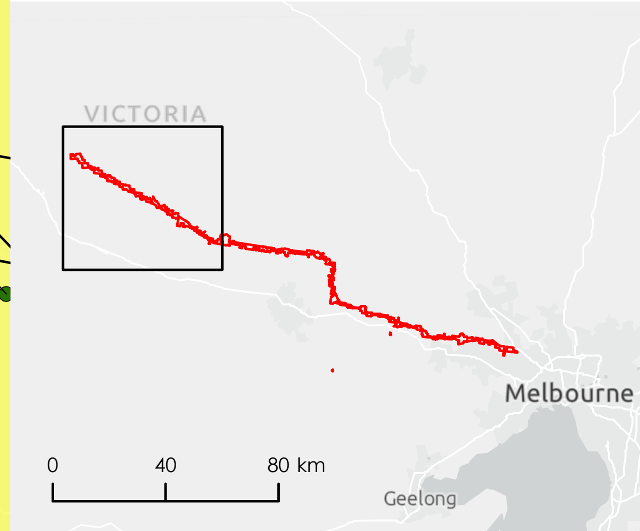

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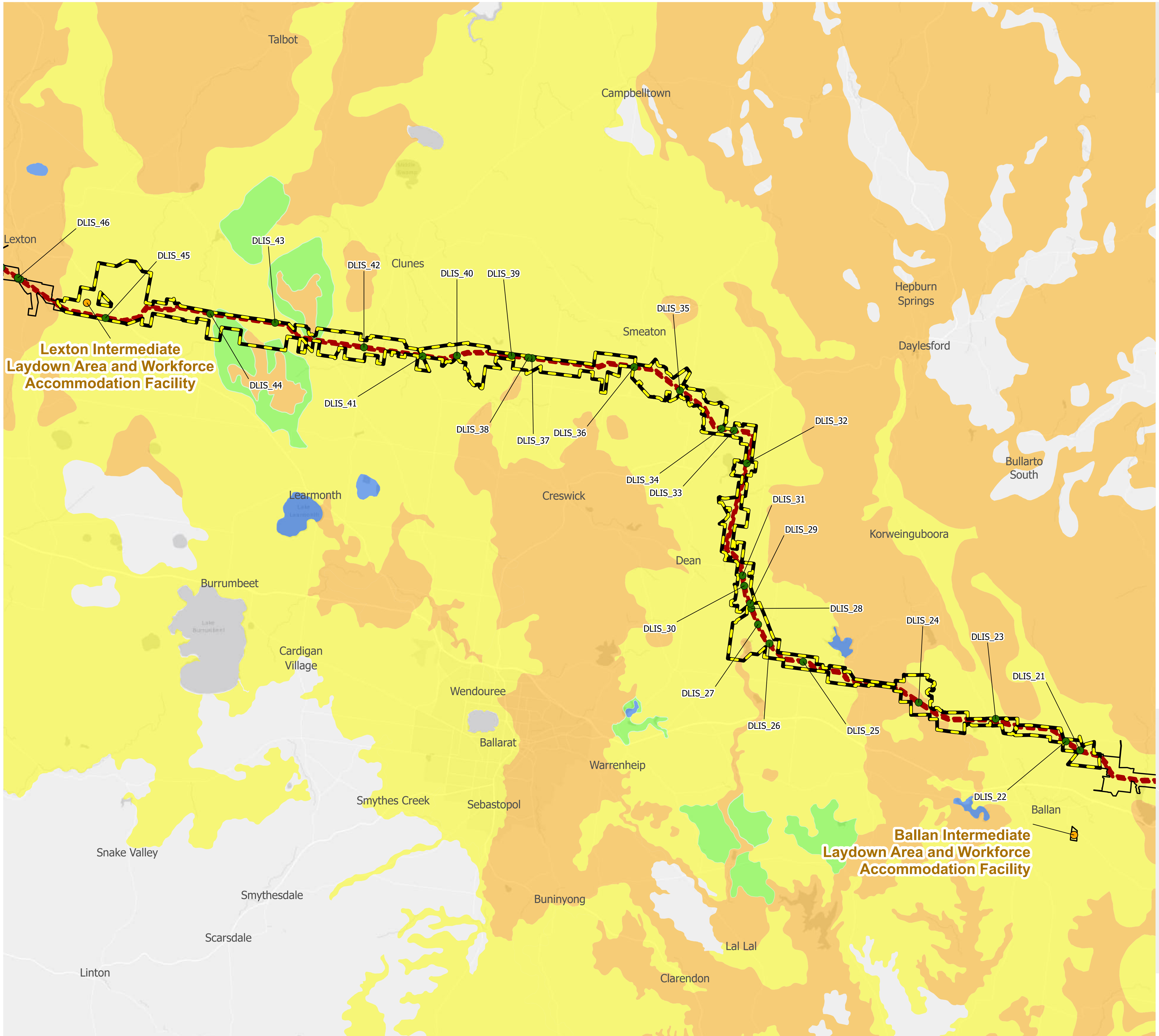
A.6.2 - Wind Erosion Susceptibility

Western Renewables Link



Lexton to Ballan Study Area
Proposed Route
Project Land
Laydown Area and Workforce Accommodation Facility
Distribution Line - Crossings

Wind Erosion Susceptibility

Moderate
Low
Very Low
Waterbody

WRL_WR1380_GCL_StudyAreas IS3118PM
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0 6 12
Kilometres

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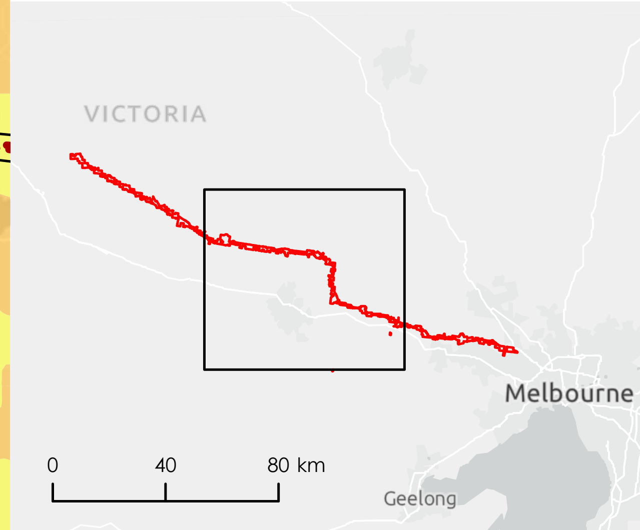

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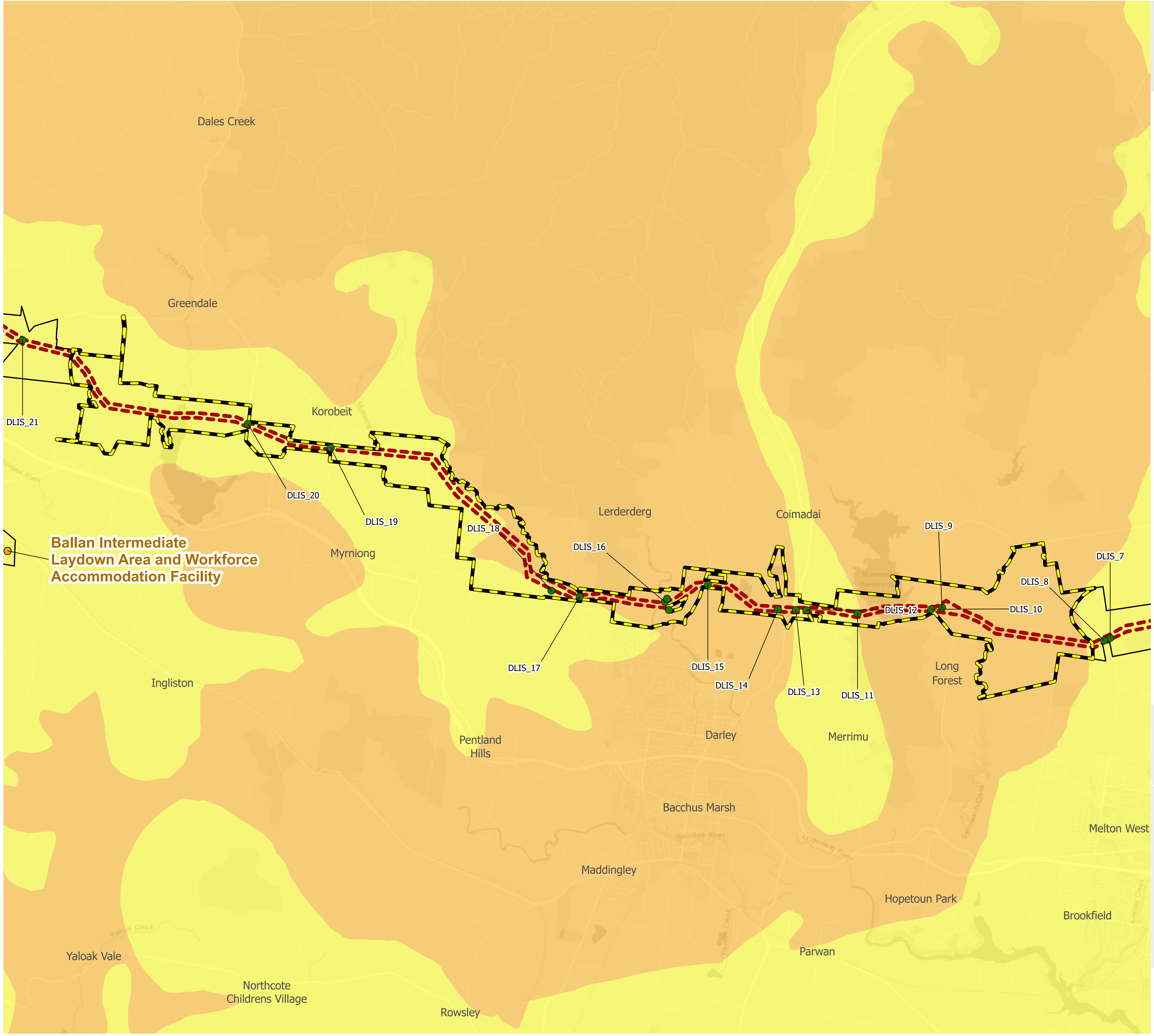
A.6.3 - Wind Erosion Susceptibility

Western Renewables Link



Ballan to Melton Study Area
Proposed Route
Project Land
Laydown Area and Workforce Accommodation Facility
Distribution Line - Crossings

Wind Erosion Susceptibility

Moderate
Low

WRL_WR1380_GCL_StudyAreas
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0 2.5 5
Kilometres

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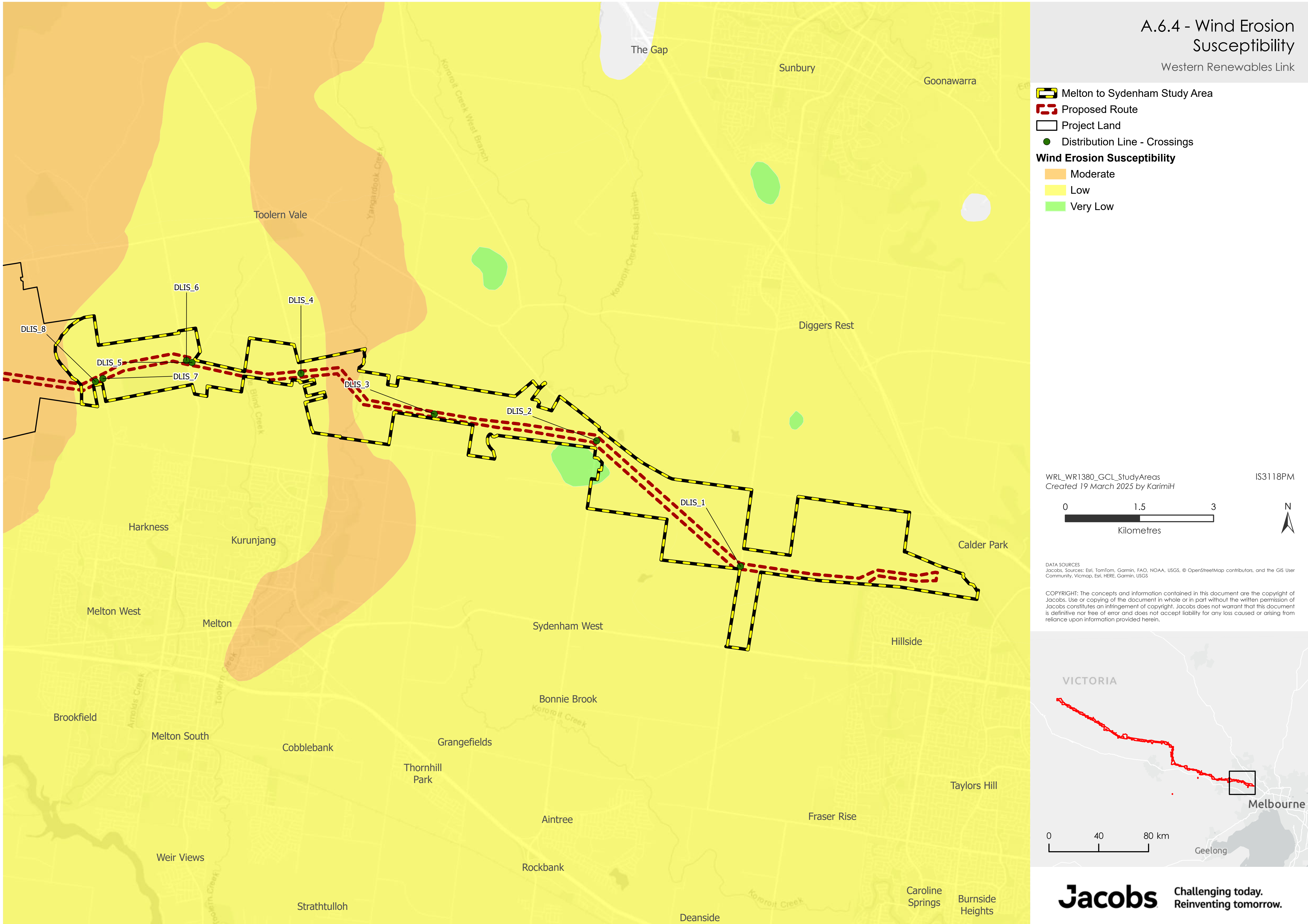
A.6.4 - Wind Erosion Susceptibility

Western Renewables Link



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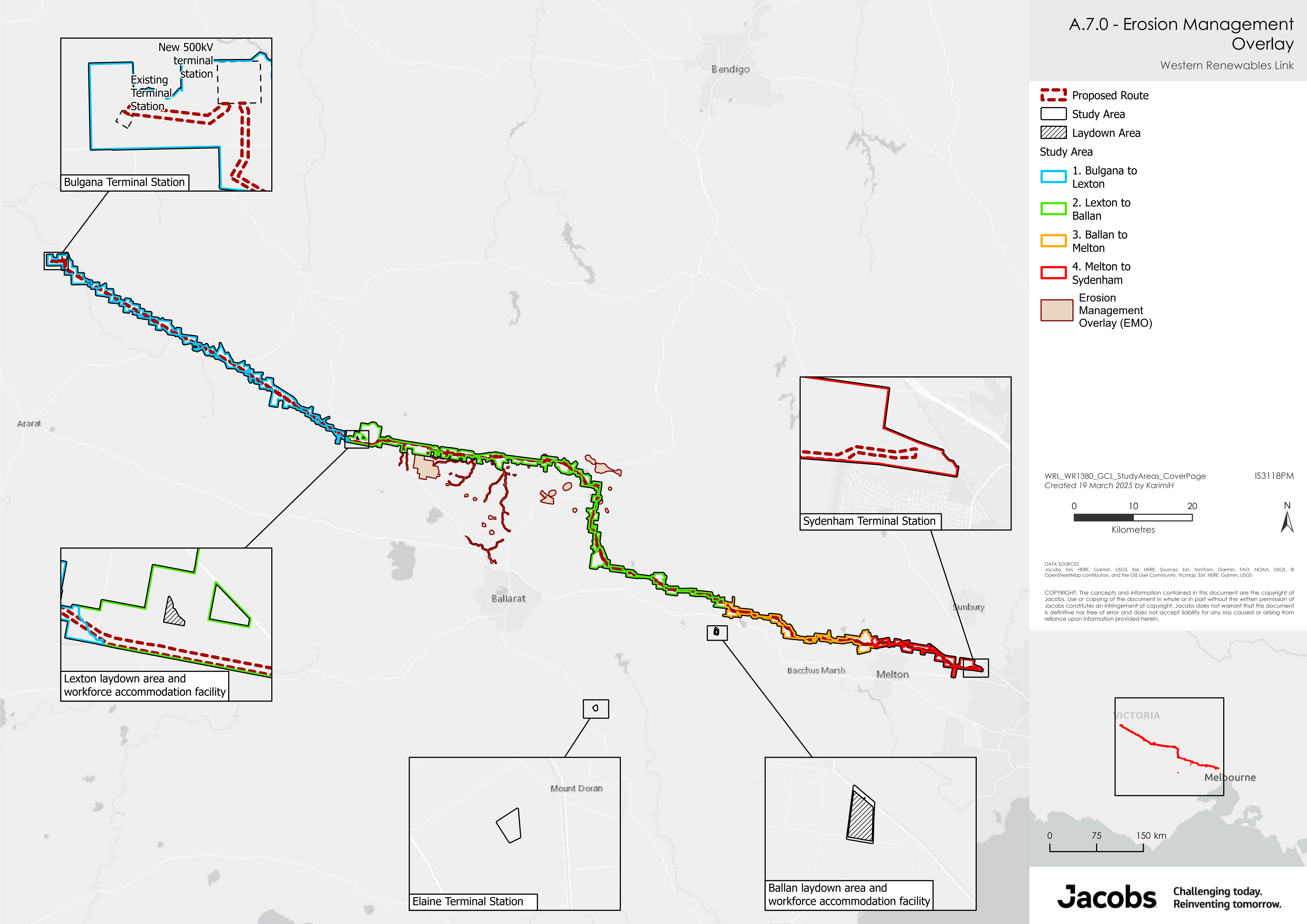

A.7.0 - Erosion Management Overlay
Western Renewables Link
Proposed Route
Study Area
Laydown Area
Study Area
1. Bulgana to Lexton
2. Lexton to Ballan
3. Ballan to Melton
4. Melton to Sydenham
Erosion Management Overlay (EMO)
New 500kV terminal station
Existing Terminal Station
Bulgana Terminal Station
Lexton laydown area and workforce accommodation facility
Sydenham Terminal Station
Elaine Terminal Station
Mount Doran
Ballan laydown area and workforce accommodation facility
Bendigo
Ararat
Ballarat
Bacchus Marsh
Melton
Sunbury
VICTORIA
Melbourne
0 75 150 km
WRL_WR1380_GCL_StudyAreas_CoverPage
Created 19 March 2025 by KarimiH
IS3118PM
0 10 20
Kilometres
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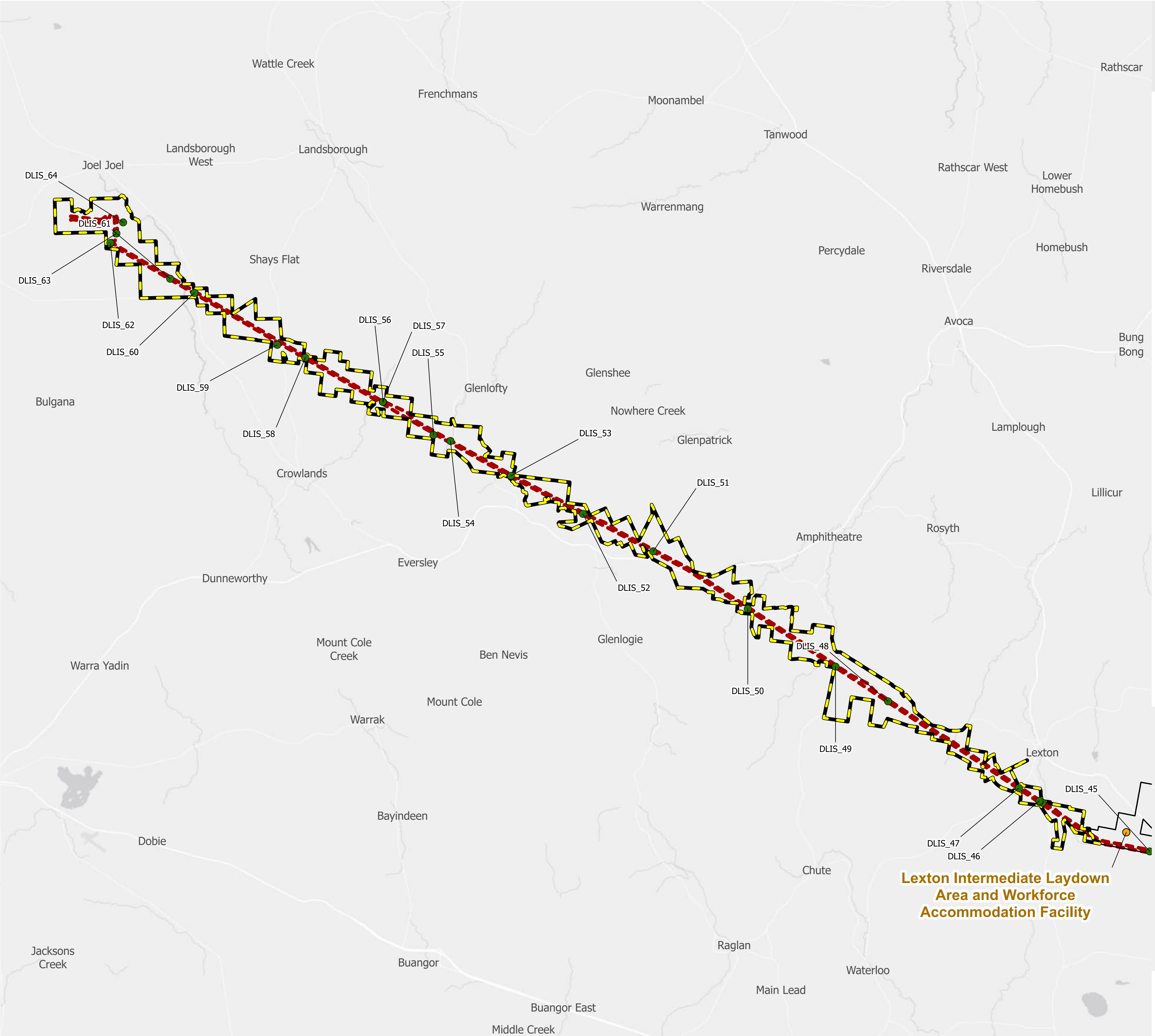
A.7.1 - Erosion Management Overlay

Western Renewables Link



- Bulgana to Lexton Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings

WRL_WR1380_GCL_StudyAreas

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IS3118PM

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Kilometres

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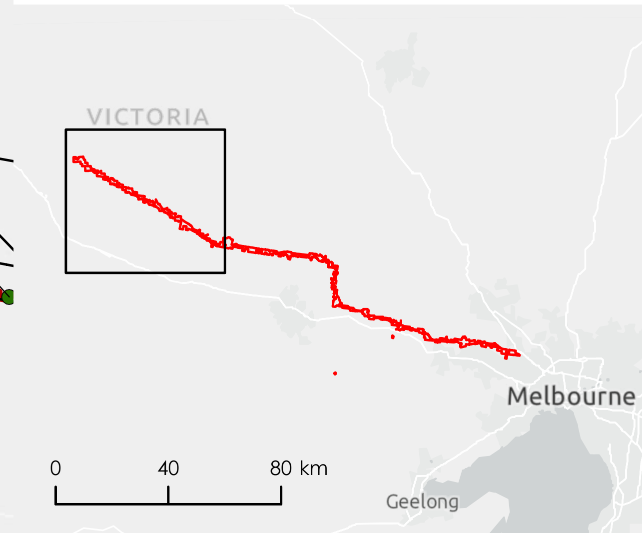

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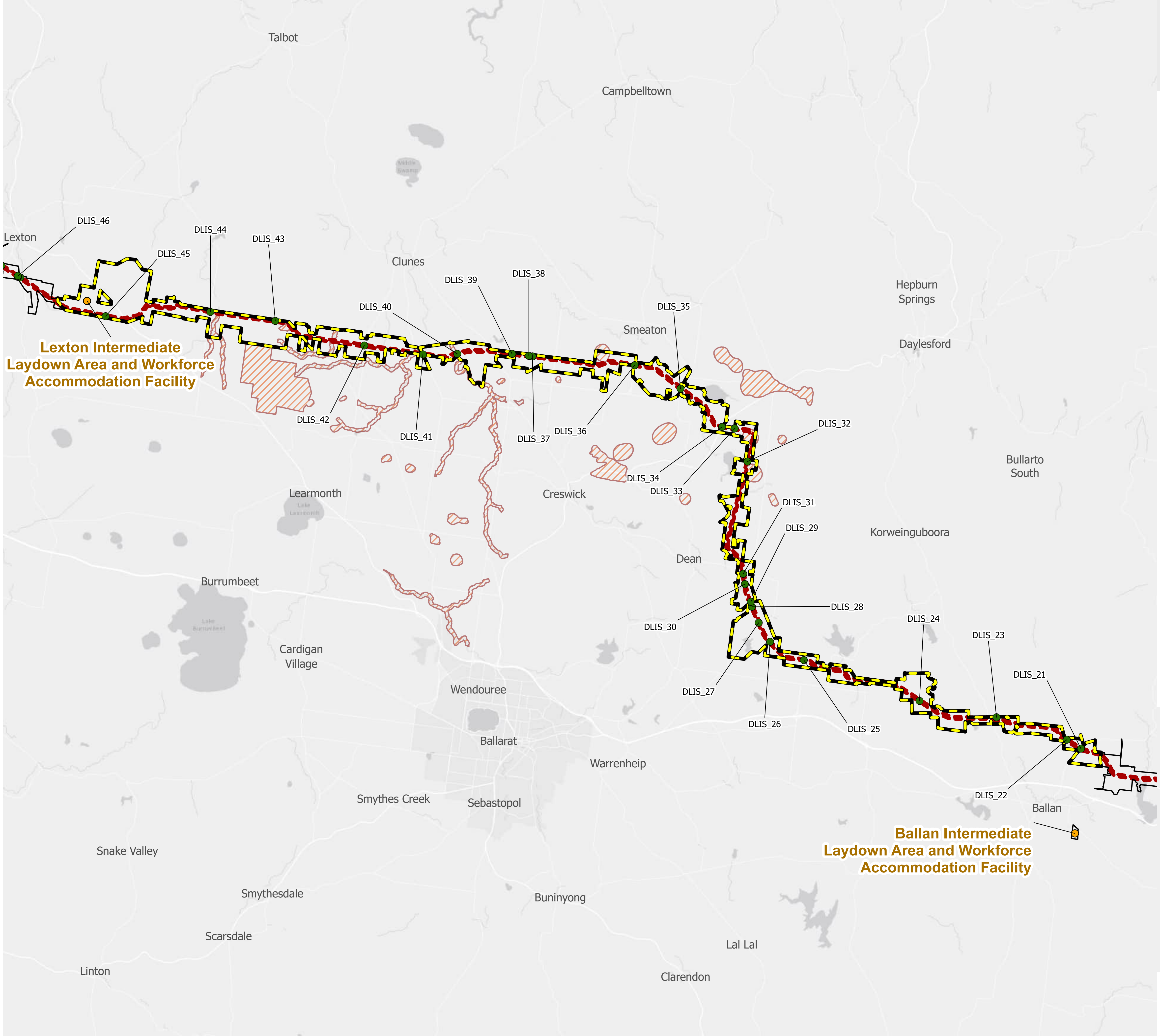
A.7.2 - Erosion Management Overlay

Western Renewables Link



Lexton to Ballan Study Area
Proposed Route
Project Land
Laydown Area and Workforce Accommodation Facility
Distribution Line - Crossings
Erosion Management Overlay (EMO)

WRL_WR1380_GCL_StudyAreas IS3118PM
Created 19 March 2025 by KarimiH

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Kilometres
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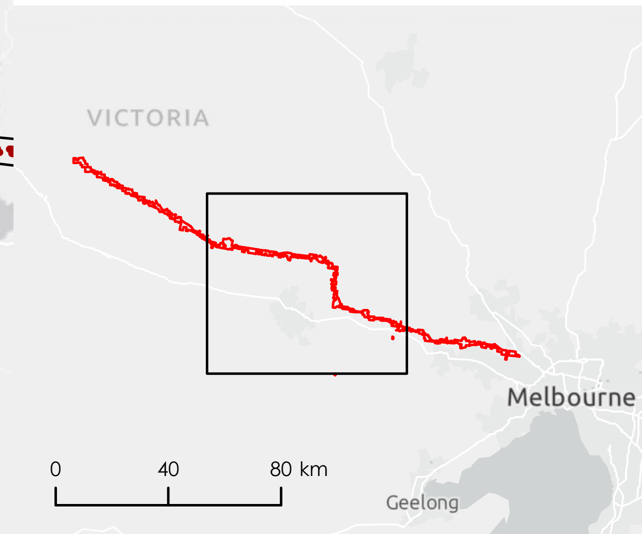

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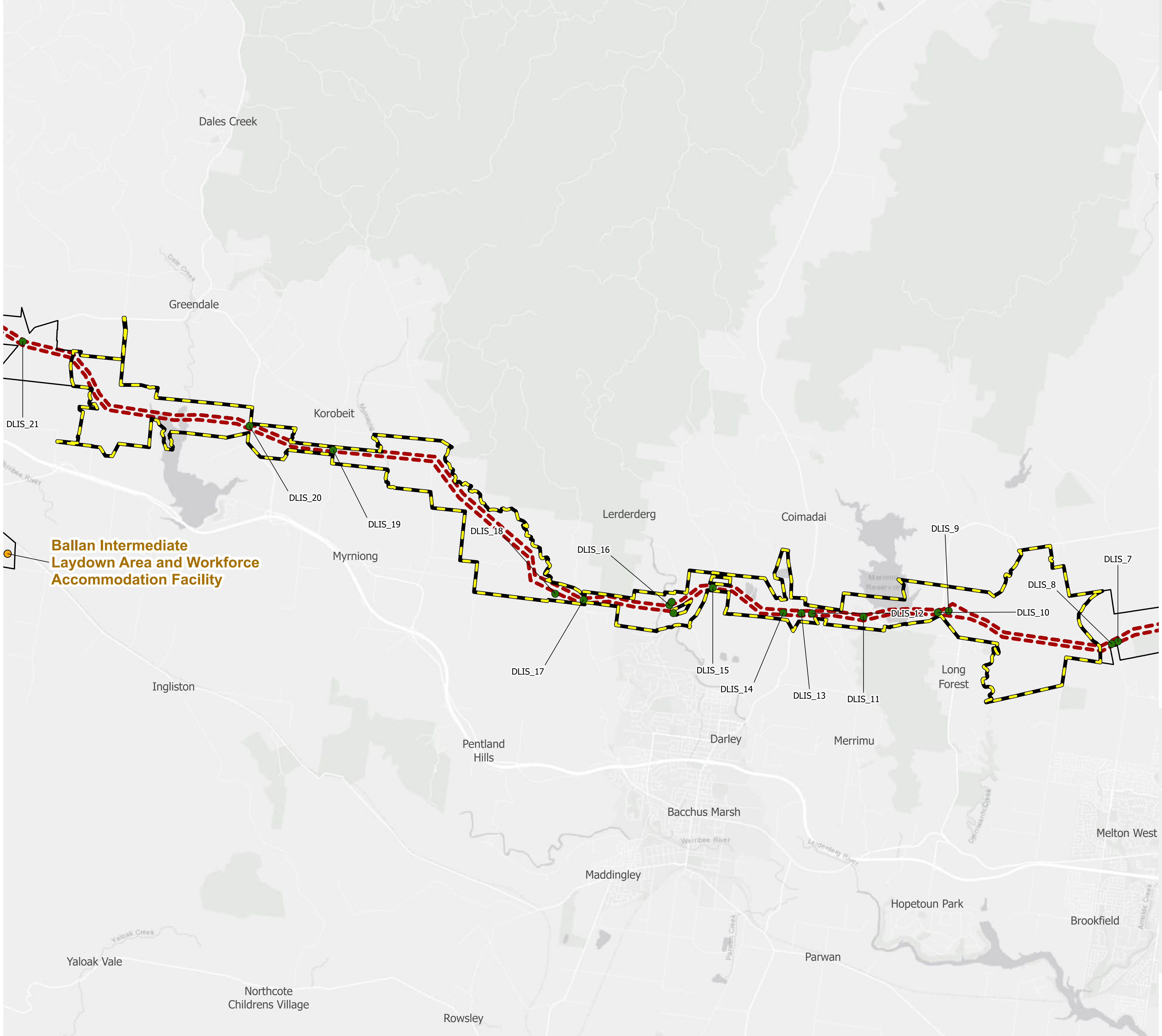
A.7.3 - Erosion Management Overlay

Western Renewables Link



- Ballan to Melton Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings

WRL_WR1380_GCL_StudyAreas
Created 19 March 2025 by KarimiH

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Kilometres

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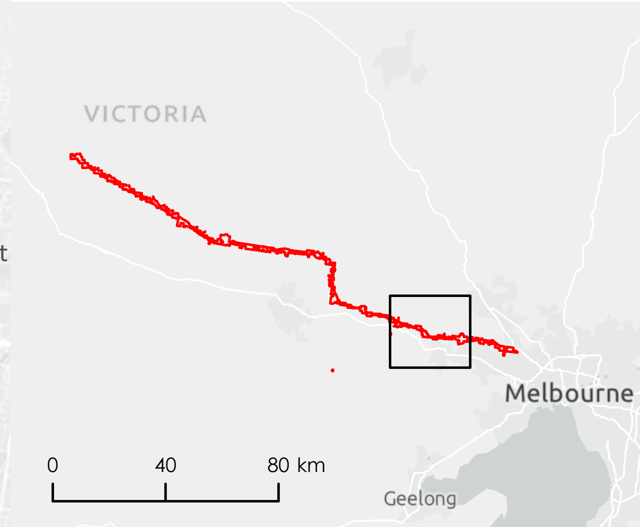

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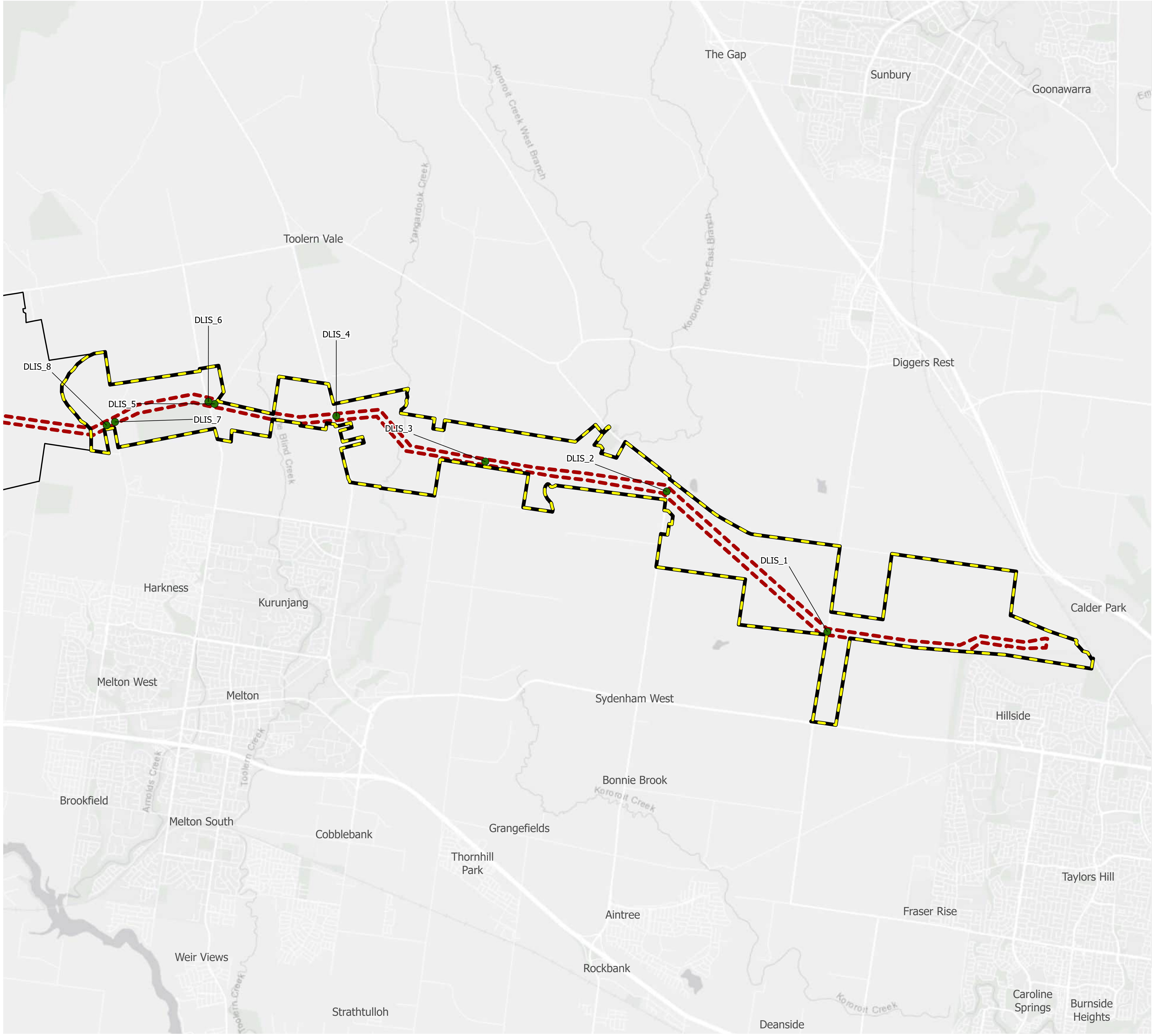
A.7.4 - Erosion Management Overlay

Western Renewables Link



- Melton to Sydenham Study Area
- Proposed Route
- Project Land
- Distribution Line - Crossings

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Kilometres

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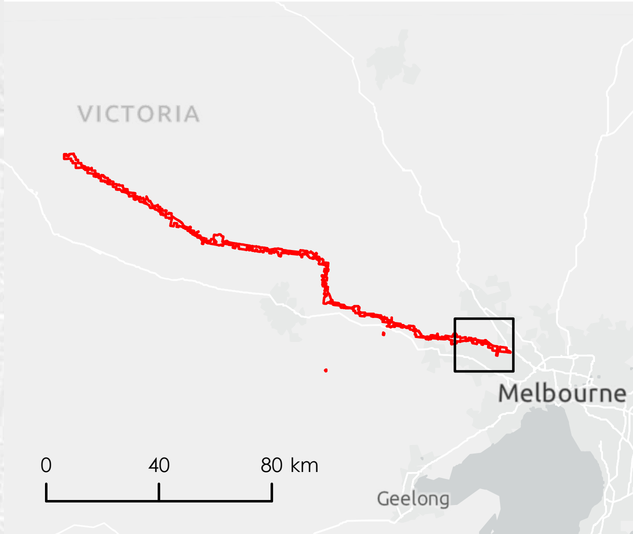

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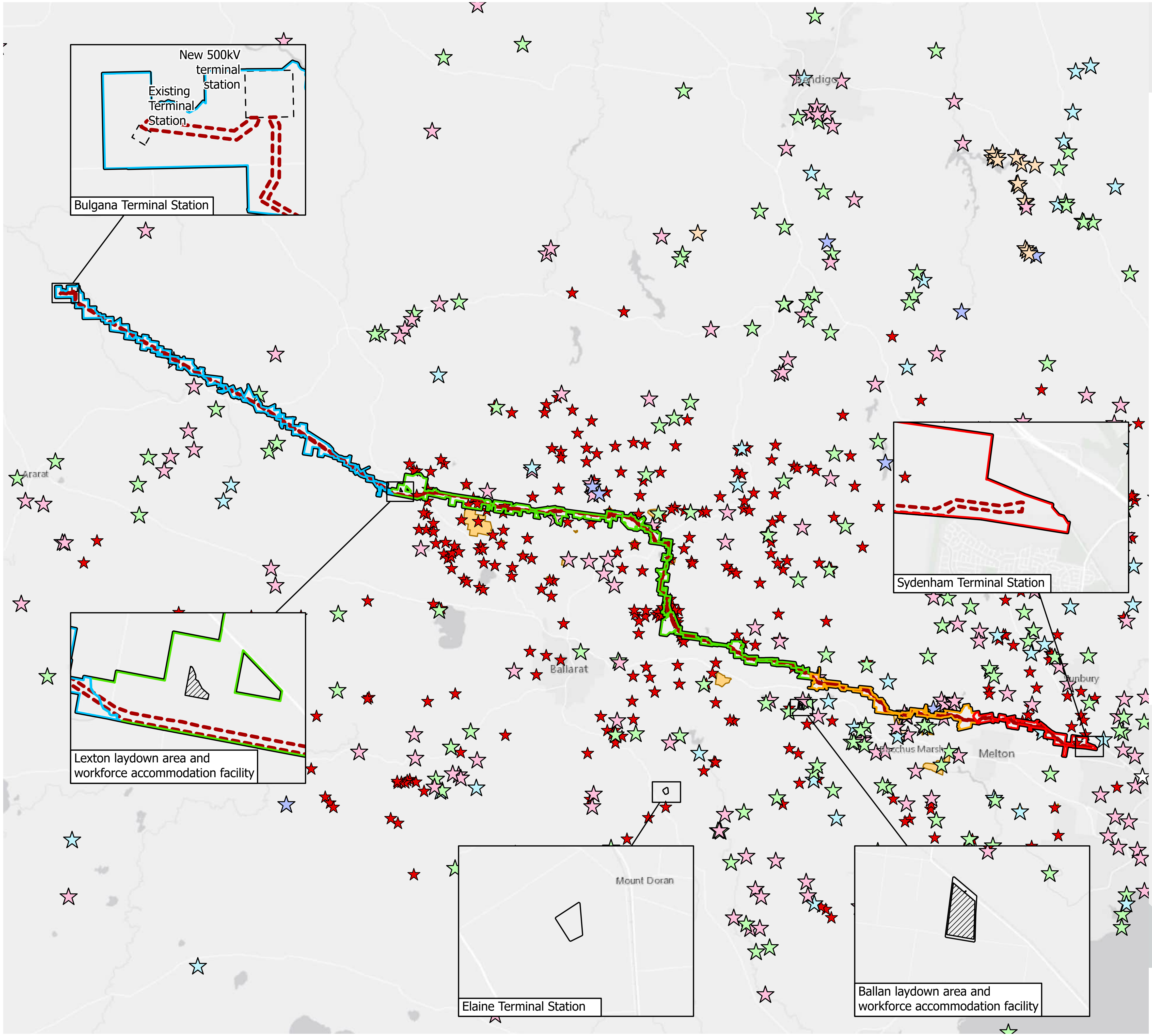
A.8.0 - Geologically Significant Features

Western Renewables Link



Proposed Route
Study Area
Laydown Area

Study Area
1. Bulgana to Lexton
2. Lexton to Ballan
3. Ballan to Melton
4. Melton to Sydenham

Geological Feature
Local Significance
Regional Significance
State Significance
National Significance
International Significance
Unknown Significance
Volcanic eruption point
Significant Landscape Overlay

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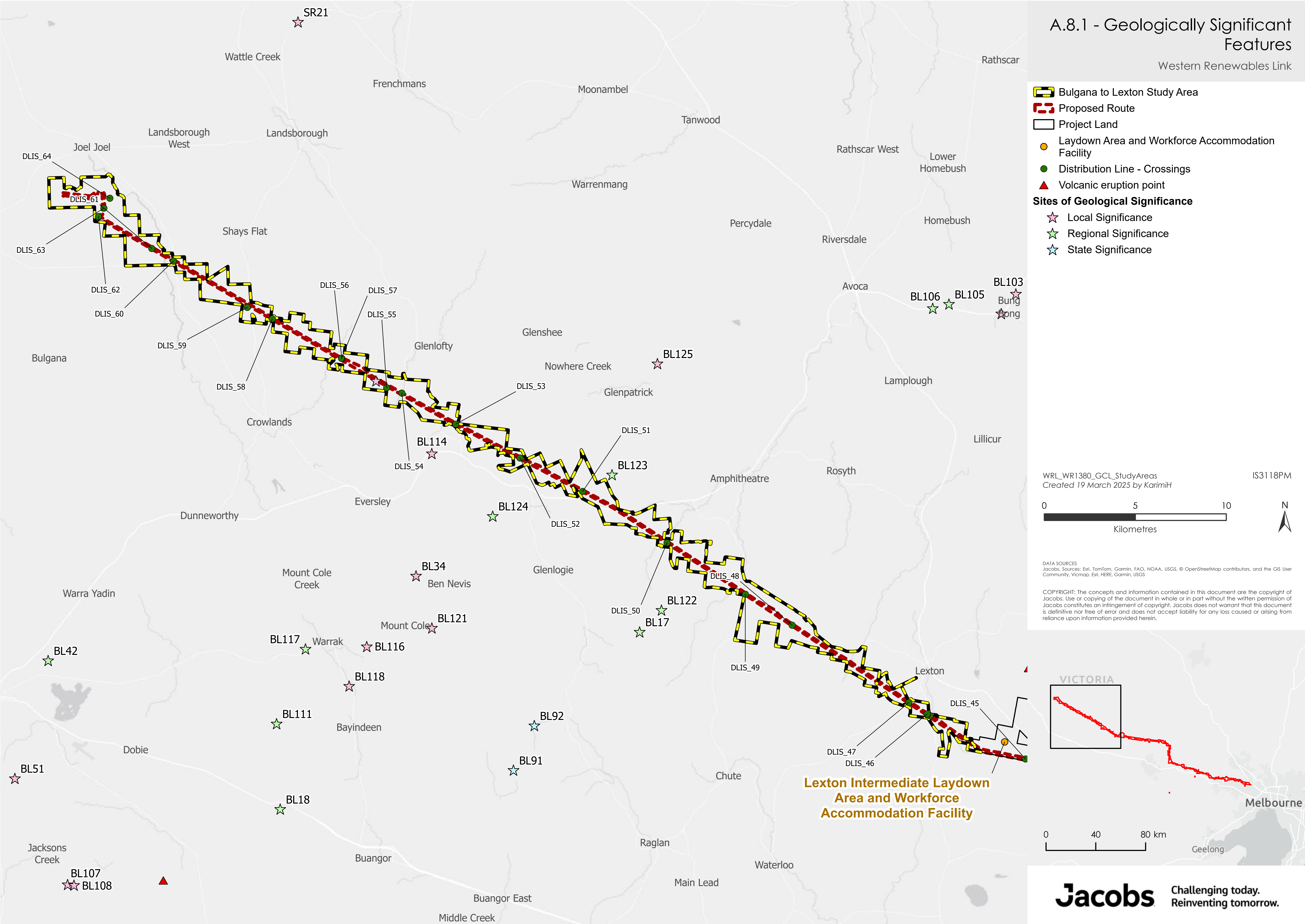

A.8.1 - Geologically Significant Features
Western Renewables Link
Bulgana to Lexton Study Area
Proposed Route
Project Land
Laydown Area and Workforce Accommodation Facility
Distribution Line - Crossings
Volcanic eruption point
Sites of Geological Significance
Local Significance
Regional Significance
State Significance
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VICTORIA
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Geelong
0
40
80 km
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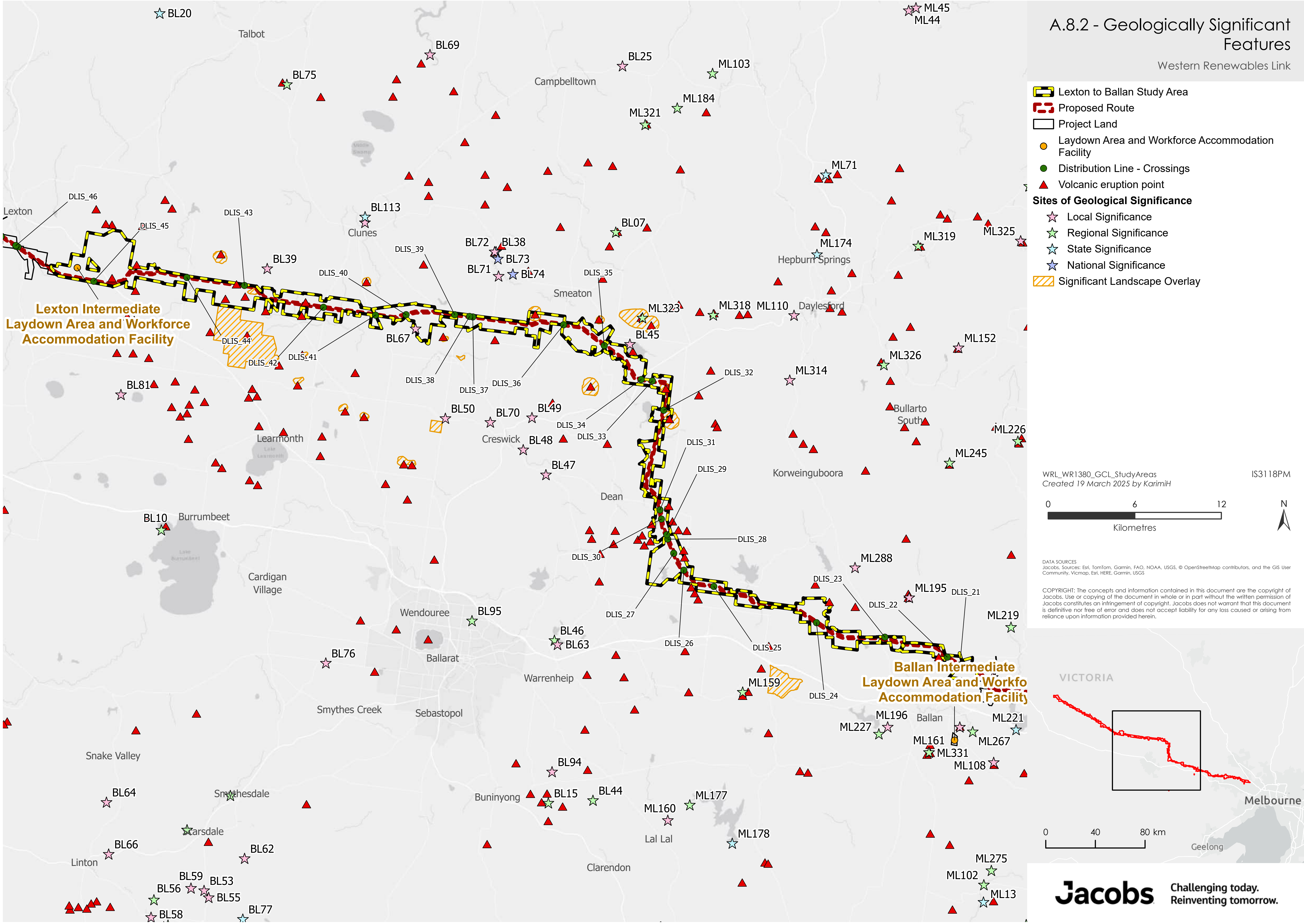
SR21
Wattle Creek
Frenchmans
Moonambel
Rathscar
Tanwood
Landsborough West
Landsborough
Joel Joel
DLIS_64
DLIS_61
DLIS_63
DLIS_62
DLIS_60
DLIS_59
DLIS_58
DLIS_56
DLIS_57
DLIS_55
DLIS_54
DLIS_53
DLIS_52
DLIS_51
DLIS_50
DLIS_49
DLIS_48
DLIS_47
DLIS_46
DLIS_45
Warrenmang
Rathscar West
Lower Homebush
Homebush
Percydale
Riversdale
Shays Flat
Avoca
BL106
BL105
BL103
Bung Bong
Bulgana
Glenlofty
Glenshee
Nowhere Creek
Glenpatrick
BL125
Lamplough
Crowlands
BL114
Lillicur
BL123
Amphitheatre
Rosyth
Eversley
BL124
Dunneworthy
BL34
Ben Nevis
Glenlogie
Mount Cole Creek
Warra Yadin
BL122
BL17
Mount Cole
BL121
BL117
Warrak
BL116
BL42
Lexton
BL118
BL111
Bayindeen
BL92
Dobie
BL91
BL51
Chute
Lexton Intermediate Laydown Area and Workforce Accommodation Facility
BL18
Raglan
Jacksons Creek
Buangor
Waterloo
BL107
BL108
Main Lead
Buangor East
Middle Creek



