Environmental Impact Statement/Environment Effects Statement

Appendix O

Geomorphology and geology

MARINUS LINK

Marinus Link

Terrestrial Geomorphology and Geology impact assessment

Environmental GeoSurveys Pty Ltd

May 2024

MARINUS LINK

Terrestrial Geomorphology and Geology impact assessment

May 2024

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EXECUTIVE SUMMARY

Tetra Tech Coffey Pty Ltd (Tetra Tech Coffey) engaged Environmental GeoSurveys Pty Ltd (EGS) to complete a terrestrial geomorphology and soils conditions report of Marinus Link (the project).

The project is a proposed 1500-megawatt (MW) HVDC electricity interconnector between Heybridge in northwest Tasmania and the Latrobe Valley in Victoria. The portion of the alignment covered in this assessment is the Waratah Bay shore crossing from mean low water mark to the Hazelwood converter station in Victoria. A specific assessment for the Heybridge converter station and shore crossing is provided in a separate technical report.

The scope of the geomorphology and soils study was primarily to:

- To describe the physical (geoscience) character of the area that could be affected by the project, including geology, landforms, soils.
- Identify and assess potential residual effects of the project on soil stability, erosion and exposure of hazardous soils due to changed geographic conditions introduced by the project.
- Identify measures to avoid or minimise project impacts on the physical (geoscience) environment. The study area is the 20-36 m wide construction corridor and broader enclosing survey area 220 m wide.

It must be noted that this is a desktop study only and no field inspection of the project alignment was undertaken to inform the assessment. The technical report draws on information from a geomorphology and soils descriptive report (Environmental GeoSurveys 2019). That study – a vehicle-based and limited walkover reconnaissance field inspection from public roads and other public access areas over 4.5 days in November 2018 – included part of the project alignment.

This geomorphology study relies on proponent-provided LiDAR Digital Elevation Model (DEM) captured in 2021 with 0.5 m vertical resolution and high resolution digital vertical aerial photography supplemented by open-source spatial information on topography, geology, hydrology and soils. The 2.2 km gap in the supplied LiDAR at the Waratah Bay shore crossing and backshore was supplemented by older (2007) LiDAR from a private source. Gaps in the supplied photography totalling 8.6 km were filled with imagery from Google Earth.

The information derived from the remote data and literature review was sufficient to define the fundamental physical baseline characteristics of the project alignment at a generalised scale as discrete areas of landscape. The discrete areas are recognised by their geomorphic attributes including physical properties of landforms, geology, soils and geomorphological process that contributes to shaping the ground surface and shallow sub-surface. Nine geomorphic attributes are identified across the study area, each attribute with a defined range of physical properties. These do not necessarily represent engineering properties, such as excavatability, which will be dealt with by geotechnical investigations and assessments by other studies. The geomorphic attributes were used to define a hierarchy of geomorphological units as the basis for description of existing conditions and impact assessment. The project was divided into fourteen initial, broad geomorphic domains, each domain with a limited range of elevation, slope form and stream density and with one geologically dominant type. Geomorphology of the study area includes active and relict coastal dunes and low backshore tidal terrain, floodplain and alluvial and colluvial terraces, as well as undulating to strongly dissected hills and low plateaus surfaces developed on weathered Mesozoic sedimentary rocks overlain by deeply weathered Cenozoic volcanic rocks and sediments.

A number of stream channels will be crossed by the project alignment including the upper reaches of tributaries and the deep valley of the Tarwin River East Branch and the floodplain and terraces of Morwell River. The hilly terrain has evidence of slope movements including probable active landslides and areas of slope instability crossed by the project corridor.

Previous field-based studies (Sargeant and Imhoff 2013) had recognised soil-landform units in south Gippsland based on associations of specific landforms and soils and other environmental variables, notably

climate and drainage pattern. Sixty-nine soil-landform units occur along the project alignment. Soil landform units have been used in to provide a second tier of landscape delineation for this study.

The project area has been assessed by identifying discrete geomorphic divisions along the alignment. These divisions are called trench sectors and are defined by a combination of soil-landform units, geology, and geomorphic processes. A change in geomorphic attributes determines the boundary of a trench sector. The trench sectors provide high resolution recognition of changes in key landforms within the broader soil-landform units. A total of 192 trench sectors was recognised, comprising 183 along the main terrestrial alignment of the project, three at the Waratah Bay shore crossing, four at the offtake to the Driffield and Hazelwood converter stations and one for each of the converter stations. The complexity of much of the dissected landscape and the density of stream incision combined with geological units gave rise to the high number of trench sectors recognised. This number must be regarded as minimal as it is based on desk study only. It is likely that a field study will distinguish geomorphic features and processes that cannot be recognised from remote data.