A.8.2 - Geologically Significant Features
Western Renewables Link
Lexton to Ballan Study Area
Proposed Route
Project Land
Laydown Area and Workforce Accommodation Facility
Distribution Line - Crossings
Volcanic eruption point
Sites of Geological Significance
Local Significance
Regional Significance
State Significance
National Significance
Significant Landscape Overlay
WRL_WR1380_GCL_StudyAreas
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IS3118PM
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Kilometres
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Lexton Intermediate Laydown Area and Workforce Accommodation Facility
Ballan Intermediate Laydown Area and Workforce Accommodation Facility
Lexton
Talbot
Clunes
Campbelltown
Smeaton
Hepburn Springs
Daylesford
Learmonth
Creswick
Dean
Korweinguboora
Bullarto South
Burrumbeet
Cardigan Village
Wendouree
Ballarat
Warrenheip
Smythes Creek
Sebastopol
Snake Valley
Smythesdale
Scarsdale
Linton
Buninyong
Lal Lal
Clarendon
Ballan
VICTORIA
Melbourne
Geelong
0
40
80 km
BL20
BL69
BL75
BL25
ML103
ML45
ML44
ML184
ML321
ML71
BL113
BL07
ML319
ML325
ML174
BL39
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ML221
ML161
ML267
ML331
ML108
BL94
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BL44
ML177
ML160
ML178
BL66
BL62
BL59
BL53
BL56
BL55
BL58
BL77
ML275
ML102
ML13
DLIS_21
DLIS_22
DLIS_23
DLIS_24
DLIS_25
DLIS_26
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DLIS_46
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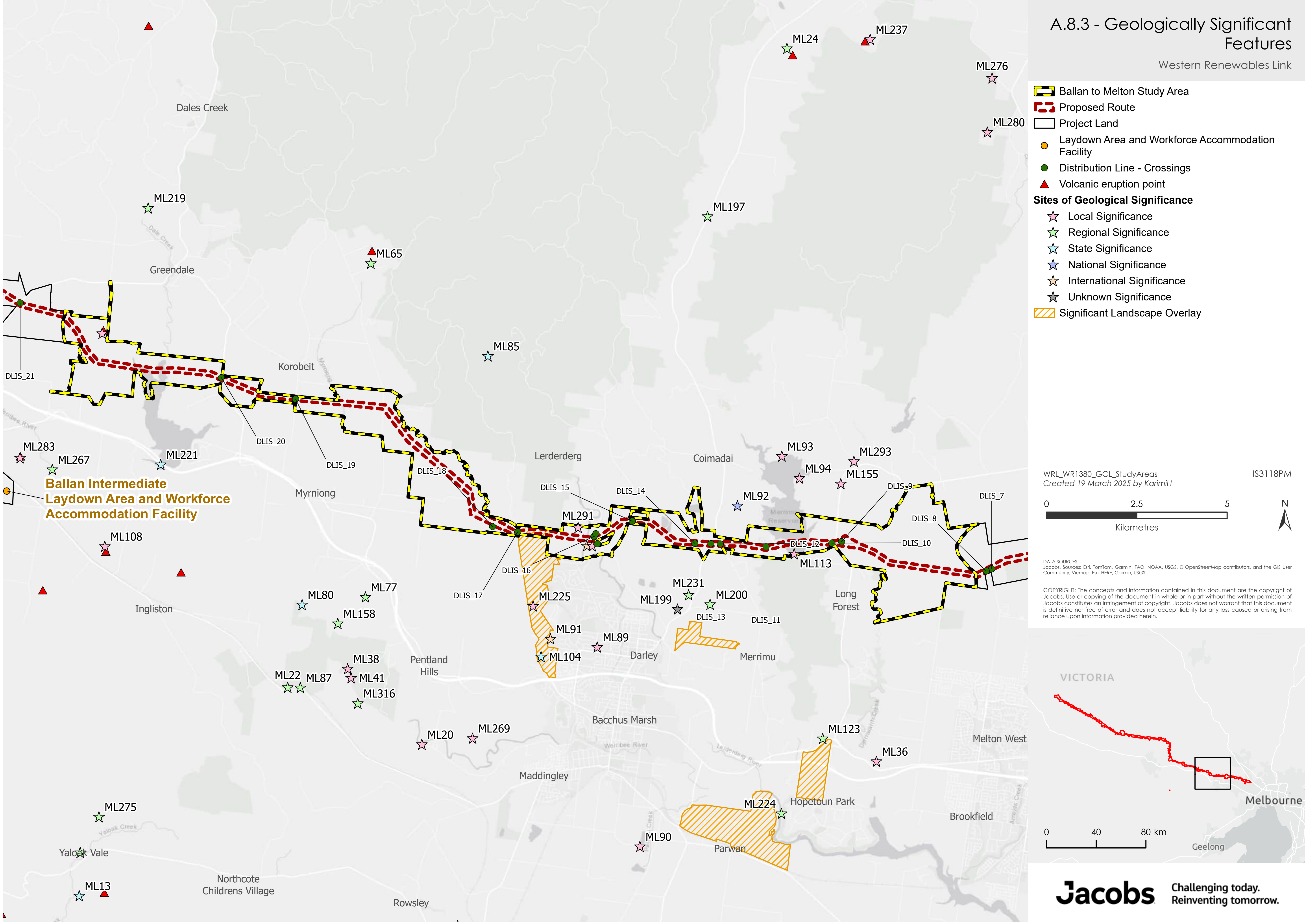

A.8.3 - Geologically Significant Features
Western Renewables Link
Ballan to Melton Study Area
Proposed Route
Project Land
Laydown Area and Workforce Accommodation Facility
Distribution Line - Crossings
Volcanic eruption point
Sites of Geological Significance
Local Significance
Regional Significance
State Significance
National Significance
International Significance
Unknown Significance
Significant Landscape Overlay
WRL_WR1380_GCL_StudyAreas
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IS3118PM
0
2.5
5
Kilometres
N
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VICTORIA
Melbourne
Geelong
0
40
80 km
Jacobs
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Dales Creek
Greendale
Korobeit
Myrniong
Lerderderg
Coimadai
Ingliston
Pentland Hills
Darley
Merrimu
Long Forest
Bacchus Marsh
Maddingley
Melton West
Hopetoun Park
Brookfield
Parwan
Yaloak Vale
Northcote Childrens Village
Rowsley
Ballan Intermediate Laydown Area and Workforce Accommodation Facility
ML24
ML237
ML276
ML280
ML219
ML65
ML197
ML85
ML283
ML267
ML221
ML108
ML93
ML293
ML94
ML155
ML92
ML291
ML113
ML80
ML77
ML158
ML225
ML231
ML199
ML200
ML91
ML89
ML104
ML38
ML22
ML87
ML41
ML316
ML20
ML269
ML123
ML36
ML275
ML224
ML90
ML13
DLIS_21
DLIS_20
DLIS_19
DLIS_18
DLIS_17
DLIS_16
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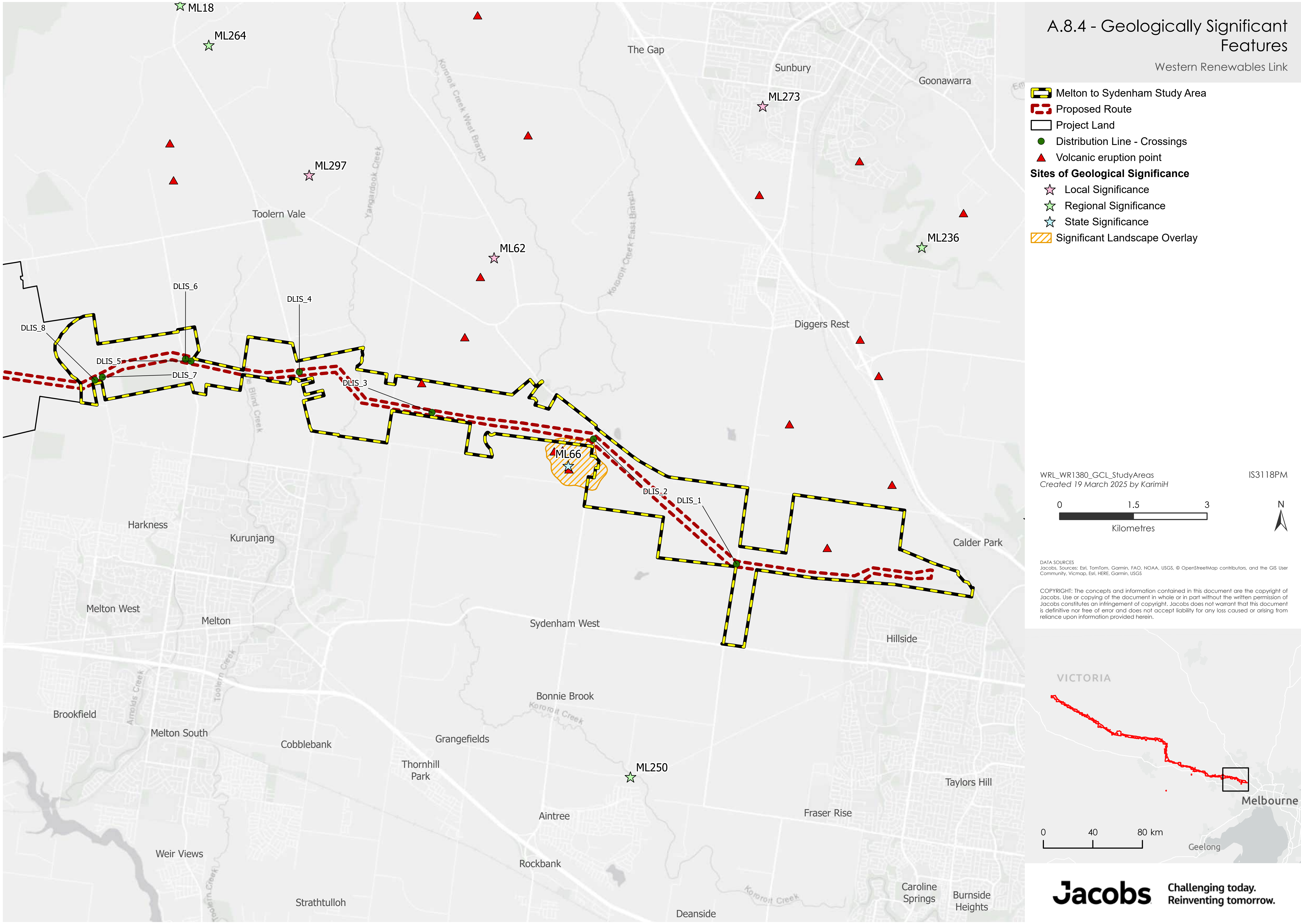
DLIS_8
DLIS_7



A.8.4 - Geologically Significant Features
Western Renewables Link
Melton to Sydenham Study Area
Proposed Route
Project Land
Distribution Line - Crossings
Volcanic eruption point
Sites of Geological Significance
Local Significance
Regional Significance
State Significance
Significant Landscape Overlay
WRL_WR1380_GCL_StudyAreas
IS3118PM
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0
1.5
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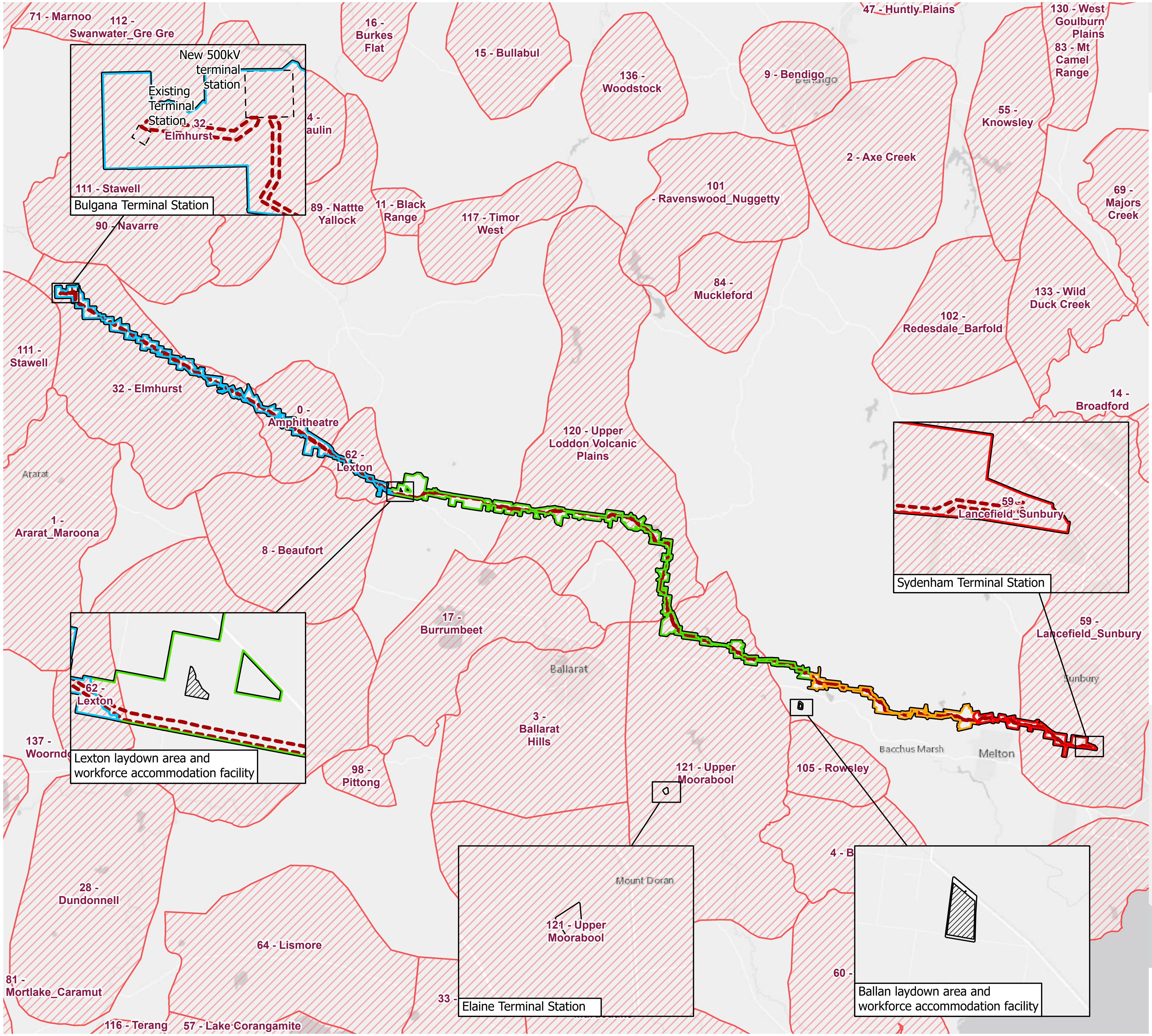
VICTORIA
Melbourne
Geelong
0
40
80 km
Jacobs
Challenging today.
Reinventing tomorrow.
ML18
ML264
ML273
ML297
ML62
ML236
ML66
ML250
DLIS_1
DLIS_2
DLIS_3
DLIS_4
DLIS_5
DLIS_6
DLIS_7
DLIS_8
The Gap
Sunbury
Goonawarra
Toolern Vale
Diggers Rest
Harkness
Kurunjang
Calder Park
Melton West
Melton
Sydenham West
Hillside
Bonnie Brook
Brookfield
Melton South
Cobblebank
Grangefields
Thornhill Park
Taylors Hill
Aintree
Fraser Rise
Weir Views
Rockbank
Strathtulloh
Deanside
Caroline Springs
Burnside Heights
Kororoit Creek West Branch
Kororoit Creek East Branch
Yangardook Creek
Blind Creek
Toolern Creek
Arnolds Creek
Kororoit Creek

A.9.0 - Salinity Provinces

Western Renewables Link



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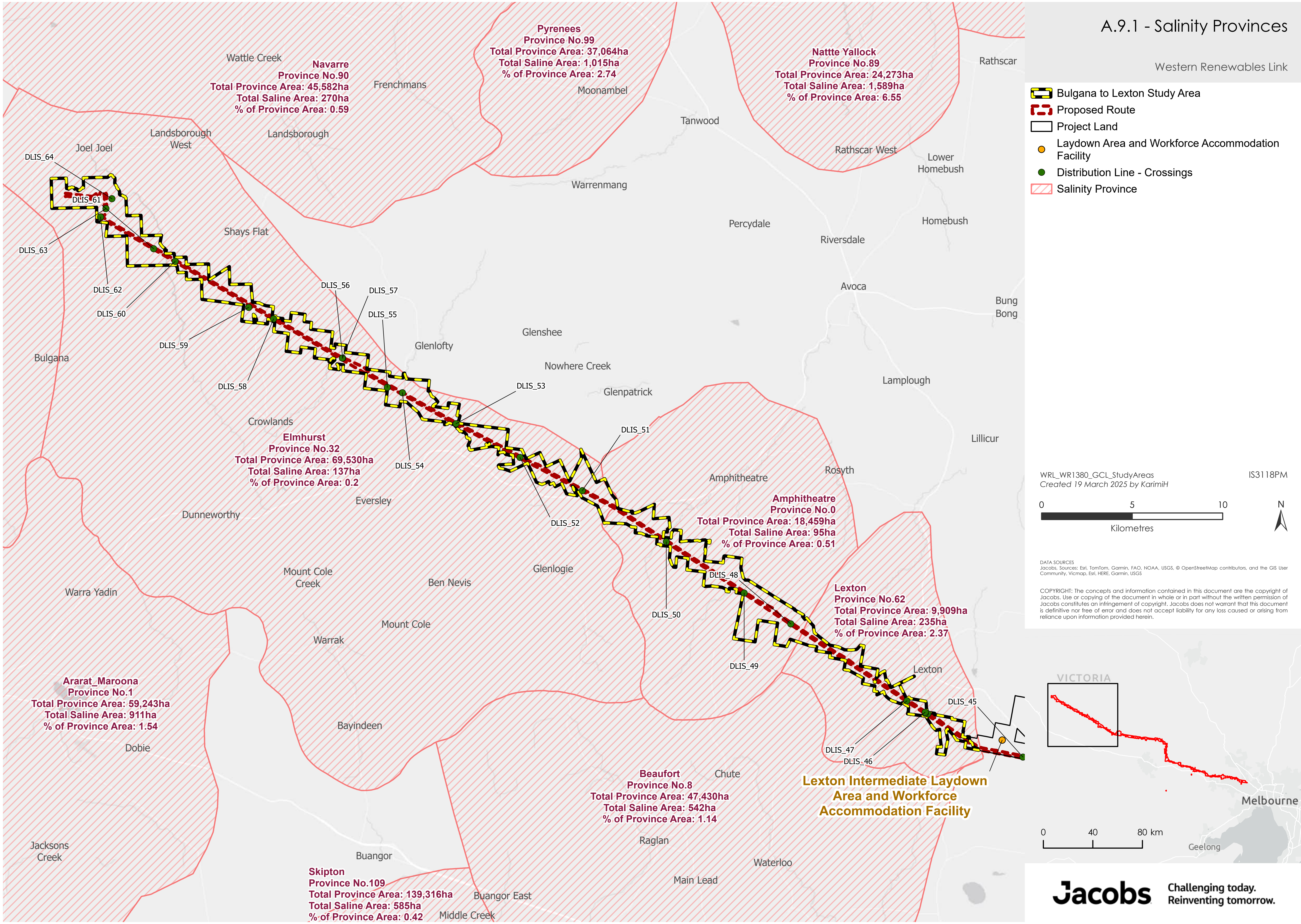
A.9.1 - Salinity Provinces
Western Renewables Link
Bulgana to Lexton Study Area
Proposed Route
Project Land
Laydown Area and Workforce Accommodation Facility
Distribution Line - Crossings
Salinity Province
Pyrenees
Province No.99
Total Province Area: 37,064ha
Total Saline Area: 1,015ha
% of Province Area: 2.74
Natte Yallock
Province No.89
Total Province Area: 24,273ha
Total Saline Area: 1,589ha
% of Province Area: 6.55
Navarre
Province No.90
Total Province Area: 45,582ha
Total Saline Area: 270ha
% of Province Area: 0.59
Elmhurst
Province No.32
Total Province Area: 69,530ha
Total Saline Area: 137ha
% of Province Area: 0.2
Amphitheatre
Province No.0
Total Province Area: 18,459ha
Total Saline Area: 95ha
% of Province Area: 0.51
Lexton
Province No.62
Total Province Area: 9,909ha
Total Saline Area: 235ha
% of Province Area: 2.37
Ararat_Maroona
Province No.1
Total Province Area: 59,243ha
Total Saline Area: 911ha
% of Province Area: 1.54
Beaufort
Province No.8
Total Province Area: 47,430ha
Total Saline Area: 542ha
% of Province Area: 1.14
Skipton
Province No.109
Total Province Area: 139,316ha
Total Saline Area: 585ha
% of Province Area: 0.42
Lexton Intermediate Laydown Area and Workforce Accommodation Facility
Wattle Creek
Frenchmans
Moonambel
Rathscar
Tanwood
Rathscar West
Lower Homebush
Landsborough West
Landsborough
Joel Joel
Warrenmang
Percydale
Riversdale
Homebush
Shays Flat
Avoca
Bung Bong
Bulgana
Glenshee
Glenlofty
Nowhere Creek
Glenpatrick
Lamplough
Crowlands
Lillicur
Amphitheatre
Rosyth
Eversley
Dunneworthy
Glenlogie
Mount Cole Creek
Ben Nevis
Warra Yadin
Mount Cole
Warrak
Lexton
Bayindeen
Dobie
Chute
Raglan
Jacksons Creek
Buangor
Waterloo
Main Lead
Buangor East
Middle Creek
DLIS_64
DLIS_61
DLIS_63
DLIS_62
DLIS_60
DLIS_59
DLIS_58
DLIS_56
DLIS_57
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DLIS_49
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DLIS_46
DLIS_45
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Kilometres
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VICTORIA
Melbourne
Geelong
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80 km
Jacobs
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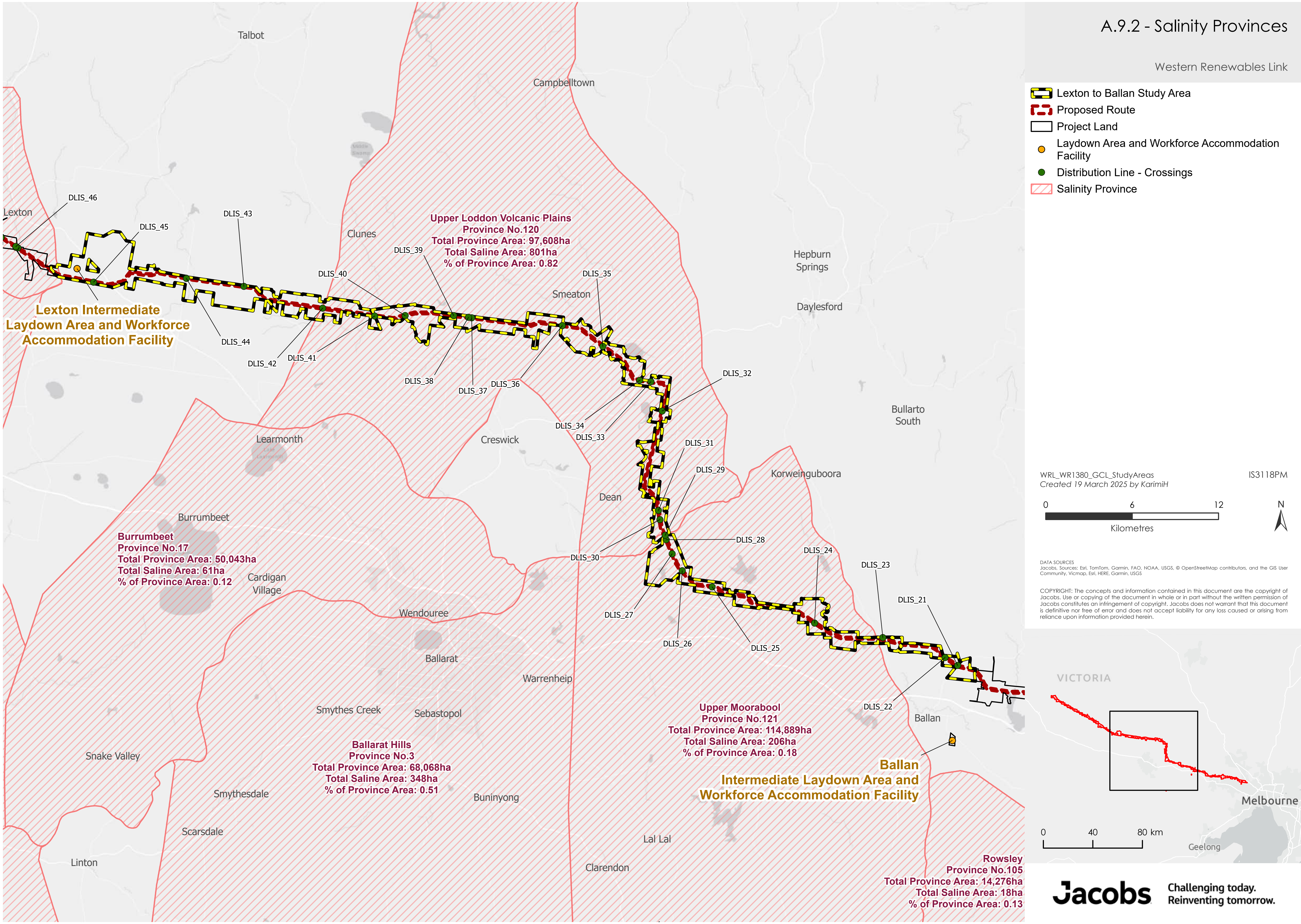
A.9.2 - Salinity Provinces
Western Renewables Link
Lexton to Ballan Study Area
Proposed Route
Project Land
Laydown Area and Workforce Accommodation Facility
Distribution Line - Crossings
Salinity Province
Upper Loddon Volcanic Plains
Province No.120
Total Province Area: 97,608ha
Total Saline Area: 801ha
% of Province Area: 0.82
Burrumbeet
Province No.17
Total Province Area: 50,043ha
Total Saline Area: 61ha
% of Province Area: 0.12
Ballarat Hills
Province No.3
Total Province Area: 68,068ha
Total Saline Area: 348ha
% of Province Area: 0.51
Upper Moorabool
Province No.121
Total Province Area: 114,889ha
Total Saline Area: 206ha
% of Province Area: 0.18
Rowsley
Province No.105
Total Province Area: 14,276ha
Total Saline Area: 18ha
% of Province Area: 0.13
Lexton Intermediate Laydown Area and Workforce Accommodation Facility
Ballan Intermediate Laydown Area and Workforce Accommodation Facility
DLIS_46
DLIS_45
DLIS_44
DLIS_43
DLIS_42
DLIS_41
DLIS_40
DLIS_39
DLIS_38
DLIS_37
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DLIS_26
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DLIS_23
DLIS_22
DLIS_21
Talbot
Campbelltown
Lexton
Clunes
Smeaton
Hepburn Springs
Daylesford
Learmonth
Creswick
Bullarto South
Korweinguboora
Dean
Burrumbeet
Cardigan Village
Wendouree
Ballarat
Warrenheip
Smythes Creek
Sebastopol
Ballan
Snake Valley
Smythesdale
Buninyong
Scarsdale
Lal Lal
Linton
Clarendon
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0
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Kilometres
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Melbourne
Geelong
0
40
80 km
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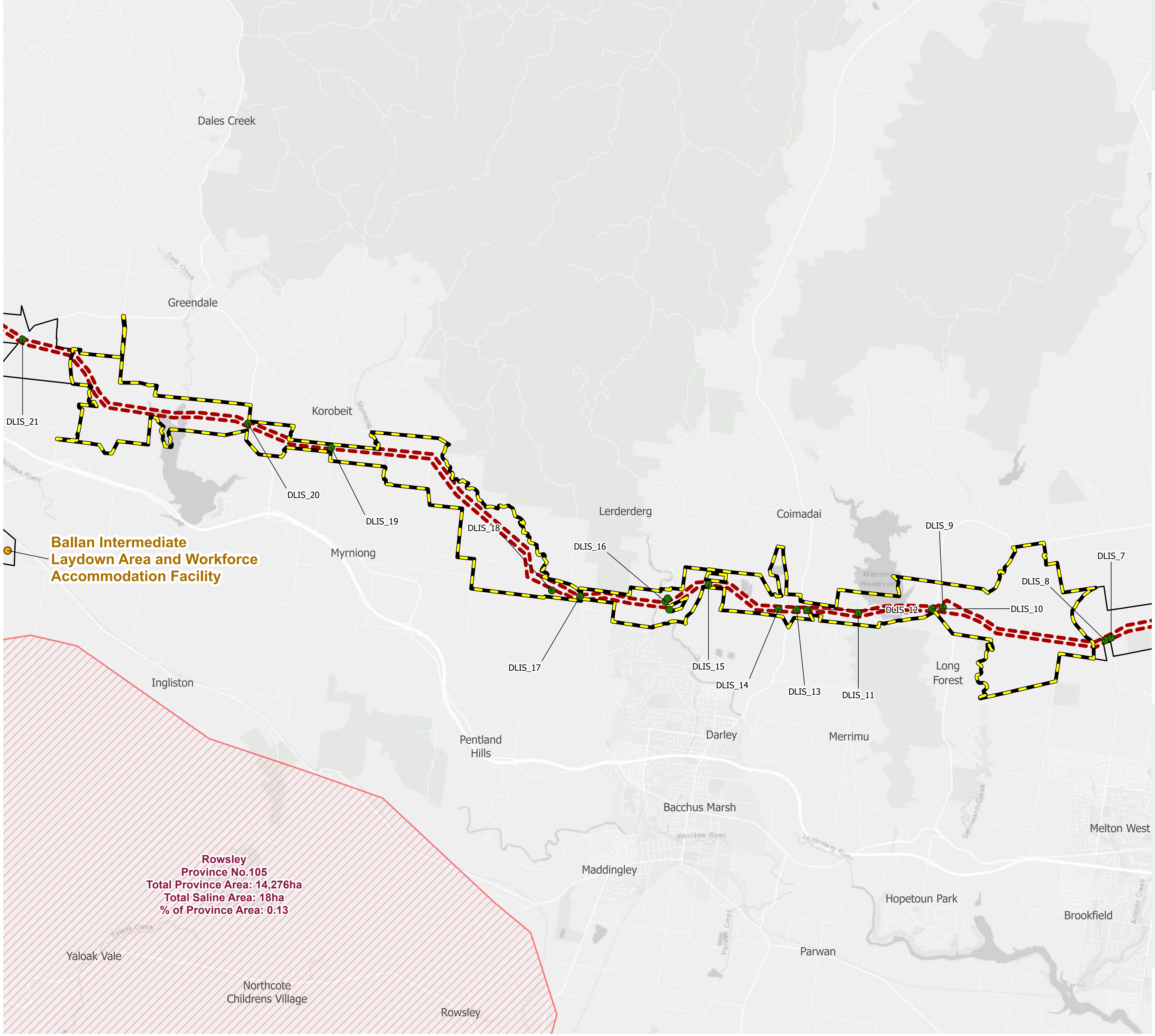
A.9.3 - Salinity Provinces

Western Renewables Link

- Ballan to Melton Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings
- Salinity Province



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Kilometres

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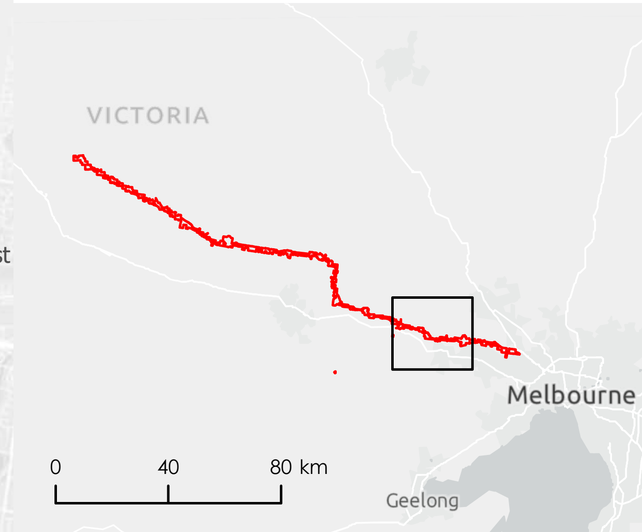

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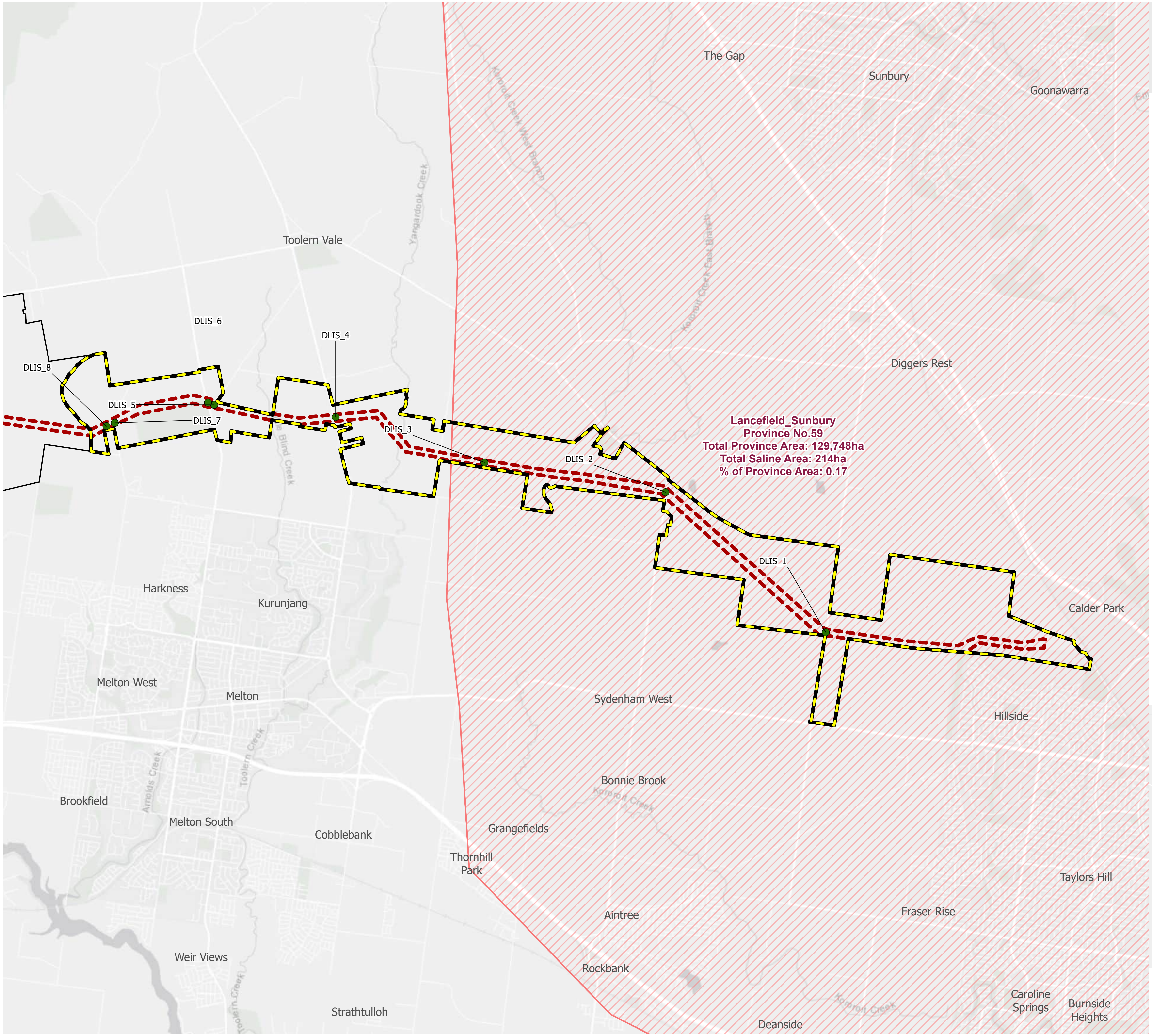
A.9.4 - Salinity Provinces

Western Renewables Link



Melton to Sydenham Study Area
Proposed Route
Project Land
Distribution Line - Crossings
Salinity Province

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Kilometres
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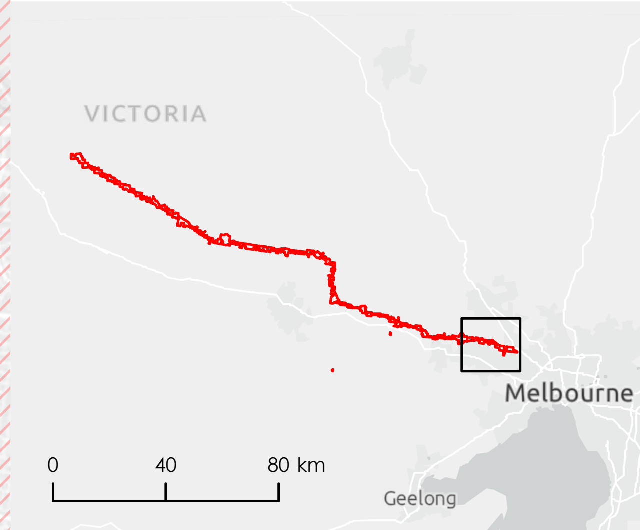

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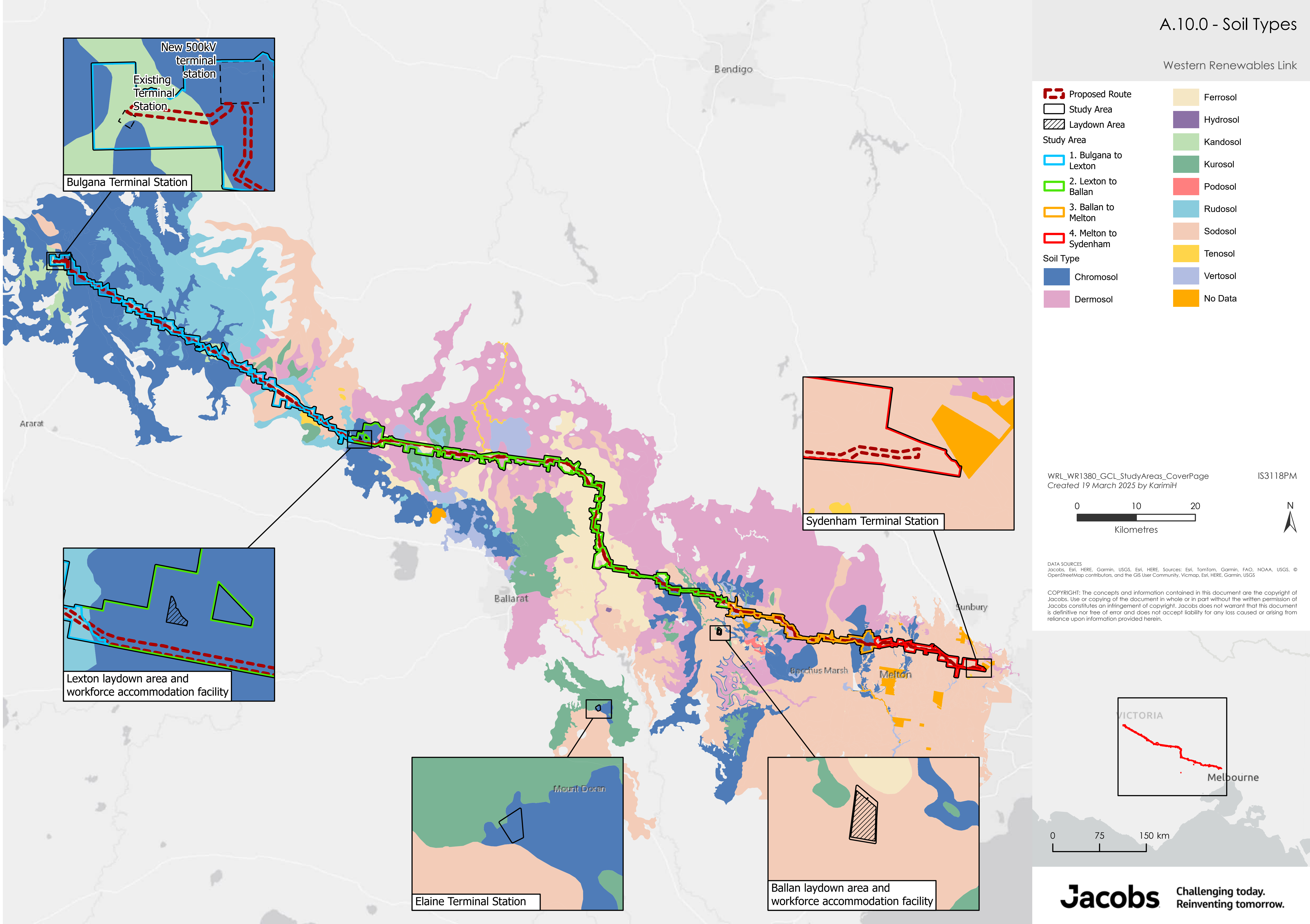

A.10.0 - Soil Types
Western Renewables Link
Proposed Route
Study Area
Laydown Area
Study Area
1. Bulgana to Lexton
2. Lexton to Ballan
3. Ballan to Melton
4. Melton to Sydenham
Soil Type
Chromosol
Dermosol
Ferrosol
Hydrosol
Kandosol
Kurosol
Podosol
Rudosol
Sodosol
Tenosol
Vertosol
No Data
New 500kV terminal station
Existing Terminal Station
Bulgana Terminal Station
Lexton laydown area and workforce accommodation facility
Sydenham Terminal Station
Elaine Terminal Station
Mount Doran
Ballan laydown area and workforce accommodation facility
Bendigo
Ararat
Ballarat
Bacchus Marsh
Melton
Sunbury
WRL_WR1380_GCL_StudyAreas_CoverPage
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IS3118PM
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Kilometres
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VICTORIA
Melbourne
0
75
150 km
Jacobs
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A.10.1 - Soil Types

Western Renewables Link

- Bulgana to Lexton Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings

Soil Type

- CH - Chromosol
- DE - Dermosol
- FE - Ferrosol
- KA - Kandosol
- KU - Kurosol
- RU - Rudusol
- SO - Sodosol
- TE - Tenosol
- VE - Vertosol

WRL_WR1380_GCL_StudyAreas
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IS3118PM

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Kilometres

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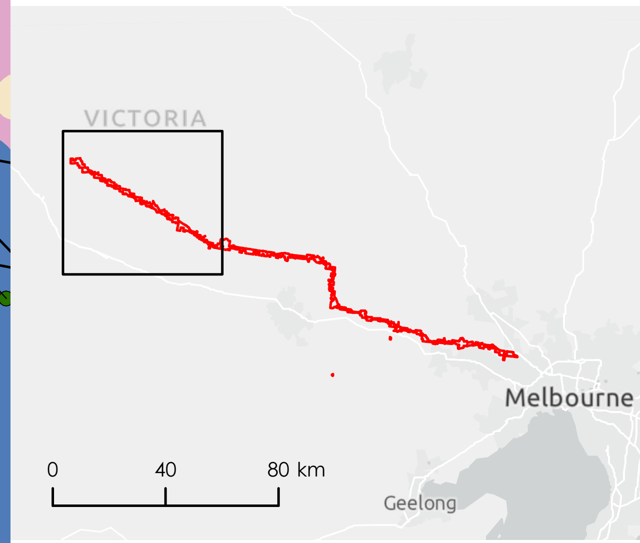

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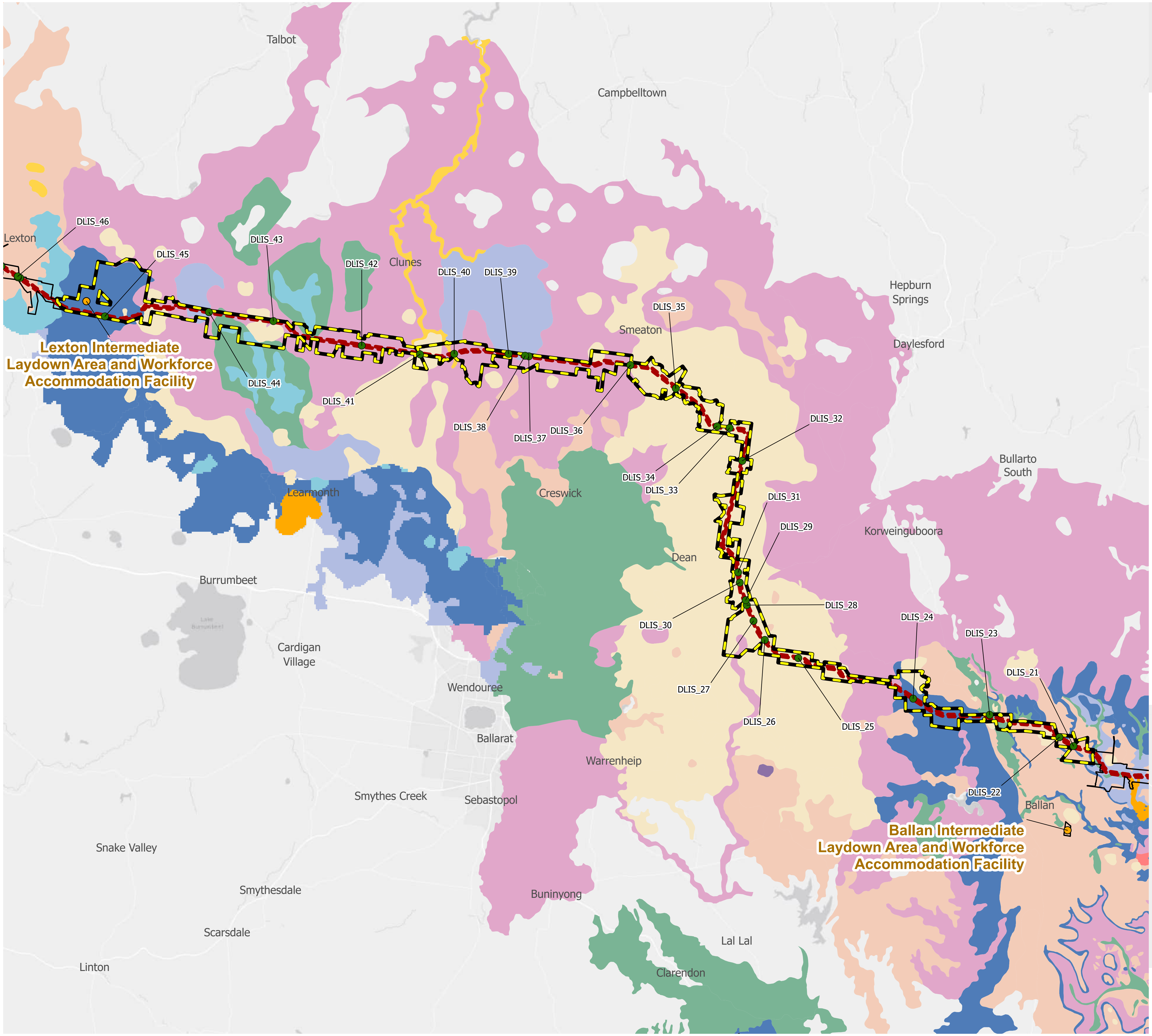
A.10.2 - Soil Types

Western Renewables Link



- Lexton to Ballan Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings

Soil Type

- CH - Chromosol
- DE - Dermosol
- FE - Ferrosol
- HY - Hydrosol
- KU - Kurosol
- PO - Podosol
- RU - Rudusol
- SO - Sodosol
- TE - Tenosol
- VE - Vertosol
- NA - Other

WRL_WR1380_GCL_StudyArea

IS3118PM

Created 19 March 2025 by KarimiH

0 6 12

Kilometres

N

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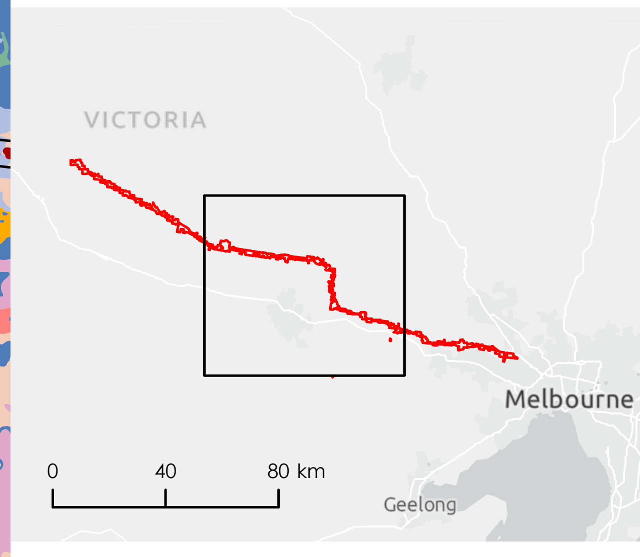

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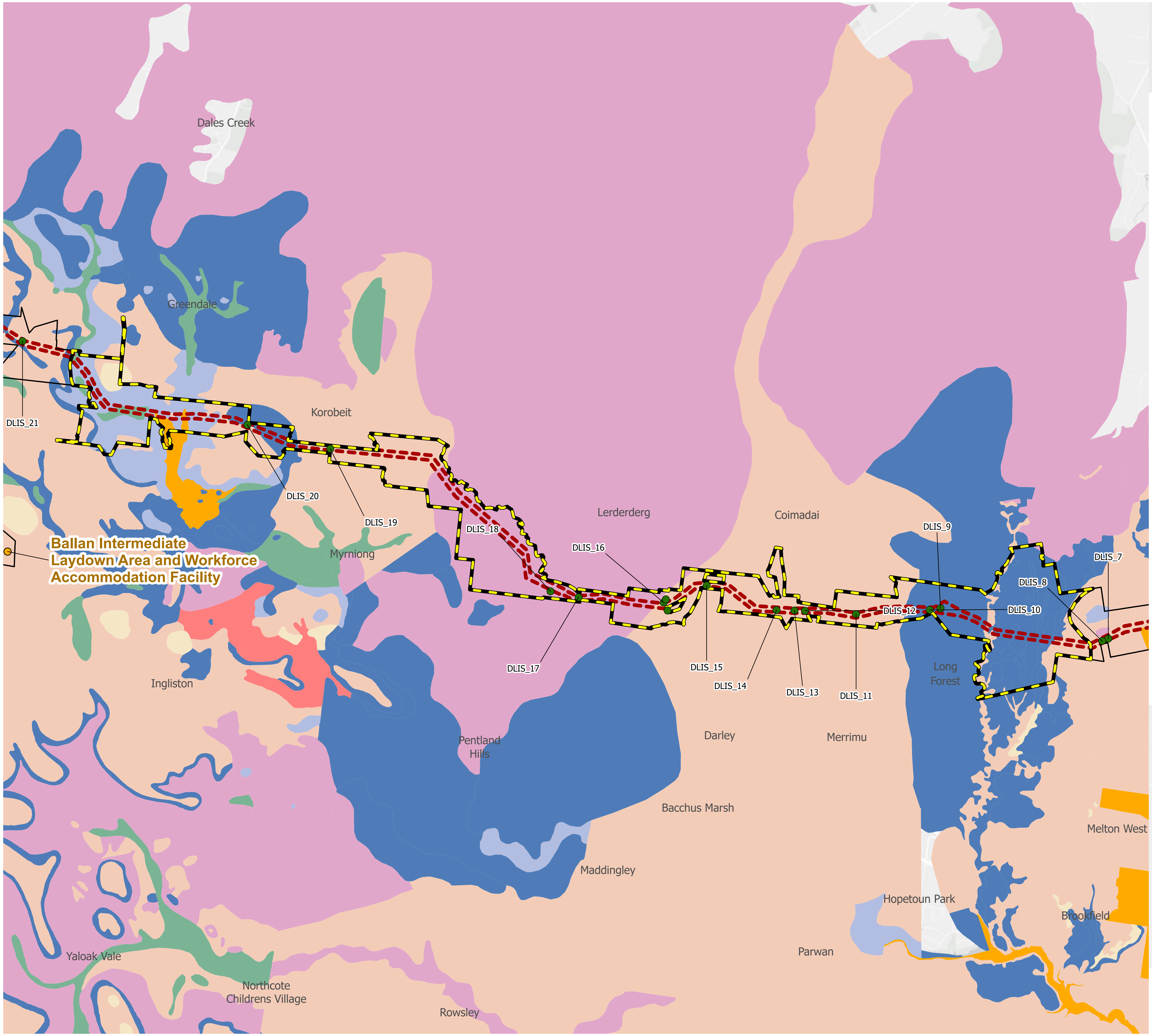
A.10.3 - Soil Types

Western Renewables Link



- Ballan to Melton Study Area
- Proposed Route
- Project Land
- Laydown Area and Workforce Accommodation Facility
- Distribution Line - Crossings

Soil Type

- CH - Chromosol
- DE - Dermosol
- FE - Ferrosol
- KU - Kurosol
- PO - Podosol
- SO - Sodosol
- VE - Vertosol
- NA - Other

WRL_WR1380_GCL_StudyAreas
Created 19 March 2025 by KarimiH

IS3118PM

0 2.5 5
Kilometres

N

DATA SOURCES
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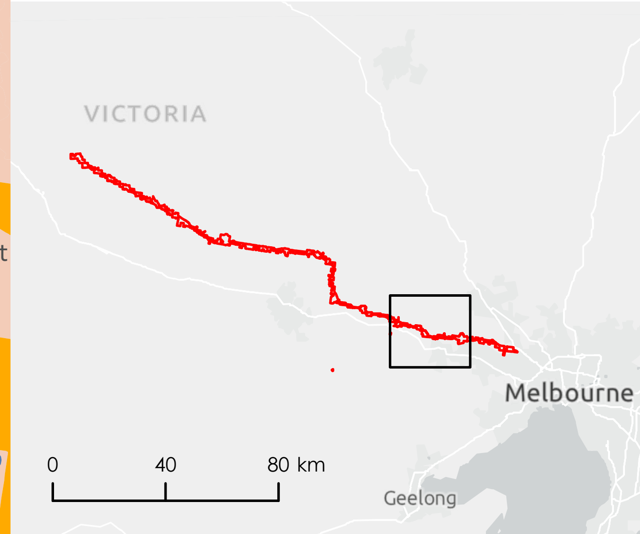

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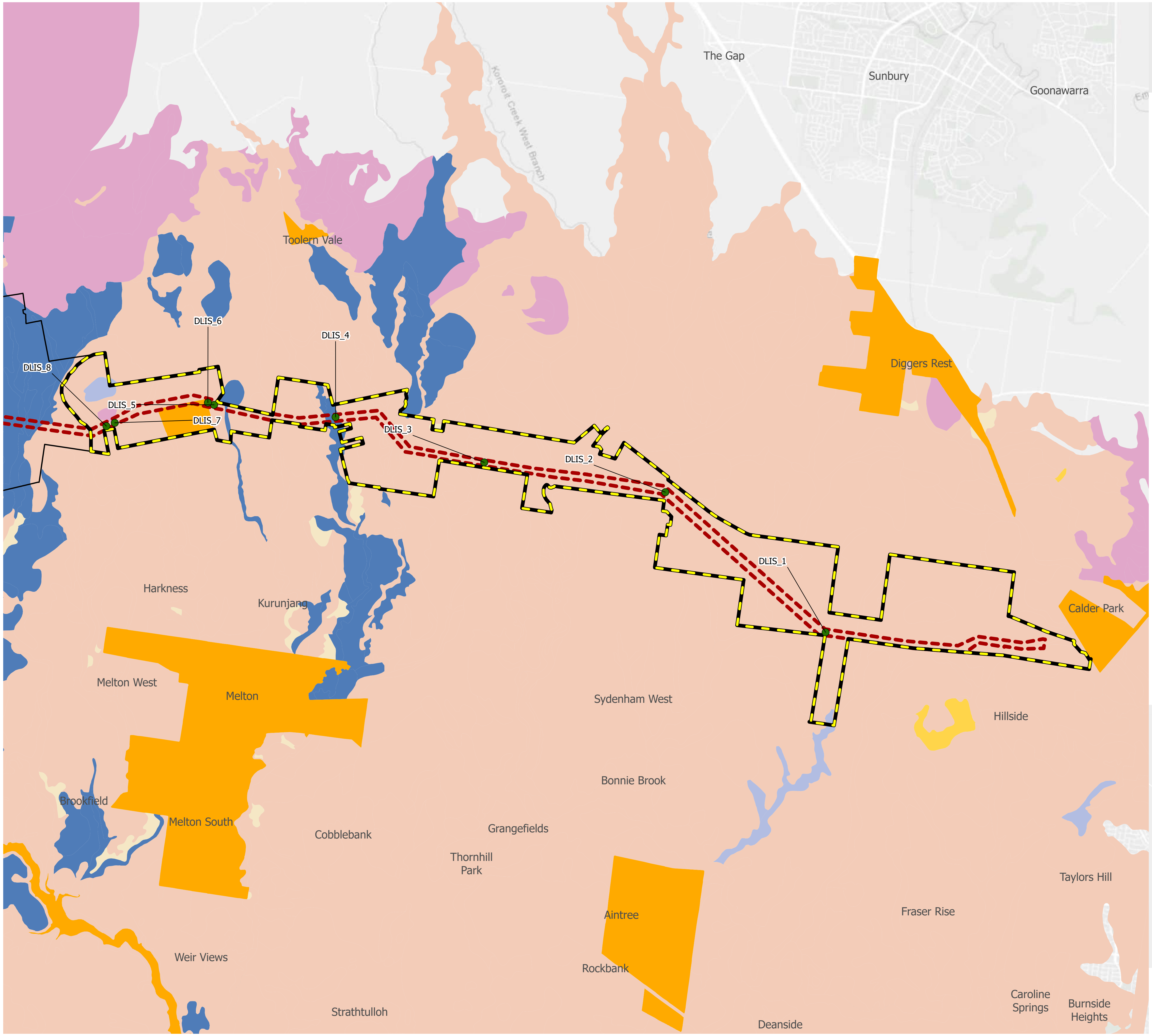
A.10.4 - Soil Types

Western Renewables Link



- Melton to Sydenham Study Area
- Proposed Route
- Project Land
- Distribution Line - Crossings

Soil Type

- CH - Chromosol
- DE - Dermosol
- FE - Ferrosol
- SO - Sodosol
- TE - Tenosol
- VE - Vertosol
- NA - Other

WRL_WR1380_GCL_StudyAreas

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0 1.5 3

Kilometres

N

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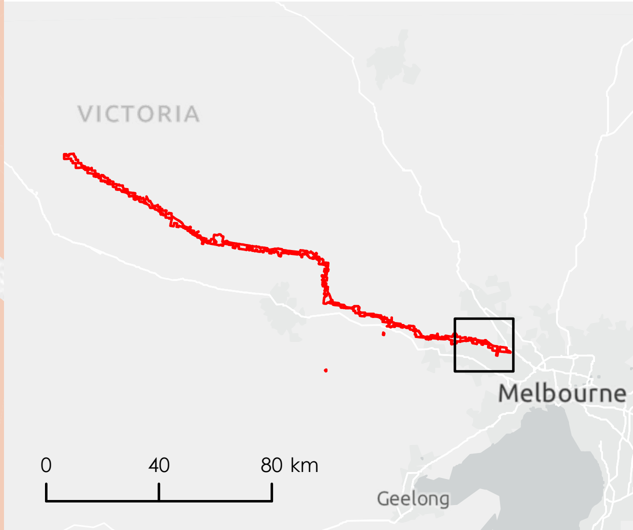

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Route Overview A.11.1

Page 1 of 50

Western Renewables Link

Project Land
Proposed Route
BGTS site options
Field Observation
Field Checkpoint
EG

DEM Desktop Analysis - Line
Drainage
Waterway
Water Body
Geological Units
Colluvial Deposits
Qc1
Shepparton Formation
Nws
St Arnaud Group Sedimentary Units
-Caw
White Hills Gravel
-Pxh

WRL_WR1380_GCL_Route
Created 21 March 2025 by KarimiH

IS3118PM

0 200 400 600
Metres

N

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Project Land
Proposed Route
Distribution Lines - Crossing
BGTS site options
Field Checkpoint
EG
DEM Desktop Analysis
Erosion

DEM Desktop Analysis - Line
Drainage
Waterway
Water Body
Geological Units
Alluvial Deposits
Qa1
Shepparton Formation
Nws
White Hills Gravel
-Pxh

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

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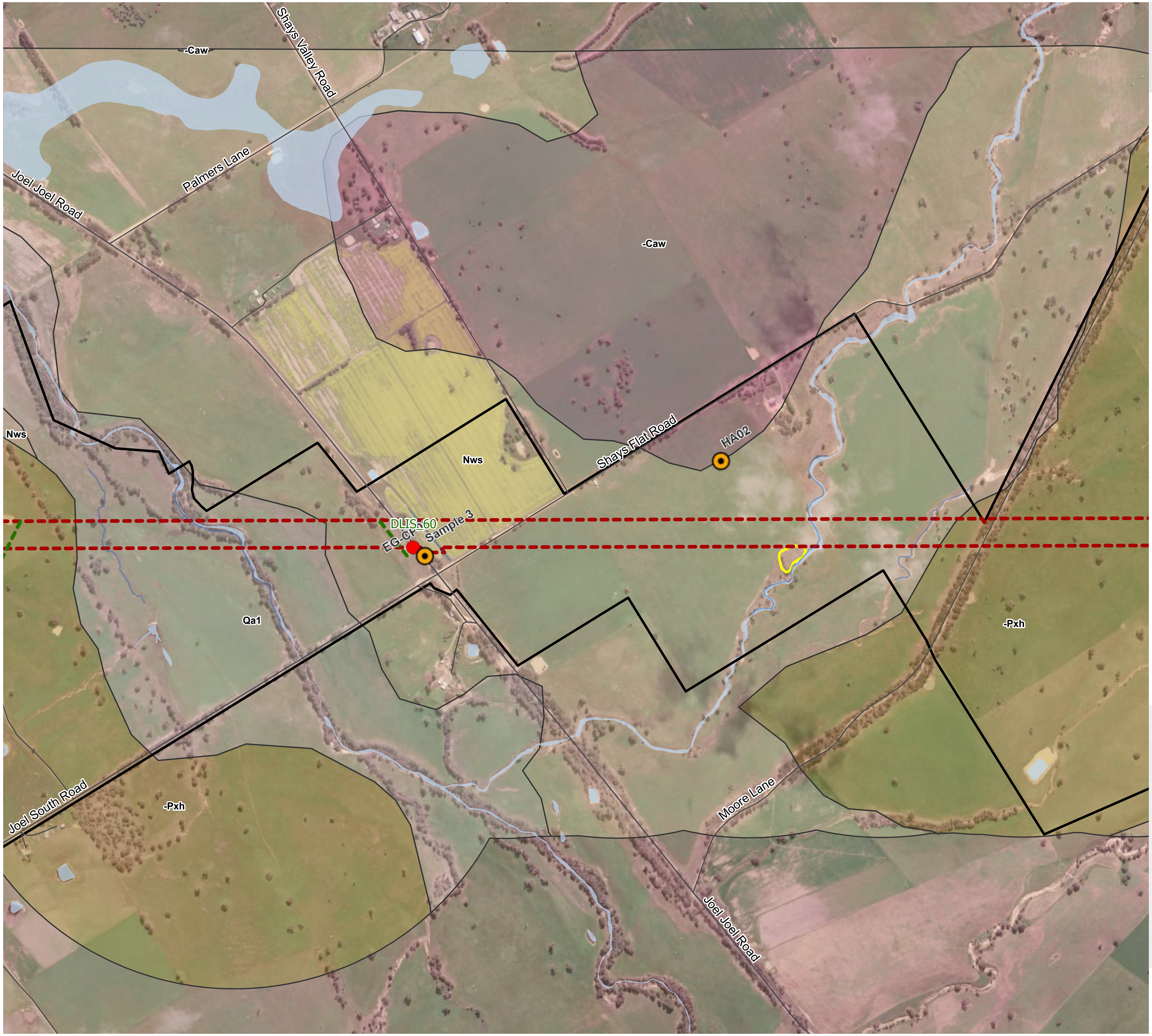

Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EG
DEM Desktop Analysis
Landslide

DEM Desktop Analysis - Line
Drainage
Waterway
Water Body
Geological Units
Alluvial Deposits
Qa1
Shepparton Formation
Nws
St Arnaud Group Sedimentary Units
-Caw
White Hills Gravel
-Pxh

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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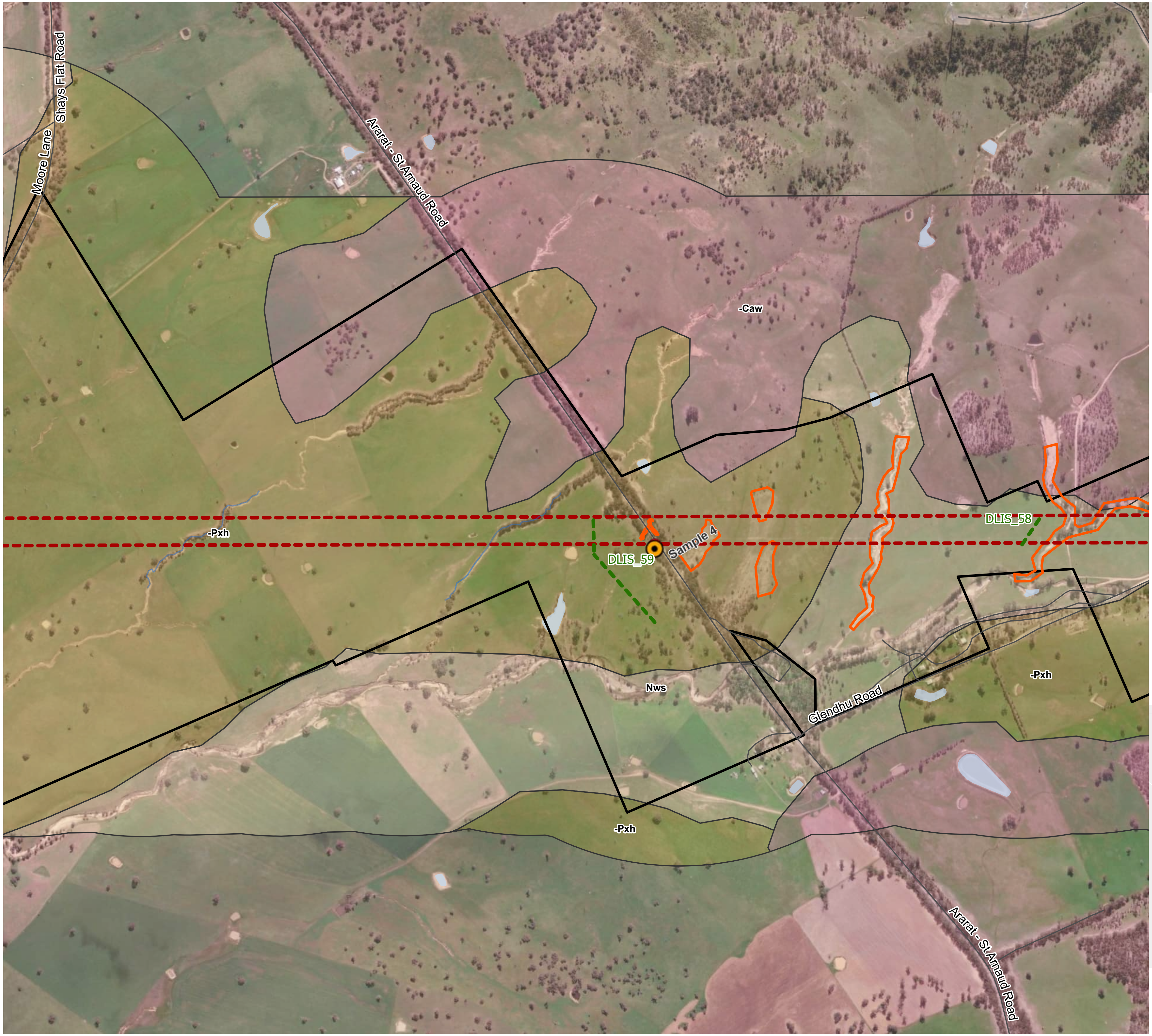

Route Overview A.11.4

Western Renewables Link

Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EG
DEM Desktop Analysis
Erosion
DEM Desktop Analysis - Line
Drainage
Waterway
Water Body
Geological Units
Shepparton Formation
Nws
St Arnaud Group Sedimentary Units
-Caw
White Hills Gravel
-Pxh

WRL_WR1380_GCL_Route
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IS3118PM

0 200 400 600
Metres

N

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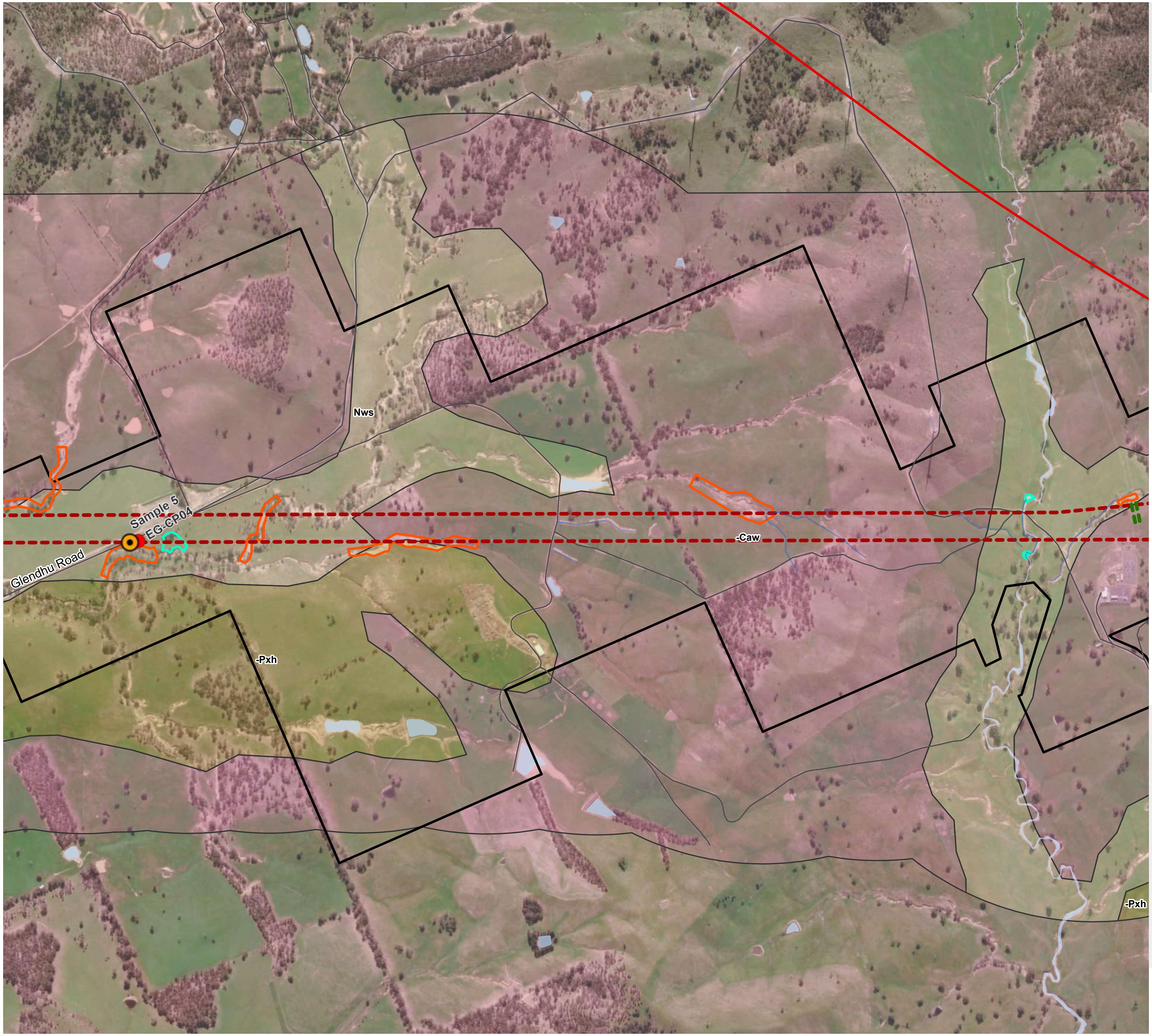

Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EG
DEM Desktop Analysis
Erosion
Other polygon
DEM Desktop Analysis - Line
Drainage
Waterway
Named fault line
Water Body
Geological Units
Shepparton Formation
Nws
St Arnaud Group Sedimentary Units
-Caw
White Hills Gravel
-Pxh

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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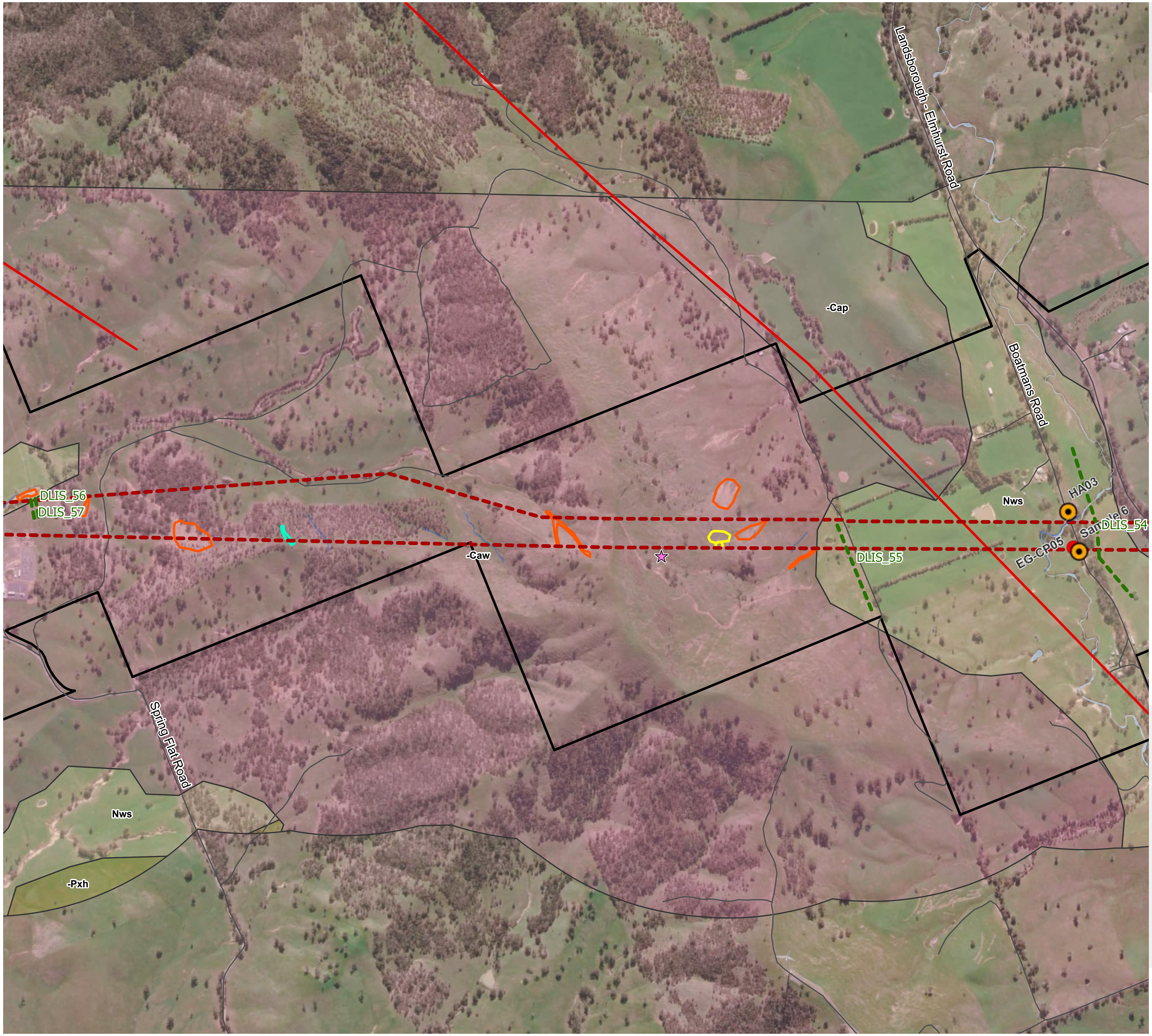

Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EG
DEM Desktop Analysis
Erosion
Landslide
Other polygon

DEM Desktop Analysis - Line
Drainage
Waterway
Geological Significance
Local
Named fault line
Water Body
Geological Units
Shepparton Formation
Nws
St Arnaud Group Sedimentary Units
-Cap
-Caw
White Hills Gravel
-Pxh

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EG
DEM Desktop Analysis
Erosion
Landslide
Other polygon
DEM Desktop Analysis - Line
Drainage
Waterway
Named fault line
Water Body
Geological Units
Alluvial Deposits
Qa1
Shepparton Formation
Nws
St Arnaud Group Sedimentary Units
-Cap

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0 200 400 600
Metres

N

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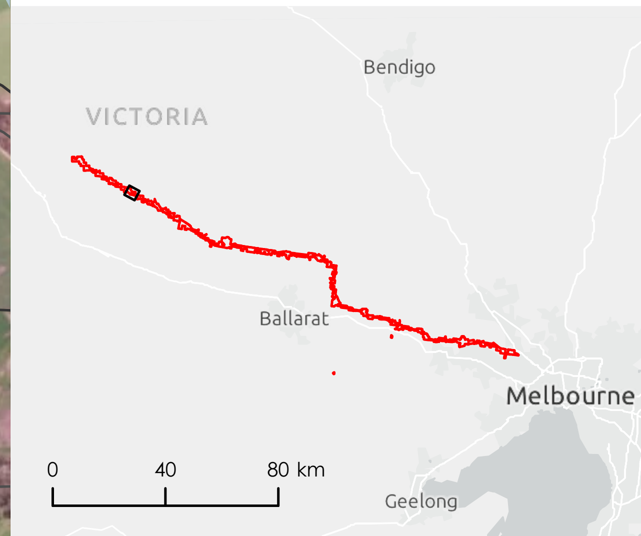

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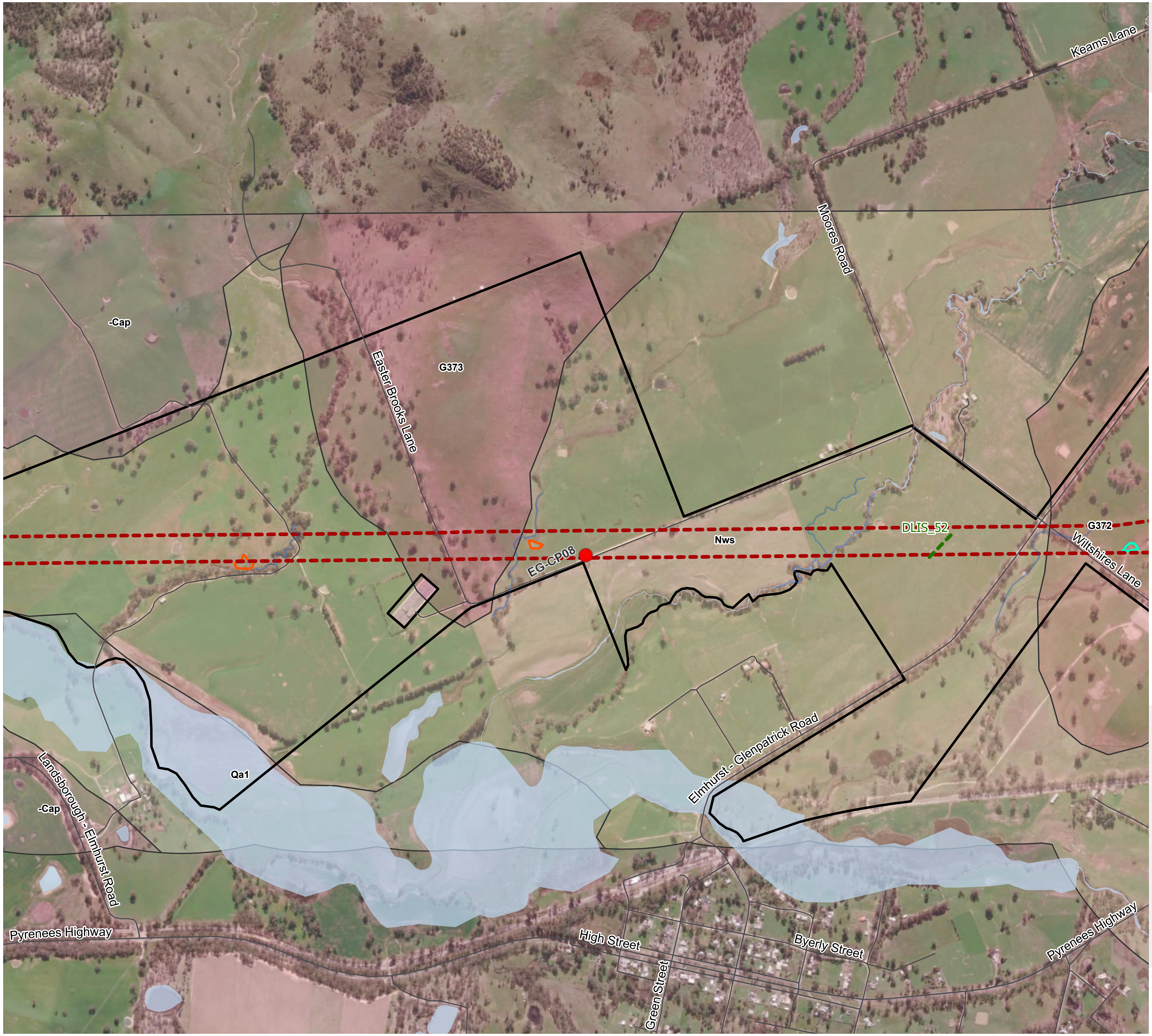

Project Land
Proposed Route
Distribution Lines - Crossing
Field Checkpoint
EG
DEM Desktop Analysis
Erosion
Other polygon

DEM Desktop Analysis - Line
Drainage
Waterway
Water Body
Geological Units
Alluvial Deposits
Qa1
Granite and Granodiorite
G372
G373
Shepparton Formation
Nws
St Arnaud Group Sedimentary Units
-Cap

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EG
DEM Desktop Analysis
Erosion
Other polygon
DEM Desktop Analysis - Line
Drainage
Waterway
Water Body
Geological Units
Colluvial Deposits
Qc4
Granite and Granodiorite
G372
Shepparton Formation
Nws

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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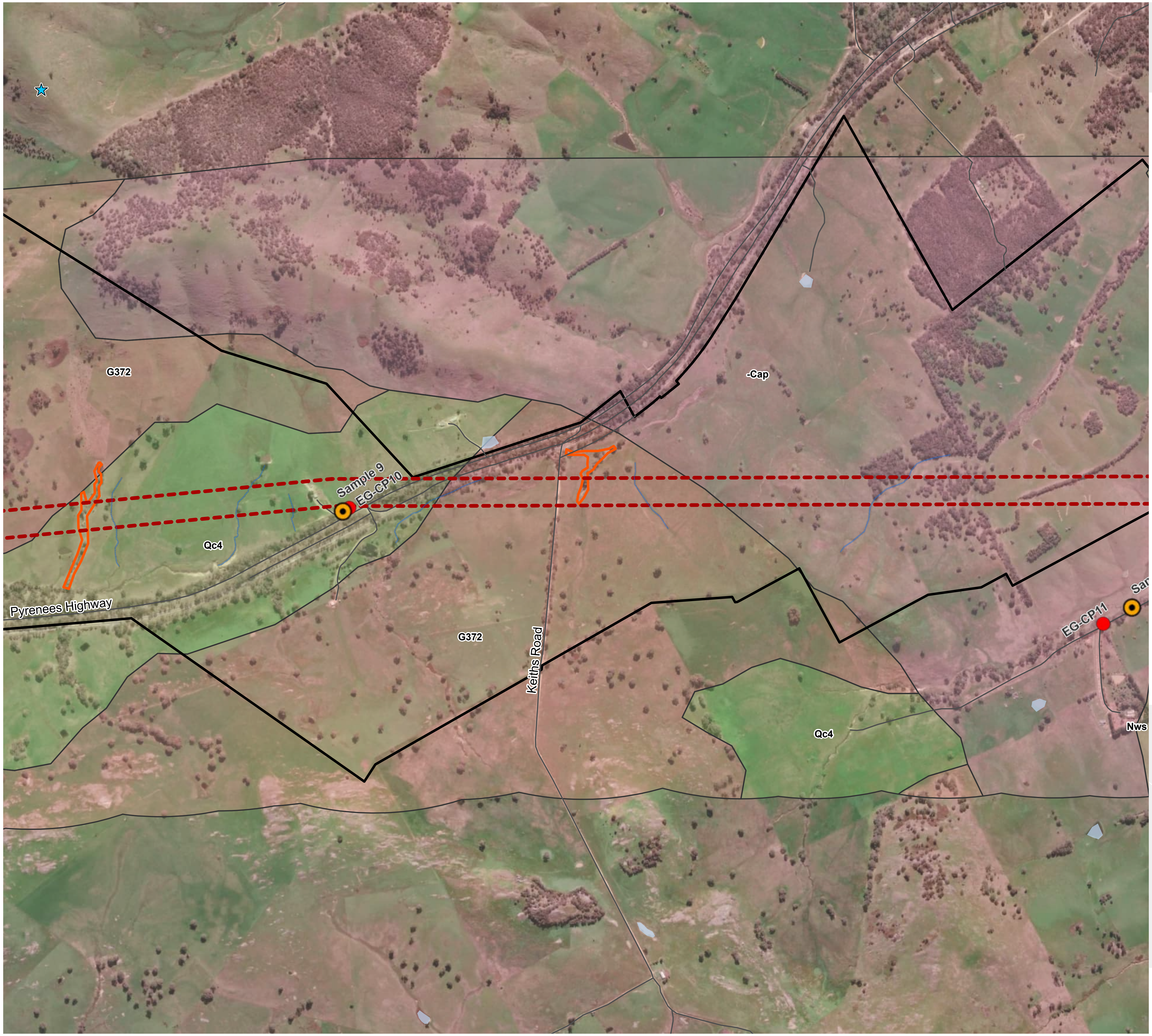

Project Land
Proposed Route
Field Observation
Field Checkpoint
EG
DEM Desktop Analysis
Erosion
DEM Desktop Analysis - Line
Drainage
Waterway
Geological Significance
Regional
Water Body
Geological Units
Colluvial Deposits
Qc4
Granite and Granodiorite
G372
St Arnaud Group Sedimentary Units
-Cap

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0 200 400 600
Metres

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Western Renewables Link

Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EG
DEM Desktop Analysis
Erosion

DEM Desktop Analysis - Line
Drainage
Waterway
Water Body
Geological Units
Shepparton Formation
Nws
St Arnaud Group Sedimentary Units
-Cab
-Cap
White Hills Gravel
-Pxh

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

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Route Overview A.11.12

Western Renewables Link

Project Land
Proposed Route
Distribution Lines - Crossing
Field Checkpoint
EG
EMO

DEM Desktop Analysis - Line
Drainage
Waterway
Water Body
Geological Units
Alluvial Deposits
Qa1
Colluvial Deposits
Nc1
Qc1
Granite and Granodiorite
G368
G371
Shepparton Formation
Nws
St Arnaud Group Sedimentary Units
-Cab
-Cap
White Hills Gravel
-Pxh

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0 200 400 600
Metres

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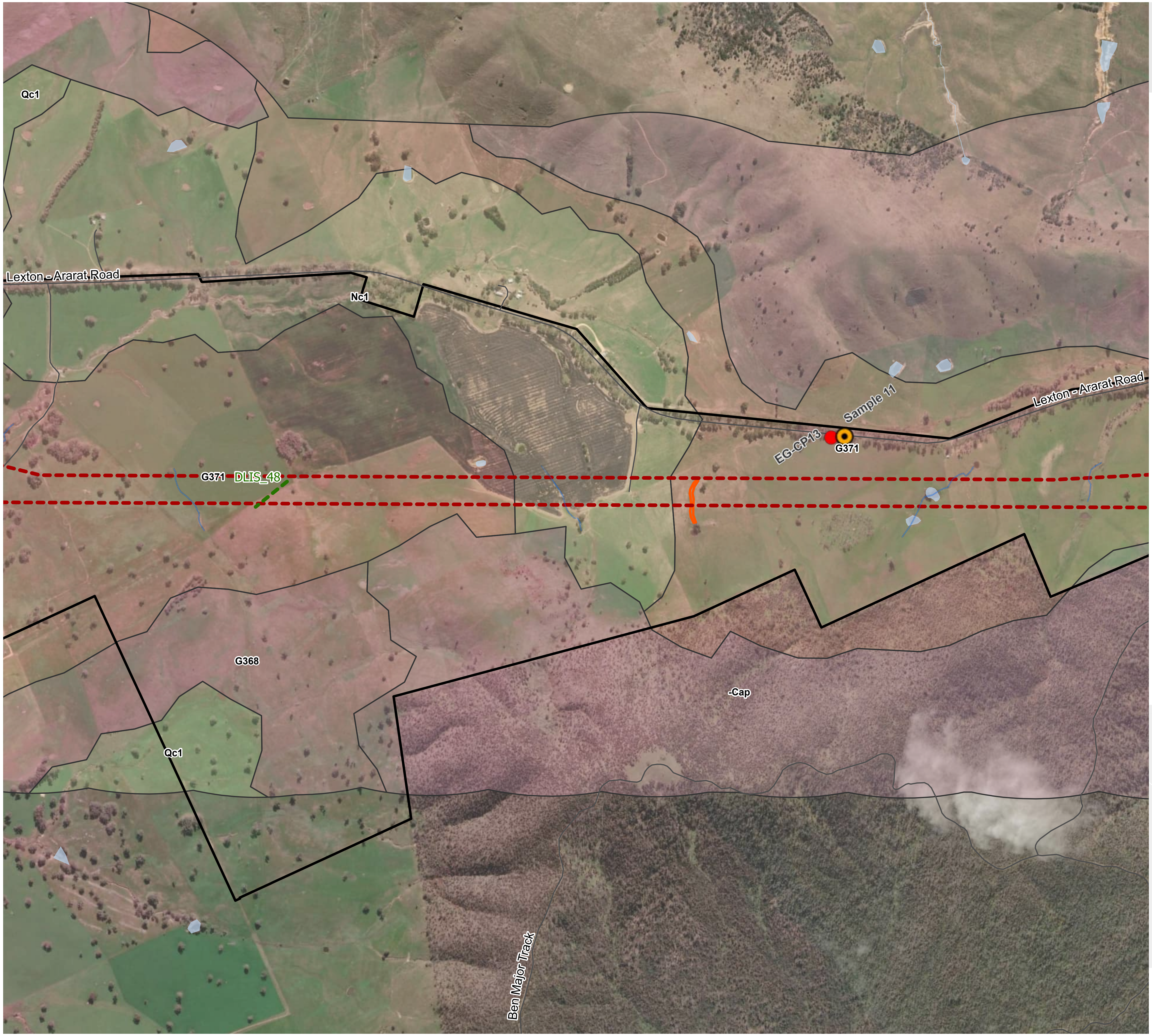
Western Renewables Link



Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EG
EMO
DEM Desktop Analysis
Erosion

DEM Desktop Analysis - Line
Drainage
Waterway
Water Body
Geological Units
Colluvial Deposits
Nc1
Qc1
Granite and Granodiorite
G368
G371
St Arnaud Group Sedimentary Units
-Cap

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

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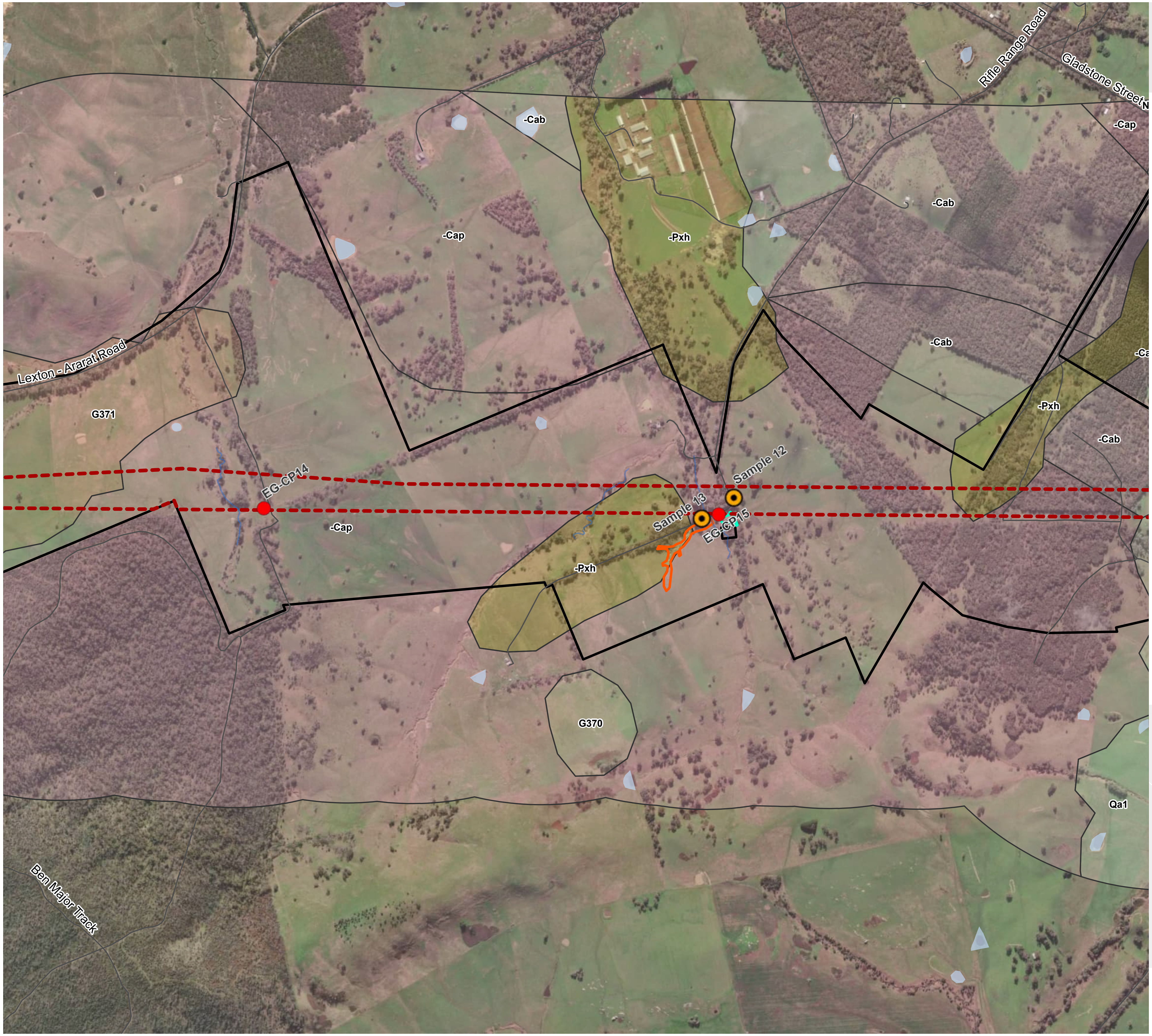

Route Overview A.11.14

Western Renewables Link

Project Land
Proposed Route
Field Observation
Field Checkpoint
EG
DEM Desktop Analysis
Erosion
Other polygon

DEM Desktop Analysis - Line
Drainage
Waterway
Water Body
Geological Units
Alluvial Deposits
Qa1
Granite and Granodiorite
G370
G371
St Arnaud Group Sedimentary Units
-Cab
-Cap
White Hills Gravel
-Pxh

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

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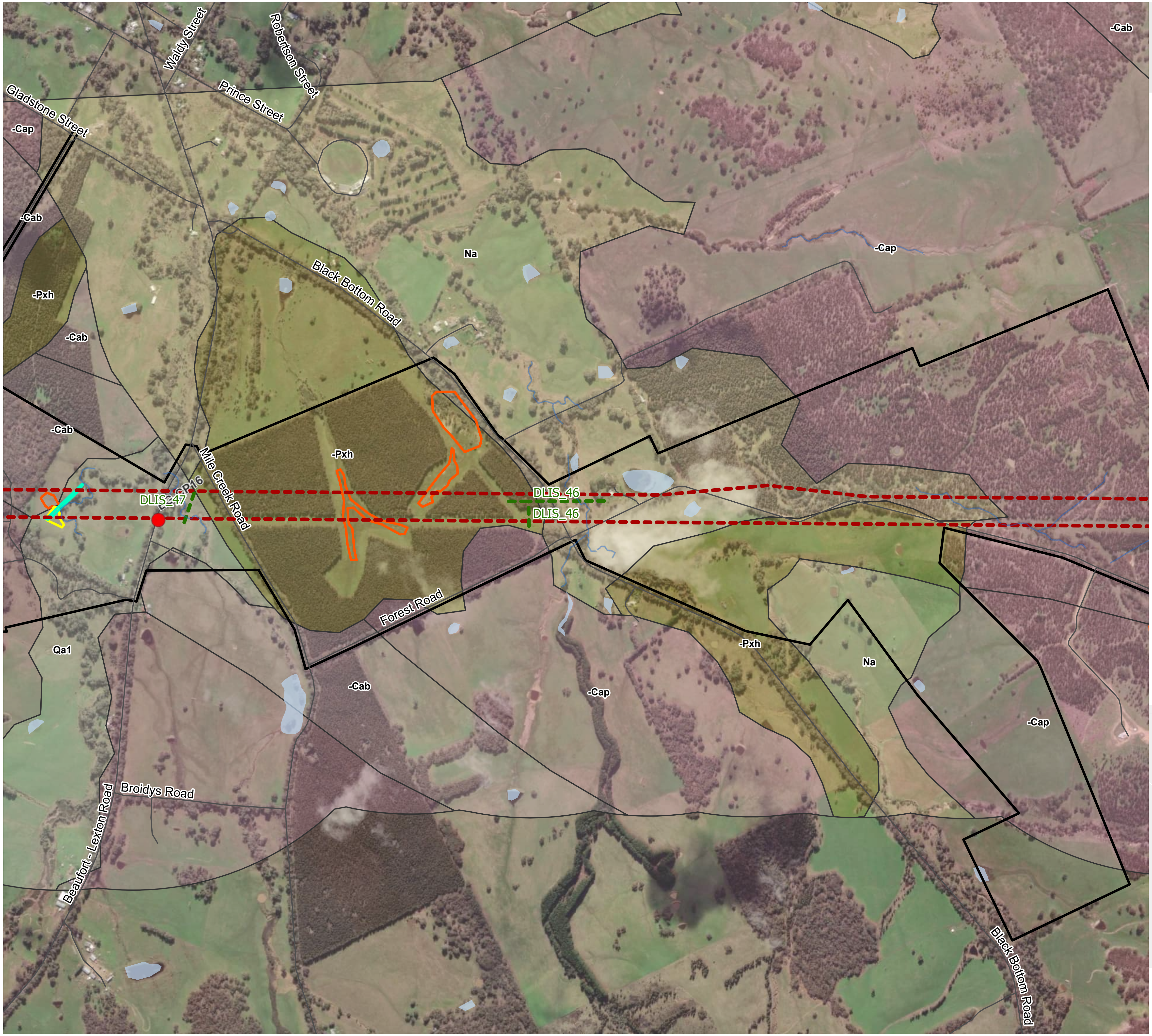

Route Overview A.11.15

Western Renewables Link

Project Land
Proposed Route
Distribution Lines - Crossing
Field Checkpoint
EG
DEM Desktop Analysis
Erosion
Landslide
Other polygon

DEM Desktop Analysis - Line
Drainage
Waterway
Water Body
Geological Units
Alluvial Deposits
Na
Qa1
St Arnaud Group Sedimentary Units
-Cab
-Cap
White Hills Gravel
-Pxh

WRL_WR1380_GCL_Route
Created 21 March 2025 by KarimiH

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0 200 400 600
Metres

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Jacobs, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Maxar

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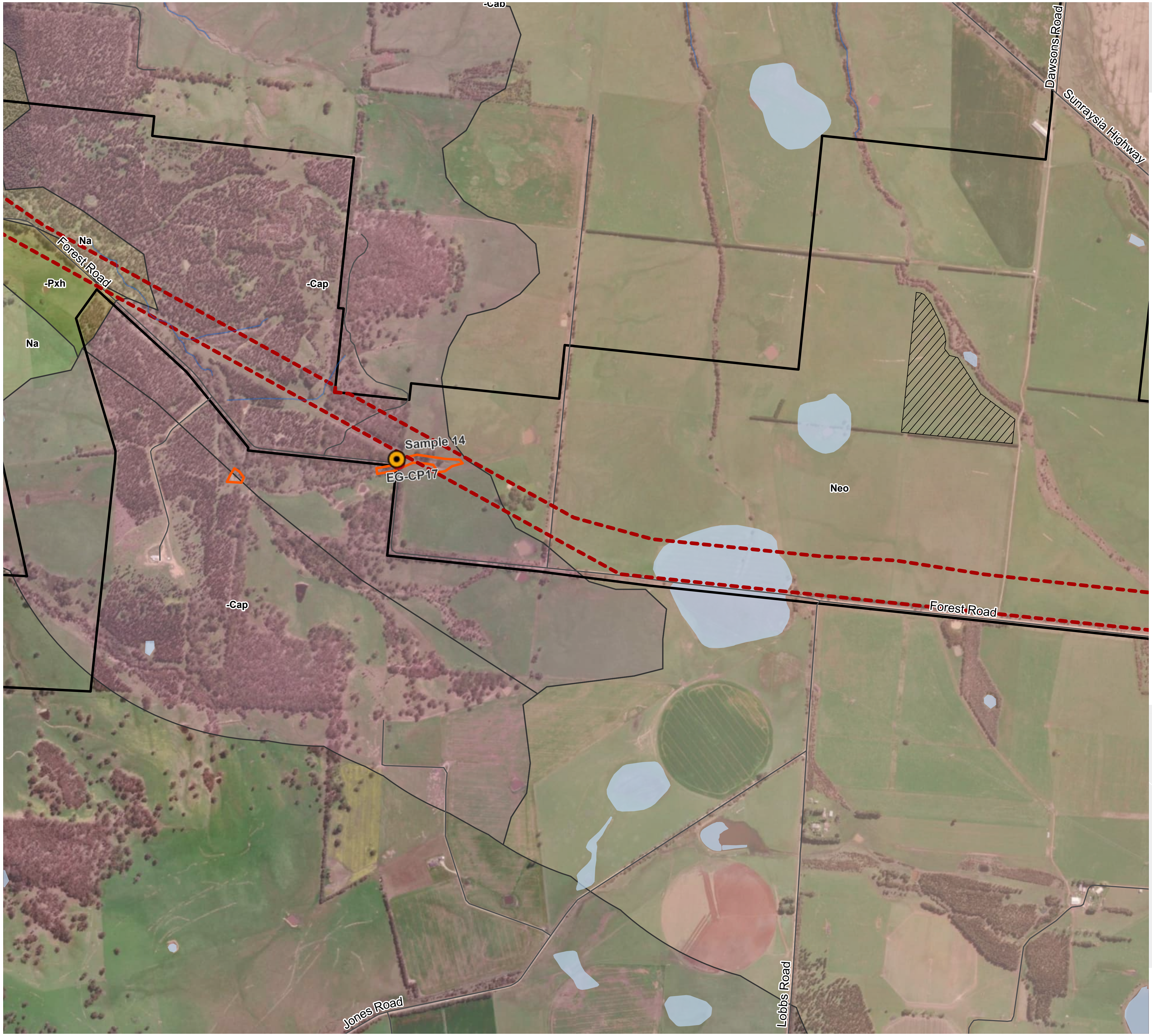

Route Overview A.11.16

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Western Renewables Link

Project Land
Proposed Route
Field Observation
Field Checkpoint
EG
DEM Desktop Analysis
Erosion
Laydown Area and Workforce Accommodation Facility

DEM Desktop Analysis - Line
Drainage
Waterway
Water Body
Geological Units
Alluvial Deposits
Na
Newer Volcanic Group
Neo
St Arnaud Group Sedimentary Units
-Cap
White Hills Gravel
-Pxh