Baseline geomorphic attributes are sensitive to varying degrees to potential impacts from the project. Sensitivity is a function of slope steepness, surface materials, evidence of slope instability and potential response to exposure on excavation and loading by materials and machinery. The sensitivity of each geomorphic attribute was assessed for the project for each of the 192 trench sectors. The sensitivity of each geomorphic attribute was determined on a five-fold scale: not sensitive, not very sensitive, sensitive, very sensitive and extremely sensitive. The ratings for the individual attributes were then combined to give an overall sensitivity of each trench sector on the same scale. The magnitude of impact of the project on each trench sector was then defined on a scale: severe, major, moderate, minor, and negligible. Combining the sensitivity of the sector with the magnitude of impact gave a rating of significance of the impact of the project on each trench sector on a scale of major, high, moderate, low, and very low. These are raw scores without applying any mitigation techniques on the project activities. The initial assessment undertaken without any mitigation measures produced 36 major impacts, 34 high impacts, 117 moderate impacts, three low impacts.

Environmental performance requirements (EPRs) were then developed and applied to the activities of the project for each trench sector. EPRs set out the environmental outcomes that must be achieved during design, construction, operation and decommissioning of the project. They do not provide prescriptive measures that must be employed but provide a framework to allow MLPL and its contractors to determine the best way to manage impacts by developing and optimising design and construction and operation solutions. Applying EPRs reduced the residual significance of impact to be 0 major residual impacts, 13 high residual impacts, 69 moderate residual impacts and 108 low residual impacts.

Site investigation by a geomorphologist (including collection of sub-surface cores down to at least trench/HDD depth to determine stratigraphy) of the 13 sectors of high residual impact is recommended to inform project design, including choice of construction methods. If site investigation reveals that ground conditions are unsuitable for construction or construction activities might impact slope stability or existing or potential landslides (i.e., geomorphic stability cannot be assured through design and application of EPRs), realignment is recommended in those sectors.

It was concluded that the engineering activities of the project without mitigation has the potential for major, high, and moderate impact on much of the terrain which it must be noted has a number of significantly sensitive geomorphic attributes. This residual impact can be reduced and managed to varying degrees by applying appropriate design, construction and operational strategies.

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ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
AHD	Australian Height Datum
ASS	acid sulfate soil
DEM	Digital Elevation Model. A 3-dimensional representation of the ground surface (bare earth) excluding vegetation and built structures such as buildings, towers and power lines. It does include human-made piles or rock or earth such as embankments and spoil heaps.
DSM	Digital Surface Model. A 3-dimensional representation of the Earth's surface, including vegetation, and human-made objects elevated above the "bare earth".
DTM	Digital Terrain Model. In this report a DTM is synonymous with a DEM.
HDD	horizontal directional drilling
HVAC	high voltage alternating current
HVDC	high voltage direct current
LiDAR	Light Detection and Ranging. The use of pulsed laser from an aerial vehicle to detect and measure distances to objects below. Topographic LiDAR typically uses a near-infrared laser to map the land, while bathymetric LiDAR uses water-penetrating green light to also measure seafloor and riverbed elevations.
PASS	potential acid sulfate soil

1. INTRODUCTION

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

The project was referred to the Australian Minister for the Environment 5 October 2021. On 4 November 2021, a delegate of the Minister for the Environment determined that the proposed action is a controlled action as it has the potential to have a significant impact on the environment and requires assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) before it can proceed. The delegate determined that the appropriate level of assessment under the EPBC Act is an environmental impact statement (EIS).

On 12 December 2021, the former Victorian Minister for Planning under the *Environment Effects Act 1978* (Vic) (EE Act) determined that the project requires an environment effects statement (EES) under the EE Act, to describe the project's effects on the environment to inform statutory decision making.

In July 2022, a delegate of the Director of the Environment Protection Authority Tasmania determined that the project be subject to environmental impact assessment by the Board of the Environment Protection Authority (the Board) under the *Environmental Management and Pollution Control Act 1994* (Tas) (EMPCA).

As the project is proposed to be located within three jurisdictions, the Victorian Department of Transport and Planning (DTP), Tasmanian Environment Protection Authority (Tasmanian EPA) and Australian Department of Climate Change, Energy, Environment and Water (DCCEEW) have agreed to coordinate the administration and documentation of the three assessment processes. One EIS/EES is being prepared to address the requirements of DTP and DCCEEW. Two EISs are being prepared to address the Tasmanian EPA requirements for the Heybridge converter station and shore crossing.

This report has been prepared by Environmental GeoSurveys Pty Ltd for the Victorian and Commonwealth jurisdictions as part of the EIS/EES being prepared for the project.

1.1 PURPOSE OF THIS REPORT

This study covers terrestrial geomorphology and soils of the Marinus Link underground electricity interconnector and associated converter station and shore crossing In Gippsland, Victoria. It builds on previous desk and field studies undertaken for Coffey during 2018 and 2019 by Environmental GeoSurveys.

The objectives of this technical study are to:

- Describe the physical (geoscience) character of the study area that could be affected by the project.
- Characterise the soil types and structures and identify the potential location and disturbance of dispersive, acid sulfate, saline, or soils of other special characteristics that could affect or be affected by the project.
- Identify and assess potential effects on coastal landforms and environments, including changes as a result of the project, and the potential for disturbance of saline, dispersive or acid sulfate soils, and including appropriate consideration of possible cumulative effects.
- Identify and assess potential residual effects of the project on soil stability, erosion, and the exposure of hazardous soils (e.g., acid sulfate soils).
- Identify and assess potential effects on nearby and downstream environments due to changed geomorphic conditions.
- Identify measures to avoid or minimise project (works and operational) impacts, including potential and proposed design options and measures that could avoid or minimise significant effects on soil stability,

and contingency measures for responding to unexpected but foreseeable impacts such as disturbance of acid sulfate soils.

An integrated approach to determining initial potential and unmitigated impacts is used by combining a range of physical and process attributes determined by this study and using data from available associated geotechnical studies Jacobs 2019, 2021, 2022a, 2022b, 2022c, 2023a, 2023b.

This was then followed by an assessment of the residual significance of impacts through the utilisation of EPRs.

1.2 PROJECT OVERVIEW

The project is a proposed 1500 megawatt (MW) HVDC electricity interconnector between Heybridge in northwest Tasmania and the Latrobe Valley in Victoria (Figure 1-1). The project is proposed to provide a second link between the Tasmanian renewable energy resources and the Victorian electricity grids enabling efficient energy trade, transmission and distribution from a diverse range of generation sources to where it is most needed, and will increase energy capacity and security across the NEM.

Marinus Link Pty Ltd (MLPL) is the proponent for the project and is a wholly owned subsidiary of Tasmanian Networks Pty Ltd (TasNetworks). TasNetworks is owned by the State of Tasmania and owns, operates and maintains the electricity transmission and distribution network in Tasmania.

Tasmania has significant renewable energy resource potential, particularly hydroelectric power and wind energy. The potential size of the resource exceeds both the Tasmanian demand and the capacity of the existing Basslink interconnector between Tasmania and Victoria. The growth in renewable energy generation in mainland states and territories participating in the NEM, coupled with the retiring of baseload coal-fired generators, is reducing the availability of dispatchable generation that is available on demand.

Tasmania’s existing and potential renewable resources are a valuable source of dispatchable generation that could benefit electricity supply in the NEM. The project will allow for the continued trading, transmission and distribution of electricity within the NEM. It will also manage the risk to Tasmania of a single interconnector across Bass Strait and complement existing and future interconnectors on mainland Australia. The project is expected to facilitate the reduction in greenhouse gas emissions at a state and national level.

Interconnectors are a key feature of the future energy landscape. They allow power to flow between different regions to enable the efficient transfer of electricity from renewable energy zones to where the electricity is needed. Interconnectors can increase the resilience of the NEM and make energy more secure, affordable and sustainable for customers. Interconnectors are common around the world including in Australia. They play a critical role in supporting Australia’s transition to a clean energy future.

LEGEND

- Landfall
- Converter station
- HVDC subsea cable
- Underground HVDC cable
- Cable option not progressing

MARINUS LINK

0 15 30 km

SCALE 1:1,500,000

PAGE SIZE: A4

PROJECTION: GDA2020 MGA Zone 55

SOURCE
Proposed route from Tetra Tech Coffey.
Imagery from ESRI Online.