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0 200 400 600
Metres

N

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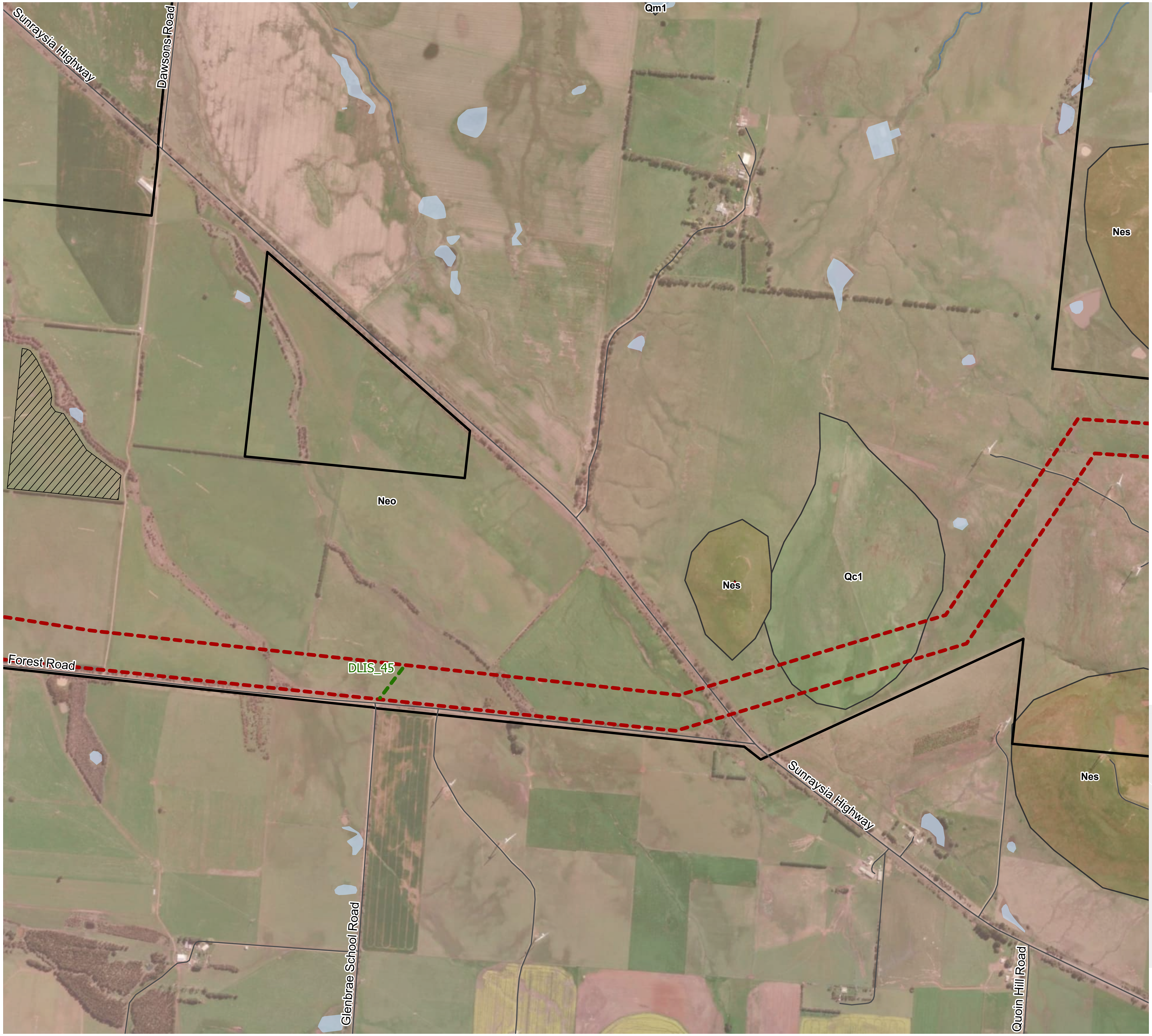

Route Overview A.11.17

Western Renewables Link

Project Land
Proposed Route
Distribution Lines - Crossing
Laydown Area and Workforce Accommodation Facility

DEM Desktop Analysis - Line
Drainage
Waterway
Volcanic eruption point
Water Body
Geological Units
Colluvial Deposits
Qc1
Newer Volcanic Group
Neo
Nes

WRL_WR1380_GCL_Route
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IS3118PM

0 200 400 600
Metres

N

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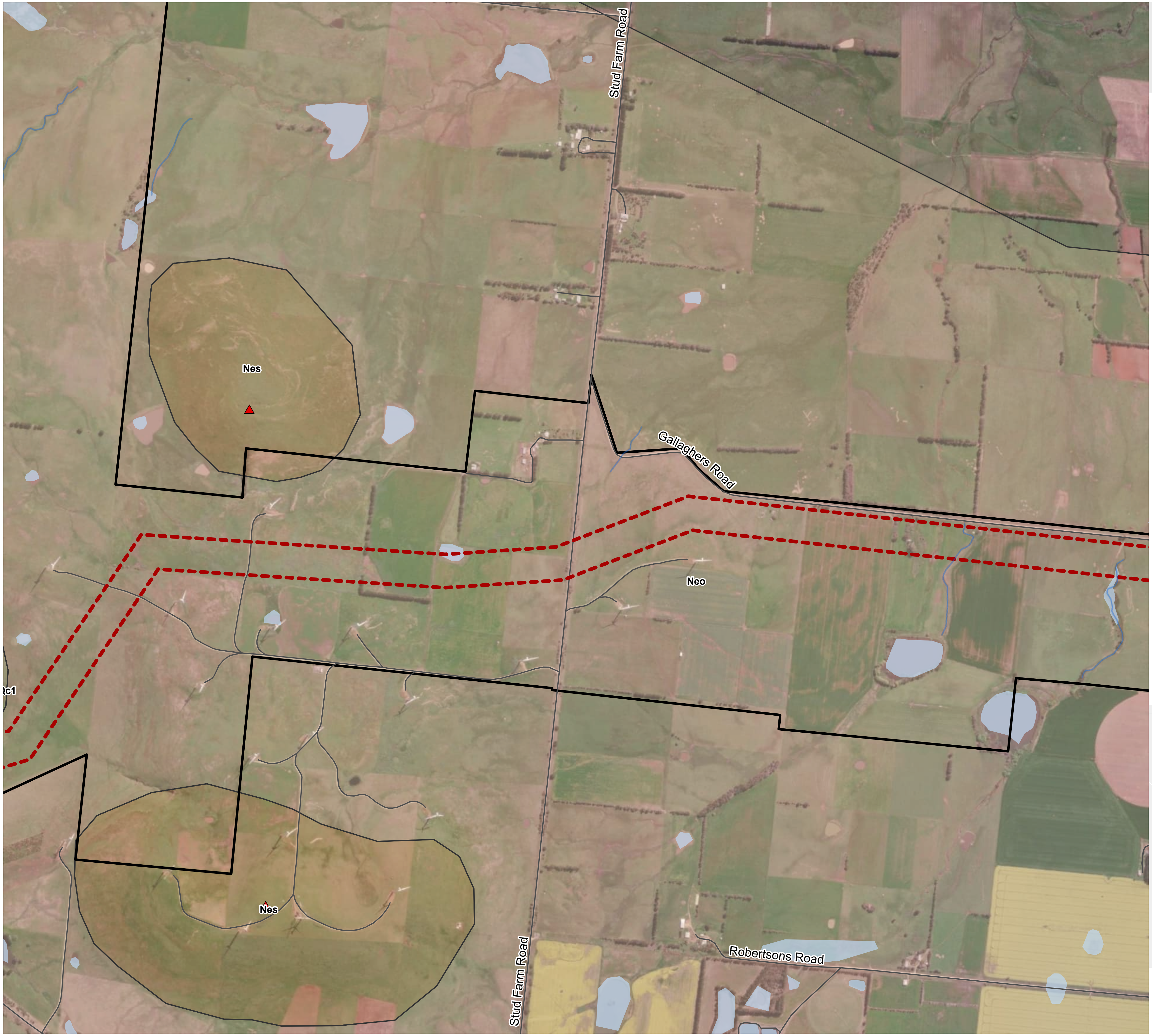

Project Land
Proposed Route

DEM Desktop Analysis - Line
Drainage
Waterway
Volcanic eruption point
Water Body
Geological Units
Newer Volcanic Group
Neo
Nes

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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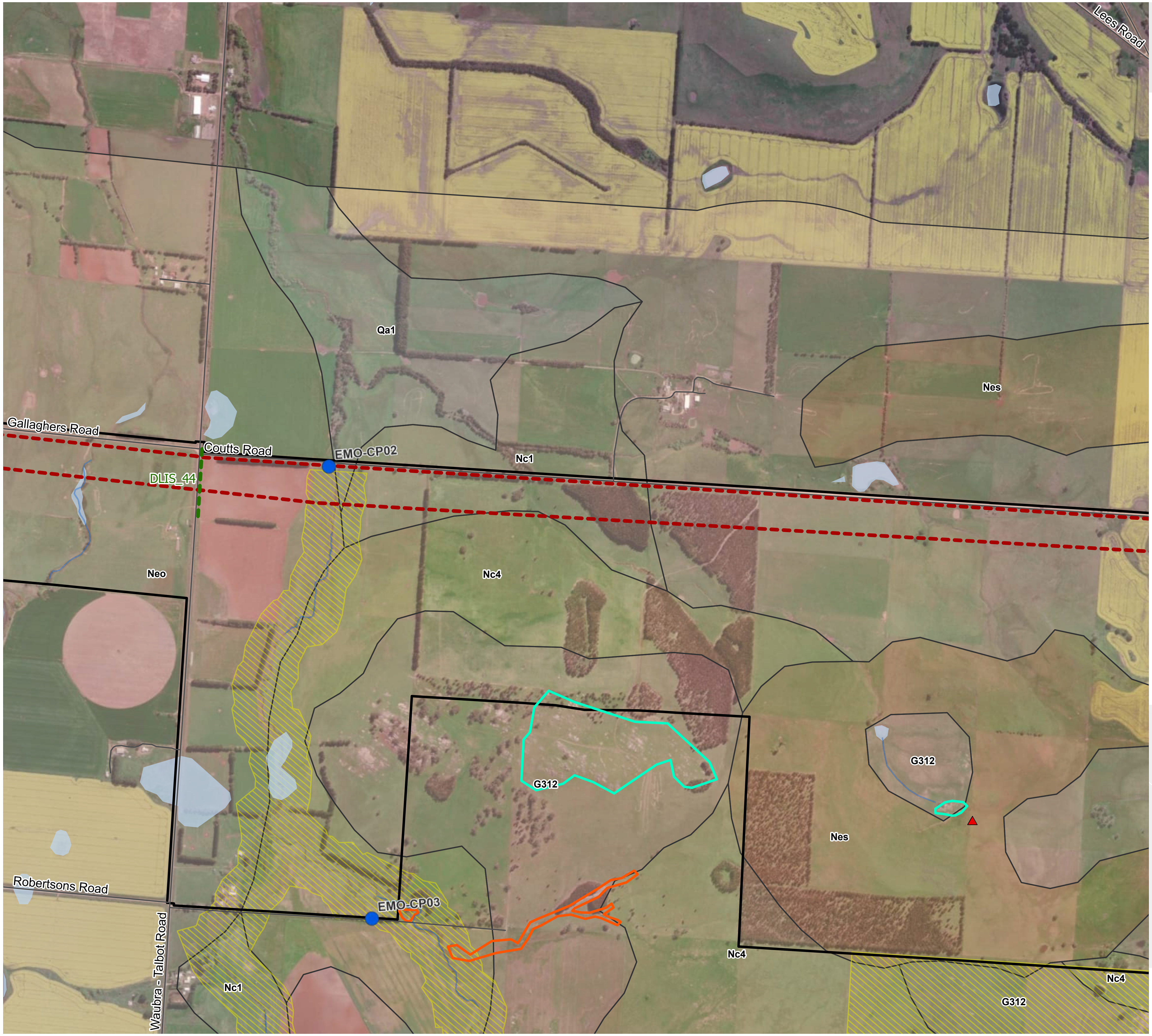

Project Land
Proposed Route
Distribution Lines - Crossing
Field Checkpoint
EMO
DEM Desktop Analysis
Erosion
Other polygon
DEM Desktop Analysis - Line
Drainage
Waterway
Volcanic eruption point
Water Body
Erosion Management Overlay (EMO)
Geological Units
Alluvial Deposits
Qa1
Colluvial Deposits
Nc1
Nc4
Granite and Granodiorite
G312
Newer Volcanic Group
Neo
Nes

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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Project Land
Proposed Route
Distribution Lines - Crossing
Field Checkpoint
EMO

DEM Desktop Analysis - Line
Drainage
Waterway
Geological Significance
Local
Volcanic eruption point
Water Body
Erosion Management Overlay (EMO)
Geological Units
Colluvial Deposits
Nc4
Granite and Granodiorite
G312
Newer Volcanic Group
Neo
Nes

WRL_WR1380_GCL_Route
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0 200 400 600
Metres
N

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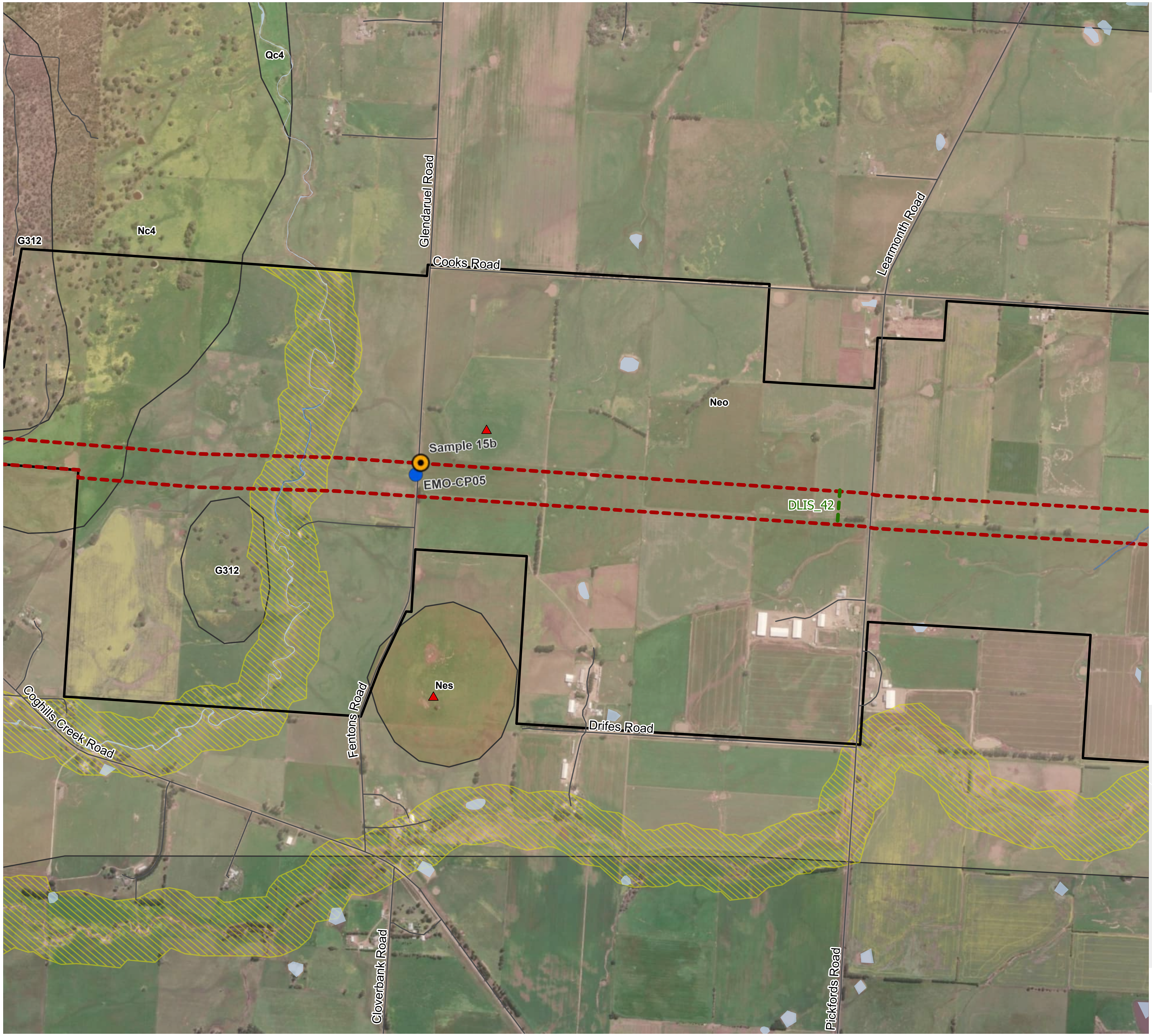
Route Overview A.11.21

Western Renewables Link



Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EMO

DEM Desktop Analysis - Line
Drainage
Waterway
Volcanic eruption point
Water Body
Erosion Management Overlay (EMO)
Geological Units
Colluvial Deposits
Nc4
Qc4
Granite and Granodiorite
G312
Newer Volcanic Group
Neo
Nes

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EMO

DEM Desktop Analysis - Line
Drainage
Waterway
Water Body
Erosion Management Overlay (EMO)
Geological Units
Newer Volcanic Group
Neo
Swamp and Lake Deposits
Qm1

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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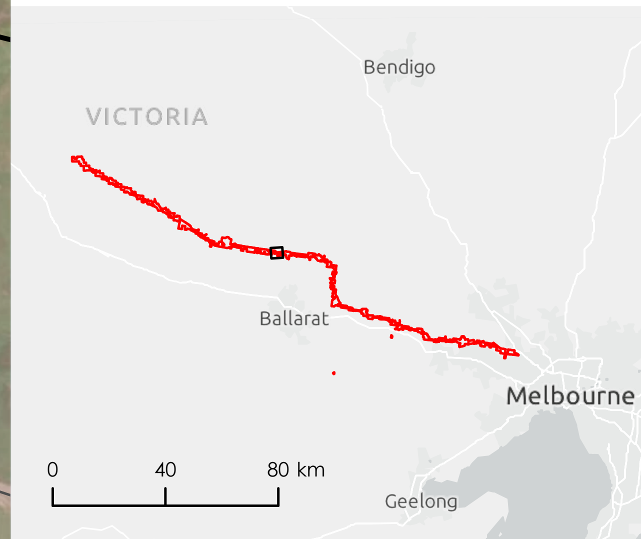

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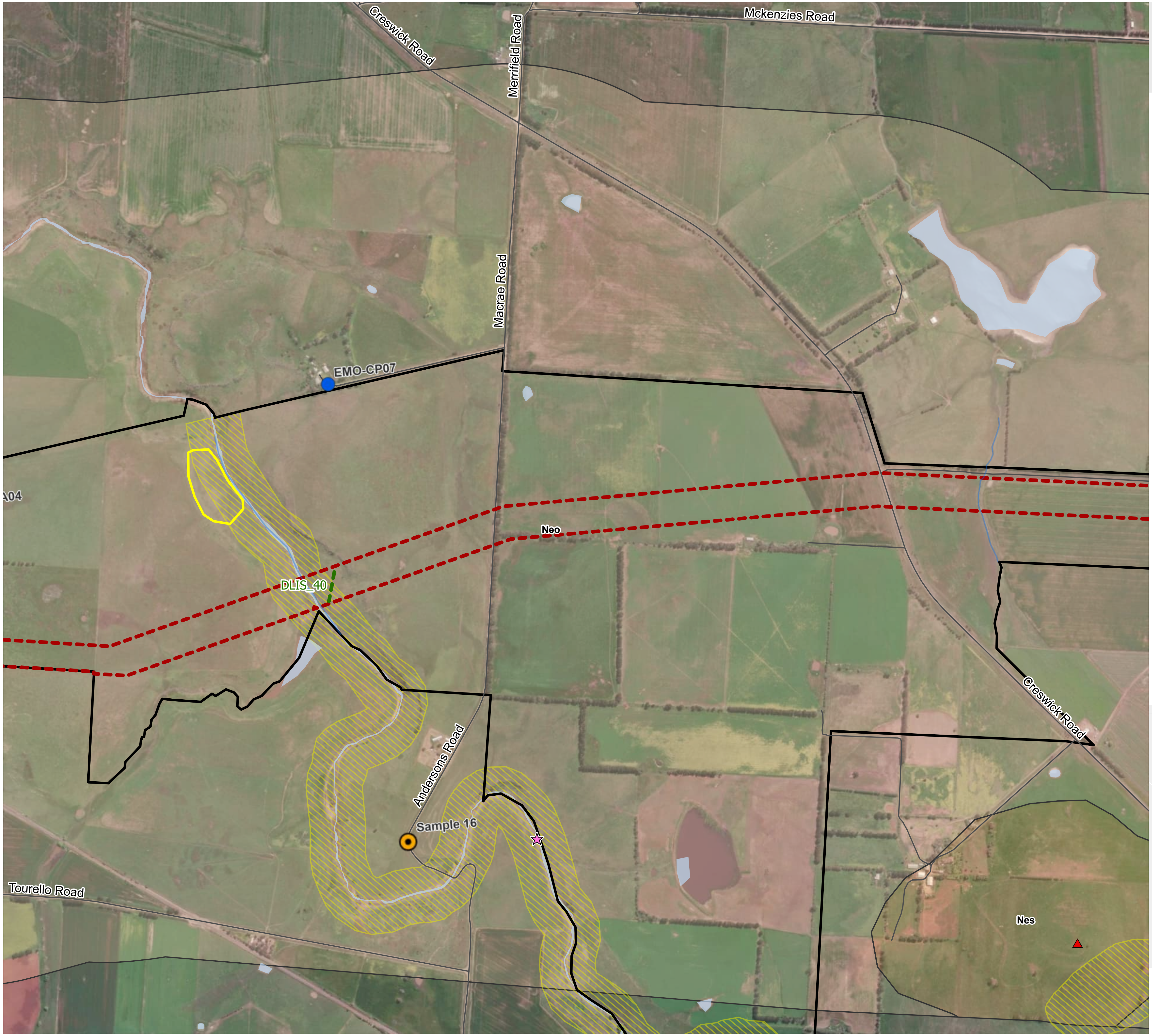
Western Renewables Link



Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EMO
DEM Desktop Analysis
Landslide

DEM Desktop Analysis - Line
Drainage
Waterway
Geological Significance
Local
Water Body
Erosion Management Overlay (EMO)
Geological Units
Newer Volcanic Group
Neo
Nes

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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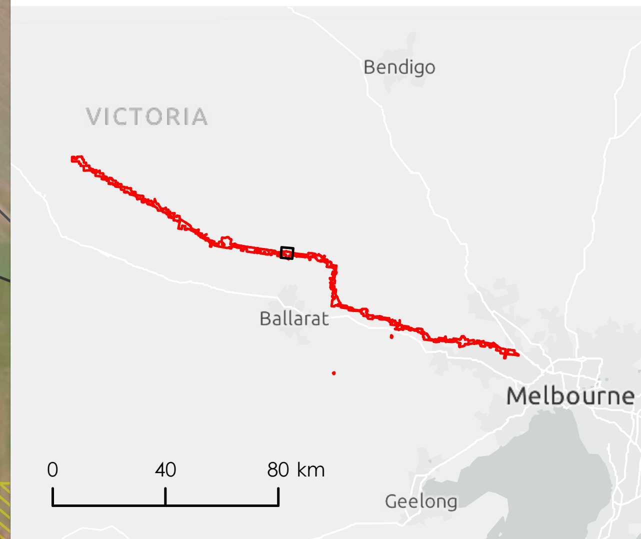

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Western Renewables Link

Project Land
Proposed Route
Distribution Lines - Crossing

DEM Desktop Analysis - Line
Drainage
Waterway
Volcanic eruption point
Water Body
Erosion Management Overlay (EMO)
Geological Units
Castlemaine Group Sedimentary Units
Ocl
Newer Volcanic Group
Neo
Nes
Swamp and Lake Deposits
Qm1

WRL_WR1380_GCL_Route
Created 21 March 2025 by KarimiH
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0 200 400 600
Metres
N

DATA SOURCES
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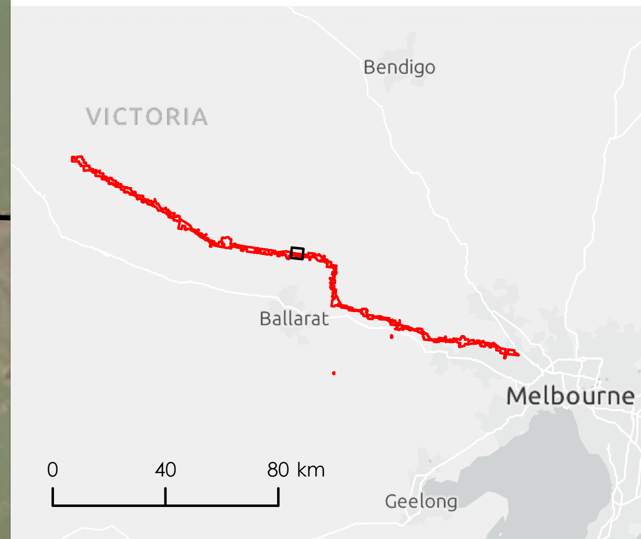

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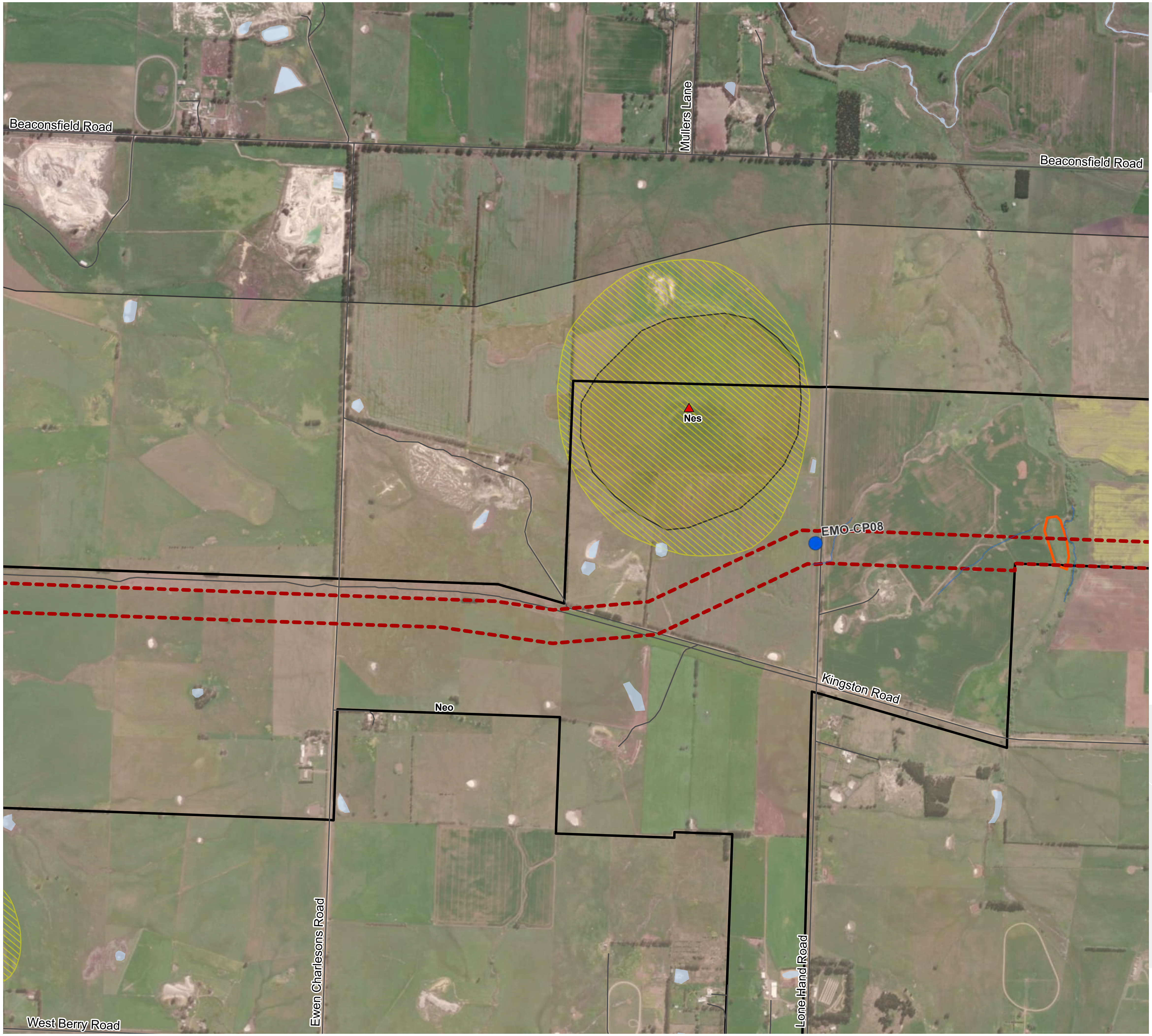

Project Land
Proposed Route
Field Checkpoint
EMO
DEM Desktop Analysis
Erosion
DEM Desktop Analysis - Line
Drainage
Waterway
Volcanic eruption point
Water Body
Erosion Management Overlay (EMO)
Geological Units
Newer Volcanic Group
Neo
Nes

WRL_WR1380_GCL_Route
Created 21 March 2025 by KarimiH
IS3118PM

0 200 400 600
Metres
N

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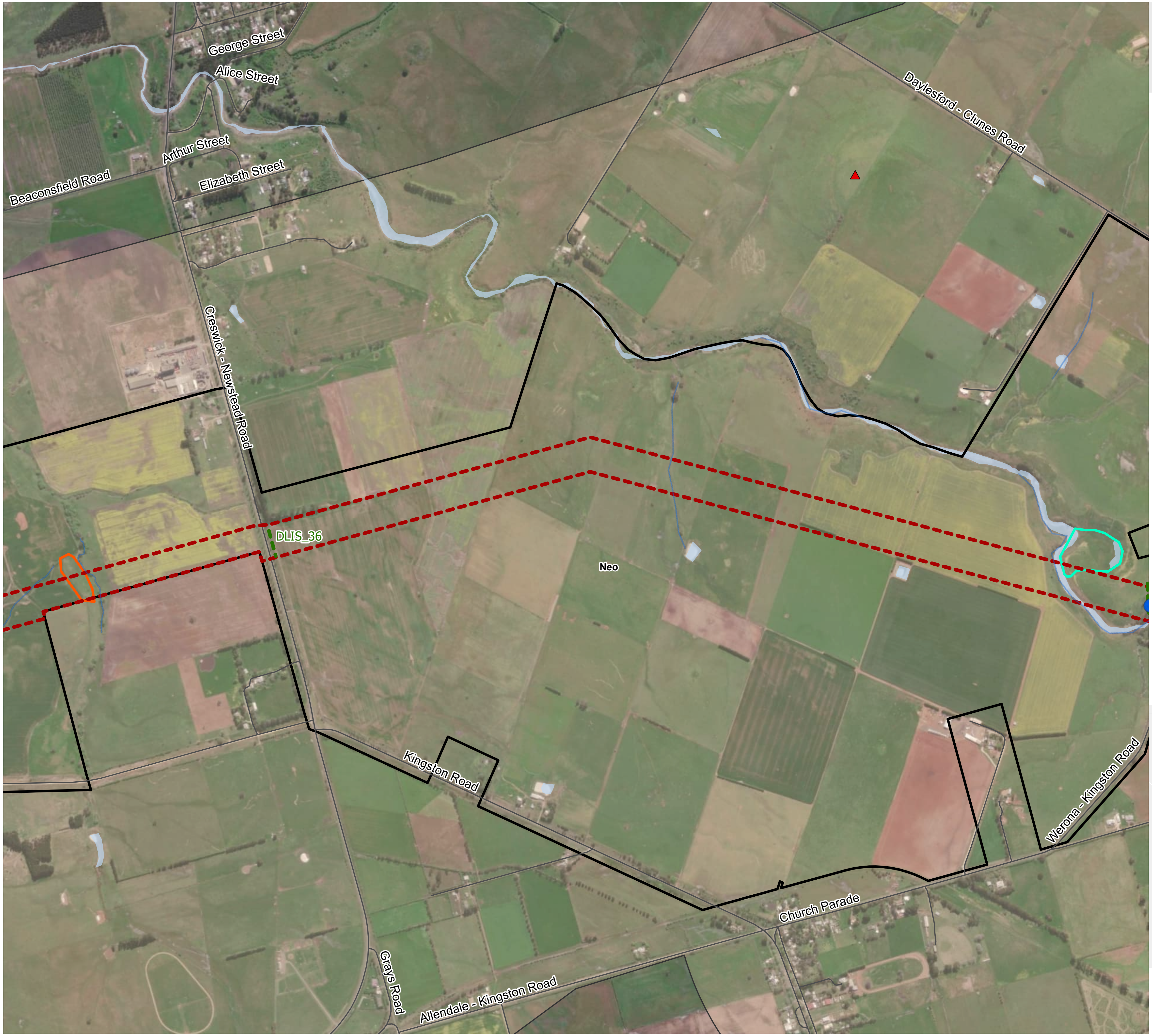

Project Land
Proposed Route
Distribution Lines - Crossing
Field Checkpoint
EMO
DEM Desktop Analysis
Erosion
Other polygon
DEM Desktop Analysis - Line
Drainage
Waterway
Volcanic eruption point
Water Body
Geological Units
Newer Volcanic Group
Neo

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0 200 400 600
Metres

N

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Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EMO
DEM Desktop Analysis
Erosion
Landslide
Other polygon
DEM Desktop Analysis - Line
Drainage
Waterway
Geological Significance
Local
Volcanic eruption point
Water Body
Geological Units
Alluvial Deposits
Qa1
Calivil Formation
-Pxa
Newer Volcanic Group
Neo
Nep1

WRL_WR1380_GCL_Route IS3118PM
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0 200 400 600
Metres

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Route Overview A.11.28

Page 28 of 50

Western Renewables Link

Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EMO

DEM Desktop Analysis - Line
Drainage
Waterway
Volcanic eruption point
Water Body
Erosion Management Overlay (EMO)
Geological Units
Alluvial Deposits
Qa1
Calivil Formation
-Pxa
Castlemaine Group Sedimentary Units
Ocl
Colluvial Deposits
Qc1
Newer Volcanic Group
Neo
Nes

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

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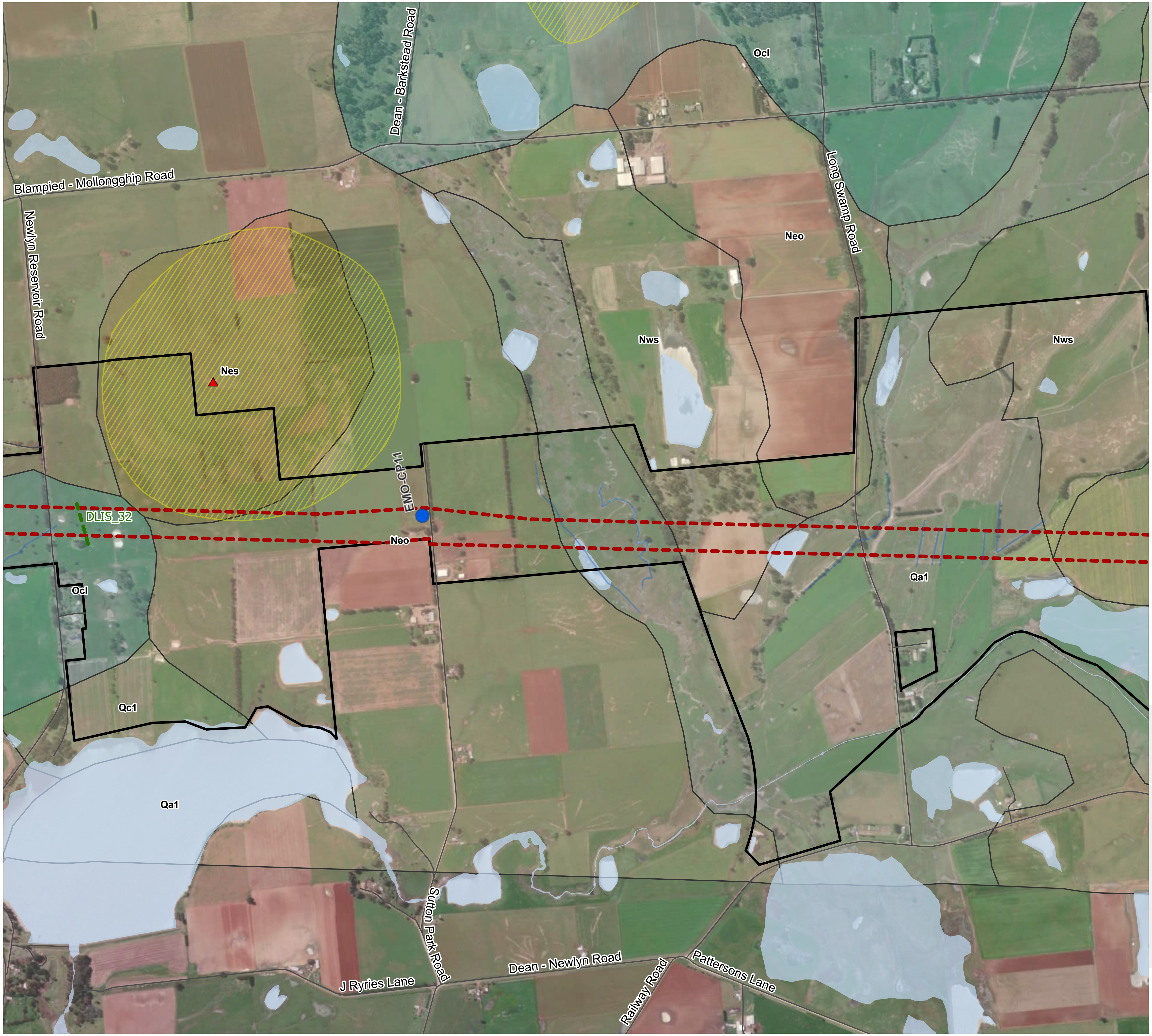
Route Overview A.11.29

Page 29 of 50

Western Renewables Link



Project Land
Proposed Route
Distribution Lines - Crossing
Field Checkpoint
EMO

DEM Desktop Analysis - Line
Drainage
Waterway
Volcanic eruption point
Water Body
Erosion Management Overlay (EMO)
Geological Units
Alluvial Deposits
Qa1
Castlemaine Group Sedimentary Units
Ocl
Colluvial Deposits
Qc1
Newer Volcanic Group
Neo
Nes
Shepparton Formation
Nws

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

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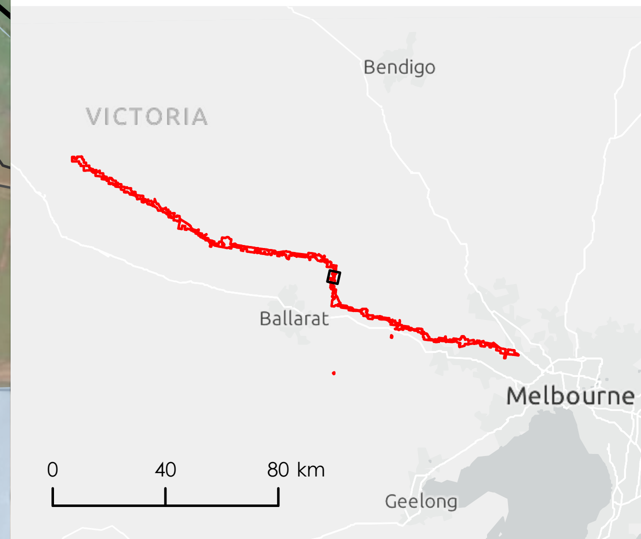

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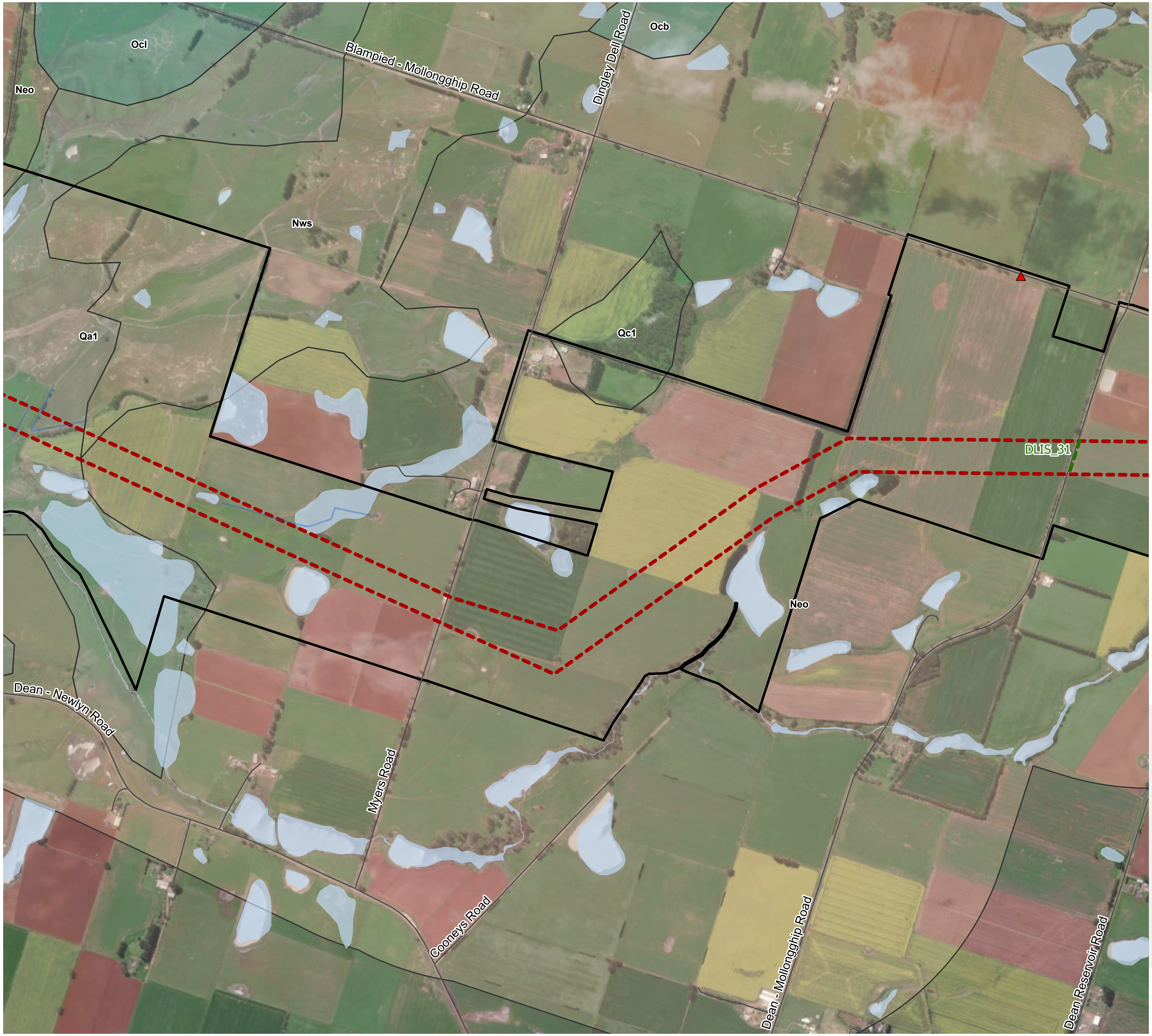

Route Overview A.11.30

Page 30 of 50

Western Renewables Link

Project Land
Proposed Route
Distribution Lines - Crossing

DEM Desktop Analysis - Line
Drainage
Waterway
Volcanic eruption point
Water Body
Geological Units
Alluvial Deposits
Qa1
Castlemaine Group Sedimentary Units
Ocb
Ocl
Colluvial Deposits
Qc1
Newer Volcanic Group
Neo
Shepparton Formation
Nws

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0 200 400 600
Metres

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Route Overview A.11.31

Western Renewables Link

Project Land
Proposed Route
Distribution Lines - Crossing
Field Checkpoint
LS
DEM Desktop Analysis
Erosion
DEM Desktop Analysis - Line
Drainage
Waterway
Volcanic eruption point
Water Body
Geological Units
Newer Volcanic Group
Neo

WRL_WR1380_GCL_Route IS3118PM
Created 21 March 2025 by KarimiH

0 200 400 600
Metres

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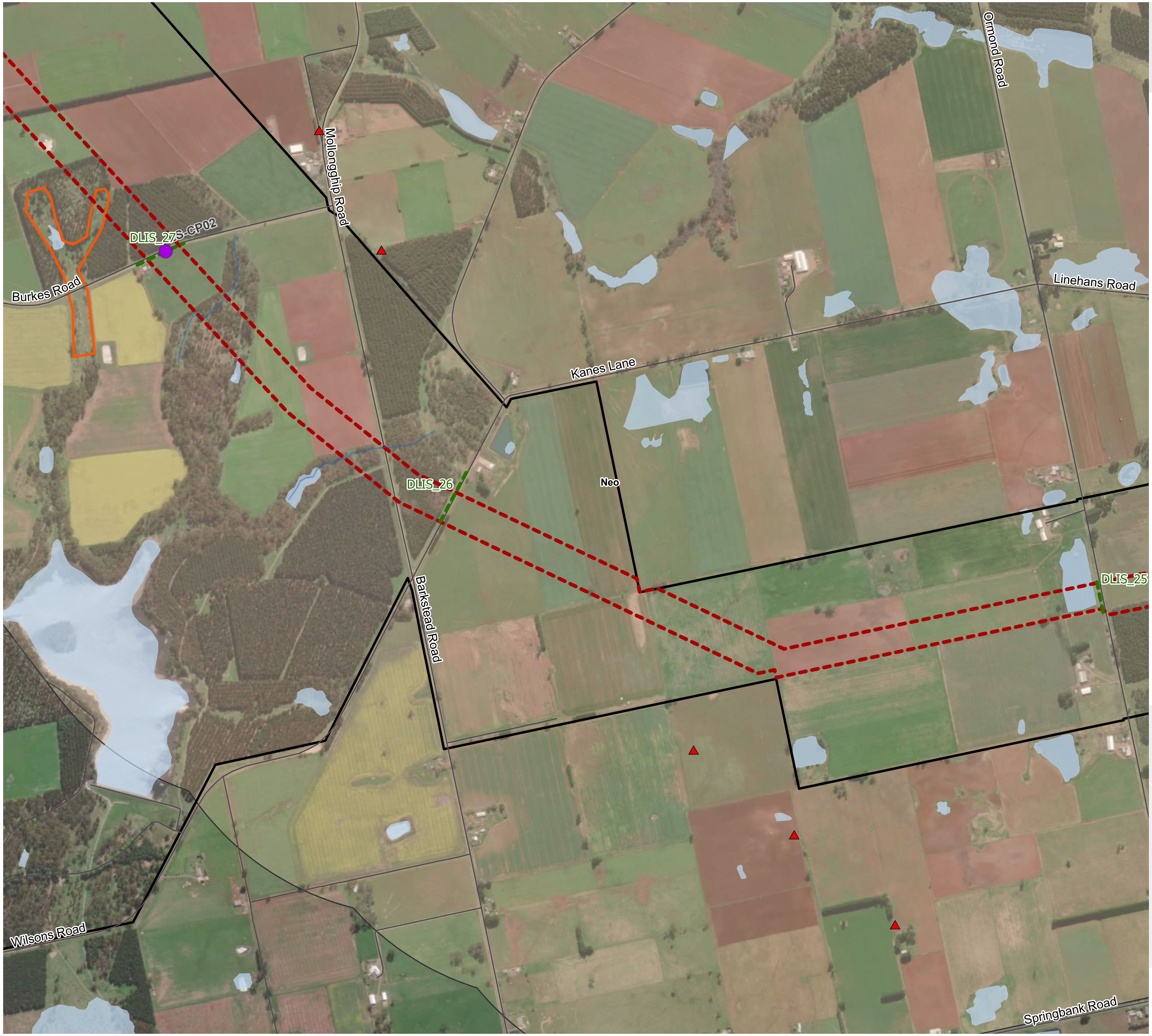
Western Renewables Link



Project Land
Proposed Route
Distribution Lines - Crossing
Field Checkpoint
LS
DEM Desktop Analysis
Erosion
DEM Desktop Analysis - Line
Drainage
Waterway
Volcanic eruption point
Water Body
Geological Units
Newer Volcanic Group
Neo

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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Project Land
Proposed Route
Distribution Lines - Crossing
DEM Desktop Analysis
Landslide

DEM Desktop Analysis - Line
Drainage
Waterway
Named fault line
Water Body
Geological Units
Alluvial Deposits
Qa1
Castlemaine Group Sedimentary Units
Ocl
Newer Volcanic Group
Neo

WRL_WR1380_GCL_Route
Created 21 March 2025 by KarimiH

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0 200 400 600
Metres

N

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- Project Land
- Proposed Route
- Distribution Lines - Crossing
- Field Observation

DEM Desktop Analysis - Line
- Drainage
- Waterway
- Volcanic eruption point
- Water Body

Geological Units
- Alluvial Deposits
  - Qa1
- Castlemaine Group Sedimentary Units
  - Occ
  - Ocl
- Newer Volcanic Group
  - Neo
- White Hills Gravel
  - -Pxh

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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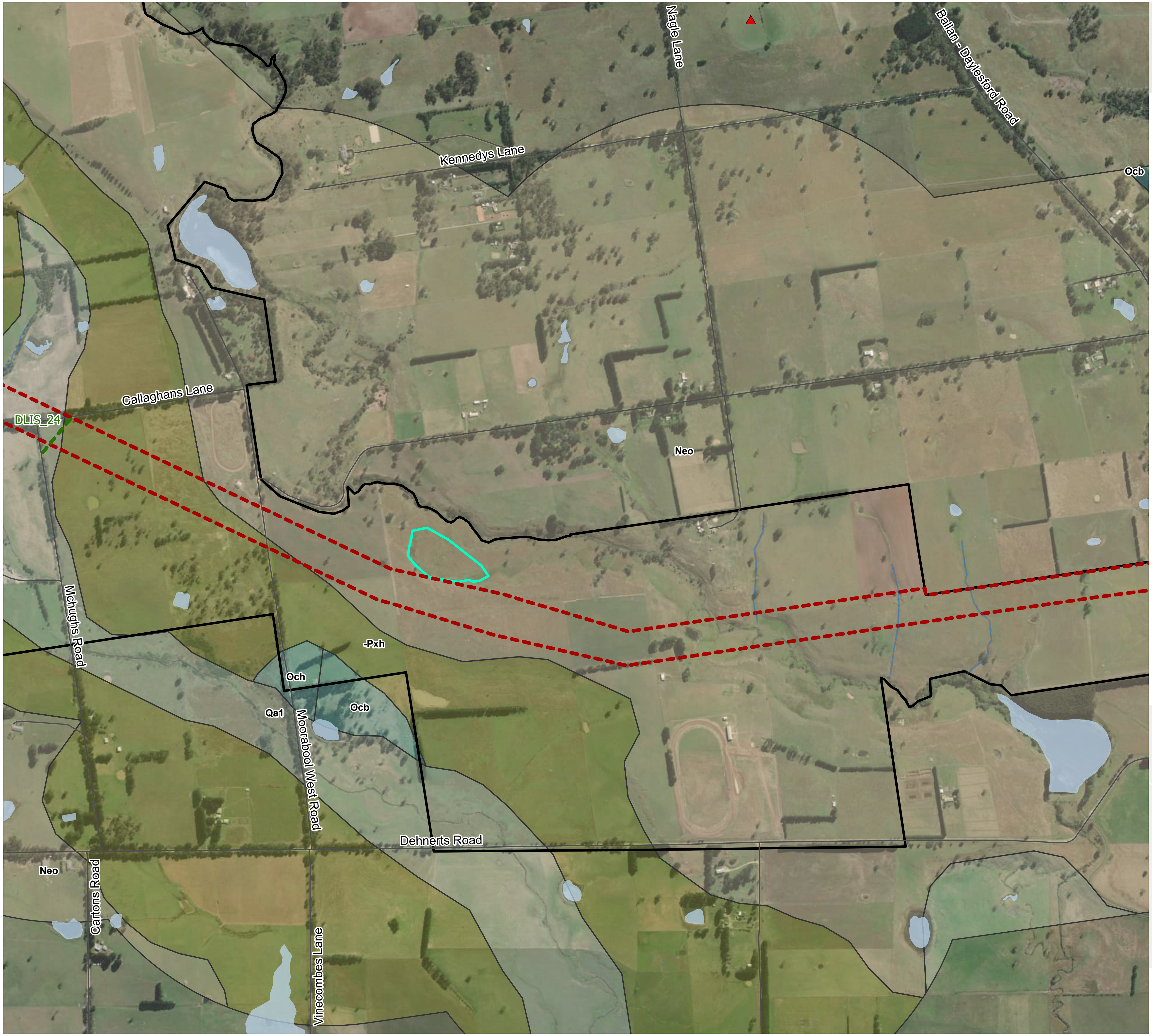
Route Overview A.11.35