MARINUS LINK PTY LTD

MARINUS LINK
GROUNDWATER IMPACT ASSESSMENT - VICTORIA

FIGURE 1-1

Project overview

TETRA TECH COFFEY

DATE: 16.05.24 PROJECT: 754-MELEN215878ML FILE: 215878ML_HYDRO_F01-1_GIS

1.3 ASSESSMENT CONTEXT

As Cooke and Doornkamp (1990 p. 11) noted "Geomorphology can provide an understanding of the nature of landscapes sufficient for engineering work to be carried out safely, predictably and economically within them". Impact assessments of a particular project must be based on prior identification of the existing geomorphological systems and land units, determination of their descriptive parameters and evaluation of the morphological features relevant to recognition of values and identification of existing hazards and those that may be introduced by the activities of the proposed land use change (Cavallin *et al.* 1994).

The geomorphology and soils assessment of this technical report contributes to understanding the nature of the morphology, materials, and processes of landforms as a basis for assessing potential constraints on – and the response of the environment to – the proposed activities required to build, operate, maintain, and decommission the project. The project will involve construction activities in a variety of surface, subsurface and subaqueous (marine and non-marine) environments comprised of diverse physical materials formed and modified by a range of past and presently active processes. The project activities will alter the appearance and dynamics of landforms to varied degrees from total to minimal.

2. ASSESSMENT GUIDELINES

This section outlines the assessment guidelines relevant to geomorphology and geology and the linkages to other EIS/EES technical studies. A single consolidated EIS/EES is being prepared to address the requirements of all the Commonwealth and Victorian jurisdictions including the requirement for an EES. This report will use the term EIS/EES going forward.

2.1 COMMONWEALTH

DCCEEW have published the following guidelines for the EIS: ‘Guidelines for the Content of a Draft Environmental Impact Statement – Environment Protection and Biodiversity Conservation Act 1999 – Marinus Link underground and subsea electricity interconnector cable (EPBC 2021/9053)’.

The Commonwealth guidelines do not provide any specific scoping guidelines relevant to geomorphology, and geology.

2.2 TASMANIA

The Tasmanian component of the project is being assessed in accordance with the EIS guidelines issued by EPA Tasmania for the converter station and shore crossing (September 2022). This assessment is documented in a separate report (EGS, 2023).

2.3 VICTORIA

The EES scoping requirements issued by the Minister for Planning (February 2023) outline the specific matters to be assessed across a number of environmental and social disciplines relevant to the project, and to be documented in the EES for the project.

The EES Scoping Requirements inform the scope of the EES technical studies and define the EES evaluation objectives. The EES evaluation objectives identify the desired outcomes to be achieved and provide a framework for an integrated assessment of the environmental effects of a proposed project.

2.3.1 EES evaluation objective

The EES evaluation objective contained in Section 4.2 of the EES scoping requirements that is relevant to this geomorphology and geology assessment is:

‘Avoid and, where avoidance is not possible, minimise adverse effects on land and water (including groundwater, surface water, waterway, wetland, and marine) quality, movement and availability.’

2.3.2 EES scoping requirements

The relevant sections of the EES scoping requirements that this assessment has addressed are summarised in Table 2-1. This study has addressed the aspects relevant to geomorphology and soils, and considered acid sulfate soils in the context of geology only. Contaminated land and management of acid sulfate soils is addressed in the Technical Appendix N: Contaminated land and acid sulfate soils.

Table 2-1 EES scoping requirements relevant to geomorphology and soils

Aspects to be assessed	Scoping Requirement	Report Section
Key issues	The potential for disturbance of contaminated, saline, dispersive or acid sulfate soils.	Section 4 (method); 4.1.11 (environmental performance requirements)
Existing environment	Characterise geology, geomorphology, landforms and soils in the project area and identify potential locations where dispersive, acid sulfate, saline or potentially contaminated soils, or soils with other special characteristics that could be disturbed by the project.	Section 5 (existing conditions)
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).	6 (potential impacts)
Mitigation	Describe potential and proposed design options and measures that could avoid or minimise significant effects on soil and land stability and rehabilitation.	6.2.2 (environmental performance requirements)
Performance	Describe the framework for monitoring and evaluating the measures implemented to mitigate impacts on water, soils and landforms and contingencies.	6.2.2 (environmental performance requirements)

2.4 LINKAGES TO OTHER TECHNICAL STUDIES

This report is informed by or informs the technical studies outlined in Table 2-2.

Table 2-2 Linkages to other technical studies

Technical studies	Relevance to this assessment
Groundwater (Tetra Tech Coffey, 2023)	Technical Appendix P: Groundwater details baseline conditions and potential impacts on groundwater. Groundwater both influences and is influenced by geomorphology.
Land use and planning (Beveridge Williams, 2023)	Technical Appendix S: Land use and planning details baseline conditions and potential impacts to land uses in the context of wider planning provisions. Geomorphology is a key factor influencing land use.
Surface water (Alluvium, 2023)	Technical Appendix Q: Surface water details baseline conditions and potential impacts on surface water. Surface water both influences and is influenced by geomorphology.
Contaminated land and acid sulfate soils (Tetra Tech Coffey, 2023)	Technical Appendix N: Contaminated land and acid sulfate soils details baseline conditions and potential impacts on contaminated land and acid sulfate soils. Geomorphology influences contamination pathways and receptors.
Aboriginal and historical cultural heritage (ELA, 2023)	Technical Appendix J: Aboriginal and historical cultural heritage details baseline condition and potential impact on cultural heritage. The presence of cultural heritage artefacts often results in geomorphological units being listed as geoheritage or geoconservation sites.

2.5 COMMONWEALTH LEGISLATION

There is no Commonwealth legislation of direct relevance to geomorphology.

2.6 VICTORIAN LEGISLATION

There is no Victorian legislation of direct relevance to geomorphology.

2.7 POLICY AND GUIDELINES

The assigning and reviewing of geoheritage significance is currently undertaken in Victoria by the Geological Society of Australia Inc (Victoria Division) (GSAV), Heritage subcommittee.

3. PROJECT DESCRIPTION

3.1 OVERVIEW

The project is proposed to be implemented as two 750 megawatt (MW) circuits to meet transmission network operation requirements in Tasmania and Victoria. Each 750 MW circuit will comprise two power cables and a fibre-optic communications cable bundled together in Bass Strait and laid in a horizontal arrangement on land. The two 750 MW circuits would be installed in two stages with the western circuit being laid first as part of stage one, and the eastern cable in stage two.

The key project components for each 750 MW circuit, from south to north, are:

- HVAC switching station and HVAC-HVDC converter station at Heybridge in Tasmania. This is where the project will connect to the North West Tasmania transmission network being augmented and upgraded by the North West Transmission Developments (NWTD).
- Shore crossing in Tasmania adjacent to the converter station.
- Subsea cable across Bass Strait from Heybridge in Tasmania to Waratah Bay in Victoria.
- Shore crossing at Waratah Bay approximately 3 kilometres (km) west of Sandy Point.
- Land-sea cable joint where the subsea cables will connect to the land cables in Victoria.
- Land cables in Victoria from the land-sea joint to the converter station site in the Driffield or Hazelwood areas.
- HVAC switching station and HVAC-HVDC converter station at Driffield or at Hazelwood, where the project will connect to the existing Victorian transmission network.

A transition station at Waratah Bay may also be required if there are different cable manufactures or substantially different cable technologies adopted for the land and subsea cables. The location of the transition station will also house the fibre optic terminal station in Victoria. However, regardless of whether a transition station is needed, a fibre optic terminal station will still be required in the same location.

Approximately 255 km of subsea HVDC cable will be laid across Bass Strait. The preferred technology for the project is two 750 MW symmetrical monopoles using ±320 kV, cross-linked polyethylene insulated cables and voltage source converter technology. Each symmetrical monopole is proposed to comprise two identical size power cables and a fibre-optic communications cable bundled together. The cable bundles for each circuit will transition from approximately 300 m apart at the HDD (offshore) exit to 2 km apart in offshore waters.