Western Renewables Link



- Project Land
- Proposed Route
- Distribution Lines - Crossing

DEM Desktop Analysis
- Other polygon

DEM Desktop Analysis - Line
- Drainage
- Waterway
- Water Body

Geological Units

Alluvial Deposits
- Qa1

Castlemaine Group Sedimentary Units
- Ocb
- Och

Newer Volcanic Group
- Neo

White Hills Gravel
- -Pxh

WRL_WR1380_GCL_Route

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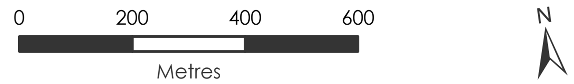

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Route Overview A.11.36

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Western Renewables Link

Project Land
Proposed Route
Distribution Lines - Crossing
Field Checkpoint
O

DEM Desktop Analysis - Line
Drainage
Waterway
Named fault line
Water Body
Geological Units
Alluvial Deposits
Qa1
Castlemaine Group Sedimentary Units
Ocb
Newer Volcanic Group
Neo
White Hills Gravel
-Pxh

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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Route Overview A.11.37

Page 37 of 50

Western Renewables Link

- Project Land
- Proposed Route
- Distribution Lines - Crossing

Field Checkpoint
- GSF

DEM Desktop Analysis
- Landslide

DEM Desktop Analysis - Line
- Drainage
- Waterway
- Volcanic eruption point
- Water Body

Geological Units

Alluvial Deposits
- Qa1

Colluvial Deposits
- Qc1

Newer Volcanic Group
- Neo

Pentland Hills Volcanic Group
- -Pp

White Hills Gravel
- -Pxh

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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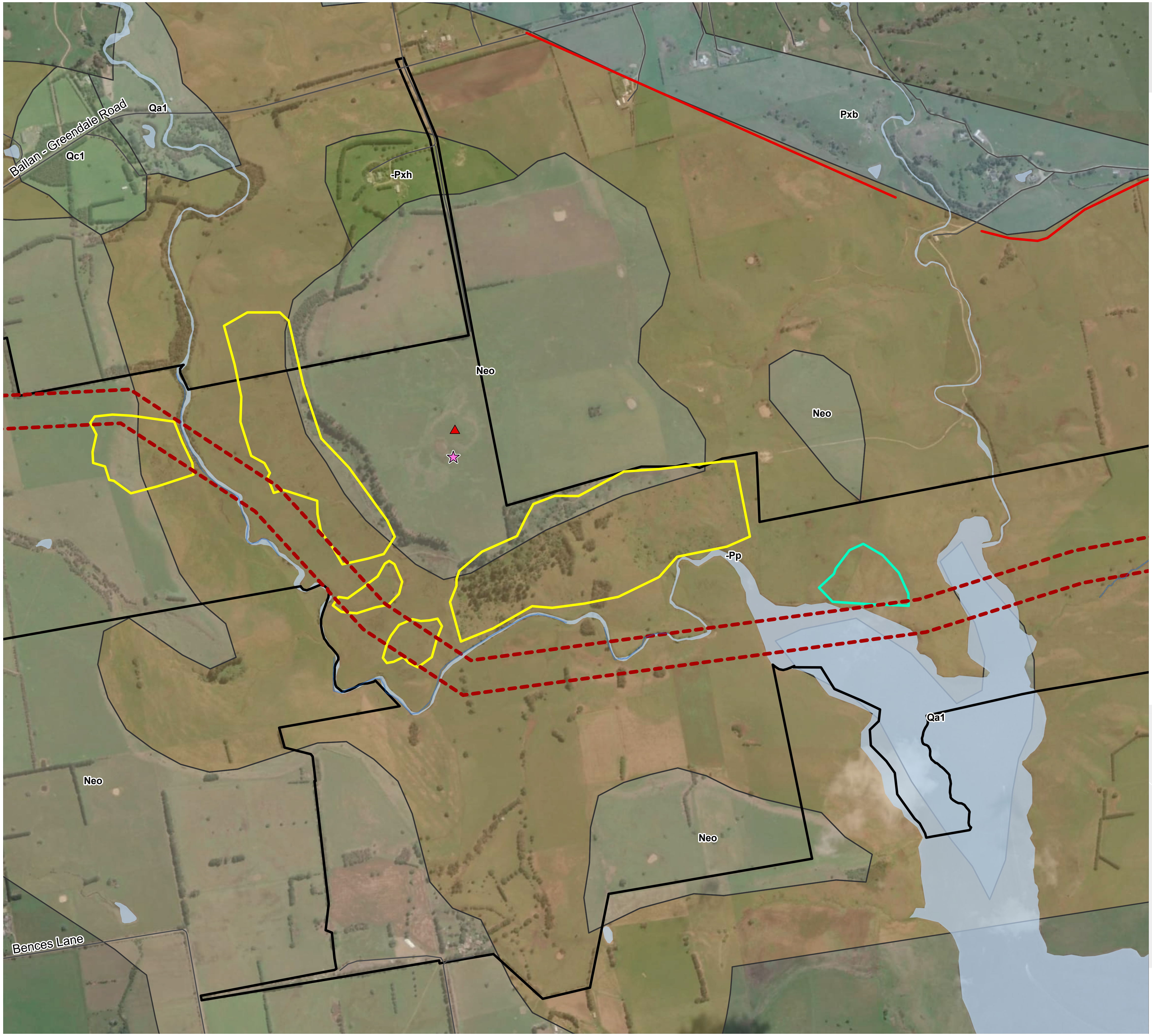

Route Overview A.11.38

Page 38 of 50

Western Renewables Link

Project Land
Proposed Route
DEM Desktop Analysis
Landslide
Other polygon

DEM Desktop Analysis - Line
Drainage
Waterway
Geological Significance
Local
Volcanic eruption point
Named fault line
Water Body
Geological Units
Alluvial Deposits
Qa1
Bacchus Marsh Formation
Pxb
Colluvial Deposits
Qc1
Newer Volcanic Group
Neo
Pentland Hills Volcanic Group
-Pp
White Hills Gravel
-Pxh

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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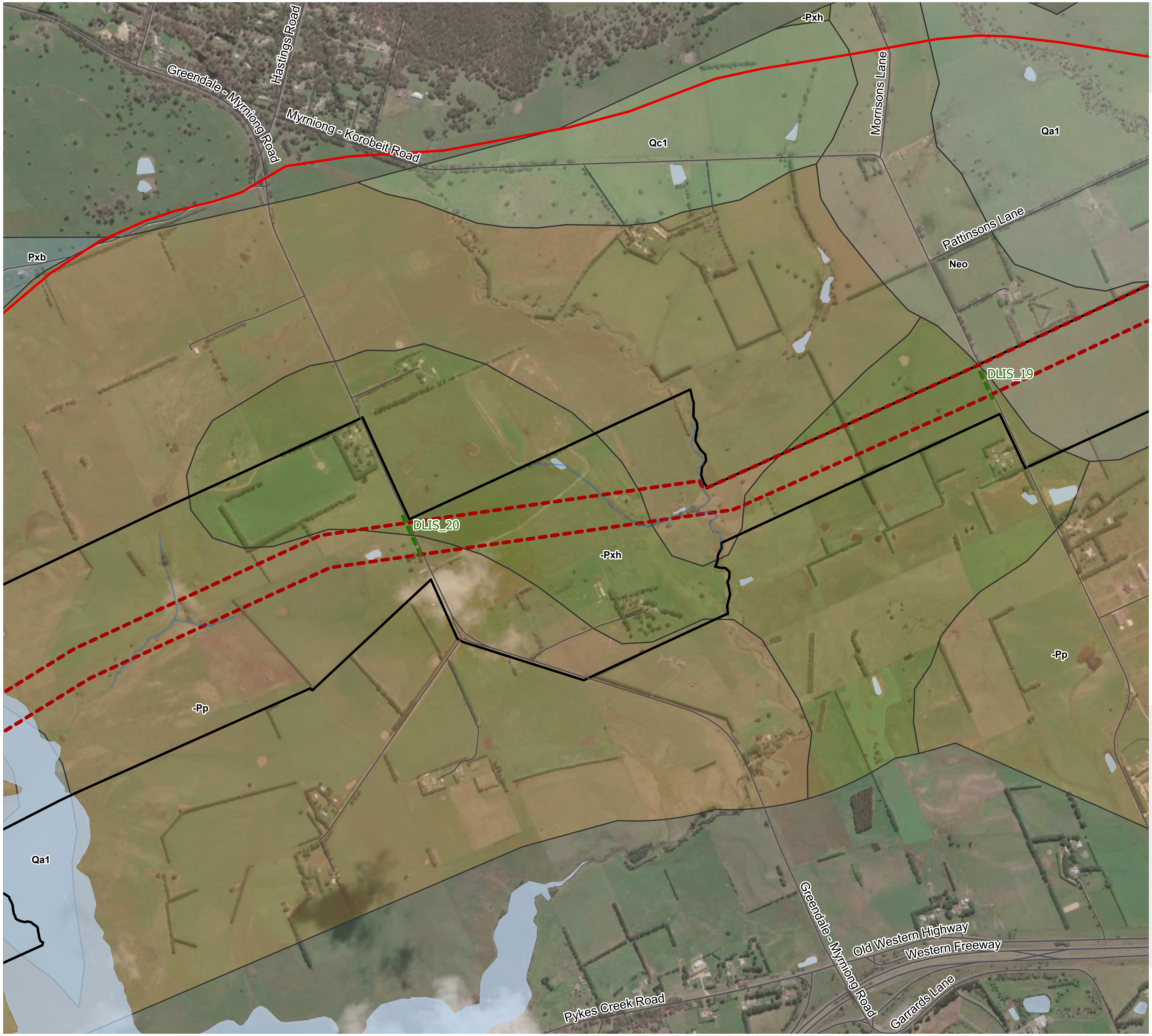

Route Overview A.11.39

Western Renewables Link

Project Land
Proposed Route
Distribution Lines - Crossing

DEM Desktop Analysis - Line
- Drainage
- Waterway

Named fault line
Water Body

Geological Units
- Alluvial Deposits
  - Qa1
- Bacchus Marsh Formation
  - Pxb
- Colluvial Deposits
  - Qc1
- Newer Volcanic Group
  - Neo
- Pentland Hills Volcanic Group
  - -Pp
- White Hills Gravel
  - -Pxh

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0 200 400 600
Metres

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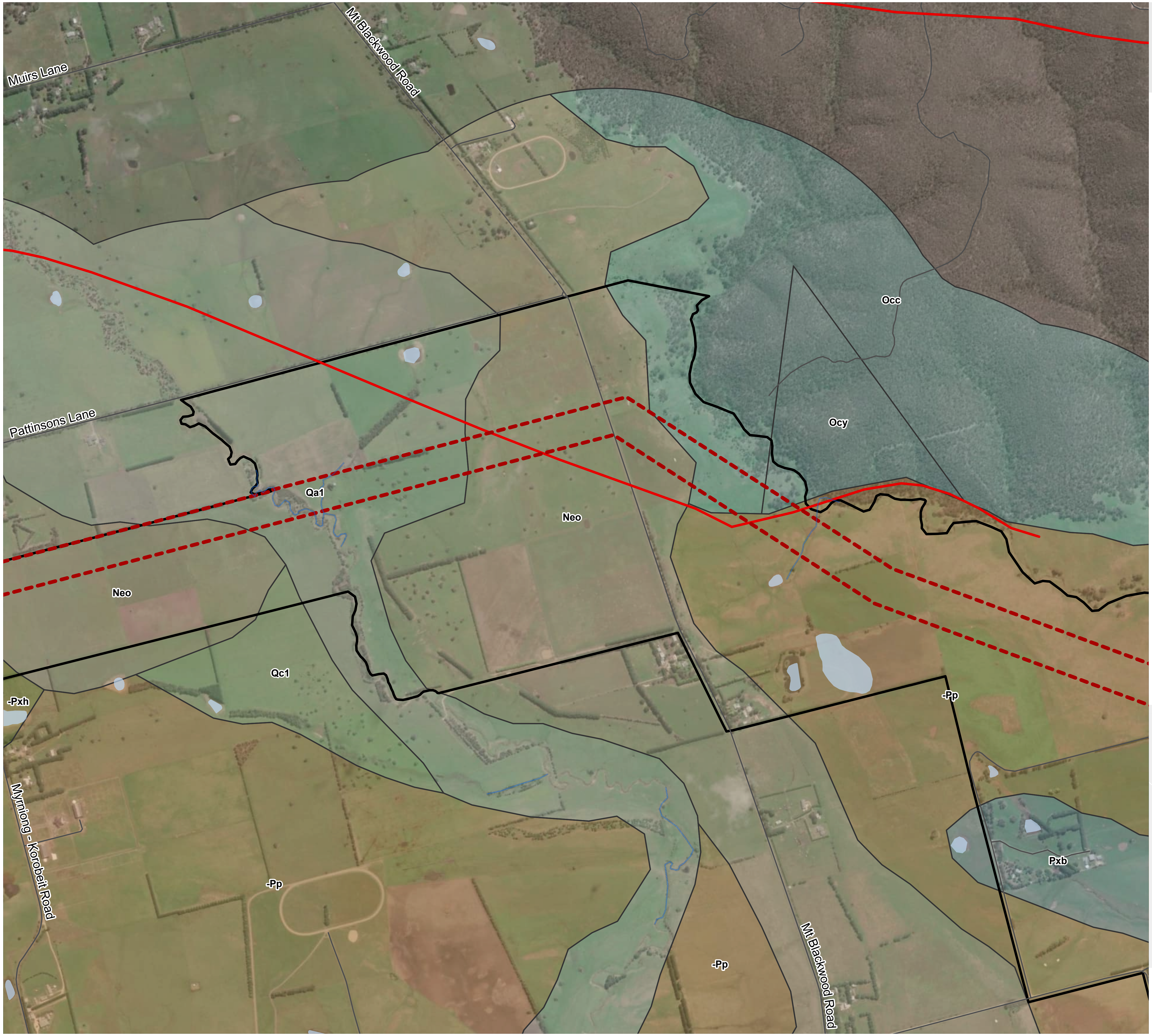
Western Renewables Link



Project Land
Proposed Route
Field Checkpoint
EG

DEM Desktop Analysis - Line
Drainage
Waterway
Named fault line
Water Body
Geological Units
Alluvial Deposits
Qa1
Bacchus Marsh Formation
Pxb
Castlemaine Group Sedimentary Units
Occ
Ocy
Colluvial Deposits
Qc1
Newer Volcanic Group
Neo
Pentland Hills Volcanic Group
-Pp
White Hills Gravel
-Pxh

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0 200 400 600
Metres

N

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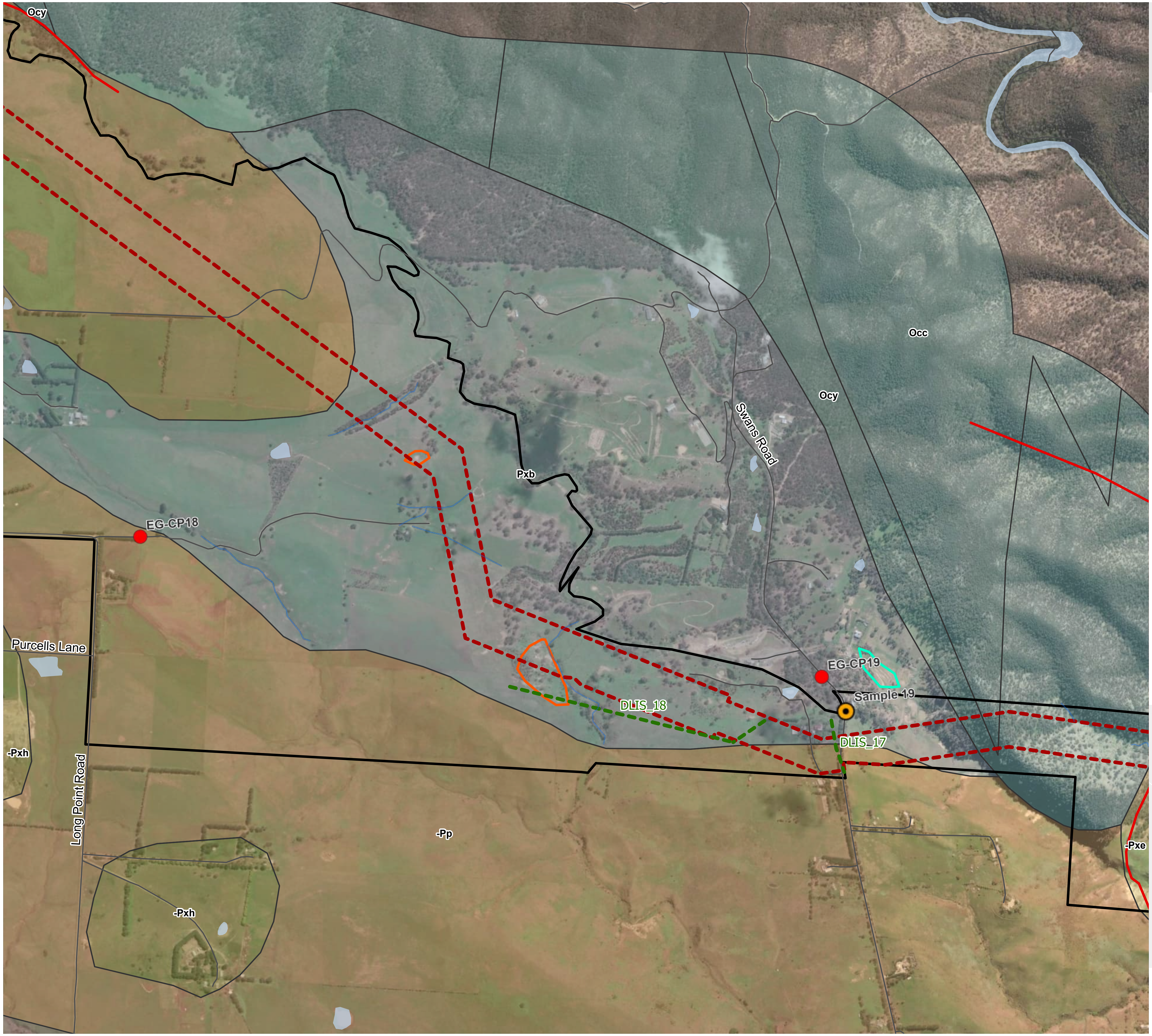

Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EG
DEM Desktop Analysis
Erosion
Other polygon

DEM Desktop Analysis - Line
Drainage
Waterway
Named fault line
Water Body
Geological Units
Bacchus Marsh Formation
Pxb
Castlemaine Group Sedimentary Units
Occ
Ocy
Pentland Hills Volcanic Group
-Pp
White Hills Gravel
-Pxh

WRL_WR1380_GCL_Route
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IS3118PM

0 200 400 600
Metres

N

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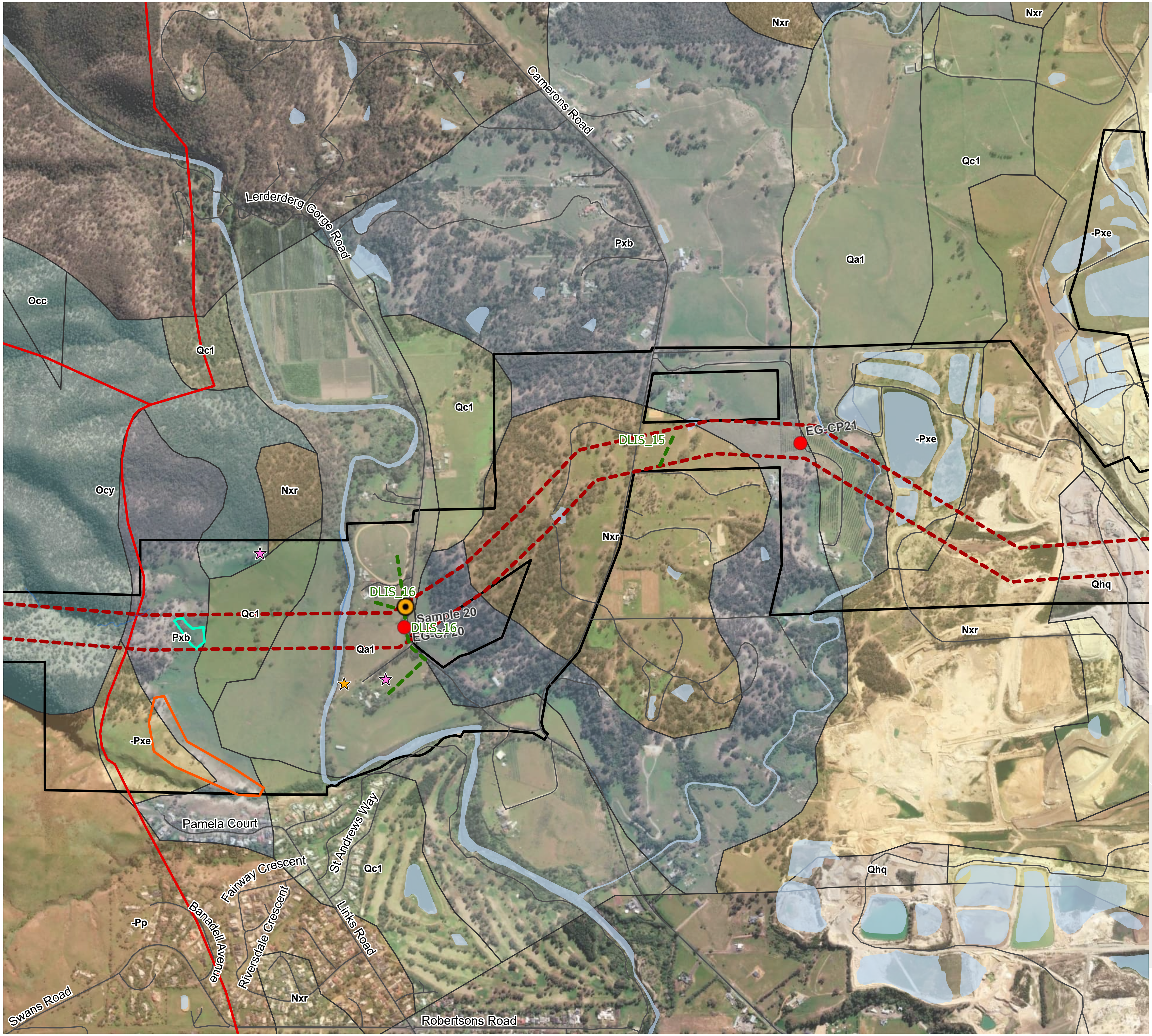

Route Overview A.11.42

Western Renewables Link

Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EG
DEM Desktop Analysis
Erosion
Other polygon

DEM Desktop Analysis - Line
Drainage
Waterway
Geological Significance
Local
International
Named fault line
Water Body
Geological Units
Alluvial Deposits
Qa1
Bacchus Marsh Formation
Pxb
Castlemaine Group Sedimentary Units
Occ
Ocy
Colluvial Deposits
Qc1
Darley Gravel
Nxr
Mine and Quarry Waste Deposits
Qhq
Pentland Hills Volcanic Group
-Pp
Werribee Formation
-Pxe

WRL_WR1380_GCL_Route
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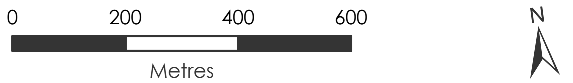

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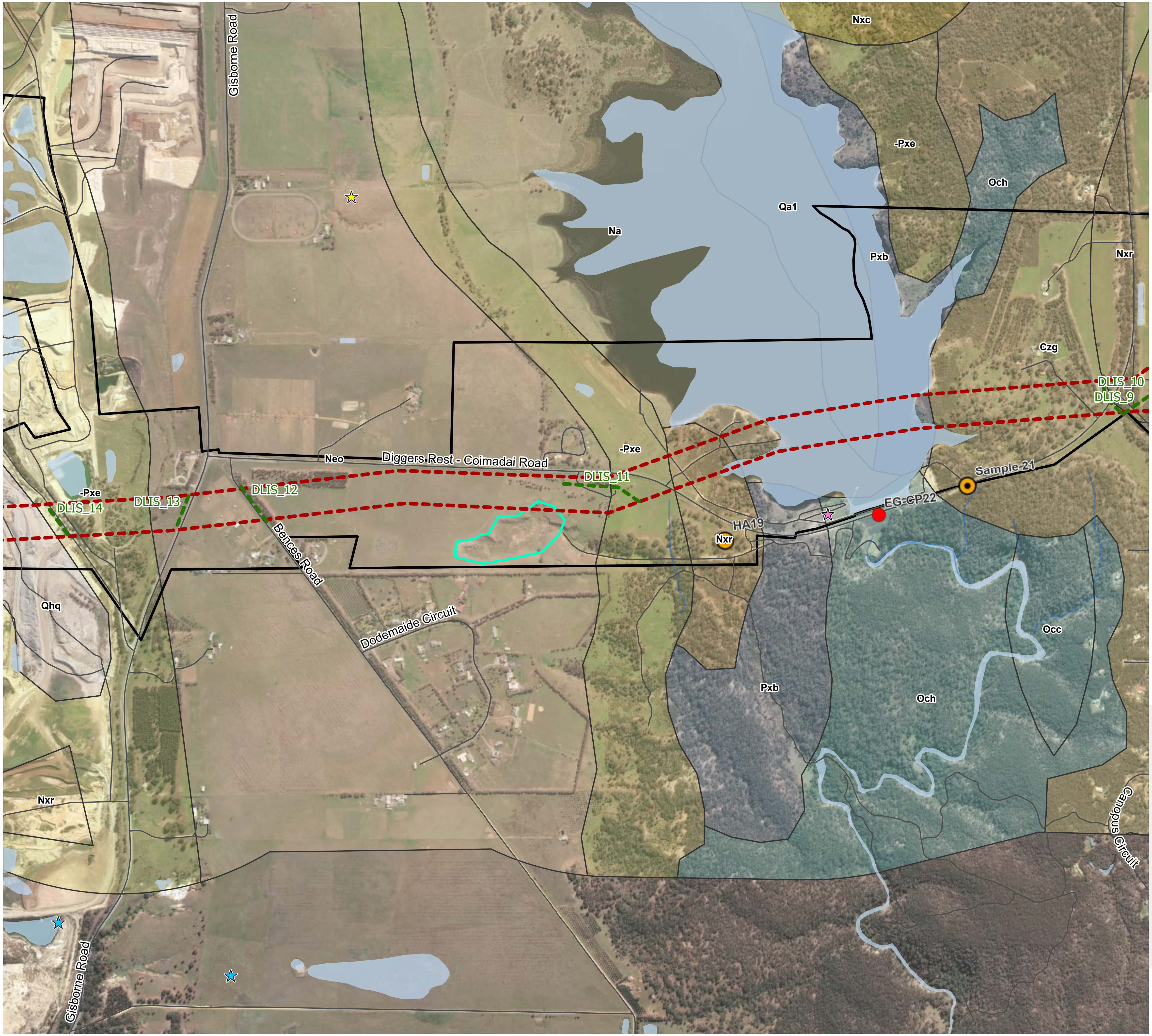
Western Renewables Link



Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EG
DEM Desktop Analysis
Other polygon

DEM Desktop Analysis - Line
Drainage
Waterway
Geological Significance
Local
Regional
National
Water Body
Geological Units
Alluvial Deposits
Na
Qa1
Bacchus Marsh Formation
Pxb
Castlemaine Group Sedimentary Units
Occ
Och
Coimadai Shale
Nxc
Conglomerate and Sandstone
Czg
Darley Gravel
Nxr
Mine and Quarry Waste Deposits
Qhq
Newer Volcanic Group
Neo
Werribee Formation
-Pxe

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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Route Overview A.11.44

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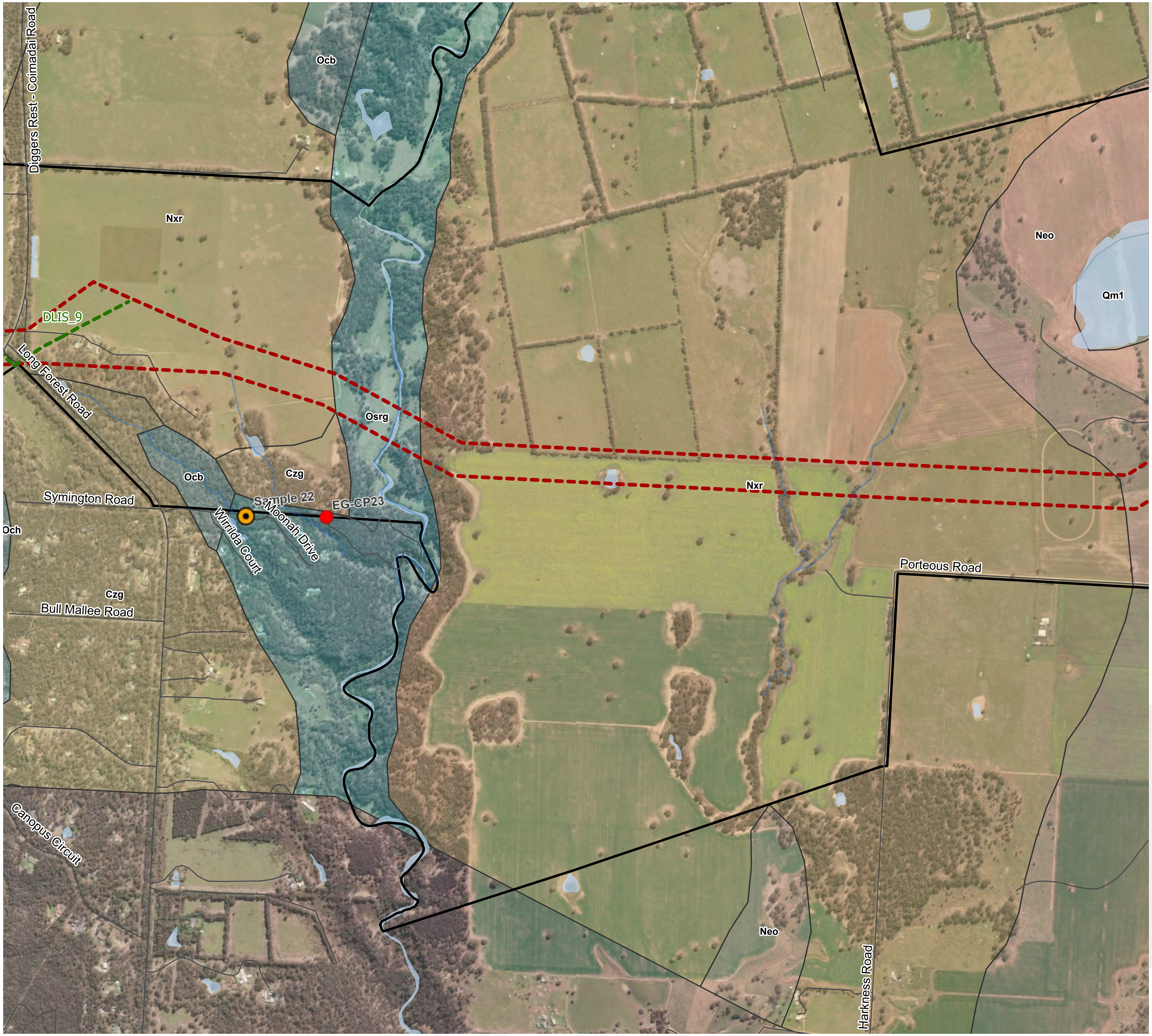
Western Renewables Link



Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
EG

DEM Desktop Analysis - Line
Drainage
Waterway
Water Body

Geological Units
Castlemaine Group Sedimentary Units
Ocb
Och
Conglomerate and Sandstone
Czg
Darley Gravel
Nxr
Newer Volcanic Group
Neo
Riddel Sandstone Gisbornian
Osrg
Swamp and Lake Deposits
Qm1

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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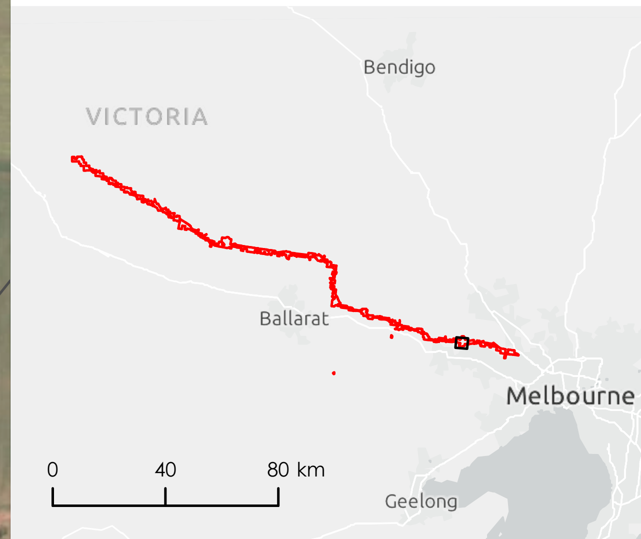

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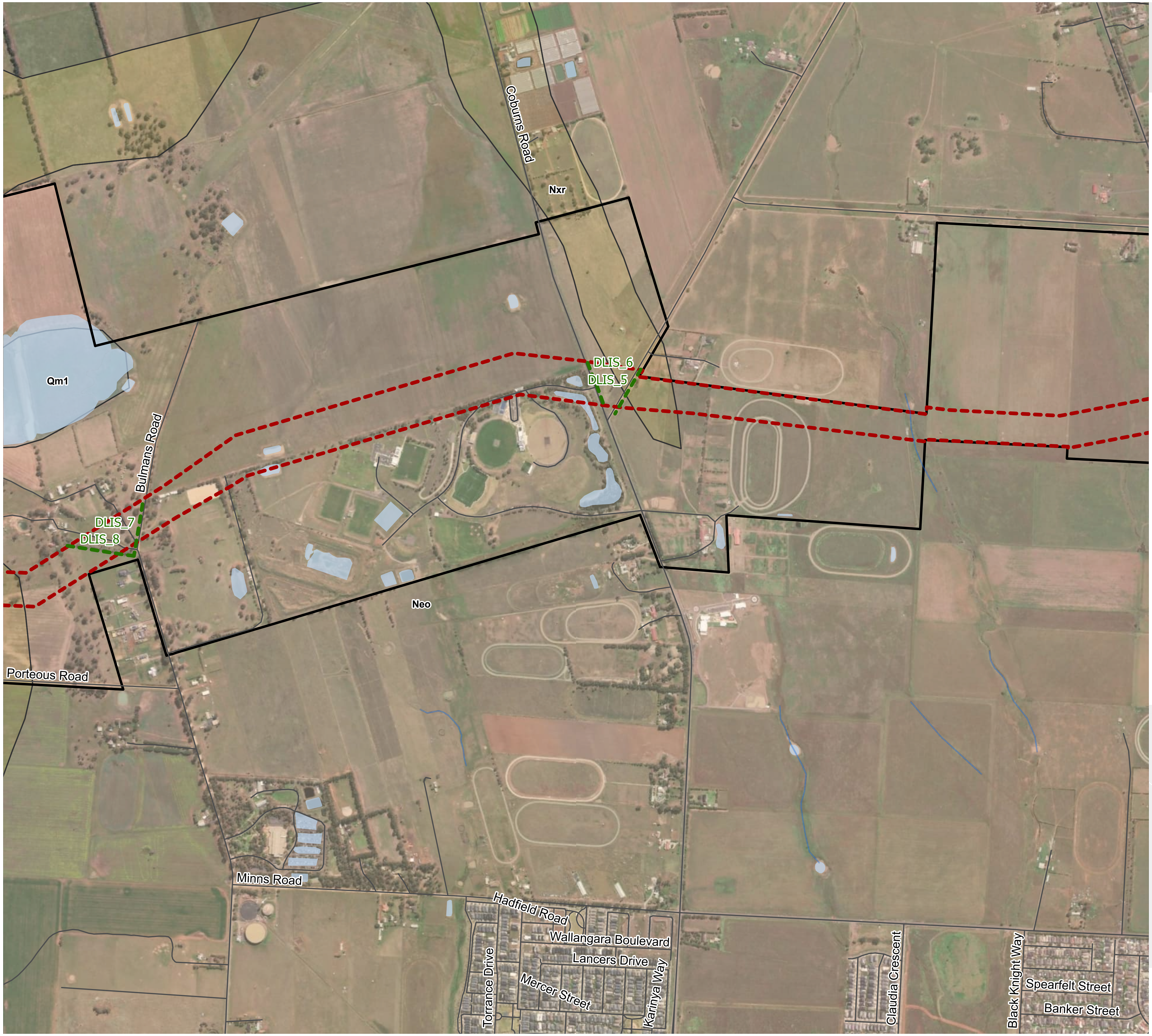

Project Land
Proposed Route
Distribution Lines - Crossing

DEM Desktop Analysis - Line
Drainage
Waterway
Water Body

Geological Units
Darley Gravel
Nxr
Newer Volcanic Group
Neo
Swamp and Lake Deposits
Qm1

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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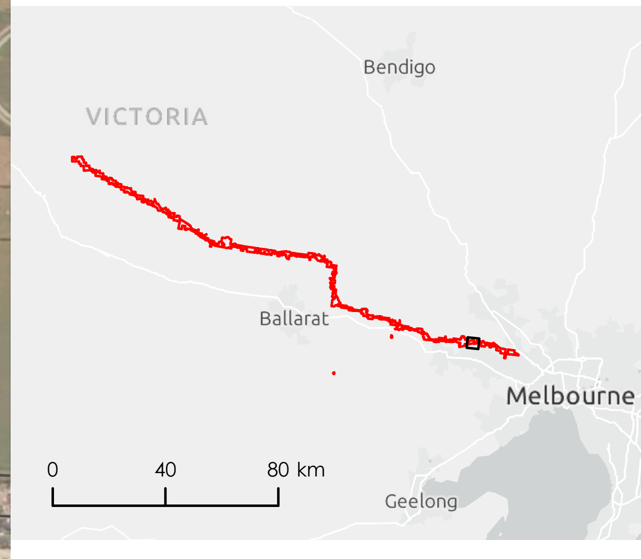

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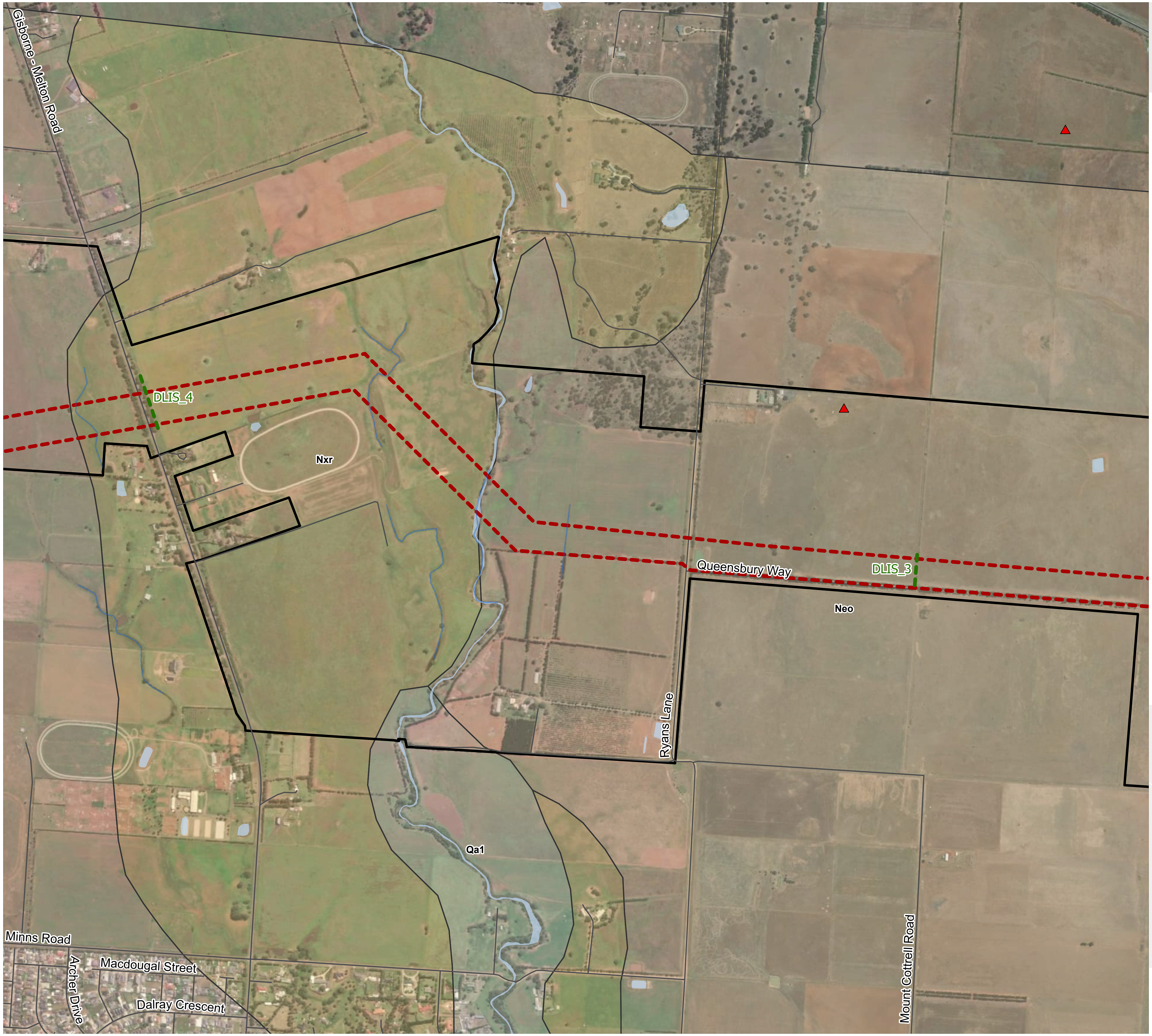

Project Land
Proposed Route
Distribution Lines - Crossing

DEM Desktop Analysis - Line
Drainage
Waterway
Volcanic eruption point
Water Body
Geological Units
Alluvial Deposits
Qa1
Darley Gravel
Nxr
Newer Volcanic Group
Neo

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0 200 400 600
Metres
N

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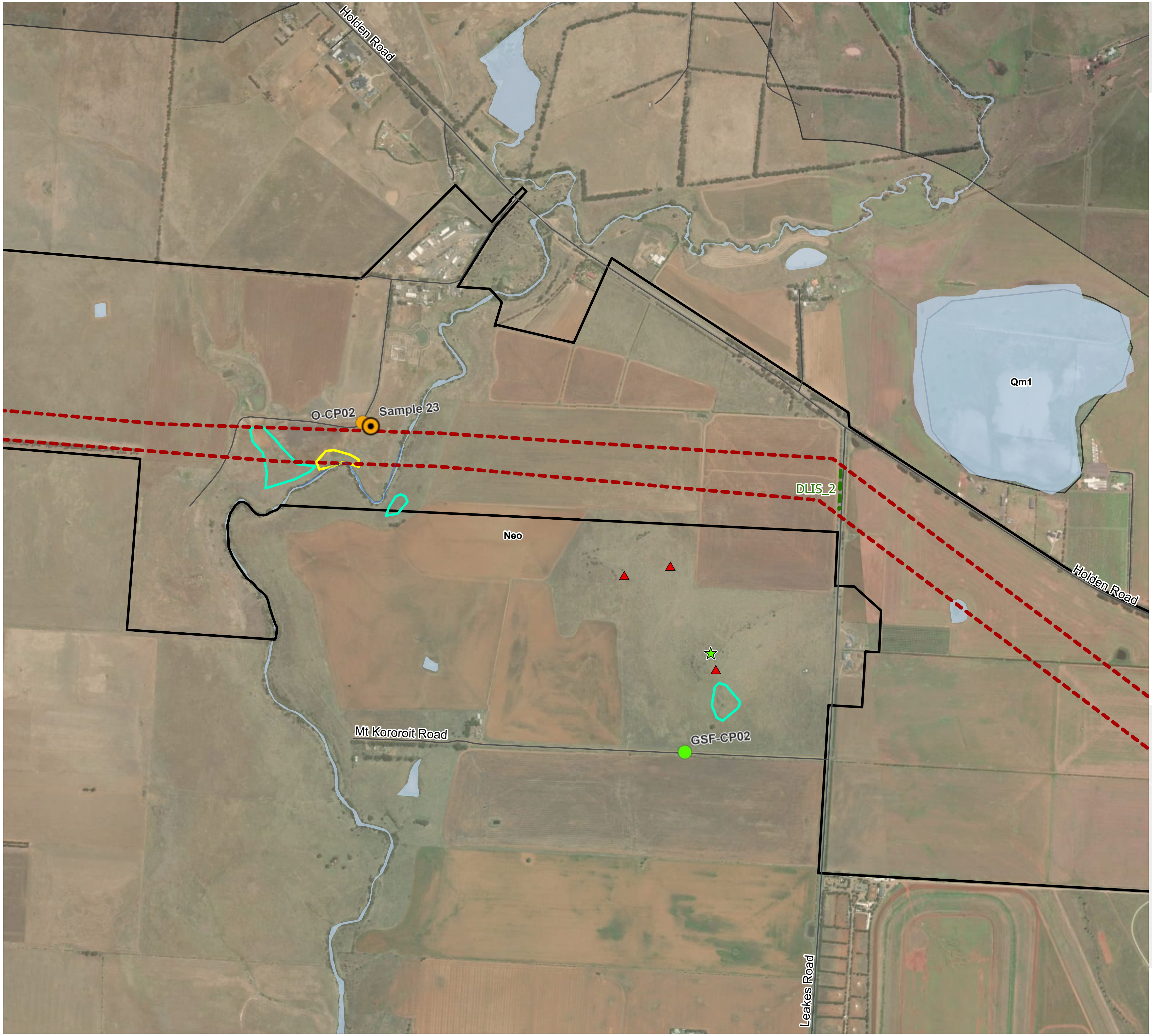

Route Overview A.11.47

Western Renewables Link

Project Land
Proposed Route
Distribution Lines - Crossing
Field Observation
Field Checkpoint
- GSF
- O

DEM Desktop Analysis
- Landslide
- Other polygon

DEM Desktop Analysis - Line
- Drainage
- Waterway

Geological Significance
- State
- Volcanic eruption point
- Water Body

Geological Units
- Newer Volcanic Group
  - Neo
- Swamp and Lake Deposits
  - Qm1

WRL_WR1380_GCL_Route
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0 200 400 600
Metres

N

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Project Land
Proposed Route
Distribution Lines - Crossing

DEM Desktop Analysis - Line
Drainage
Waterway
Water Body
Geological Units
Newer Volcanic Group
Neo

WRL_WR1380_GCL_Route
IS3118PM
Created 21 March 2025 by KarimiH

0 200 400 600
Metres

N

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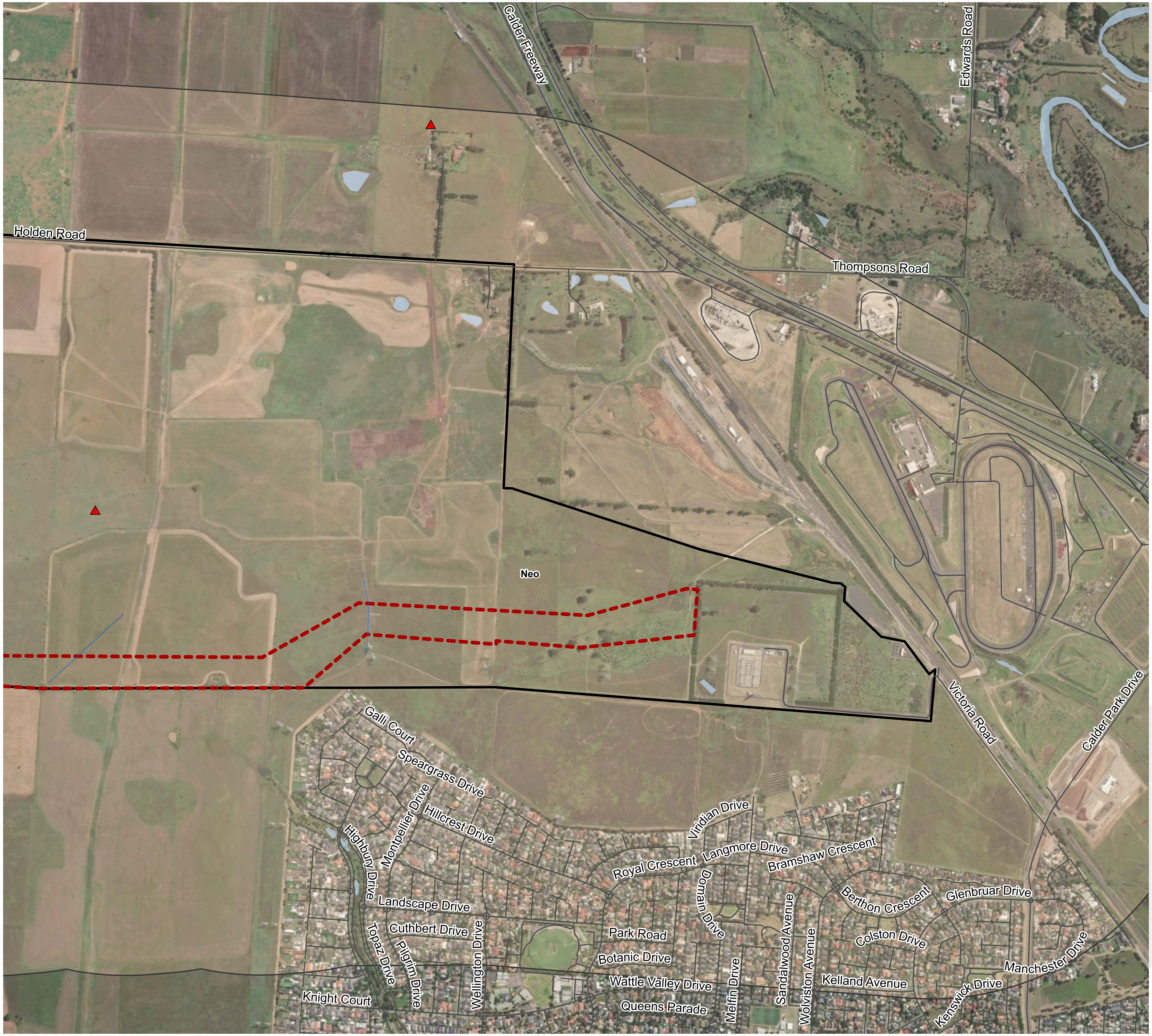

Route Overview A.11.49

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Western Renewables Link

Project Land
Proposed Route

DEM Desktop Analysis - Line
Drainage
Waterway
Volcanic eruption point
Water Body
Geological Units
Newer Volcanic Group
Neo

WRL_WR1380_GCL_Route
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IS3118PM

0 200 400 600
Metres

N

DATA SOURCES
Jacobs, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Maxar

Jacobs

Challenging today.
Reinventing tomorrow.

Route Overview A.11.50

Page 50 of 50

Western Renewables Link

Project Land

Laydown Area and Workforce Accommodation Facility

DEM Desktop Analysis - Line

Drainage

Waterway

Geological Significance

Local

Regional

Volcanic eruption point

Water Body

Geological Units

Newer Volcanic Group

Neo

WRL_WR1380_GCL_Route
Created 21 March 2025 by KarimiH

IS3118PM

0 200 400 600
Metres

N

DATA SOURCES
Jacobs, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Maxar

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Reinventing tomorrow.

Appendix B. Laboratory Testing Summary

Table B.1: Atterberg Test Results

Section	Sample ID	Location	Sample depth (m bgl)	Geology unit	Soil description	Atterberg Limits			
						Liquid limit (%)	Plastic limit (%)	Plasticity index (%)	Linear shrinkage (%)
Lexton to Ballan	Sample 15b	EMO-CP05	0.0-0.5	Newer Volcanic Group - basalt flows (Neo)	CLAY	26	17	9	3.0
Lexton to Ballan	Sample 18	EMO-CP10	0.0-0.5	Newer Volcanic Group - basalt flows (Neo)	SILT	56	37	19	8.5
Melton West to Sydenham	Sample 23	O-CP2	0.0-0.5	Newer Volcanic Group - basalt flows (Neo)	CLAY	61	20	41	19.0

Table B.2: Particle Size Distribution Test Results

Section	Sample ID	Location	Sample depth (m bgl)	Geology unit	Soil description	Moisture content (%)	Gravel (%)	Sand (%)	Silt / Clay (%)
Ballan to Melton West	HA19_GT_0.2-0.4	HA19	0.2-0.4	Darley Gravel (Nxr)	Clayey Sandy GRAVEL	5.6	40	33	27
Bulgana to Lexton	Sample 1	EG-CP01	0.0-0.5	Shepparton Formation (Nws)	Sandy CLAY/SILT	8.3	14	31	55
Bulgana to Lexton	Sample 4	EG-CP03	0.0-0.5	White Hills Gravel (Pxh)	Clayey/Silty GRAVEL	4.5	43	29	28
Bulgana to Lexton	Sample 6	EG-CP05	0.0-0.5	Shepparton Formation (Nws)	CLAY/SILT	11	12	6	82
Bulgana to Lexton	Sample 9	EG-CP10	0.0-0.5	Granite-derived colluvium (Qc4)	Clayey/Silty SAND	15.2	1	84	15
Bulgana to Lexton	Sample 11	EG-CP13	0.0-0.5	Mount Lonarch Granite (G371)	Sandy CLAY/SILT	17	1	35	64
Ballan to Melton West	Sample 20	EG-CP20	0.0-0.5	Alluvium (Qa1)	Sandy CLAY/SILT	7.8	2	35	63

Table B.3: Emerson Class Test Results

Section	Sample ID	Location	Sample depth (m bgl)	Geology unit	Soil type	Soil description	Emerson Class number
Bulgana to Lexton	HA03-GT_0.67-1.0	HA03	0.67-1.0	Shepparton Formation (Nws)	Chromosol	CLAY	3
Lexton to Ballan	HA17-GT_0.8-1.0	HA17	0.8-1.0	White Hills Gravel (Pxh)	Chromosol	CLAY	3
Bulgana to Lexton	Sample 2	EG-CP01	0.0-0.5	Shepparton Formation (Nws)	Kandosol	Clayey SILT	2
Bulgana to Lexton	Sample 7	EG-CP07	0.0-0.5	Shepparton Formation (Nws)	Chromosol	CLAY/SILT	2
Bulgana to Lexton	Sample 8	EG-CP09	0.0-0.5	Glenlogie Granodiorite (G372)	Rudosol	CLAY	2
Bulgana to Lexton	Sample 12	EG-CP15	0.0-0.5	Pyrenees Formation (Cap)	Sodosol	CLAY	2
Bulgana to Lexton	Sample 14	EG-CP17	0.0-0.5	Pyrenees Formation (Cap)	Rudosol	Clayey/Silty SAND	3
Lexton to Ballan	Sample 16	EMO-CP07	0.0-0.5	Newer Volcanic Group - basalt flows (Neo)	Dermosol	SAND	4
Ballan to Melton West	Sample 19	EG-CP19	0.0-0.5	Bacchus Marsh Formation (Pxb)	Dermosol	SILT	3
Ballan to Melton West	Sample 22	EG-CP23	0.0-0.5	Riddell Sandstone Gisbornian (Osrg)	Chromosol	Silty GRAVEL	3

Table B.4: Soil Salinity Test Results

Section	Sample ID	Location	Sample depth (m bgl)	Geology unit	Salinity province	Soil description	ECe[1] (µS/cm)	Soil salinity class[2]
Bulgana to Lexton	Sample 5	EG-CP04	0.0-0.5	Shepparton Formation (Nws)	Elmhurst	SILT	3960	Slightly saline
Bulgana to Lexton	Sample 13	EG-CP15	0.0-0.5	Pyrenees Formation (Cap)	Lexton	Clayey SILT	1216	Non-saline
Lexton to Ballan	Sample 17	EMO-CP09	0.0-0.5	Newer Volcanic Group - basalt flows (Neo)	Upper Loddon Volcanic Plains	Sandy SILT	281	Non-saline

1. ECe = Electrical Conductivity of a saturated soil Extract
2. Soil Salinity Class Based on Agriculture Victoria VRO Soil Salinity Class Ranges for ECe retrieved from http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/water_spotting_soil_salting_class_ranges

Non-saline	ECe = 0-2000 µS/cm
Slightly saline	ECe = 2000-4000 µS/cm
Moderately saline	ECe = 4000-8000 µS/cm
Highly saline	ECe = 8000-16000 µS/cm
Severely saline	ECe = 16000-32000 µS/cm
Extremely saline	ECe = > 32000 µS/cm

Appendix C. Laboratory Testing Certificates

Material Test Report

Report Number:	**GS5925/1-1**
Issue Number:	1
Date Issued:	08/09/2021
Client:	Jacobs (Melbourne)
	452 Flinders St, Melbourne Victoria 3000
Contact:	Jayden Robertson
Project Number:	GS5925/1
Project Name:	WVTNP EES
Project Location:	IS311800
Work Request:	5220
Sample Number:	59251-S1
Date Sampled:	03/09/2021
Dates Tested:	03/09/2021 - 07/09/2021
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Sample Location:	**HA03 ((0.67-1.0m))**

Ground Science Pty Ltd
Ground Science Laboratory
13 Brock Street Thomastown Victoria 3074
Phone: (03) 9464 4617
Email: tim@groundscience.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Tim Senserrick
Laboratory 21C
NATA Accredited Laboratory Number: 15055

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**3**		
Soil Description	CLAY, medium to high plasticity, brown		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	20		

Material Test Report

Report Number: **GS5925/1-1**
Issue Number: 1
Date Issued: 08/09/2021
Client: Jacobs (Melbourne)
452 Flinders St, Melbourne Victoria 3000
Contact: Jayden Robertson
Project Number: GS5925/1
Project Name: WVTNP EES
Project Location: IS311800
Work Request: 5220
Sample Number: 59251-S2
Date Sampled: 03/09/2021
Dates Tested: 03/09/2021 - 07/09/2021
Sampling Method: Sampled by Client - Tested as Received
The results apply to the sample as received
Sample Location: **HA17 ((0.8-1.0m))**

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NATA Accredited Laboratory Number: 15055

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**3**		
Soil Description	CLAY, medium to high plasticity, brown		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	20		

Material Test Report

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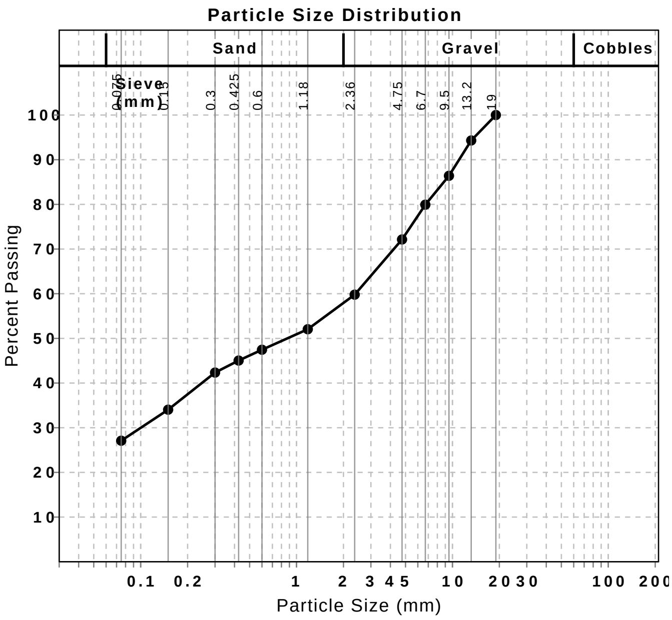
Approved Signatory: Tim Senserrick
Laboratory 21C
NATA Accredited Laboratory Number: 15055

Report Number: **GS5925/1-1**
Issue Number: 1
Date Issued: 08/09/2021
Client: Jacobs (Melbourne)
452 Flinders St, Melbourne Victoria 3000
Contact: Jayden Robertson
Project Number: GS5925/1
Project Name: WVTNP EES
Project Location: IS311800
Work Request: 5220
Sample Number: 59251-S3
Date Sampled: 03/09/2021
Dates Tested: 03/09/2021 - 07/09/2021
Sampling Method: Sampled by Client - Tested as Received
The results apply to the sample as received
Sample Location: **HA19 ((0.2-0.4m))**
Material: clayey sandy GRAVEL, fine to coarse, brown, sand fine to coarse, fines of low to Medium Plasticity

Particle Size Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
13.2 mm	**94**			6		
9.5 mm	**86**			8		
6.7 mm	**80**			6		
4.75 mm	**72**			8		
2.36 mm	**60**			12		
1.18 mm	**52**			8		
0.6 mm	**47**			5		
0.425 mm	**45**			2		
0.3 mm	**42**			3		
0.15 mm	**34**			8		
0.075 mm	**27**			7		

Moisture Content (AS1289.2.1.1)	
Moisture Content (%)	5.6



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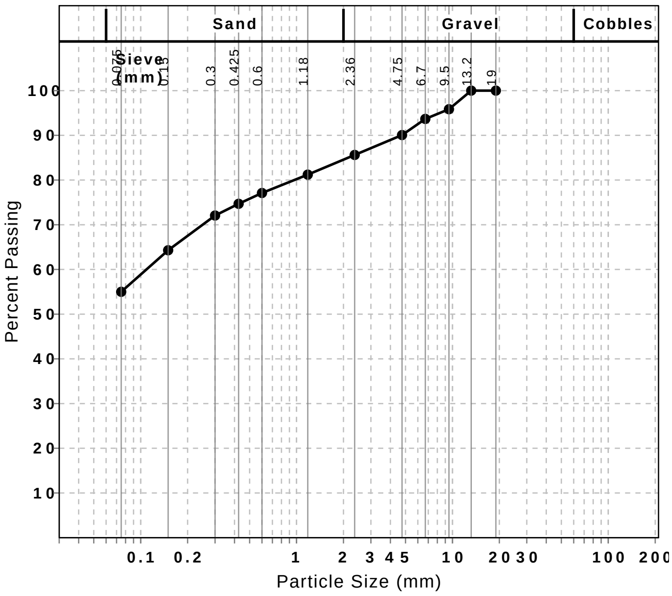
Report Number: **GS5925/1-1**
Issue Number: 1
Date Issued: 08/09/2021
Client: Jacobs (Melbourne)
452 Flinders St, Melbourne Victoria 3000
Contact: Jayden Robertson
Project Number: GS5925/1
Project Name: WVTNP EES
Project Location: IS311800
Work Request: 5220
Sample Number: 59251-S4
Date Sampled: 03/09/2021
Dates Tested: 03/09/2021 - 07/09/2021
Sampling Method: Sampled by Client - Tested as Received
The results apply to the sample as received
Sample Location: **SAMPLE 1 EG-CP01 ((0.0-0.5m))**
Material: sandy CLAY/SILT, low to Medium Plasticity, brown, sand fine to coarse, trace gravel

Particle Size Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
13.2 mm	**100**			0		
9.5 mm	**96**			4		
6.7 mm	**94**			2		
4.75 mm	**90**			4		
2.36 mm	**86**			4		
1.18 mm	**81**			4		
0.6 mm	**77**			4		
0.425 mm	**75**			2		
0.3 mm	**72**			3		
0.15 mm	**64**			8		
0.075 mm	**55**			9		

Moisture Content (AS1289.2.1.1)	
Moisture Content (%)	8.3

Particle Size Distribution



Material Test Report

Report Number:	**GS5925/1-1**
Issue Number:	1
Date Issued:	08/09/2021
Client:	Jacobs (Melbourne)
	452 Flinders St, Melbourne Victoria 3000
Contact:	Jayden Robertson
Project Number:	GS5925/1
Project Name:	WVTNP EES
Project Location:	IS311800
Work Request:	5220
Sample Number:	59251-S5
Date Sampled:	03/09/2021
Dates Tested:	03/09/2021 - 07/09/2021
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Sample Location:	**SAMPLE 2 EG-CP01 ((0.0-0.5m))**

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Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	clayey SILT, low to medium plasticity, brown		
Nature of Water	Disitilled		
Temperature of Water (^{o}C)	20		

Material Test Report

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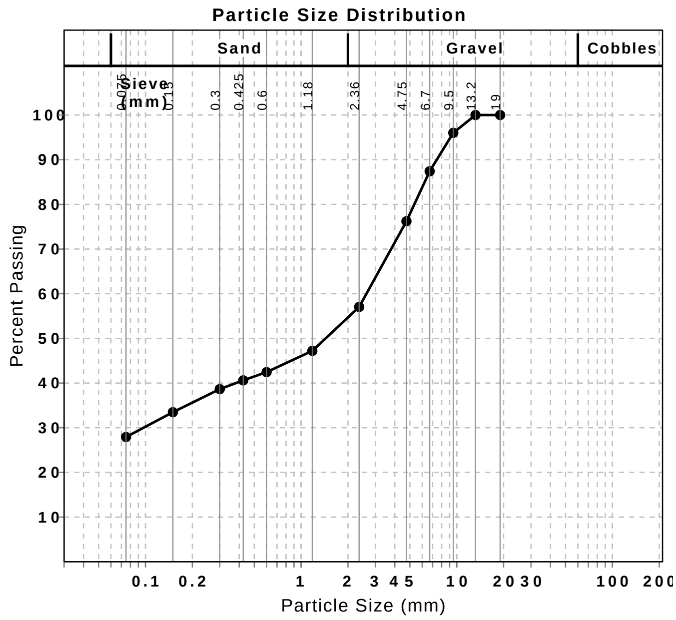
Report Number:	**GS5925/1-1**
Issue Number:	1
Date Issued:	08/09/2021
Client:	Jacobs (Melbourne)
	452 Flinders St, Melbourne Victoria 3000
Contact:	Jayden Robertson
Project Number:	GS5925/1
Project Name:	WVTNP EES
Project Location:	IS311800
Work Request:	5220
Sample Number:	59251-S6
Date Sampled:	03/09/2021
Dates Tested:	03/09/2021 - 07/09/2021
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Sample Location:	**EG-CP03 ((0.0-0.5m))**
Material:	clayey/silty GRAVEL, fine to coarse, brown, fines of low to Medium Plasticity, with sand

Particle Size Distribution (AS1289 3.6.1)

Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
13.2 mm	**100**			0		
9.5 mm	**96**			4		
6.7 mm	**87**			9		
4.75 mm	**76**			11		
2.36 mm	**57**			19		
1.18 mm	**47**			10		
0.6 mm	**42**			5		
0.425 mm	**41**			2		
0.3 mm	**39**			2		
0.15 mm	**33**			5		
0.075 mm	**28**			6		

Moisture Content (AS1289.2.1.1)

Moisture Content (%)	4.5



Material Test Report

Report Number:	**GS5925/1-1**
Issue Number:	1
Date Issued:	08/09/2021
Client:	Jacobs (Melbourne)
	452 Flinders St, Melbourne Victoria 3000
Contact:	Jayden Robertson
Project Number:	GS5925/1
Project Name:	WVTNP EES
Project Location:	IS311800
Work Request:	5220
Sample Number:	59251-S8
Date Sampled:	03/09/2021
Dates Tested:	03/09/2021 - 07/09/2021
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Sample Location:	**EG-CP05 ((0.0-0.5m))**
Material:	CLAY/SILT, low to medium plasticity, brown, trace sand, trace gravel

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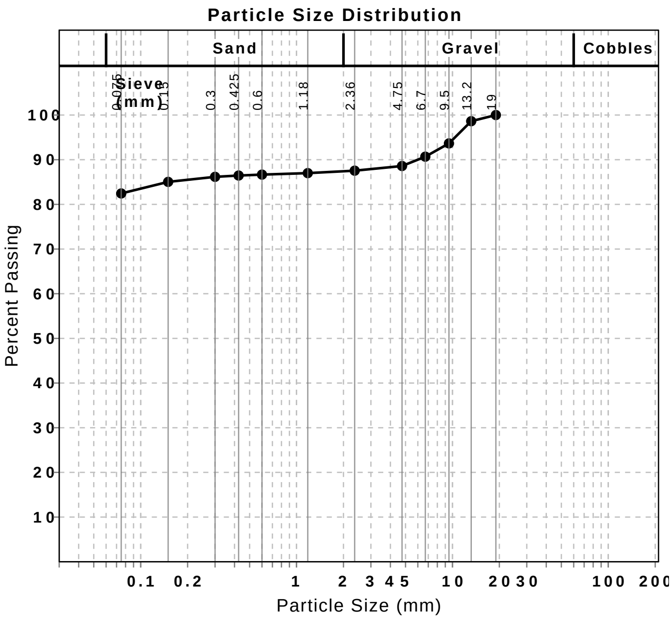
Particle Size Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
13.2 mm	**99**			1		
9.5 mm	**94**			5		
6.7 mm	**91**			3		
4.75 mm	**89**			2		
2.36 mm	**88**			1		
1.18 mm	**87**			1		
0.6 mm	**87**			0		
0.425 mm	**86**			0		
0.3 mm	**86**			0		
0.15 mm	**85**			1		
0.075 mm	**82**			3		

Moisture Content (AS1289.2.1.1)	
Moisture Content (%)	11.0



Material Test Report

Report Number: **GS5925/1-1**
Issue Number: 1
Date Issued: 08/09/2021
Client: Jacobs (Melbourne)
452 Flinders St, Melbourne Victoria 3000
Contact: Jayden Robertson
Project Number: GS5925/1
Project Name: WVTNP EES
Project Location: IS311800
Work Request: 5220
Sample Number: 59251-S9
Date Sampled: 03/09/2021
Dates Tested: 03/09/2021 - 07/09/2021
Sampling Method: Sampled by Client - Tested as Received
The results apply to the sample as received
Sample Location: **EG-CP07 ((0.0-0.5m))**

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Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	CLAY/SILT, low to medium plasticity, brown, trace gravel		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	20		

Material Test Report

Report Number:	**GS5925/1-1**
Issue Number:	1
Date Issued:	08/09/2021
Client:	Jacobs (Melbourne)
	452 Flinders St, Melbourne Victoria 3000
Contact:	Jayden Robertson
Project Number:	GS5925/1
Project Name:	WVTNP EES
Project Location:	IS311800
Work Request:	5220
Sample Number:	59251-S10
Date Sampled:	03/09/2021
Dates Tested:	03/09/2021 - 07/09/2021
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Sample Location:	**EG-CP09 ((0.0-0.5m))**

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Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	CLAY, medium to high plasticity, brown		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	20		

Material Test Report

Report Number: **GS5925/1-1**
Issue Number: 1
Date Issued: 08/09/2021
Client: Jacobs (Melbourne)
452 Flinders St, Melbourne Victoria 3000
Contact: Jayden Robertson
Project Number: GS5925/1
Project Name: WVTNP EES
Project Location: IS311800
Work Request: 5220
Sample Number: 59251-S11
Date Sampled: 03/09/2021
Dates Tested: 03/09/2021 - 07/09/2021
Sampling Method: Sampled by Client - Tested as Received
The results apply to the sample as received
Sample Location: **EG-CP10 ((0.0-0.5m))**
Material: clayey/silty SAND, fine to coarse, brown, fines of low to medium plasticity, trace gravel

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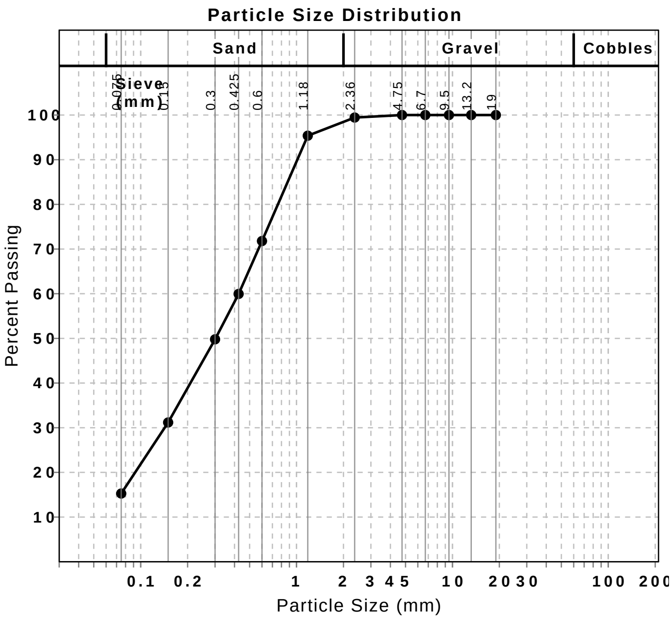
Laboratory 21C
NATA Accredited Laboratory Number: 15055

Particle Size Distribution (AS1289 3.6.1)				
Sieve	Passed %	Passing Limits	Retained %	Retained Limits
19 mm	**100**		0	
13.2 mm	**100**		0	
9.5 mm	**100**		0	
6.7 mm	**100**		0	
4.75 mm	**100**		0	
2.36 mm	**99**		1	
1.18 mm	**95**		4	
0.6 mm	**72**		24	
0.425 mm	**60**		12	
0.3 mm	**50**		10	
0.15 mm	**31**		19	
0.075 mm	**15**		16	

Moisture Content (AS1289.2.1.1)	
Moisture Content (%)	15.2



Material Test Report

Report Number:	**GS5925/1-1**
Issue Number:	1
Date Issued:	08/09/2021
Client:	Jacobs (Melbourne)
	452 Flinders St, Melbourne Victoria 3000
Contact:	Jayden Robertson
Project Number:	GS5925/1
Project Name:	WVTNP EES
Project Location:	IS311800
Work Request:	5220
Sample Number:	59251-S12
Date Sampled:	03/09/2021
Dates Tested:	03/09/2021 - 07/09/2021
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Sample Location:	**EG-CP13 ((0.0-0.5m))**
Material:	sandy CLAY/SILT, low to medium plasticity, brown, sand fine to coarse, trace gravel

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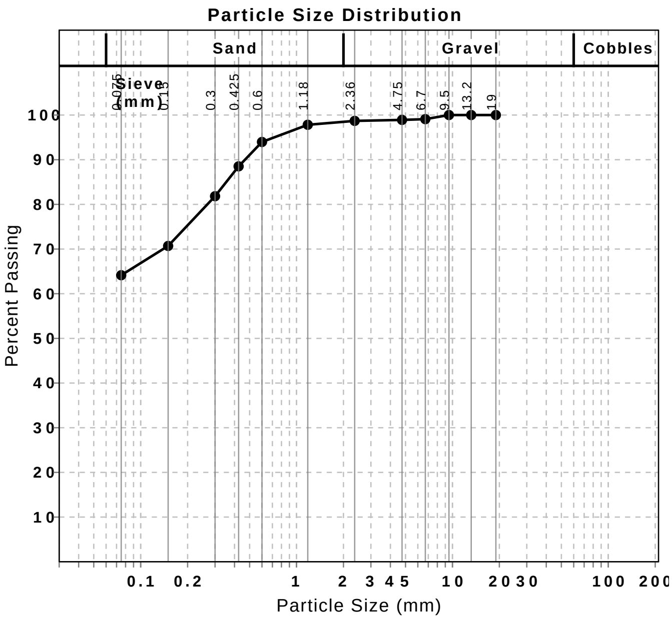
Laboratory 21C
NATA Accredited Laboratory Number: 15055

Particle Size Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
13.2 mm	**100**			0		
9.5 mm	**100**			0		
6.7 mm	**99**			1		
4.75 mm	**99**			0		
2.36 mm	**99**			0		
1.18 mm	**98**			1		
0.6 mm	**94**			4		
0.425 mm	**89**			5		
0.3 mm	**82**			7		
0.15 mm	**71**			11		
0.075 mm	**64**			7		

Moisture Content (AS1289.2.1.1)	
Moisture Content (%)	17.0



Material Test Report

Report Number: **GS5925/1-1**
Issue Number: 1
Date Issued: 08/09/2021
Client: Jacobs (Melbourne)
452 Flinders St, Melbourne Victoria 3000
Contact: Jayden Robertson
Project Number: GS5925/1
Project Name: WVTNP EES
Project Location: IS311800
Work Request: 5220
Sample Number: 59251-S13
Date Sampled: 03/09/2021
Dates Tested: 03/09/2021 - 07/09/2021
Sampling Method: Sampled by Client - Tested as Received
The results apply to the sample as received
Sample Location: **SAMPLE 12 EG-CP15 ((0.0-0.5m))**

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Laboratory 21C
NATA Accredited Laboratory Number: 15055

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	CLAY, medium to high plasticity, brown		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	20		

Material Test Report

Report Number:	**GS5925/1-1**
Issue Number:	1
Date Issued:	08/09/2021
Client:	Jacobs (Melbourne)
	452 Flinders St, Melbourne Victoria 3000
Contact:	Jayden Robertson
Project Number:	GS5925/1
Project Name:	WVTNP EES
Project Location:	IS311800
Work Request:	5220
Sample Number:	59251-S15
Date Sampled:	03/09/2021
Dates Tested:	03/09/2021 - 07/09/2021
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Sample Location:	**EG-CP17 ((0.0-0.5m))**

Ground Science Pty Ltd
Ground Science Laboratory
13 Brock Street Thomastown Victoria 3074
Phone: (03) 9464 4617
Email: tim@groundscience.com.au

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Approved Signatory: Tim Senserrick
Laboratory 21C

NATA Accredited Laboratory Number: 15055

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**3**		
Soil Description	clayey/silty SAND, fine to coarse, brown		
Nature of Water	Distilled		
Temperature of Water (^oC)	20		

Material Test Report

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Email: tim@groundscience.com.au

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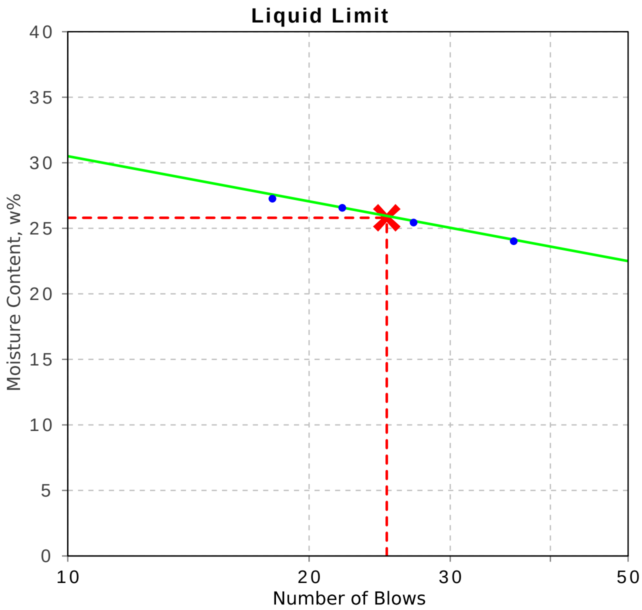
Approved Signatory: Tim Senserrick
Laboratory 21C
NATA Accredited Laboratory Number: 15055

Report Number:	**GS5925/1-1**
Issue Number:	1
Date Issued:	08/09/2021
Client:	Jacobs (Melbourne)
	452 Flinders St, Melbourne Victoria 3000
Contact:	Jayden Robertson
Project Number:	GS5925/1
Project Name:	WVTNP EES
Project Location:	IS311800
Work Request:	5220
Sample Number:	59251-S16
Date Sampled:	03/09/2021
Dates Tested:	03/09/2021 - 06/09/2021
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Sample Location:	**EMO-CP05 ((0.0-0.5m))**
Material:	CLAY, low plasticity, brown

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	26		
Plastic Limit (%)	17		
Plasticity Index (%)	**9**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	3.0		
Cracking Crumbling Curling	Cracking		



Material Test Report

Report Number:	**GS5925/1-1**
Issue Number:	1
Date Issued:	08/09/2021
Client:	Jacobs (Melbourne)
	452 Flinders St, Melbourne Victoria 3000
Contact:	Jayden Robertson
Project Number:	GS5925/1
Project Name:	WVTNP EES
Project Location:	IS311800
Work Request:	5220
Sample Number:	59251-S17
Date Sampled:	03/09/2021
Dates Tested:	03/09/2021 - 07/09/2021
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Sample Location:	**EMO-CP07 ((0.0-0.5m))**

Ground Science Pty Ltd
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13 Brock Street Thomastown Victoria 3074
Phone: (03) 9464 4617
Email: tim@groundscience.com.au

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Approved Signatory: Tim Senserrick
Laboratory 21C

NATA Accredited Laboratory Number: 15055

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**4 ***		
Soil Description	SAND, fine to coarse, brown		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	20		
* Mineral Present	Carbonate		

Material Test Report

Report Number:	**GS5925/1-1**
Issue Number:	1
Date Issued:	08/09/2021
Client:	Jacobs (Melbourne)
	452 Flinders St, Melbourne Victoria 3000
Contact:	Jayden Robertson
Project Number:	GS5925/1
Project Name:	WVTNP EES
Project Location:	IS311800
Work Request:	5220
Sample Number:	59251-S19
Date Sampled:	03/09/2021
Dates Tested:	03/09/2021 - 06/09/2021
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Sample Location:	**EMO-CP10 ((0.0-0.5m))**
Material:	SILT, high plasticity, brown

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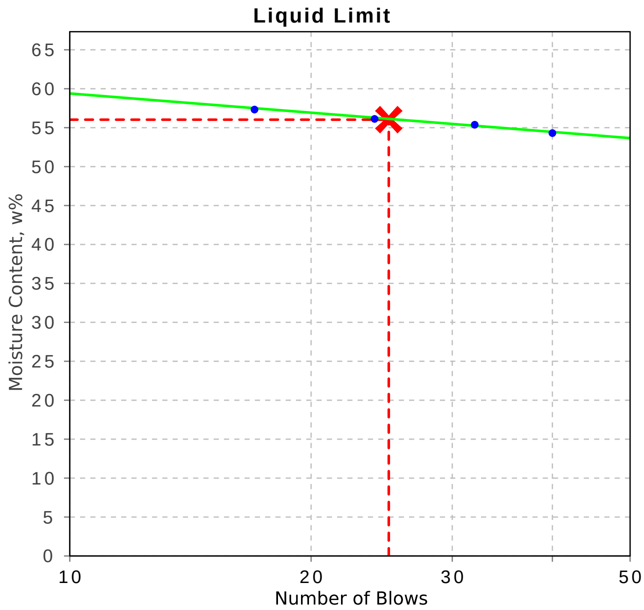
Approved Signatory: Tim Senserrick
Laboratory 21C
NATA Accredited Laboratory Number: 15055

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	56		
Plastic Limit (%)	37		
Plasticity Index (%)	**19**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	8.5		
Cracking Crumbling Curling	Cracking		



Material Test Report

Report Number:	**GS5925/1-1**
Issue Number:	1
Date Issued:	08/09/2021
Client:	Jacobs (Melbourne)
	452 Flinders St, Melbourne Victoria 3000
Contact:	Jayden Robertson
Project Number:	GS5925/1
Project Name:	WVTNP EES
Project Location:	IS311800
Work Request:	5220
Sample Number:	59251-S20
Date Sampled:	03/09/2021
Dates Tested:	03/09/2021 - 07/09/2021
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Sample Location:	**EG-CP19 ((0.0-0.5m))**

Ground Science
Geotechnical & Environmental Consultants

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Approved Signatory: Tim Senserrick
Laboratory 21C

NATA Accredited Laboratory Number: 15055

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**3**		
Soil Description	SILT, low to medium plasticity, brown		
Nature of Water	Distilled		
Temperature of Water (^oC)	20		

Material Test Report

Report Number:	**GS5925/1-1**
Issue Number:	1
Date Issued:	08/09/2021
Client:	Jacobs (Melbourne)
	452 Flinders St, Melbourne Victoria 3000
Contact:	Jayden Robertson
Project Number:	GS5925/1
Project Name:	WVTNP EES
Project Location:	IS311800
Work Request:	5220
Sample Number:	59251-S21
Date Sampled:	03/09/2021
Dates Tested:	03/09/2021 - 07/09/2021
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Sample Location:	**EG-CP20 ((0.0-0.5m))**
Material:	sandy CLAY/SILT, low to medium plasticity, brown, sand fine to coarse, trace gravel

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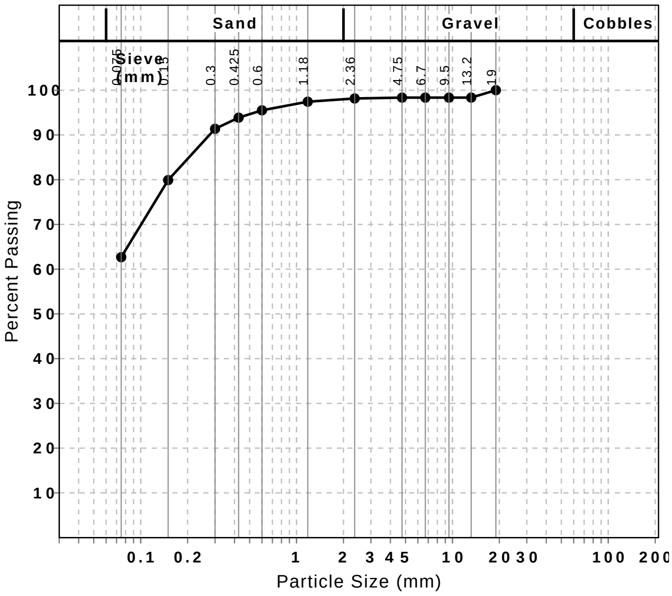
Particle Size Distribution (AS1289 3.6.1)							
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
13.2 mm	**98**			2		
9.5 mm	**98**			0		
6.7 mm	**98**			0		
4.75 mm	**98**			0		
2.36 mm	**98**			0		
1.18 mm	**97**			1		
0.6 mm	**96**			2		
0.425 mm	**94**			2		
0.3 mm	**91**			3		
0.15 mm	**80**			11		
0.075 mm	**63**			17		

Moisture Content (AS1289.2.1.1)	
Moisture Content (%)	7.8

Particle Size Distribution



Material Test Report

Report Number:	**GS5925/1-1**
Issue Number:	1
Date Issued:	08/09/2021
Client:	Jacobs (Melbourne)
	452 Flinders St, Melbourne Victoria 3000
Contact:	Jayden Robertson
Project Number:	GS5925/1
Project Name:	WVTNP EES
Project Location:	IS311800
Work Request:	5220
Sample Number:	59251-S22
Date Sampled:	03/09/2021
Dates Tested:	03/09/2021 - 07/09/2021
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Sample Location:	**EG-CP23 ((0.0-0.5m))**

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Approved Signatory: Tim Senserrick
Laboratory 21C

NATA Accredited Laboratory Number: 15055

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**3**		
Soil Description	silty GRAVEL, fine to coarse, brown, fines of low to medium plasticity		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	20		

Material Test Report

Report Number:	**GS5925/1-1**
Issue Number:	1
Date Issued:	08/09/2021
Client:	Jacobs (Melbourne)
	452 Flinders St, Melbourne Victoria 3000
Contact:	Jayden Robertson
Project Number:	GS5925/1
Project Name:	WVTNP EES
Project Location:	IS311800
Work Request:	5220
Sample Number:	59251-S23
Date Sampled:	03/09/2021
Dates Tested:	03/09/2021 - 06/09/2021
Sampling Method:	Sampled by Client - Tested as Received
	The results apply to the sample as received
Sample Location:	**O-CP2 ((0.0-0.5m))**
Material:	CLAY, high plasticity, brown

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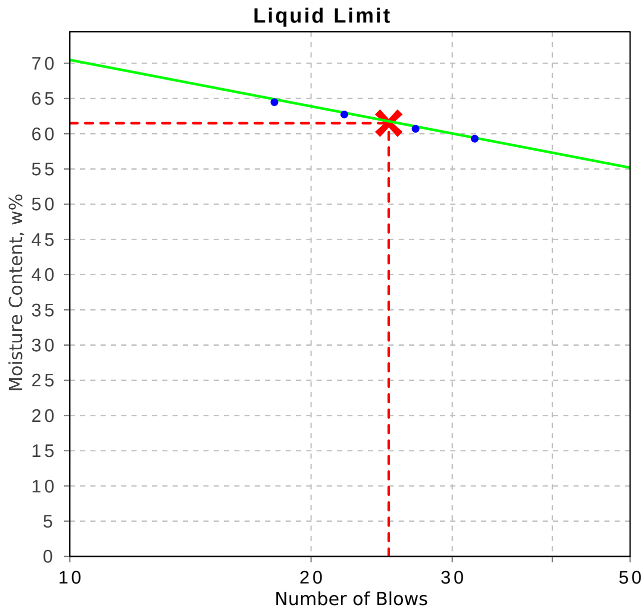
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Tim Senserrick
Laboratory 21C
NATA Accredited Laboratory Number: 15055

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	61		
Plastic Limit (%)	20		
Plasticity Index (%)	**41**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	19.0		
Cracking Crumbling Curling	Cracking & Curling		



SWEP PTY. LTD. ANALYTICAL LABORATORIES

Tel: (03) 9701 6007
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REPORT ON SAMPLE OF SOIL

FILE NO : 2109163349 **DATE ISSUED :** 8/09/2021

GROUND SCIENCE PTY LTD
13 BROCK STREET
THOMASTOWN, VIC 3074

CLIENT ID : GRO029
PHONE : 03 9464 4617
03 9469 4618

E-mail: aaronp@groundscience.com.au

REFERENCE :
REFERENCE PHONE :

SAMPLE ID : #S7 EG-CP04 (0-0.5 M)
DEPTH OF SAMPLE (cm): 0 to 50
LAND USE : PASTURE

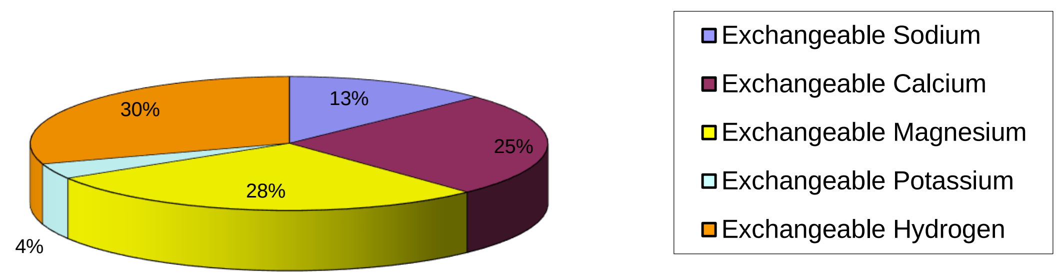
DATE RECEIVED : 6/09/2021
ANALYSIS REQUIRED : Gypsum+Lime Req

ITEMS			RESULTS	DESIRABLE LEVEL
COLOUR			REDDISH BROWN	
TEXTURE			MEDIUM CLAY	
ECe	µS/cm		3960	
pH(1:5 Water)			6.1	5.5-7.5
pH(1:5 0.01M $CaCl_2$)			5.56	
Electrical Conductivity	EC	µS/cm	495	< 300
TOTAL SOLUBLE SALT	TSS	ppm	1633.5	< 990
EXCHANGEABLE CALCIUM	Ca	meq/100 of soil	2.43	6.28
EXCHANGEABLE MAGNESIUM	Mg	meq/100 of soil	2.73	1.45
EXCHANGEABLE SODIUM	Na	meq/100 of soil	1.24	< 0.483
EXCHANGEABLE POTASSIUM	K	meq/100 of soil	0.36	0.483
EXCHANGEABLE HYDROGEN	H	meq/100 of soil	3.19	< 1.45
ADJ. EXCHANG. HYDROGEN	H	meq/100 of soil	2.9	
AVAILABLE SULPHUR	S	ppm	11	
TOTAL ORGANIC MATTER	OM	%	0.585	
CATION EXCHANGE CAPACITY	CEC	meq/100g of soil	9.95	
ADJUSTED CEC	ACEC	meq/100g of soil	9.66	
EXCH. SODIUM PERCENTAGE	ESP		12.5	< 5
CALCIUM / MAGNESIUM RATIO	Ca/Mg		0.887	4-4.7

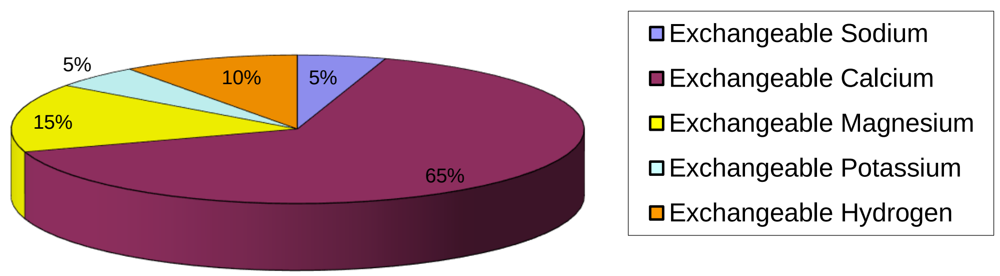
RECOMMENDATION

GYPSUM REQUIREMENT	16.31	t/ha				
LIME REQUIREMENT	0.25	t/ha				
DOLOMITE REQUIREMENT	0	t/ha				
MAGNESIUM SULPHATE	0	kg/ha	or	MAGNESIUM OXIDE	0	kg/ha

Actual Exchangeable Cation Percentage



Desirable Exchangeable Cation Percentage



- Desirable levels for Exchangeable Cations (Ca, Mg, Na, K and H) is directly related to the constant desirable level percentages (see pie graph page 2) and the soil's Adjusted CEC. The other elements vary in relation to the soil's CEC, landuse, leaching requirement and yield.

ANALYTICAL METHODS

Items	Methods
pH (1:5 Water)	4A1
pH (1:5 $CaCl_2$)	4B1
Electrical conductivity (1:5 Water)	3A1
Total Soluble Salts	Calculation from Electrical conductivity
Exchangeable Calcium	15D3 or 15A1
Exchangeable Magnesium	15D3 or 15A1
Exchangeable Sodium	15D3 or 15A1
Exchangeable Potassium	15D3 or 15A1
Exchangeable Hydrogen	Barium Chloride-Triethanolamine method*
Available Sulphur	KCl 40, 10D1
Total Organic Matter	modified Walkley & Black, 6A1
Chloride	5A1

NB. For available Iron and Manganese, SWEP uses the method developed by E.H. Mikhail (1980) due to the tendency for the standard EDTA method to produce erroneously high results.

For numbered test methods:

Rayment, G.E. & Lyons, D.J. (2011). Soil Chemical Methods - Australasia. CSIRO Publishing, 150 Oxford Street, Collingwood Vic 3066, Australia.

*Peech, M., Cowan, R.L. & Baker, J.H. (1962). Soil Science Society American Procedures, A critical study of the Barium chloride-Triethanolamine and ammonium acetate methods for determining exchangeable Hydrogen of soils.

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REPORT ON SAMPLE OF SOIL

FILE NO : 2109163350 **DATE ISSUED :** 13/09/2021

GROUND SCIENCE PTY LTD
13 BROCK STREET
THOMASTOWN, VIC 3074

CLIENT ID : GRO029
PHONE : 03 9464 4617
03 9469 4618

E-mail: aaronp@groundscience.com.au

REFERENCE :
REFERENCE PHONE :

SAMPLE ID : #S14 SAMPLE 13 EG-CP15 (0-0.5 M)
DEPTH OF SAMPLE (cm): 0 to 50
LAND USE : PASTURE

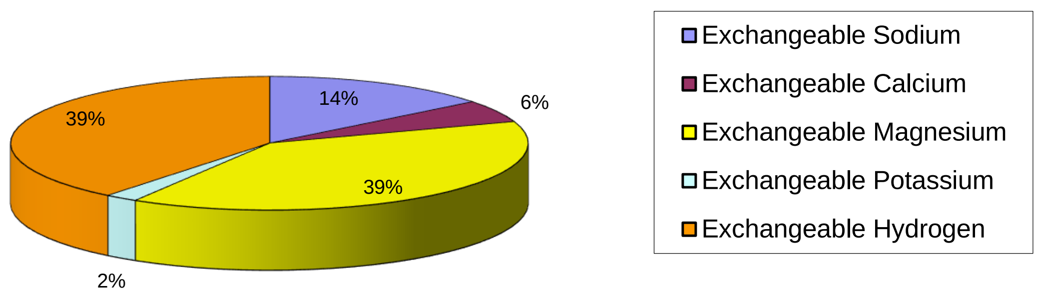
DATE RECEIVED : 6/09/2021
ANALYSIS REQUIRED : Gypsum+Lime Req

ITEMS			RESULTS	DESIRABLE LEVEL
COLOUR			YELLOWISH BROWN	
TEXTURE			SILTY MEDIUM CLAY	
Ece		µS/cm	1216	
pH(1:5 Water)			5.7	5.5-7.5
pH(1:5 0.01M $CaCl_2$)			5.1	
Electrical Conductivity	EC	µS/cm	152	< 300
TOTAL SOLUBLE SALT	TSS	ppm	501.6	< 990
EXCHANGEABLE CALCIUM	Ca	meq/100 of soil	0.39	4.67
EXCHANGEABLE MAGNESIUM	Mg	meq/100 of soil	2.79	1.08
EXCHANGEABLE SODIUM	Na	meq/100 of soil	1.03	< 0.359
EXCHANGEABLE POTASSIUM	K	meq/100 of soil	0.147	0.359
EXCHANGEABLE HYDROGEN	H	meq/100 of soil	3.12	< 1.08
ADJ. EXCHANG. HYDROGEN	H	meq/100 of soil	2.82	
AVAILABLE SULPHUR	S	ppm	6.44	
TOTAL ORGANIC MATTER	OM	%	0.594	
CATION EXCHANGE CAPACITY	CEC	meq/100g of soil	7.48	
ADJUSTED CEC	ACEC	meq/100g of soil	7.18	
EXCH. SODIUM PERCENTAGE	ESP		13.8	< 5
CALCIUM / MAGNESIUM RATIO	Ca/Mg		0.14	4-4.7

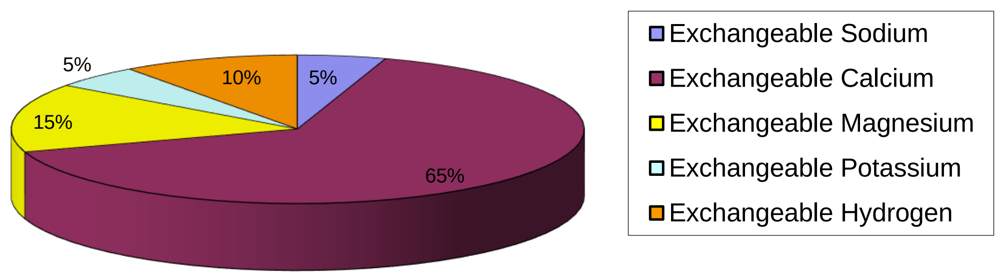
RECOMMENDATION

GYPSUM REQUIREMENT	19.07	t/ha				
LIME REQUIREMENT	0	t/ha				
DOLOMITE REQUIREMENT	0	t/ha				
MAGNESIUM SULPHATE	0	kg/ha	or	MAGNESIUM OXIDE	0	kg/ha

Actual Exchangeable Cation Percentage



Desirable Exchangeable Cation Percentage



- Desirable levels for Exchangeable Cations (Ca, Mg, Na, K and H) is directly related to the constant desirable level percentages (see pie graph page 2) and the soil's Adjusted CEC. The other elements vary in relation to the soil's CEC, landuse, leaching requirement and yield.

ANALYTICAL METHODS

Items	Methods
pH (1:5 Water)	4A1
pH (1:5 $CaCl_2$)	4B1
Electrical conductivity (1:5 Water)	3A1
Total Soluble Salts	Calculation from Electrical conductivity
Exchangeable Calcium	15D3 or 15A1
Exchangeable Magnesium	15D3 or 15A1
Exchangeable Sodium	15D3 or 15A1
Exchangeable Potassium	15D3 or 15A1
Exchangeable Hydrogen	Barium Chloride-Triethanolamine method*
Available Sulphur	KCl 40, 10D1
Total Organic Matter	modified Walkley & Black, 6A1
Chloride	5A1

NB. For available Iron and Manganese, SWEP uses the method developed by E.H. Mikhail (1980) due to the tendency for the standard EDTA method to produce erroneously high results.

For numbered test methods:

Rayment, G.E. & Lyons, D.J. (2011). Soil Chemical Methods - Australasia. CSIRO Publishing, 150 Oxford Street, Collingwood Vic 3066, Australia.

*Peech, M., Cowan, R.L. & Baker, J.H. (1962). Soil Science Society American Procedures, A critical study of the Barium chloride-Triethanolamine and ammonium acetate methods for determining exchangeable Hydrogen of soils.

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REPORT ON SAMPLE OF SOIL

FILE NO : 2109163351 **DATE ISSUED :** 13/09/2021

GROUND SCIENCE PTY LTD
13 BROCK STREET
THOMASTOWN, VIC 3074

CLIENT ID : GRO029
PHONE : 03 9464 4617
03 9469 4618

E-mail: aaronp@groundscience.com.au

REFERENCE :
REFERENCE PHONE :

SAMPLE ID : #S18 EMO-CP09 (0-0.5 M)
DEPTH OF SAMPLE (cm): 0 to 50
LAND USE : PASTURE

DATE RECEIVED : 6/09/2021
ANALYSIS REQUIRED : Gypsum+Lime Req

ITEMS			RESULTS	DESIRABLE LEVEL
COLOUR			DARK REDDISH BROWN	
TEXTURE			SILTY LIGHT CLAY	
Ece		µS/cm	281	
pH(1:5 Water)			6.4	5.5-7.5
pH(1:5 0.01M $CaCl_2$)			5.78	
Electrical Conductivity	EC	µS/cm	35.1	< 300
TOTAL SOLUBLE SALT	TSS	ppm	115.83	< 990
EXCHANGEABLE CALCIUM	Ca	meq/100 of soil	3.14	7.8
EXCHANGEABLE MAGNESIUM	Mg	meq/100 of soil	3.44	1.8
EXCHANGEABLE SODIUM	Na	meq/100 of soil	0.233	< 0.60
EXCHANGEABLE POTASSIUM	K	meq/100 of soil	0.714	0.60
EXCHANGEABLE HYDROGEN	H	meq/100 of soil	5.47	< 1.8
ADJ. EXCHANG. HYDROGEN	H	meq/100 of soil	4.47	
AVAILABLE SULPHUR	S	ppm	1.94	
TOTAL ORGANIC MATTER	OM	%	2	
CATION EXCHANGE CAPACITY	CEC	meq/100g of soil	13	
ADJUSTED CEC	ACEC	meq/100g of soil	12	
EXCH. SODIUM PERCENTAGE	ESP		1.79	< 5
CALCIUM / MAGNESIUM RATIO	Ca/Mg		0.912	4-4.7

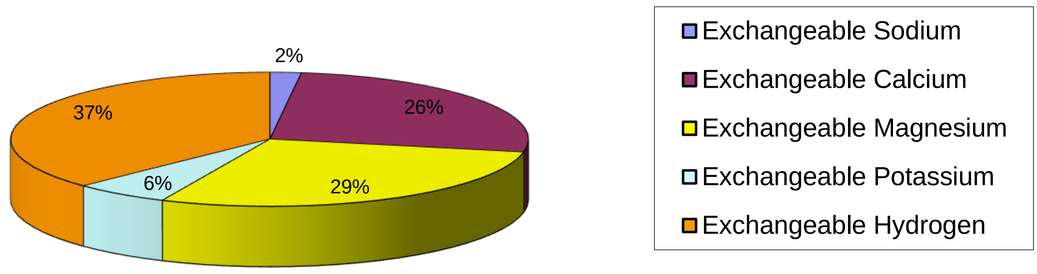
RECOMMENDATION

GYPSUM REQUIREMENT	13.15	t/ha				
LIME REQUIREMENT	4.1	t/ha				
DOLOMITE REQUIREMENT	0	t/ha				
MAGNESIUM SULPHATE	0	kg/ha	or	MAGNESIUM OXIDE	0	kg/ha

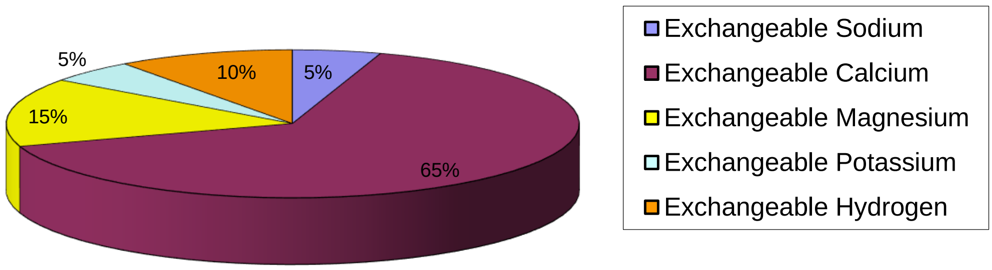
SWEP Analytical Laboratories
45-47 / 174 Bridge Road
Keysborough VIC 3173 Australia

Website: www.swep.com.au
E-mail: services@swep.com.au
Postal Address: P.O. Box 583 Noble Park VIC 3174

Actual Exchangeable Cation Percentage



Desirable Exchangeable Cation Percentage



- Desirable levels for Exchangeable Cations (Ca, Mg, Na, K and H) is directly related to the constant desirable level percentages (see pie graph page 2) and the soil's Adjusted CEC. The other elements vary in relation to the soil's CEC, landuse, leaching requirement and yield.