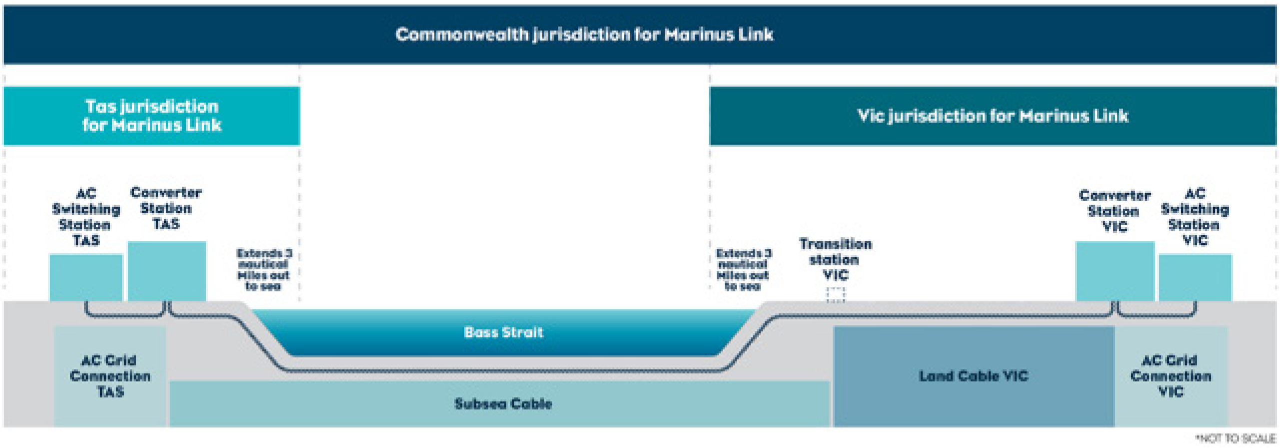
In Victoria, the shore crossing is proposed to be located at Waratah Bay with the route crossing at the Waratah Bay–Shallow Inlet Coastal Reserve. From the land-sea joint located behind the coastal dunes, the land cable will extend underground for approximately 90 km to the converter station. From Waratah Bay the cable will run northwest to the Tarwin River Valley and then travel to the north to the Strzelecki Ranges. The route crosses the ranges between Dumbalk and Mirboo North before descending to the Latrobe Valley where it turns northeast to Hazelwood. The Victorian converter station will be at either a site south of Driffield or Hazelwood adjacent to the existing terminal station.

The land cables will be directly laid in trenches or installed in conduits in the trenches. A construction area of 20 to 36 m wide would be required for laying the land cables and construction of joint bays. Temporary roads for accessing the construction area and temporary laydown areas will also be required to support construction. Where possible, existing roads and tracks will be used for access, for example, farm access tracks or plantation forestry tracks.

Land cables will be installed in ducts under major roads, railways, major watercourses and substantial patches of native vegetation using trenchless construction methods (e.g., HDD), where geotechnical conditions permit. A larger area than the 36 m construction area will be required for the HDD crossings.

The assessment is focused on the Victorian section of the project. This report will inform the EIS/EES being prepared to assess the project's potential environmental effects in accordance with the legislative requirements of the Commonwealth and Victorian governments (see Figure 3-1).

Figure 3-1 Project components considered under applicable jurisdictions (Marinus Link Pty Ltd 2022, Consultation Plan)