ANALYTICAL METHODS

Items	Methods
pH (1:5 Water)	4A1
pH (1:5 $CaCl_2$)	4B1
Electrical conductivity (1:5 Water)	3A1
Total Soluble Salts	Calculation from Electrical conductivity
Exchangeable Calcium	15D3 or 15A1
Exchangeable Magnesium	15D3 or 15A1
Exchangeable Sodium	15D3 or 15A1
Exchangeable Potassium	15D3 or 15A1
Exchangeable Hydrogen	Barium Chloride-Triethanolamine method*
Available Sulphur	KCl 40, 10D1
Total Organic Matter	modified Walkley & Black, 6A1
Chloride	5A1

NB. For available Iron and Manganese, SWEP uses the method developed by E.H. Mikhail (1980) due to the tendency for the standard EDTA method to produce erroneously high results.

For numbered test methods:

Rayment, G.E. & Lyons, D.J. (2011). Soil Chemical Methods - Australasia. CSIRO Publishing, 150 Oxford Street, Collingwood Vic 3066, Australia.

*Peech, M., Cowan, R.L. & Baker, J.H. (1962). Soil Science Society American Procedures, A critical study of the Barium chloride-Triethanolamine and ammonium acetate methods for determining exchangeable Hydrogen of soils.

Appendix D. Detailed Walkover Observations

Bulgana to Lexton

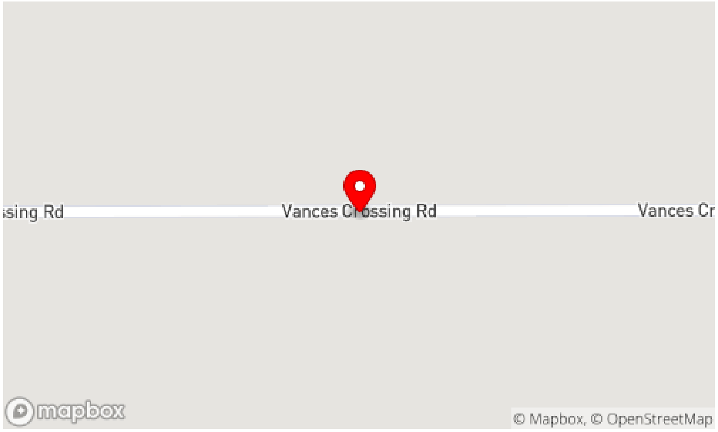
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	25/08/2021
Time	13:44 (10 GMT)
Weather	Windy

Walkover Checkpoint Notes

Checkpoint ID	EG-CP01
Precinct	Western Precinct
Address	Vances Crossing Road
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	Natural erosion and possible dispersion observed in Shepparton formation at creek 300m west of Checkpoint. Outside of the creek no signs of erosion where soils have not been disturbed.
Notes on Erosion Management	

Notes on Landslide Susceptibility	
Notes on Geological Significant Features	
General Ground Conditions Comments	Tower location in area of farmland. Shepparton Formation and White Hills Gravel geology.
Notes on Topography	Flat farmland, low lying gentle undulations.
Other Observations	Soil sample 1, Sandy SILT: low plasticity, pale brown, sand fine grained, trace gravel (Shepparton Formation, taken near creek). Soil sample 2, Clayey Silty SAND: fine grained, red brown, medium plasticity clay (Shepparton Formation). Sample taken near alignment, no obvious signs of salinity impacts, soil supporting crop growth.
Photos	   

WVTNP EES Walkover Notes

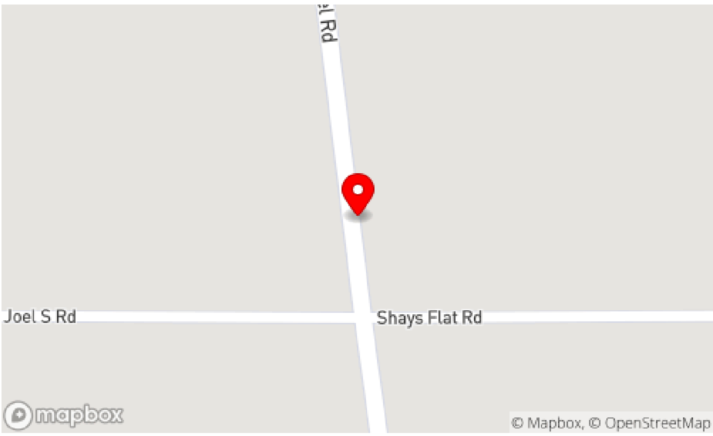
30/08/2021 08:08 AM

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	25/08/2021
Time	14:15 (10 GMT)
Weather	Windy

Walkover Checkpoint Notes

Checkpoint ID	EG-CP02
Precinct	Western Precinct
Address	Joel Joel Rd
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	N/A
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Possible soft soils in alluvium, geology is Shepparton Formation with areas of alluvium to west and Warrack Formation to east.
Notes on Topography	Flat to slightly undulating, low lying areas.
Other Observations	Soil sample 3 taken, Clayey Silty SAND: fine grained, red brown, medium plasticity clay, trace gravel (Shepparton Formation, no signs of erosion or salinity impacts).
Photos	   



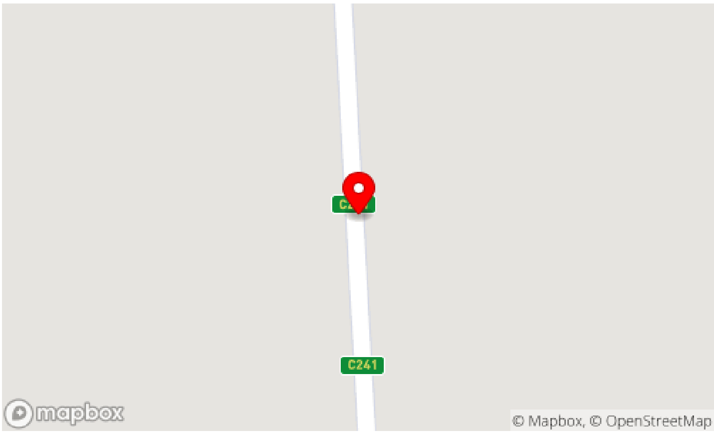

WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	25/08/2021
Time	14:40 (10 GMT)
Weather	Windy

Walkover Checkpoint Notes

Checkpoint ID	EG-CP03
Precinct	Western Precinct
Address	Ararat St Arnard Rd
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No

Notes on Erosion and Gullying	Some minor bare patches of soil, not eroding.
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Area is mostly White Hills Gravel with Shepparton Formation to south and Warrack Formation to north.
Notes on Topography	Moderately undulating.
Other Observations	Soil sample 4, Gravelly SAND: fine to coarse, red brown, with trace clay (White Hills Gravel).
Photos	   




Jacobs

30/08/2021 08:13 AM

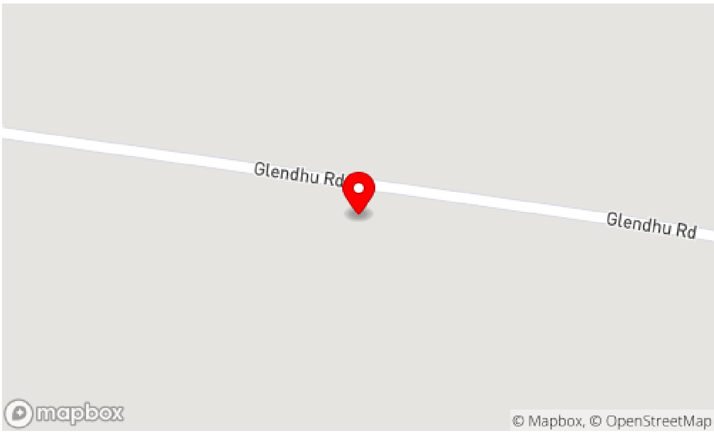
WVTNP EES Walkover Notes

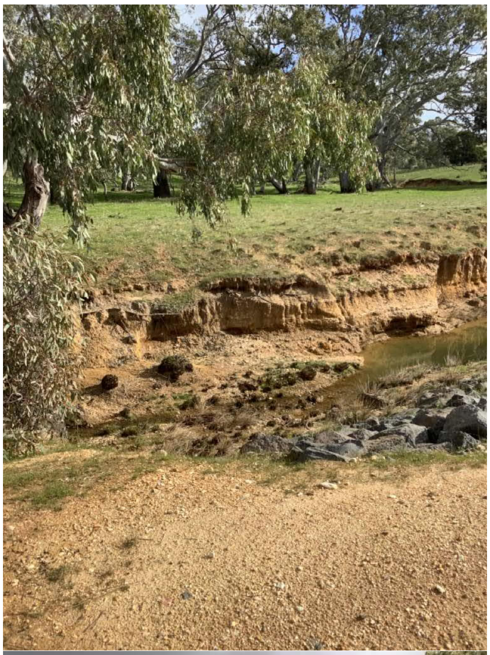
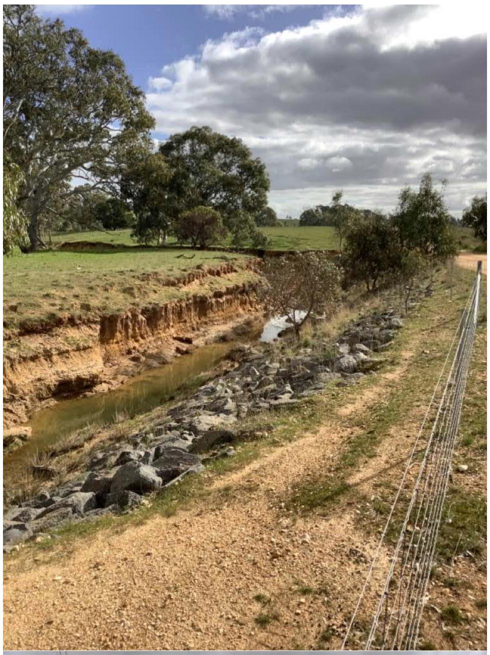
Project Details

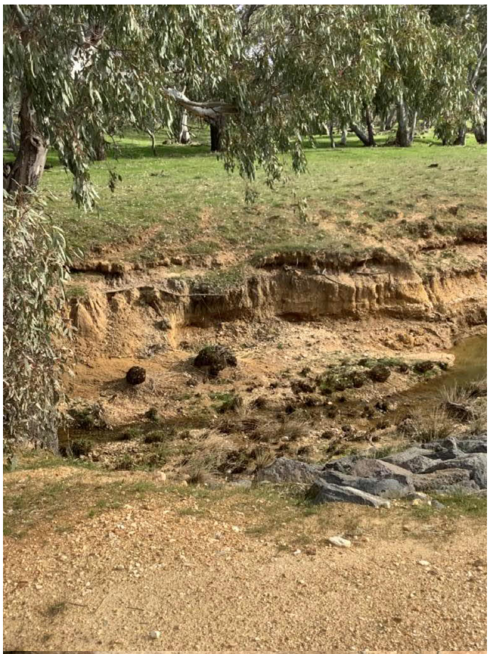
Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

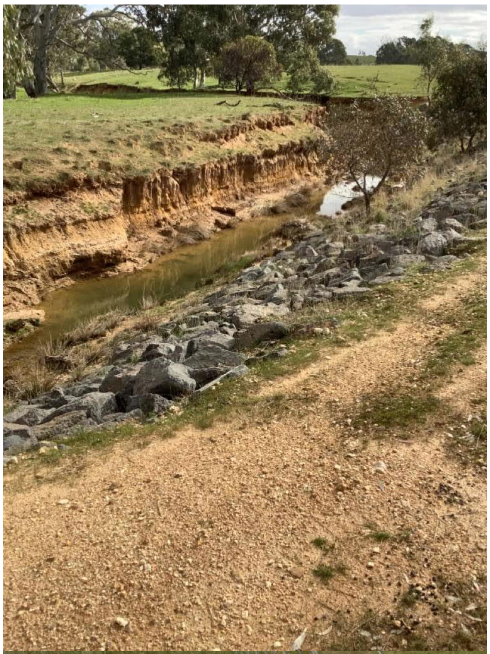
Date	25/08/2021
Time	15:04 (10 GMT)
Weather	Sunshine

Walkover Checkpoint Notes

Checkpoint ID	EG-CP04
Precinct	Western Precinct
Address	Crowlands Wind Farm, Glendhu Rd
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	Natural erosion observed in nearby creek caused by creek, rock armour adopted as mitigation measure to protect creek and nearby road.
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Localised failures observed in creek, geology is Shepparton Formation in low lying valley, Warrack Formation in hills, natural material shows potential for erosion when exposed to runoff.
Notes on Topography	Undulating to hilly topography.
Other Observations	Soil sample 5, SILT: low plasticity, red brown, with fine to coarse quartz gravel, rounded, with clay (Shepparton Formation). Check for geotechnical reports for Crowlands WF.
Photos	   






HERCULES
EG CP04



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30/08/2021 08:14 AM

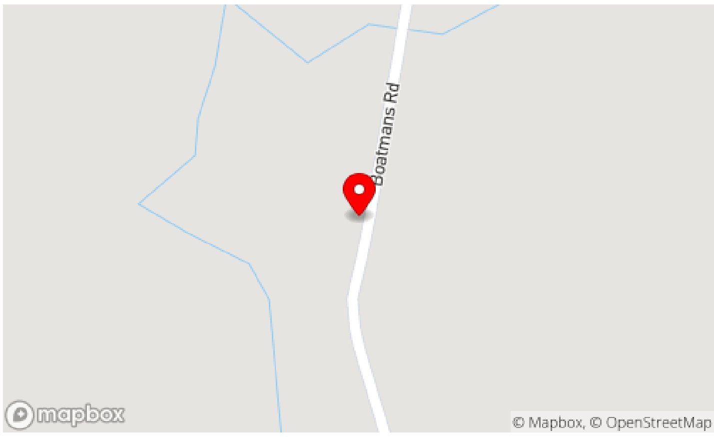
WVTNP EES Walkover Notes

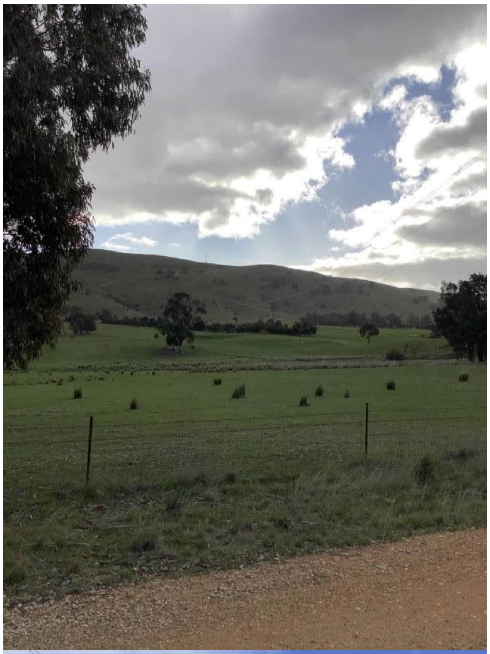
Project Details

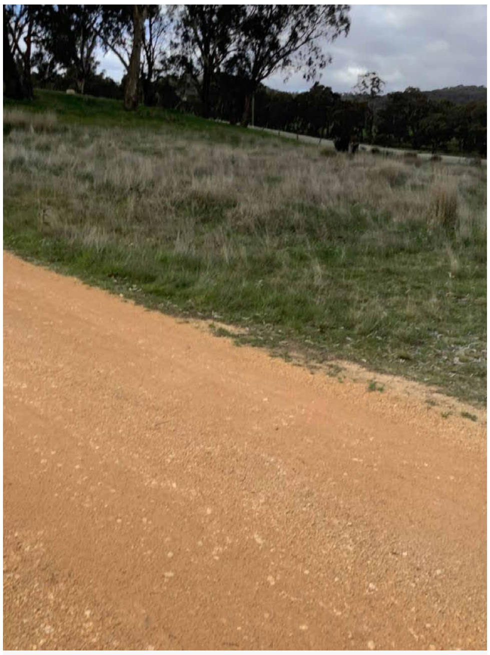
Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	25/08/2021
Time	15:48 (10 GMT)
Weather	Windy

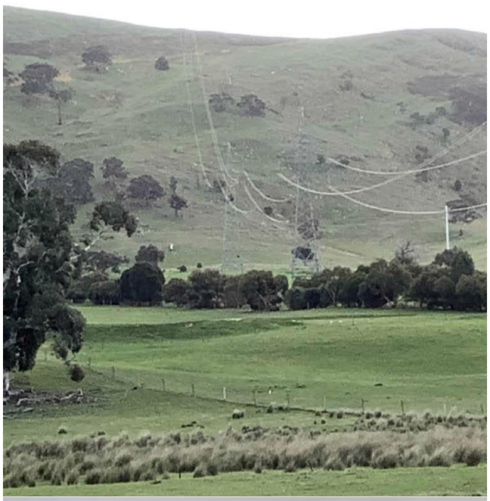
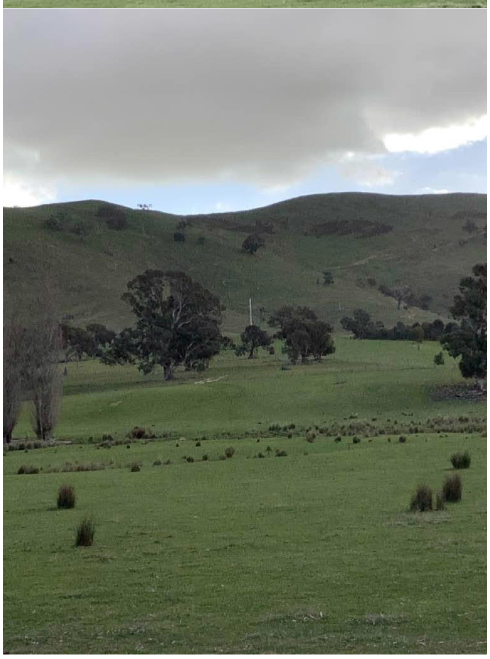
Walkover Checkpoint Notes

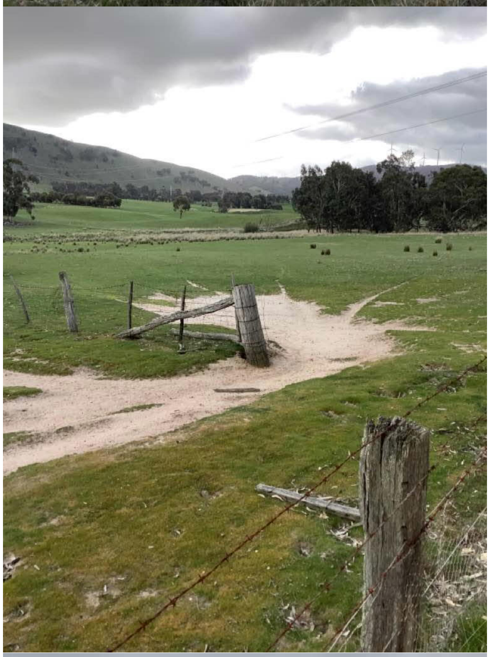
Checkpoint ID	EG-CP05
Precinct	Western Precinct
Address	Boatmans Road
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	Yes
Are there any geological significant features? (Yes/No)	Yes
Notes on Erosion and Gullying	Natural erosion in nearby creeks, potential erosion also seen in hills to the west on steep slopes.
Notes on Erosion Management	
Notes on Landslide Susceptibility	Steep hills, Warrack Formation to west of checkpoint, may be prone to land slips. Evidence of land slipping occurring in the past in form of hummocky terrain.

Notes on Geological Significant Features	High strain fault area associated with Lansborough fault to west at top of hill.
General Ground Conditions Comments	Shepparton Formation in valley and Warrack Formation and Pyrenees Formation to east.
Notes on Topography	Very steep hills and low-lying alluvium areas.
Other Observations	Soil sample 6, SILT: low plasticity, red brown, with fine to coarse quartz gravel, rounded, with clay (Shepparton formation). Possibly some soil creep on valley sides.
Photos	   







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30/08/2021 08:16 AM

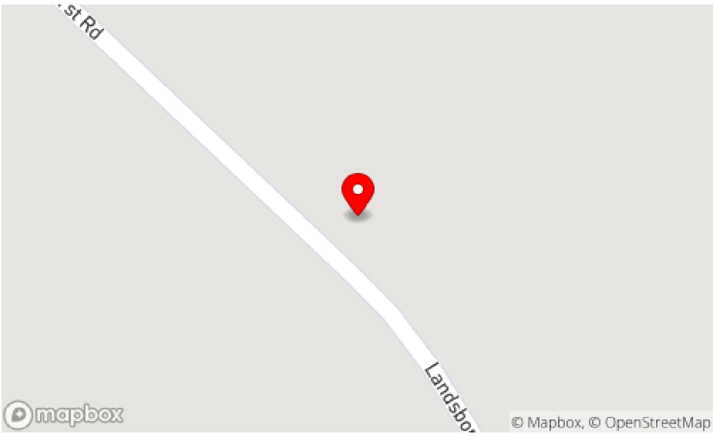
WVTNP EES Walkover Notes

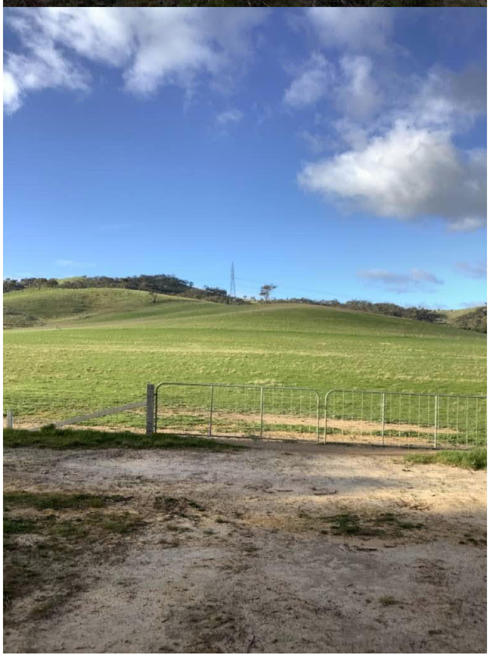
Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	25/08/2021
Time	16:31 (10 GMT)
Weather	Sunshine

Walkover Checkpoint Notes

Checkpoint ID	EG-CP06
Precinct	Western Precinct
Address	Landsborough Elmhurst Road
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	No obvious signs of gullying or land sliding, some soil creep in steeper areas. Geology is Pyrenees Formation in hills and Shepparton Formation in low lying areas, rock outcropping on hills.
Notes on Topography	Hilly terrain.
Other Observations	
Photos	   

30/08/2021 08:15 AM

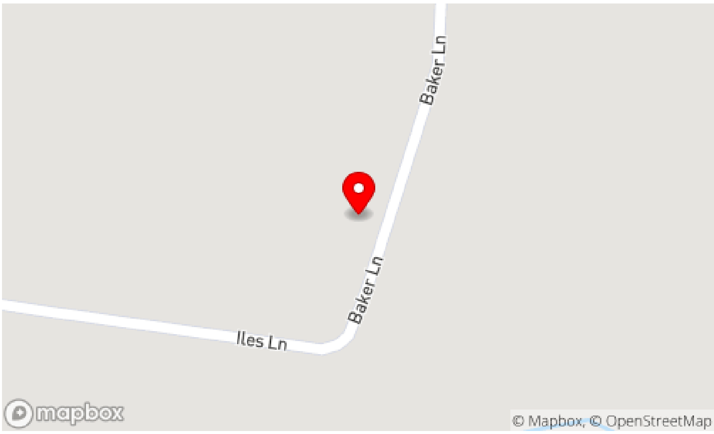
WVTNP EES Walkover Notes

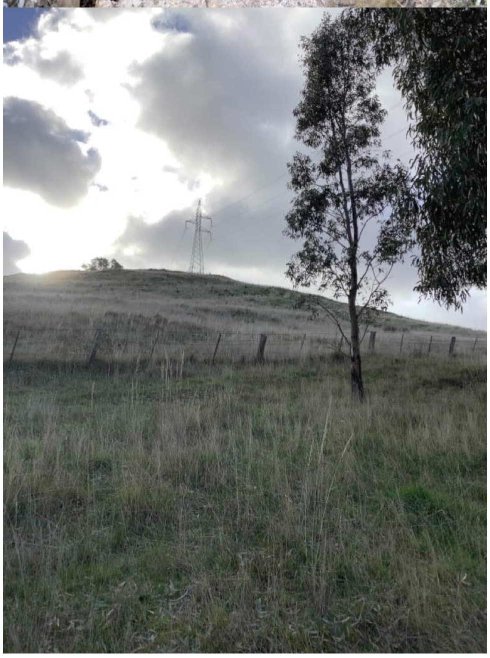
Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	25/08/2021
Time	16:15 (10 GMT)
Weather	Cloudy

Walkover Checkpoint Notes

Checkpoint ID	EG-CP07
Precinct	Western Precinct
Address	Baker Lane
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	Evidence of erosion of natural residual soils in areas where topsoil has been disturbed.
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Pyrenees Formation hills to north and alluvium associated with Wimmera River to the south, inferred rock depth quite shallow on slopes, rock boulders on slopes.
Notes on Topography	Steep slopes and low-lying flat alluvium.
Other Observations	Soil sample 7, SILT: low plasticity, light brown, with trace clay (Pyrenees Formation).
Photos	   






30/08/2021 08:16 AM

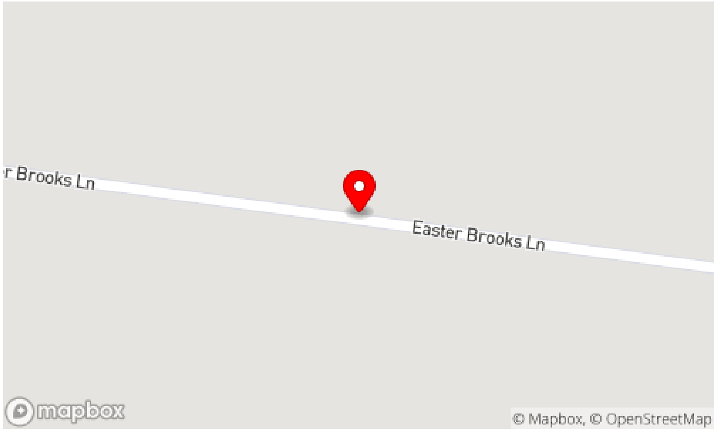
WVTNP EES Walkover Notes

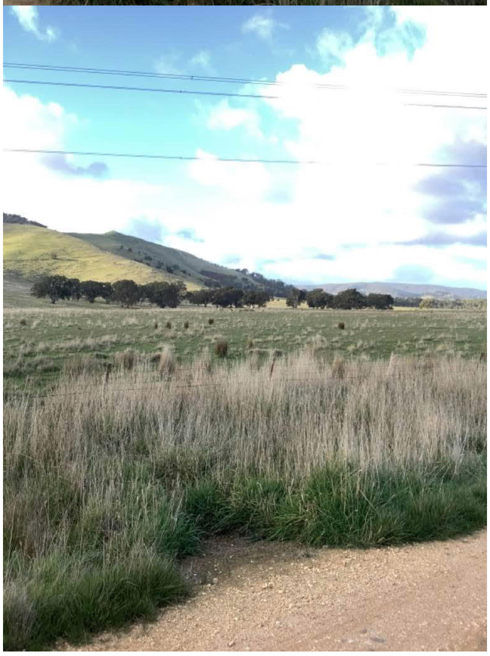
Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	25/08/2021
Time	16:50 (10 GMT)
Weather	Cloudy

Walkover Checkpoint Notes

Checkpoint ID	EG-CP08
Precinct	Western Precinct
Address	
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Area mostly in low lying alluvium/Shepparton Formation, mainly grassed over with little soil exposure, granite rock to the west.
Notes on Topography	Flat to gentle undulating in valley, surrounded by hills.
Other Observations	Flat farmland
Photos	   

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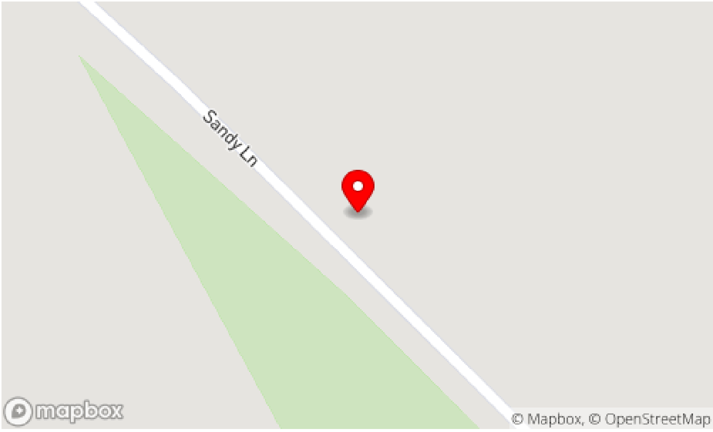
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

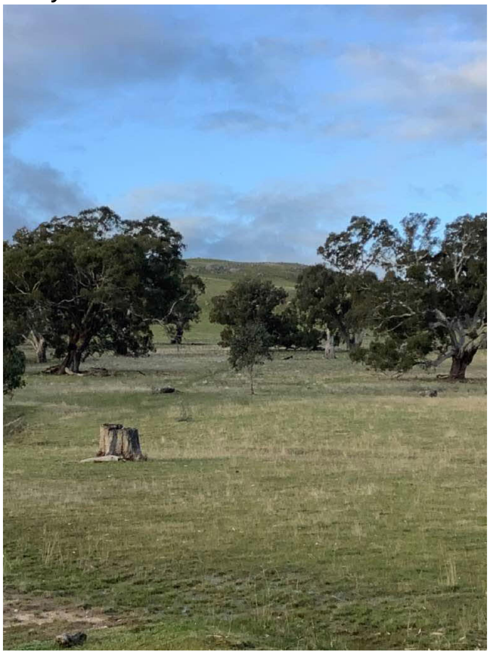
Date	25/08/2021
Time	17:05 (10 GMT)
Weather	Sunshine

Walkover Checkpoint Notes

Checkpoint ID	EG-CP09
Precinct	Western Precinct
Address	
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	Granite derived soils displaying gully erosion when soils exposed on slopes.
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Glenlogie Granodiorite and granite derived colluvium at base of slopes.
Notes on Topography	Hilly topography.
Other Observations	Sample 8, Sandy CLAY: medium plasticity, brown, with gravels (Glenlogie Granodiorite).
Photos	   

Gully erosion



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30/08/2021 08:17 AM

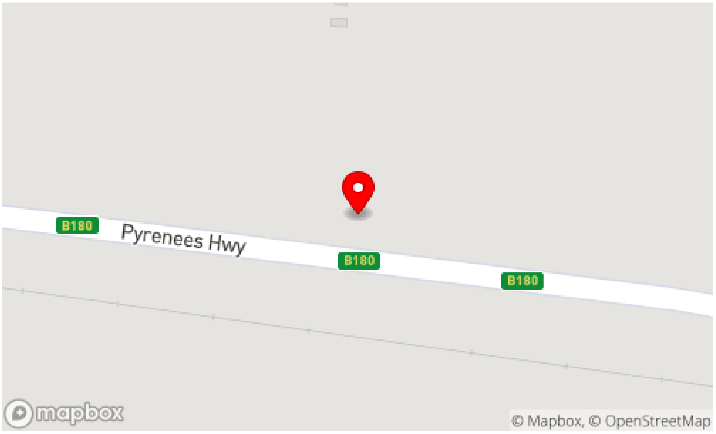
WVTNP EES Walkover Notes

Project Details

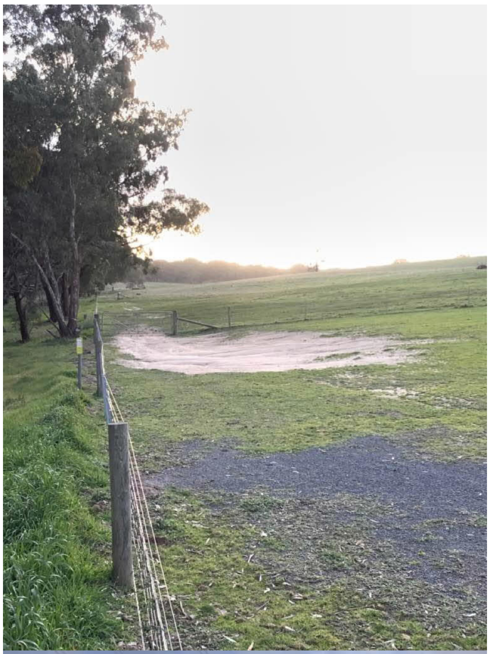
Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	25/08/2021
Time	17:19 (10 GMT)
Weather	Windy

Walkover Checkpoint Notes

Checkpoint ID	EG-CP10
Precinct	Western Precinct
Address	Pyrenees Hwy
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	Yes

Notes on Erosion and Gullying	Natural erosion observed in creek, also seen where soil has disturbed for farming.
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	Granite exposure to north of alignment.
General Ground Conditions Comments	Transmission line passes through area of granite derived colluvium at base of slope.
Notes on Topography	Gentle slopes in colluvium and steep slopes to north in granite hills.
Other Observations	Soil sample 9, SAND: fine to coarse, brown, with fine gravel, trace fines (granite derived colluvium).
Photos	   


Jacobs

30/08/2021 08:18 AM

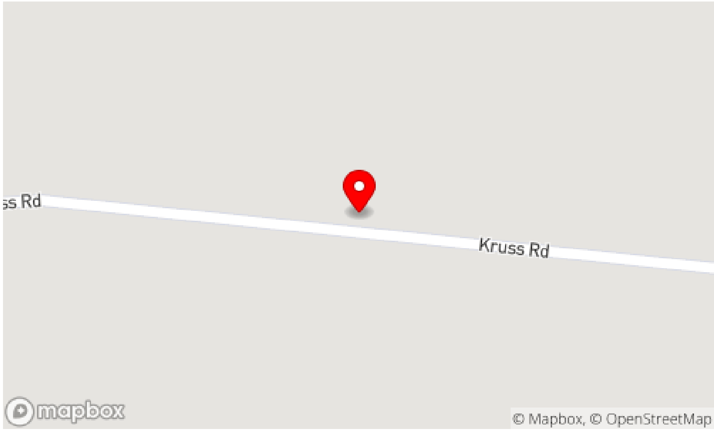
WVTNP EES Walkover Notes

Project Details

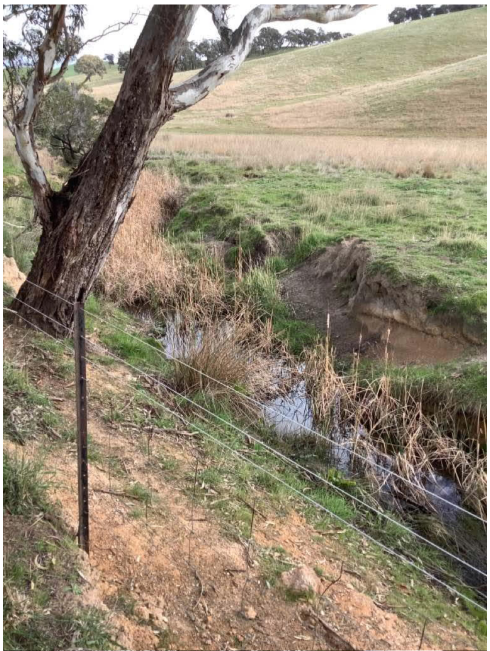
Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2017
Time	09:20 (10 GMT)
Weather	Cloudy

Walkover Checkpoint Notes

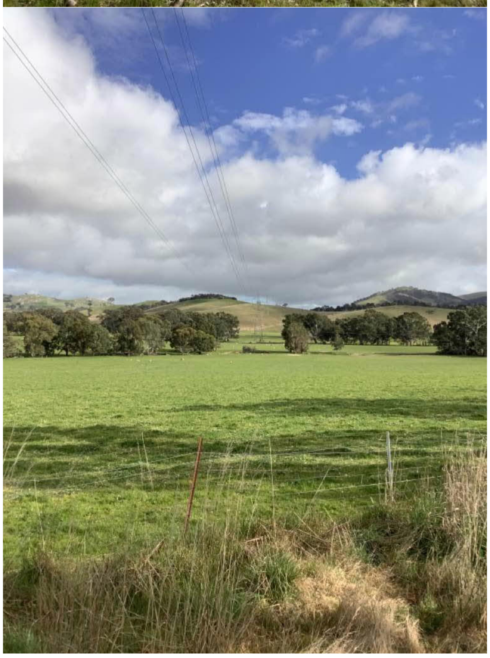
Checkpoint ID	EG-CP-011
Precinct	Western Precinct
Address	
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No

Notes on Erosion and Gullying	Evidence of natural gully erosion on slopes that has subsequently been stabilised, natural erosion in creeks.
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Pyrenees Formation in the hills, Shepparton Formation in low lying creek area to the east, soil creep on steeper part of hills.
Notes on Topography	Hilly topography.
Other Observations	Soil sample 10, CLAY: Medium plasticity, red brown, with sand/gravels (Pyrenees Formation).
Photos	   





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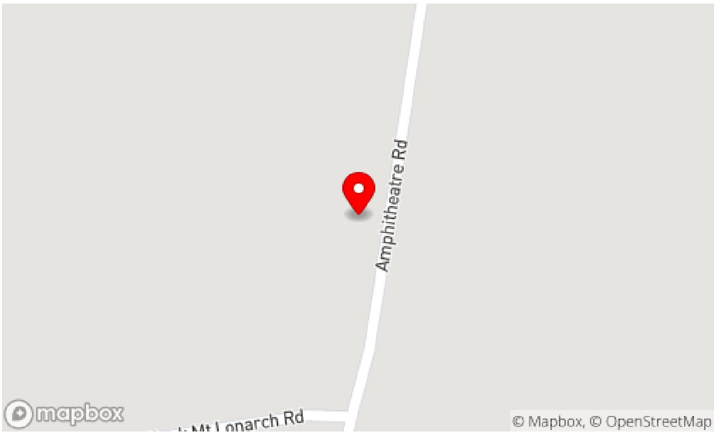
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	09:59 (10 GMT)
Weather	Cloudy

Walkover Checkpoint Notes

Checkpoint ID	EG-CP12
Precinct	Western Precinct
Address	Amphitheatre Rd
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	Yes
Are there any geological significant features? (Yes/No)	No

Notes on Erosion and Gullying	Possibly erosion on hills but since stabilised, some evidence of natural erosion in creeks.
Notes on Erosion Management	
Notes on Landslide Susceptibility	Steeps may be prone to land slips or instability if disturbed.

Notes on Geological Significant Features	
General Ground Conditions Comments	Beaufort Formation in hills to west, Shepparton Formation and recent alluvium in valley. Evidence of rock outcropping on hills.
Notes on Topography	Very hilly in Beaufort Formation, flat in low lying Shepparton Formation.
Other Observations	Current land use, farmland and pasture.
Photos	   

30/08/2021 08:20 AM

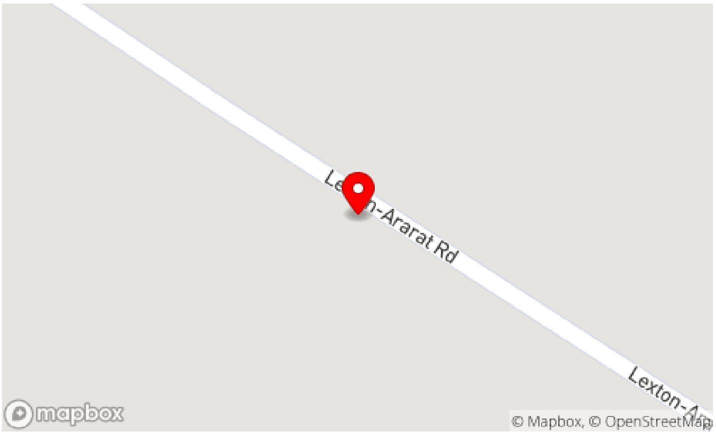
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	10:43 (10 GMT)
Weather	Windy

Walkover Checkpoint Notes

Checkpoint ID	EMO-CP01
Precinct	Western Precinct
Address	
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	Yes
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	Creek area fenced off, signs of active erosion in creek, young trees planted indicate recent attempts to stabilise.
Notes on Erosion Management	Trees and fencing around the creek area to re-establish vegetation.
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Creek runs through area of granite residual soils.
Notes on Topography	Gently undulating.
Other Observations	
Photos	   

30/08/2021 08:19 AM

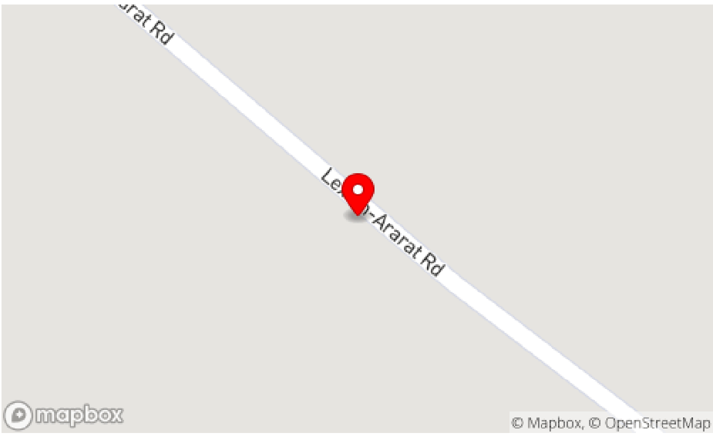
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	10:26 (10 GMT)
Weather	Windy

Walkover Checkpoint Notes

Checkpoint ID	EG-CP13
Precinct	Western Precinct
Address	Lexton Ararat Rd
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	Minor erosion around water courses.
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Pyrenees Formation in hills, granite in valley, rock outcropping on hills, alignment passes through granite in valley.
Notes on Topography	Alignment moderately undulating ground surrounded by steep hills.
Other Observations	Soil sample 11, Silty SAND: fine to medium, red brown, low plasticity fines (Mount Lonarch Granite).
Photos	   

Jacobs

30/08/2021 08:20 AM

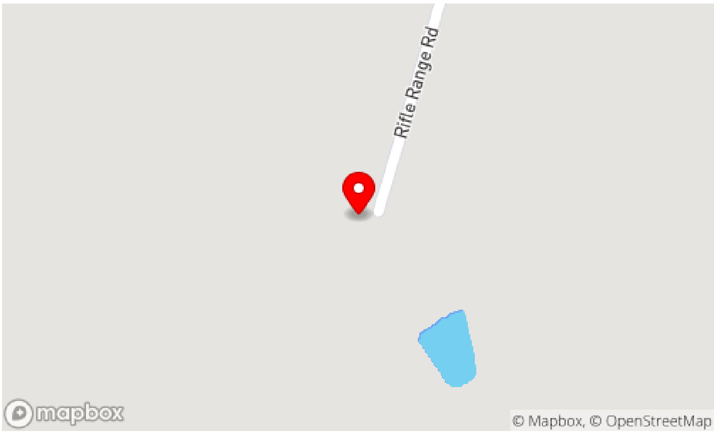
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	11:09 (10 GMT)
Weather	Cloudy

Walkover Checkpoint Notes

Checkpoint ID	EG-CP15
Precinct	Western Precinct
Address	Rifle Range Rd
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	Erosion in creeks and areas where soil has been disturbed mostly associated with natural processes. Very large area of erosion to east of checkpoint good example of gully erosion.
Notes on Erosion Management	

Notes on Landslide Susceptibility	
Notes on Geological Significant Features	
General Ground Conditions Comments	Pyrenees Formation with areas of White Hills Gravel in low lying areas, white crust observed on bare patches of soil.
Notes on Topography	Moderately undulating.
Other Observations	Soil sample 12, CLAY: medium plasticity, red brown (Pyrenees formation residual soil). Soil sample 13, Clayey SILT: low plasticity, brown, with gravels (residual soil, possible White Hills Gravel).
Photos	   










WVTNP EES Walkover Notes

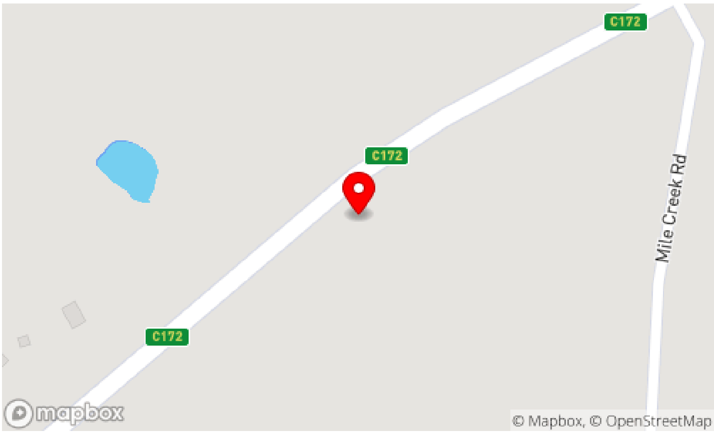
30/08/2021 08:21 AM

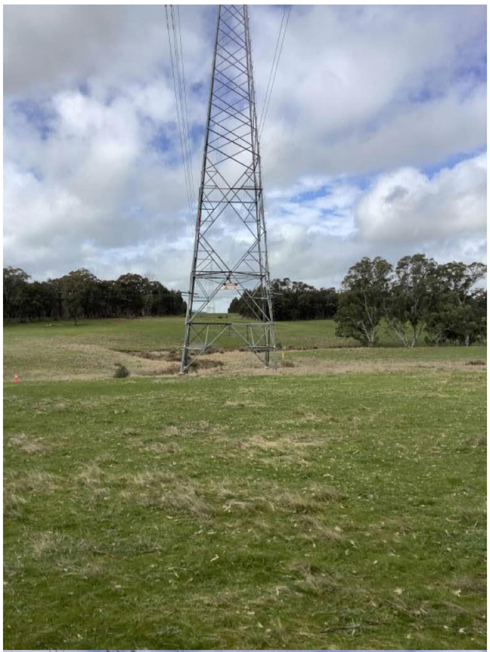
Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	11:45 (10 GMT)
Weather	Sunshine

Walkover Checkpoint Notes

Checkpoint ID	EG-CP16
Precinct	Western Precinct
Address	Beaufort-Lexton Rd
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	Yes
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	Natural erosion associated with creeks, gully erosion and soil creep on steep slopes.
Notes on Erosion Management	
Notes on Landslide Susceptibility	Area of soil creep and apparent progressive failure at creek bank. Potential large scale rotational failure close to toe of existing tower 400m north west of road.

Notes on Geological Significant Features	
General Ground Conditions Comments	Alluvium in low lying areas and sedimentary units in hills.
Notes on Topography	Moderately undulating to hilly.
Other Observations	
Photos	   






30/08/2021 08:22 AM

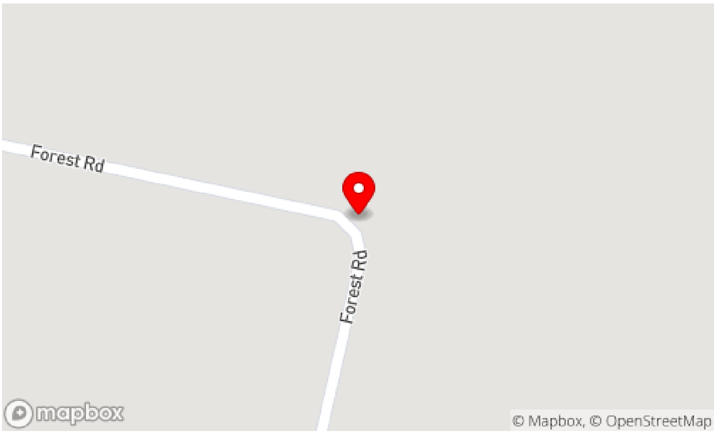
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

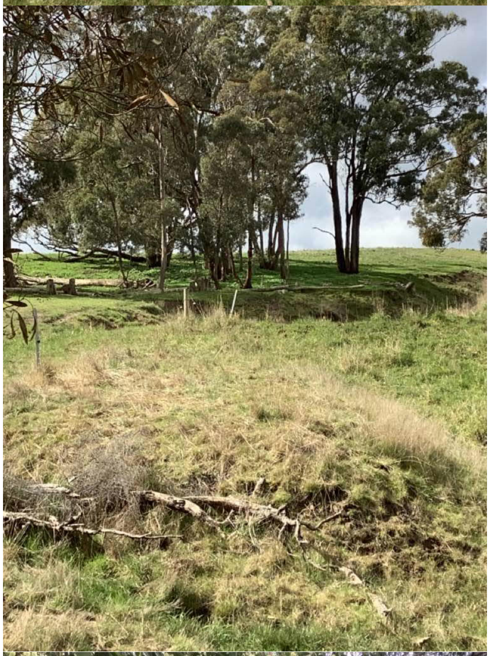
Date	26/08/2021
Time	12:40 (10 GMT)
Weather	Sunshine

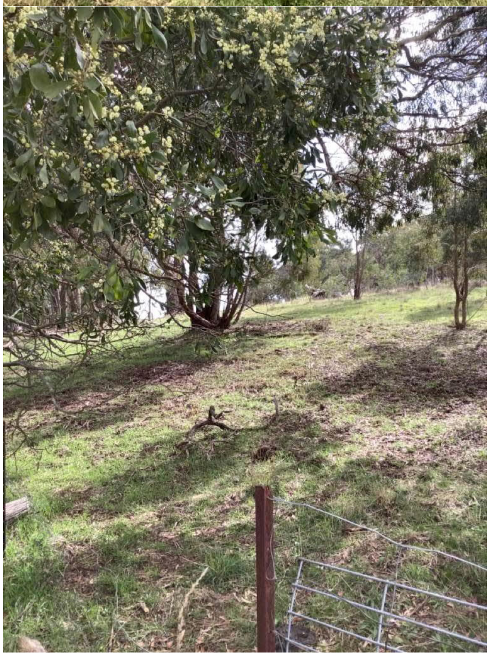
Walkover Checkpoint Notes

Checkpoint ID	EG-CP17
Precinct	Western Precinct
Address	Forest Rd
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No

Notes on Erosion and Gullying	Natural erosion associated with dry creek.
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Geology is Pyrenees Formation, evidence of thin layer of colluvium overlying residual soil.
Notes on Topography	Hilly topography.
Other Observations	Soil sample 14, Clayey Silty SAND: fine to medium, light brown, with trace gravel (Pyrenees Formation).
Photos	





Lexton to Ballan

Jacobs

30/08/2021 08:22 AM

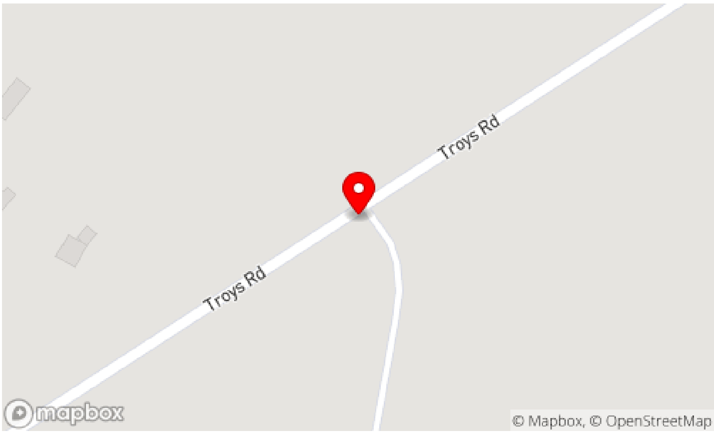
WVTNP EES Walkover Notes

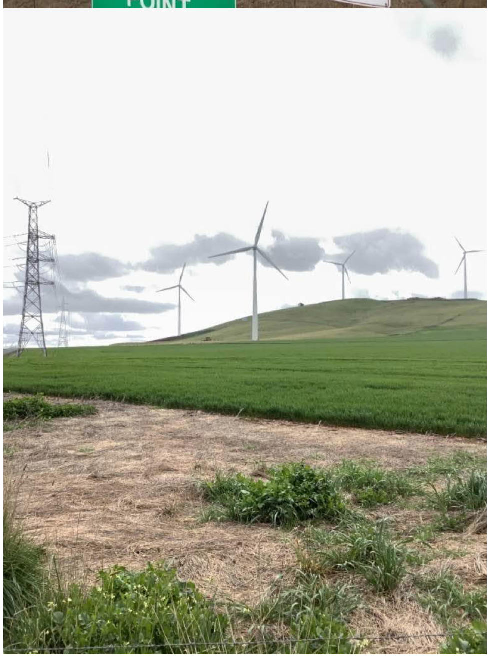
Project Details

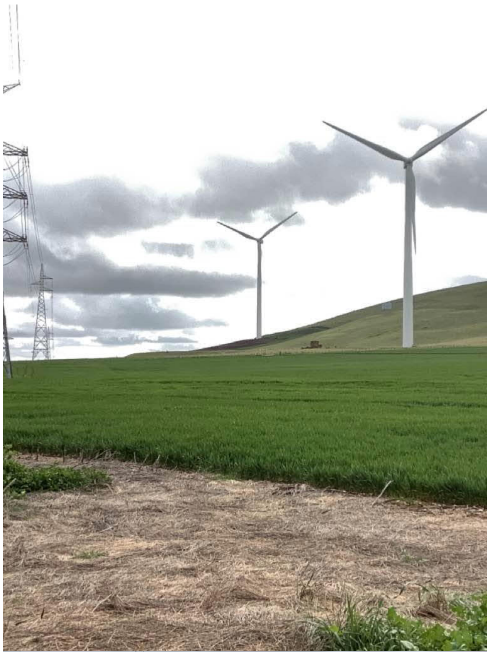
Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	13:11 (10 GMT)
Weather	Windy

Walkover Checkpoint Notes

Checkpoint ID	LS-CP01
Precinct	Western Precinct
Address	Troys Rd
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	Yes
Notes on Erosion and Gullying	
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	Two volcanic eruption points to the north of the alignment.
General Ground Conditions Comments	Newer Volcanics basalt and scoria cones associated with eruption points.
Notes on Topography	Slightly undulating to flat in low lying areas with hills surrounding.
Other Observations	Soil sample 15, Clayey SILT (Newer Volcanics residual soil). Site adjacent to Waubra WF and TS. Existing wind turbine foundation north of alignment appears to have benched backfill on side of slope. Land use for crops and grazing.
Photos	   



30/08/2021 08:29 AM

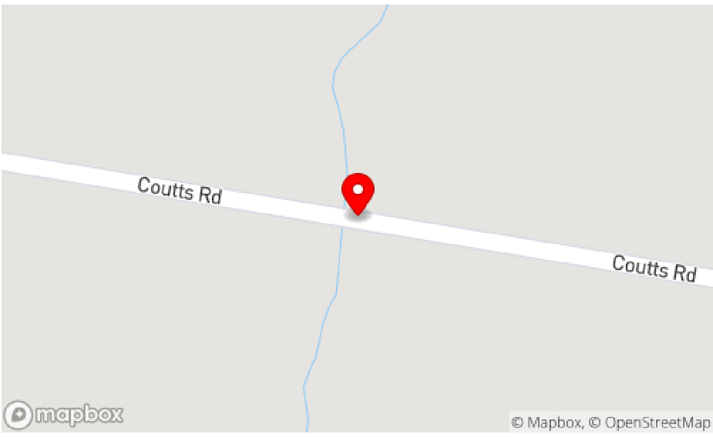
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	13:55 (10 GMT)
Weather	Windy

Walkover Checkpoint Notes

Checkpoint ID	EMO-CP02
Precinct	Western Precinct
Address	
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	Yes
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	
Notes on Erosion Management	Area has Erosion Management Overlay (EMO) associated with creek, no active erosion management measures as not necessary, creek is relatively stable with no active erosion.

Notes on Landslide Susceptibility	
Notes on Geological Significant Features	
General Ground Conditions Comments	Alluvial flats within basalt plains surrounded by granite hills.
Notes on Topography	Flat topography around creek surrounded by hills.
Other Observations	
Photos	   



30/08/2021 08:24 AM

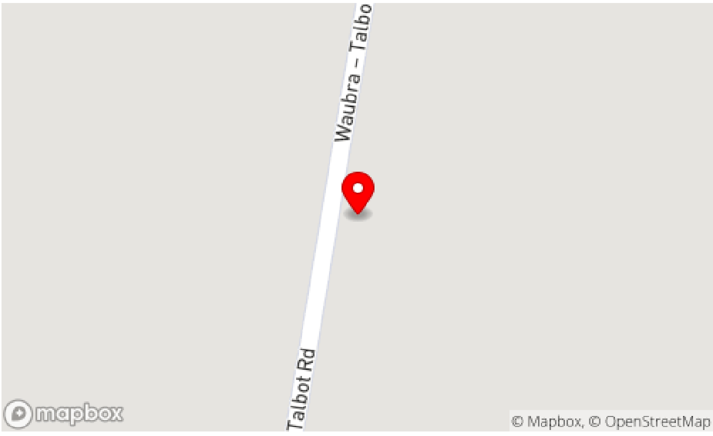
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	13:34 (10 GMT)
Weather	Windy

Walkover Checkpoint Notes

Checkpoint ID	EMO-CP03
Precinct	Western Precinct
Address	
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Newer volcanics in low lying areas surrounded by granite hills.
Notes on Topography	Flat surrounded by hills.
Other Observations	Farm use, landscape fairly lush with vegetation, landforms appear stable.
Photos	   

30/08/2021 08:29 AM

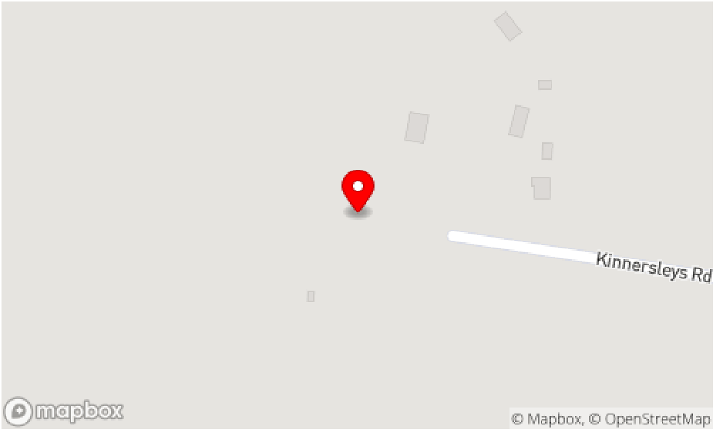
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	14:20 (10 GMT)
Weather	Windy

Walkover Checkpoint Notes

Checkpoint ID	EMO-CP04
Precinct	Western Precinct
Address	Kinnersley Rd
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	Yes
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	Yes
Are there any geological significant features? (Yes/No)	Yes
Notes on Erosion and Gullying	
Notes on Erosion Management	Erosion Management Overlay (EMO) present associated with creek passing under proposed alignment.
Notes on Landslide Susceptibility	Potentially some small-scale localised instability associated with slopes of scoria cone to north of alignment.

Notes on Geological Significant Features	Volcanic eruption point to the north of alignment, not impacting.
General Ground Conditions Comments	Localised alluvium and Newer Volcanics in flat areas, surrounded by scoria cone and granite hills/colluvium to south.
Notes on Topography	Slightly undulating surrounded by hills.
Other Observations	Farm use, pasture/crops.
Photos	   

Jacobs

30/08/2021 08:30 AM

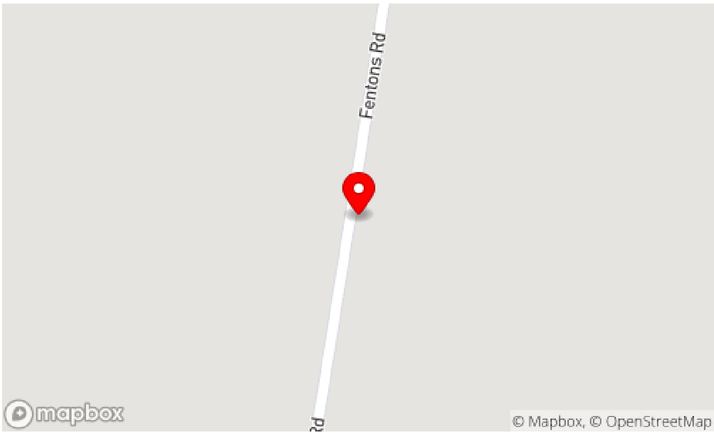
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	14:36 (10 GMT)
Weather	Cloudy

Walkover Checkpoint Notes

Checkpoint ID	EMO-CP05
Precinct	Western Precinct
Address	Fentons Rd
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	Yes
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	Yes
Notes on Erosion and Gullying	Signs of natural erosion and progressive failure of creek banks in EMO area, some historic gully erosion associated with drainage pathways into creek.
Notes on Erosion Management	EMO associated with creek to the west.
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	Small eruption point to north of alignment.
General Ground Conditions Comments	Newer Volcanics basalt, possible shallow rock, outcropping observed near creek.
Notes on Topography	Slightly undulating.
Other Observations	Soil sample 15b, Silty CLAY: medium to high plasticity, dark red brown (Newer Volcanics residual soil).
Photos	   



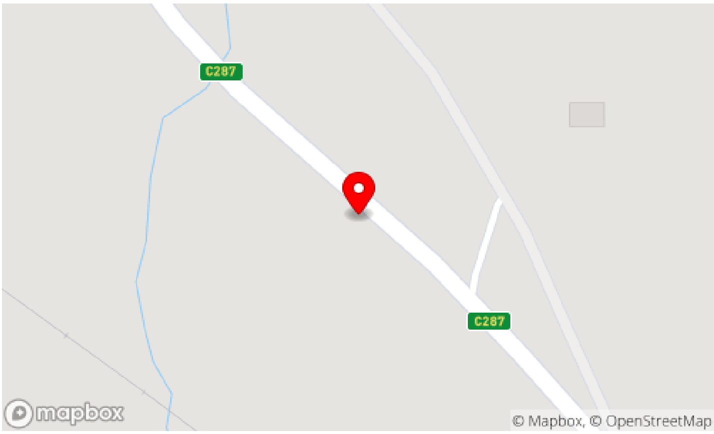

WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	15:02 (10 GMT)
Weather	Windy

Walkover Checkpoint Notes

Checkpoint ID	EMO-CP06
Precinct	Western Precinct
Address	
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	Yes
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	Minor slumping evident on creek banks.
Notes on Erosion Management	Large culvert present for rail with concrete protection at outlets.
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Newer Volcanics basalt, no alluvium present.
Notes on Topography	Gently undulating.
Other Observations	Large rail culvert present.
Photos	   

30/08/2021 08:41 AM

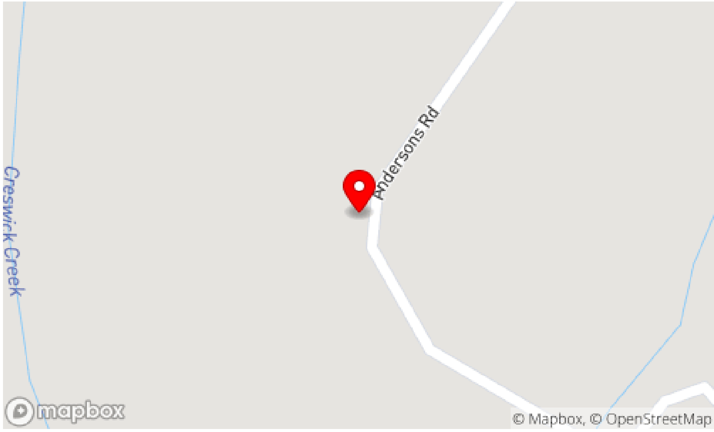
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	15:26 (10 GMT)
Weather	Windy

Walkover Checkpoint Notes

Checkpoint ID	EMO-CP07
Precinct	Western Precinct
Address	Anderson's Rd
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	Yes
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	Yes
Are there any geological significant features? (Yes/No)	No

Notes on Erosion and Gullying	Progressive stepping failure on sides of valley wall and natural erosion associated with creek, also gully erosion associated with drainage pathways.
Notes on Erosion Management	Area has EMO covering creek valley, no signs of active erosion management features.
Notes on Landslide Susceptibility	Sides of creek valley display progressive slipping failure.

Notes on Geological Significant Features	
General Ground Conditions Comments	Newer Volcanics basalt plains with creek running through north to south forming steep valley.
Notes on Topography	Slightly undulating with steep creek valley.
Other Observations	Soil sample 16, Clayey Sandy SILT: medium to high plasticity, red brown (Newer Volcanics residual soil).
Photos	   



30/08/2021 08:45 AM

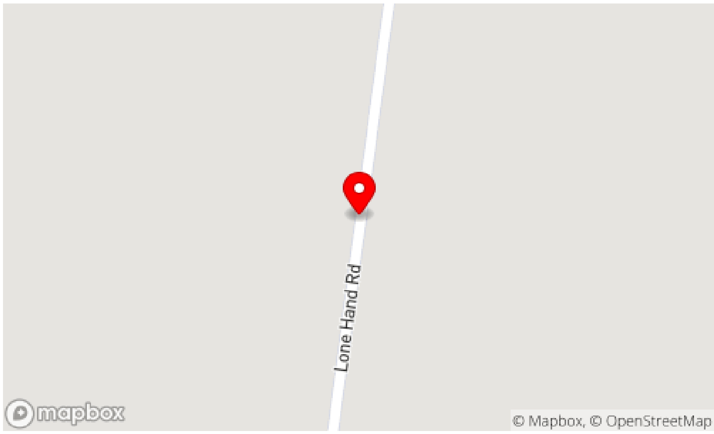
WVTNP EES Walkover Notes

Project Details

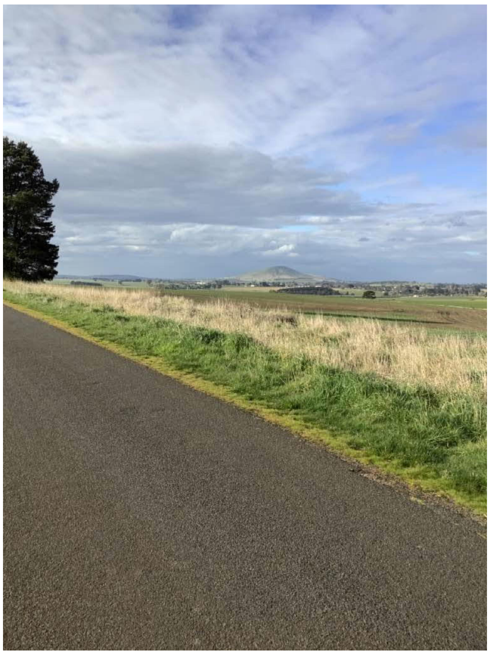
Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	15:55 (10 GMT)
Weather	Sunshine

Walkover Checkpoint Notes

Checkpoint ID	EMO-CP08
Precinct	Western Precinct
Address	
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	Yes
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	Yes
Notes on Erosion and Gullying	
Notes on Erosion Management	Erosion Management Overlay (EMO) to north of alignment associated with eruption point.
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	Eruption point.
General Ground Conditions Comments	Newer Volcanics basalt.
Notes on Topography	Undulating with eruption points.
Other Observations	Farmland.
Photos	   

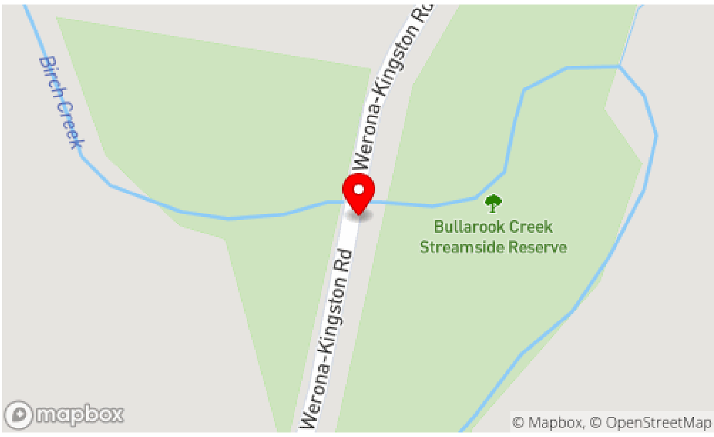


Project Details

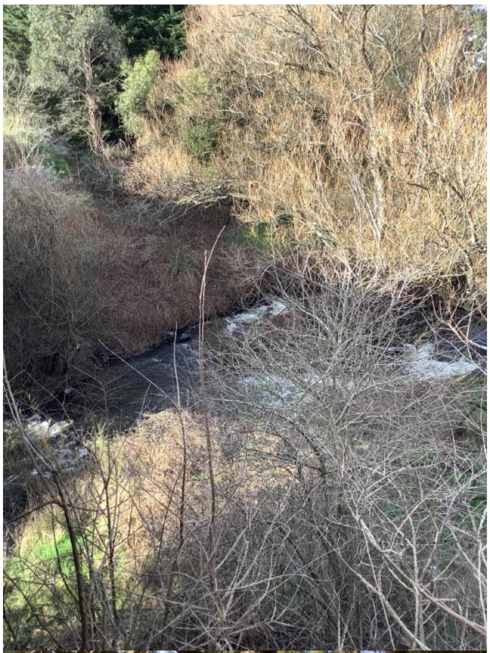
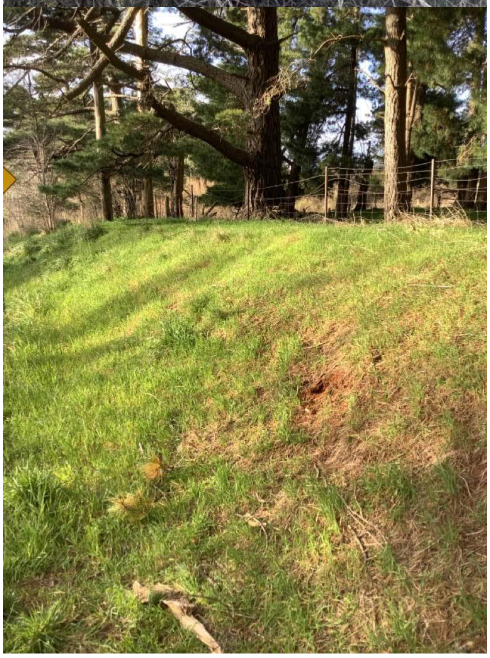
Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	16:18 (10 GMT)
Weather	Sunshine

Walkover Checkpoint Notes

Checkpoint ID	EMO-CP09
Precinct	Western Precinct
Address	Werona Kingston Rd
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No

Notes on Erosion and Gullying	Natural erosion from formation of creek.
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Newer Volcanics basalt with stream/creek.
Notes on Topography	Undulating.
Other Observations	Creek area heavily vegetated near historic bridge. Soil sample 17, Sandy SILT: medium to high plasticity, red brown (Newer Volcanics).
Photos	   

30/08/2021 08:46 AM

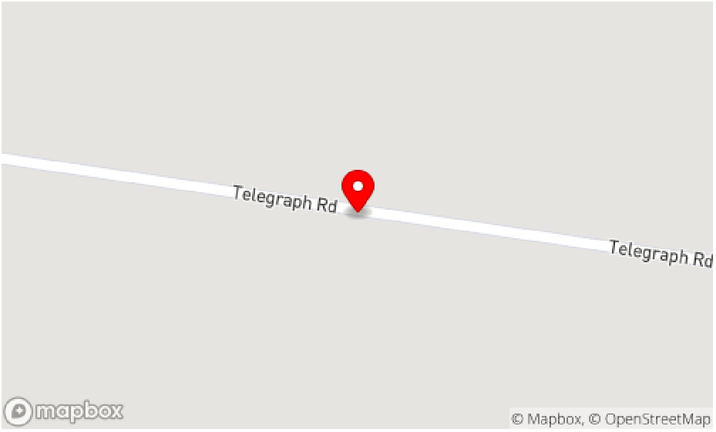
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	16:44 (10 GMT)
Weather	Windy

Walkover Checkpoint Notes

Checkpoint ID	EMO-CP10
Precinct	Western Precinct
Address	Telegraph road
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	Yes
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	Yes

Notes on Erosion and Gullying	
Notes on Erosion Management	Large erosion management overlay associated with eruption point to south of alignment.
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	Large hill eruption point.
General Ground Conditions Comments	Newer Volcanics basalt.
Notes on Topography	Flat with hills at eruption points.
Other Observations	Soil sample 18, Silty CLAY: medium plasticity, red brown (Newer Volcanics residual soil).
Photos	   

30/08/2021 08:46 AM

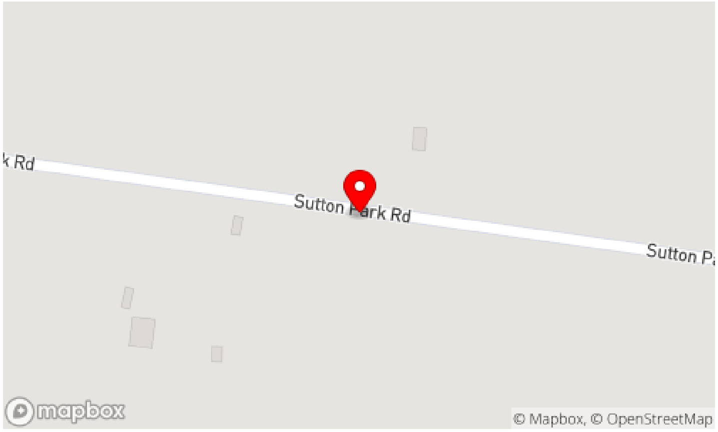
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	26/08/2021
Time	17:11 (10 GMT)
Weather	Windy

Walkover Checkpoint Notes

Checkpoint ID	EMO-CP11
Precinct	Eastern Precinct
Address	
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	Yes
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	Yes
Notes on Erosion and Gullying	
Notes on Erosion Management	Alignment passes near base of scoria cone which forms EMO.
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	Eruption point, scoria
General Ground Conditions Comments	Newer Volcanics basalt and scoria cone.
Notes on Topography	Slightly undulating with isolated scoria cones.
Other Observations	
Photos	

Jacobs

30/08/2021 08:46 AM

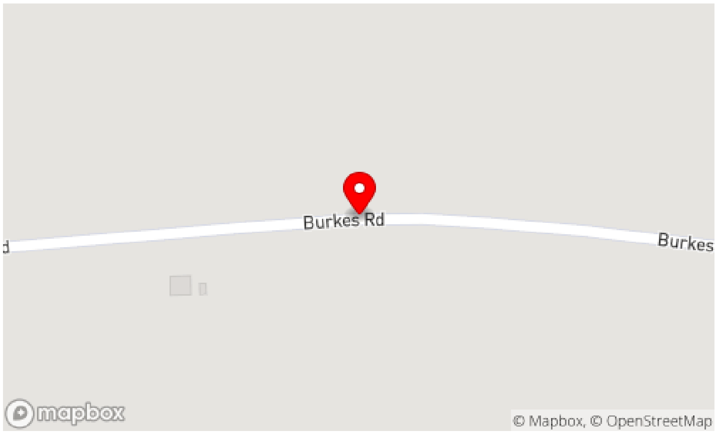
WVTNP EES Walkover Notes

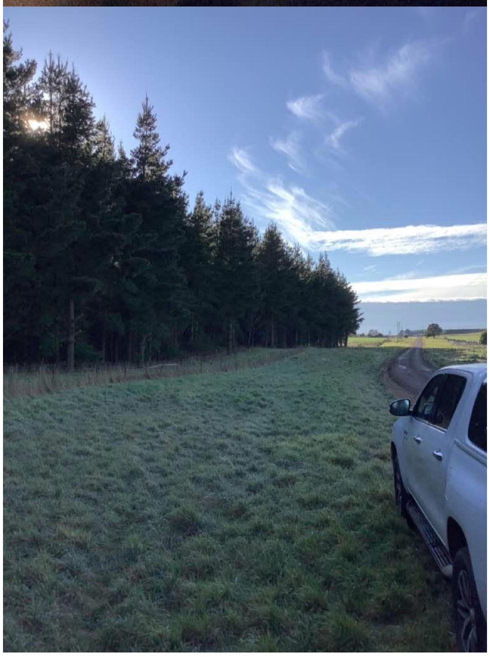
Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	27/08/2021
Time	08:37 (10 GMT)
Weather	Sunshine

Walkover Checkpoint Notes

Checkpoint ID	LS-CP02
Precinct	Eastern Precinct
Address	
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Newer Volcanics basalt.
Notes on Topography	Slightly undulating, no soil exposure apart from ploughed fields.
Other Observations	Tree plantations and arable fields, check plantation area for slope stability.
Photos	   

Jacobs

30/08/2021 08:09 AM

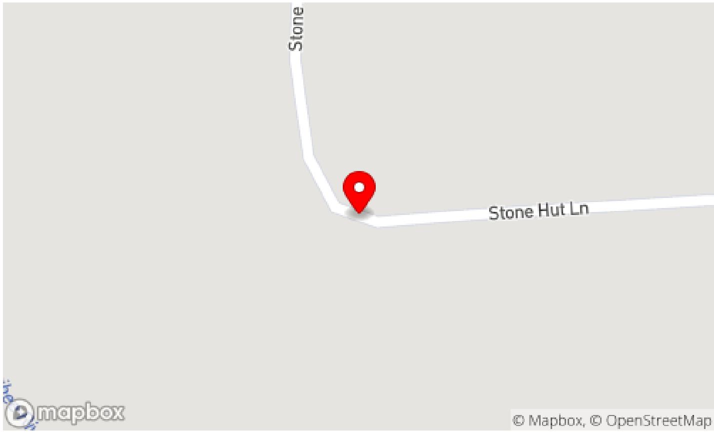
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	27/08/2021
Time	09:13 (10 GMT)
Weather	Sunshine

Walkover Checkpoint Notes

Checkpoint ID	O-CP01
Precinct	Eastern Precinct
Address	Stone Hut Lane
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	Yes
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No

Notes on Erosion and Gullying	
Notes on Erosion Management	Trees and other measures used to protect natural creek.
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Site geology is Newer Volcanics in higher area and Alluvium near creek.
Notes on Topography	Moderately undulating topography.
Other Observations	Encountered angry landowners.
Photos	  

Ballan to Melton

30/08/2021 08:47 AM

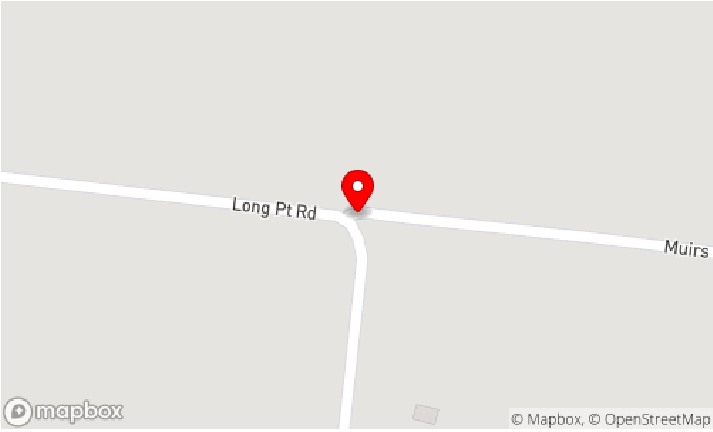
WVTNP EES Walkover Notes

Project Details

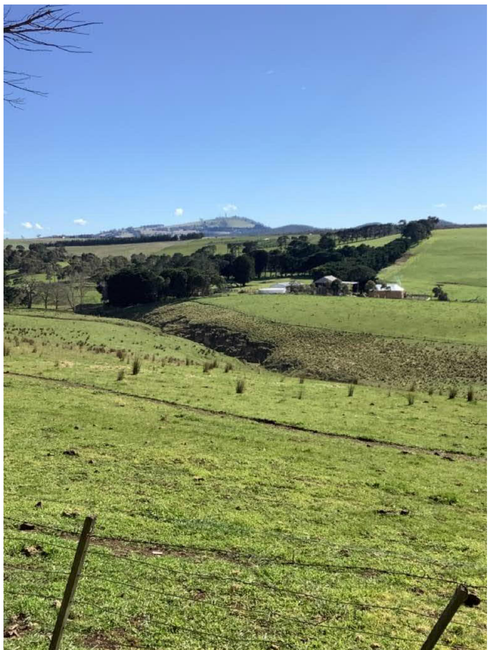
Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

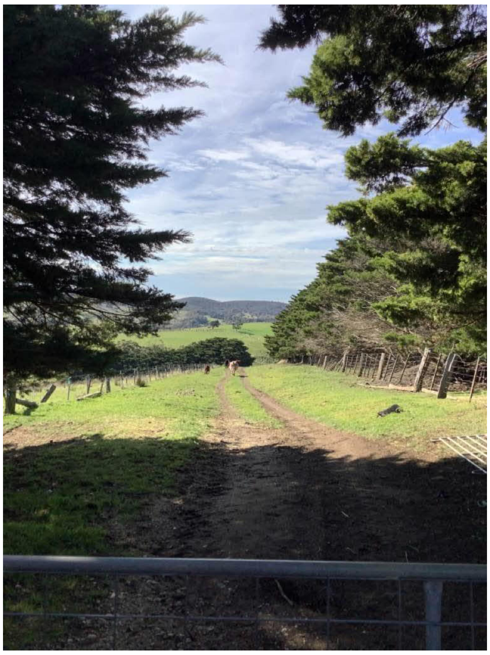
Date	27/08/2021
Time	10:26 (10 GMT)
Weather	Sunshine

Walkover Checkpoint Notes

Checkpoint ID	EG-CP18
Precinct	Eastern Precinct
Address	
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	Yes
Are there any geological significant features? (Yes/No)	No

Notes on Erosion and Gullying	Erosion localised around landslips on valley sides where soil has been exposed.
Notes on Erosion Management	
Notes on Landslide Susceptibility	Steep valley sides with land slipping observed, mainly within the river valley and not on the slopes above.

Notes on Geological Significant Features	
General Ground Conditions Comments	Pentland Hills Older Volcanics with Permian Bacchus Marsh Formation at base of valley.
Notes on Topography	Moderately undulating to hilly topography.
Other Observations	
Photos	   



Jacobs

30/08/2021 08:47 AM

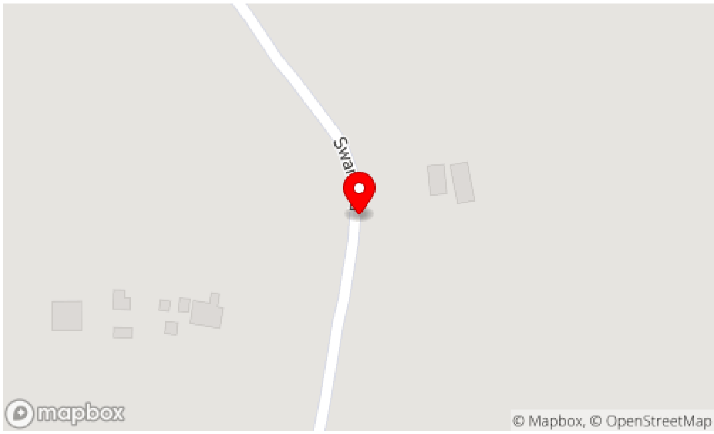
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	27/08/2021
Time	11:01 (10 GMT)
Weather	Sunshine

Walkover Checkpoint Notes

Checkpoint ID	EG-CP19
Precinct	Eastern Precinct
Address	Swans Rd
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	Yes
Are there any geological significant features? (Yes/No)	No

Notes on Erosion and Gullying	Gully erosion on steep valley slopes.
Notes on Erosion Management	
Notes on Landslide Susceptibility	Very steep valley slopes.

Notes on Geological Significant Features	
General Ground Conditions Comments	Bacchus Marsh Formation and Castlemaine Group sedimentary rock units, high rock head, low to high strength rock.
Notes on Topography	Very steep valley and hills.
Other Observations	Difficult access to locations, soil sample 19, Clayey SILT: low plasticity, orange brown, trace gravel (Bacchus Marsh Formation Permian).
Photos	   











Jacobs

30/08/2021 08:48 AM

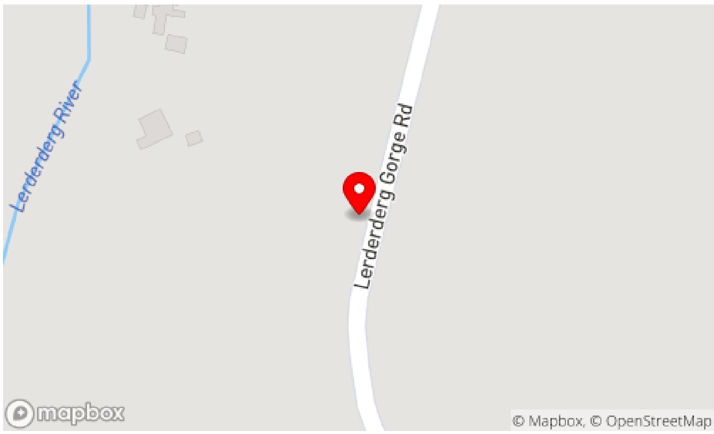
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	27/08/2021
Time	12:09 (10 GMT)
Weather	Sunshine

Walkover Checkpoint Notes

Checkpoint ID	EG-CP20
Precinct	Eastern Precinct
Address	Lerderberg Gorge Road
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No

Notes on Erosion and Gullying	Areas of gully erosion in Older Volcanics outside alignment, very steep slopes in Permian and Castlemaine group.
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Transmission line coming over Permian and Castlemaine group hill onto alluvium flats associated with Lerderberg River, upper surface of alluvium comprises orange brown silty sand with gravel.
Notes on Topography	Flat in alluvial terraces, hilly elsewhere.
Other Observations	Soil sample 20, Silty SAND: fine to medium grained, red brown (Alluvium).
Photos	   

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30/08/2021 08:10 AM

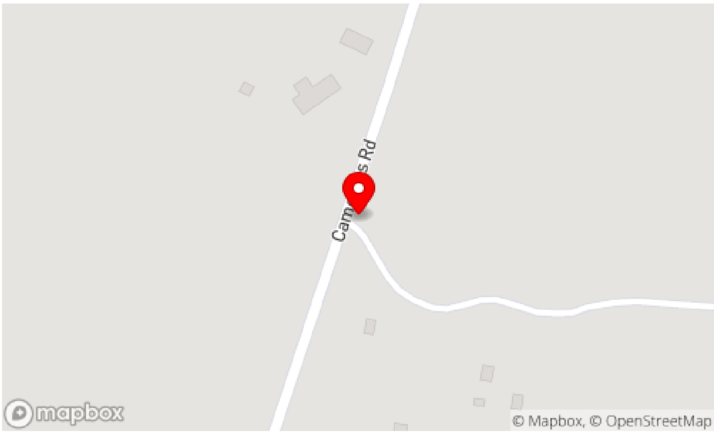
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	27/08/2021
Time	12:32 (10 GMT)
Weather	Sunshine

Walkover Checkpoint Notes

Checkpoint ID	EG-CP21
Precinct	Eastern Precinct
Address	Cameron’s Road
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	Yes
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	Yes

Notes on Erosion and Gullying	
Notes on Erosion Management	Quarry erosion management, looking at quarry slopes no signs of erosion.
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	Large quarry in Werribee Formation sands.
General Ground Conditions Comments	Mixture of geological units, refer to web map.
Notes on Topography	Moderately undulating.
Other Observations	Alignment passes through large quarry, noted that one tower location currently placed in quarry waste deposits.
Photos	   

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30/08/2021 08:48 AM

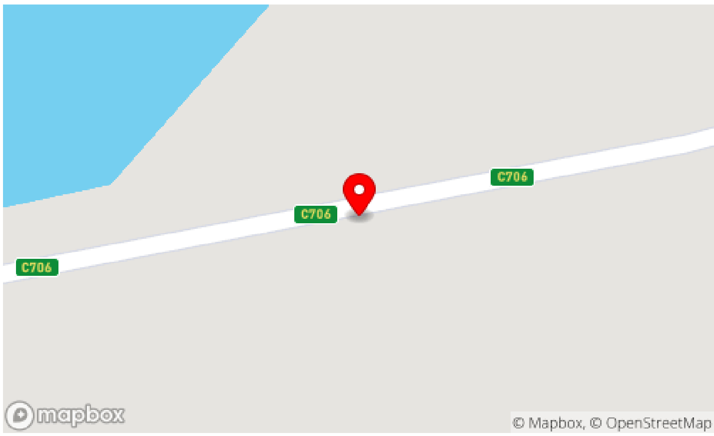
WVTNP EES Walkover Notes

Project Details

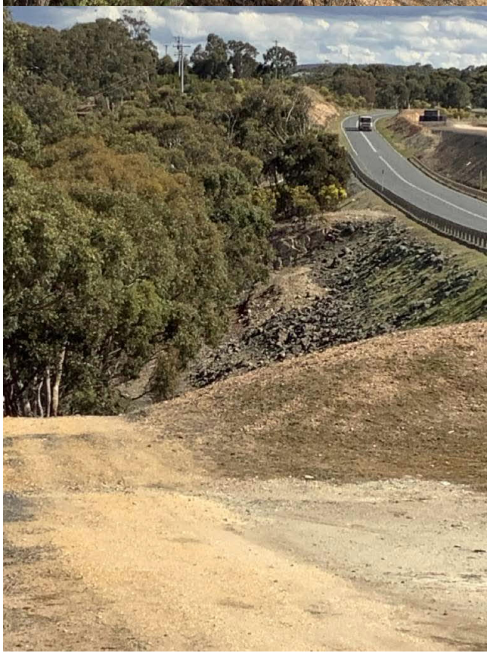
Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	27/08/2021
Time	12:55 (10 GMT)
Weather	Sunshine

Walkover Checkpoint Notes

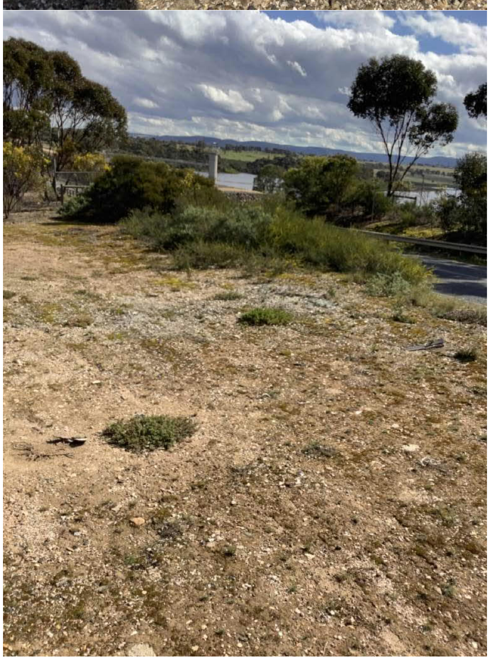
Checkpoint ID	EG-CP22
Precinct	Eastern Precinct
Address	
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	Yes

Notes on Erosion and Gullying	Natural gully on slope in long forest area, indicates that historic gully erosion happened in the past.
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	Large man-made dam Merrimu Reservoir.
General Ground Conditions Comments	Multiple units, refer to geological maps, no observed saline soil conditions, rock outcropping near dam wall.
Notes on Topography	Creek valley adjacent to dam with steep sides.
Other Observations	Large man-made dam, large span over dam wall, soil sample 21, XW SILTSTONE: conglomerate siltstone XW very low strength (conglomerate siltstone).
Photos	   





Proposed tower location near historic gully

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30/08/2021 08:49 AM

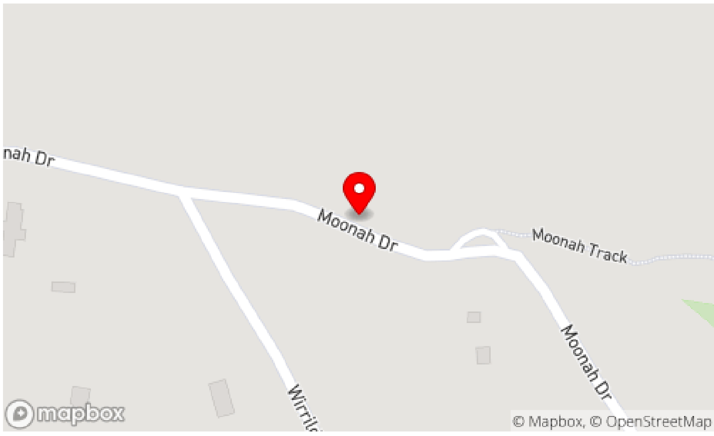
WVTNP EES Walkover Notes

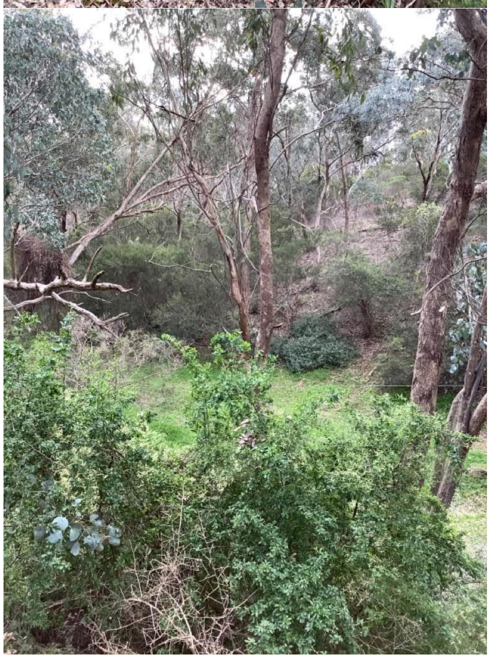
Project Details

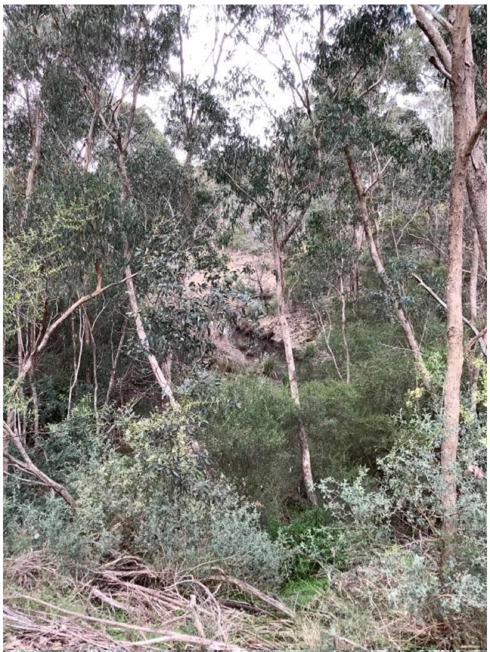
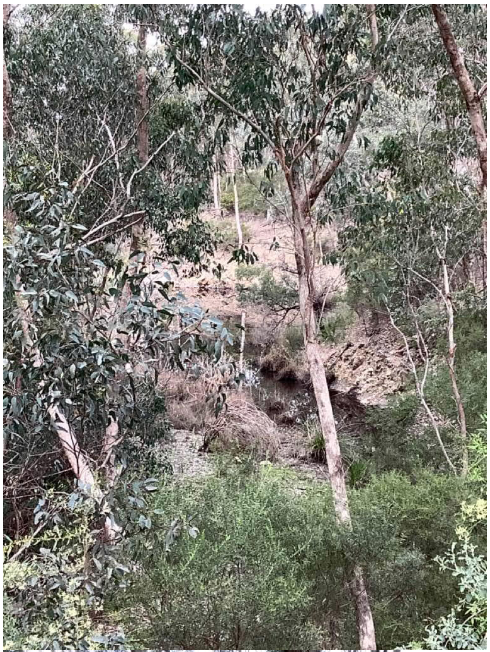
Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	27/08/2021
Time	13:19 (10 GMT)
Weather	Cloudy

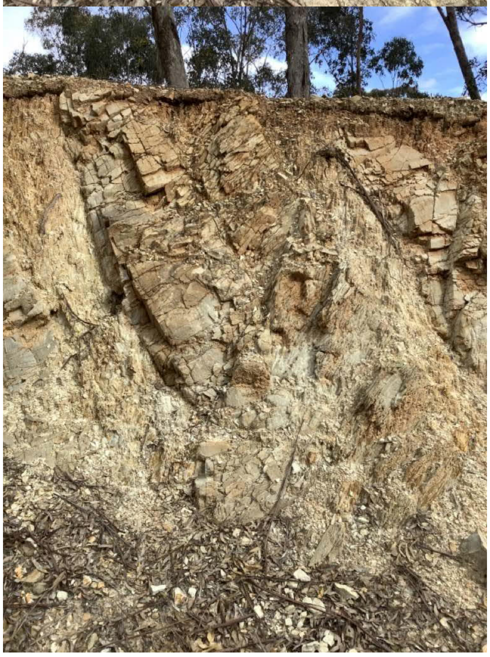
Walkover Checkpoint Notes

Checkpoint ID	EG-CP23
Precinct	Eastern Precinct
Address	Moonah Drive
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	Yes
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	Yes
Notes on Erosion and Gullying	Natural erosion associated with creek.
Notes on Erosion Management	
Notes on Landslide Susceptibility	

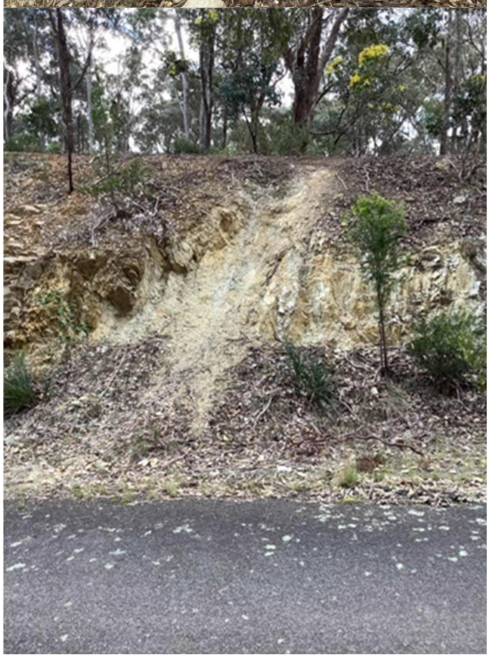
Notes on Geological Significant Features	Exposed siltstone/sandstone, cut good example of highly disturbed rock.
General Ground Conditions Comments	Creek incised into siltstone/sandstone units, Riddle Sandstone Gisbornian, road cut into sedimentary rock, cuttings bedding dipping steeply to the west, interbeds of competent bands mixed with shaly bands, both highly deformed. Failures observed in shaly bands, intact competent bands medium to high strength rock, shaly bands low to very low strength, rock level appears to be high.
Notes on Topography	Undulating steep slopes at creek.
Other Observations	Soil sample 22, Sandy SILT: low plasticity, light brown, with gravel (Riddell Sandstone Gisbornian, residual soil).
Photos	   





Localised failure in cut slope



Melton to Sydenham

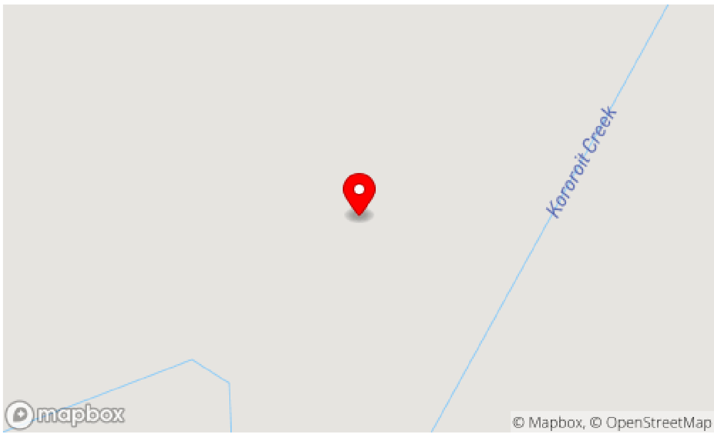
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

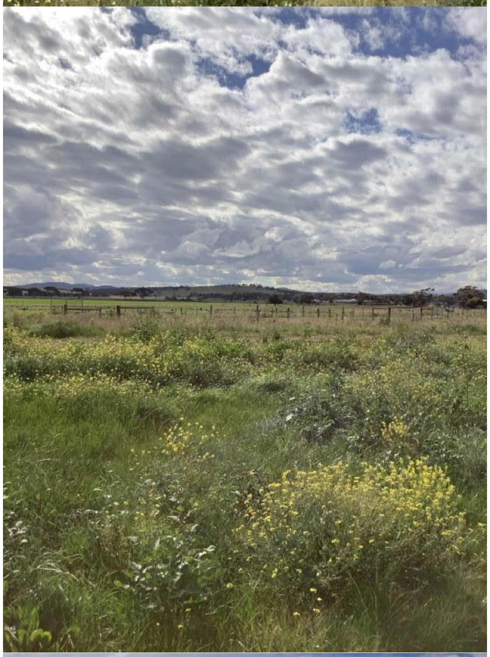
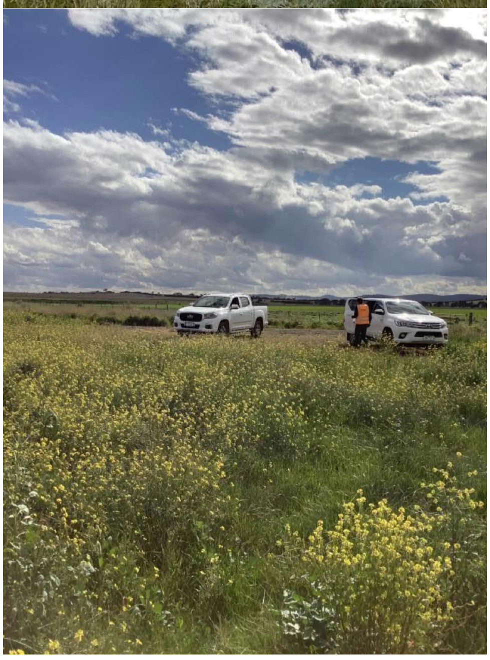
Date	27/08/2021
Time	14:01 (10 GMT)
Weather	Sunshine

Walkover Checkpoint Notes

Checkpoint ID	O-CP02
Precinct	Eastern Precinct
Address	
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	No
Notes on Erosion and Gullying	
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	
General Ground Conditions Comments	Newer Volcanics basalt with Kororoit Creek incised through basalt, shrink swell cracking observed in residual soil, rock exposed on steep slopes, basalt floaters and cobbles in residual soil.
Notes on Topography	Gentle to steep slopes around creek, mostly flat basalt plains
Other Observations	Soil sample 23, CLAY: high plasticity, brown, with gravel (Newer Volcanics Basalt Residual Soil).
Photos	    Shrinkage cracking in newer volcanics RS

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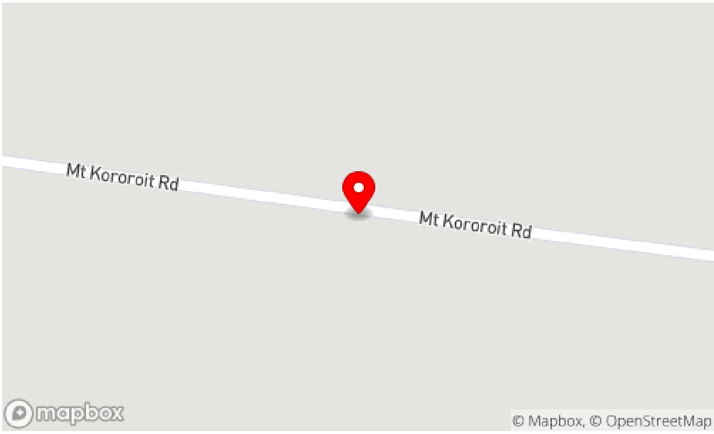
WVTNP EES Walkover Notes

Project Details

Project Name	Western Victoria Transmission Network Project
Project ID	IS311800
Field Engineer	Jayden Robertson

Date	27/08/2021
Time	14:23 (10 GMT)
Weather	Cloudy

Walkover Checkpoint Notes

Checkpoint ID	GSF-CP02
Precinct	Eastern Precinct
Address	
Coordinates	
Are there signs of erosion or gullying or areas susceptible to erosion and gullying? (Yes/No)	No
Are there signs of erosion management? (Yes/No)	No
Are there signs of landslides or areas of landslide susceptibility visible? (Yes/No)	No
Are there any geological significant features? (Yes/No)	Yes
Notes on Erosion and Gullying	
Notes on Erosion Management	
Notes on Landslide Susceptibility	

Notes on Geological Significant Features	Mt Kororoit eruption point, already has phone tower and radio tower with small power line, not publicly accessible, can be viewed from Mount Kororoit road at base of eruption point, towers positioned at base of eruption point, no decrease in accessibility to feature.
General Ground Conditions Comments	Newer Volcanics basalt with rock outcropping at top of eruption point.
Notes on Topography	Flat with eruption point.
Other Observations	
Photos	   

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