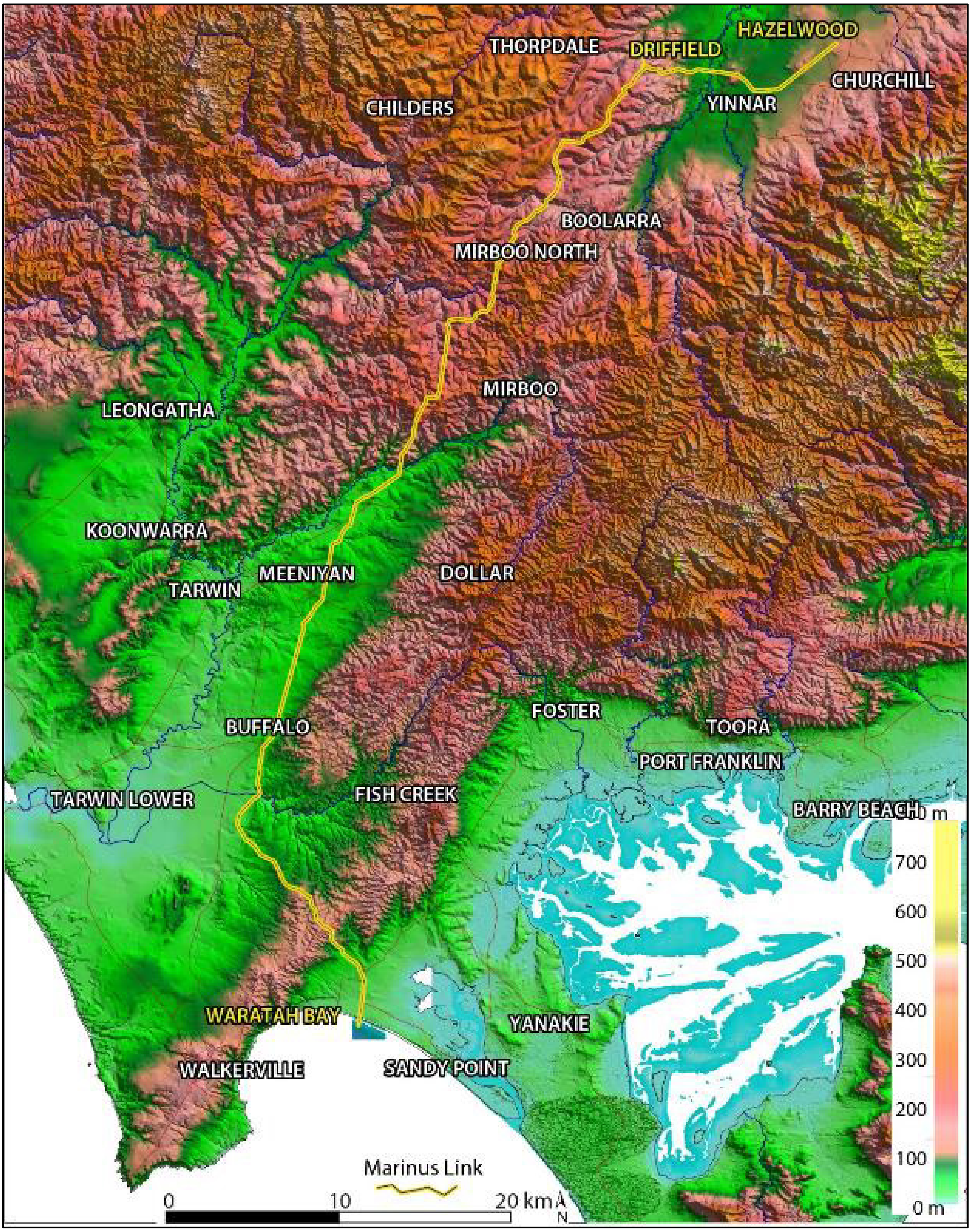


The project is proposed to be constructed in two stages over approximately five years following the award of works contracts to construct the project. On this basis, stage 1 of the project is expected to be operational by 2030, with Stage 2 to follow, with final timing to be determined by market demand. The project will be designed for an operational life of at least 40 years.

3.2 STUDY AREA

The study area (as outlined in Figure 3-2 below) for this assessment is between the proposed landside shore crossing at Waratah Bay and converter station site at Hazelwood, Victoria and includes the proposed converter station site and land cable connection at Driffield.

**Figure 3-2 Location of Marinus Link, Victoria
(Base: 10 metre State-wide DEM, Landata Vic)**



3.3 WATERWAY CROSSING CONSTRUCTION

Crossing of waterways with HDD includes:

- Access track construction to HDD drill entry and exit pads.
- Preparing hardstands at entry and exit points.
- Installing erosion and sediment controls.
- Digging entry and exit pits.
- Delivery and set up of HDD drill rig and associated equipment.
- Drilling of pilot hole under feature (e.g., waterway).
- Ream borehole to required diameter.
- Weld high density polyethylene (HDPE) duct lengths together.
- Pull duct through borehole and set with bentonite.

After construction the site is rehabilitated through:

- Removing all equipment and drill cuttings.
- Removing hardstand and reinstating/rehabilitating entry and exit pads.

3.4 JOINT PITS AND CABLE CONSTRUCTION

Land cables are supplied in standard section lengths of either 800 m or 1.2 km. For areas not required HDD, cables will be laid in trenches. The cable lengths will be joined at joint pits. Joint pits are around 12 m long, 2.5 m wide and 2.5 m deep, buried at least 0.5 m below the surface.

The key construction activities for land cables and joint pits include:

- Establishing laydown areas, site offices and amenities.
- Site establishment (site entries, gates, access, weed control, stock proof fencing, etc.).
- Topsoil stripping and stockpiling (around 300 to 400 mm in depth).
- Constructing haul roads along construction working corridors.
- HDD and duct installation at road, waterway, and third-party infrastructure crossings.

Excavation of trenches and stockpiling of subsoil – trenches to be a nominal width of 1 m and typical depth of greater than 1.2 m to the top of the duct from ground level.

- Installation of ducts and thermal backfill where required.
- Backfilling trenches with subsoil and topsoil and reinstatement except at cable joint pits and where equipment required to assist cable installation, e.g., at bends and HDD crossings.
- Construction (in-situ) or installation (pre-cast modules) of cable joint pits.
- Pulling of cables through ducts.
- Cable jointing.
- Backfilling and reinstatement of cable installation and cable joint pit workspaces.

Cable joint pits will be constructed in-situ or prefabricated using precast concrete modules and brought to site for installation. The area to accommodate the cable joint pit and associated works including jointing will be topsoil stripped. The joint bay itself will be excavated and suitable drainage installed to prevent moisture ingress during the works. All spoil will be separated and stockpiled on the construction working corridor.

3.5 OPERATION

The project will ideally be operational 24 hours a day, 365 days per year over a minimum lifespan of 40 years. Operational and maintenance activities in the Victoria land portion of the Marinus Link are likely to include:

- Routine inspection across the easement for operational and maintenance issues.
- Servicing, testing and repair of the land cables, transition station and converter stations equipment and infrastructure including scheduled minor and major outages.
- Maintenance of access tracks.

In general, maintenance requirements for land cables are minimal with routine maintenance being limited to a number of smaller activities around the jointing pits. These activities will be sheathing tests every five years involving two workers for one day at each joint bay. They will have a standard 4WD vehicle and use handheld testing equipment. A route drive over will also occur around once a fortnight to ensure that no unknown construction activities or non-permitted activities are occurring above the cables.

Easement conditions on title will set out restrictions on activities on the easement. Most farming and cropping activities can continue. No buildings or trees will be allowed on the easement.

3.6 CONVERTER AND TRANSITION STATIONS

The study area also includes the area enclosing two proposed HVAC-HVDC converter stations and one transition station in Victoria.

3.6.1 Hazelwood converter station

The Hazelwood converter station comprises an area of approximately 17 hectares and consists of a HVAC-HVDC converter station and expansion of the Hazelwood Terminal Station in Victoria where the project will connect to the existing Victorian transmission network.

3.6.2 Driffield converter station

An alternative converter station site to the south of Driffield comprising an area of approximately 96.5 hectares has also been included in the study area.

3.6.3 Waratah Bay transition station

The shore crossing at Waratah Bay is approximately 3 km west of Sandy Point. Here, the subsea cables will connect to the land cables in Victoria, with a fibre optic terminal station.

3.7 DECOMMISSIONING

The operational lifespan of the project is a minimum 40 years. At this time the project will be either decommissioned or upgraded to extend its operational lifespan.

Decommissioning will be planned and carried out in accordance with regulatory and landowner or land manager requirements at the time. A decommissioning management plan will be prepared prior to planned end of service and decommissioning of the project.

Requirements at the time will determine the scope of decommissioning activities and impacts. The key objective of decommissioning is to leave a safe, stable and non-polluting environment, and minimise impacts during the removal of infrastructure.

In the event that the project is decommissioned, all above-ground infrastructure will be removed, and associated land returned to the previous land use or as agreed with the landowner or land manager.

Decommissioning activities required to meet the objective will include, as a minimum, removal of above ground buildings and structures. Remediation of any contamination and reinstatement and rehabilitation of the site will be undertaken to provide a self-supporting landform suitable for the end land use.

Decommissioning and demolition of project infrastructure will implement the waste management hierarchy principles being avoid, minimise, reuse, recycle and appropriately dispose. Waste management will accord with applicable legislation at the time.

Decommissioning activities may include recovery of land and subsea cables and removal of land cable joint pits. Recovery of land cables will involve opening the cable joint pits and pulling the land cables out of the conduits, spooling them onto cable drums and transporting them to metal recyclers for recovery of component materials. The conduits and shore crossing ducts will be left in-situ as removal will cause significant environmental impact.

The concrete cable joint pits will be broken down to at least one metre below ground level and buried in-situ or excavated and removed. Subsea cables will be recovered by water jetting or removal of rock mattresses or armouring to free the cables from the seabed.

A decommissioning management plan will be prepared to outline how activities will be undertaken and potential impacts managed.

For the purposes of this geomorphology and soils technical report, it has been assumed that cables will remain in the ground and decommissioning impacts are not further considered.

4. ASSESSMENT METHOD

4.1 STUDY COMPONENTS

This technical report has two key components:

(A) a desktop study characterisation of the geology, geomorphology, geomorphic processes, and soils of the project areas in Victoria.

(B) an assessment of the potential impact of the project on geology, geomorphology, geomorphic processes, and soils.

4.2 DESKTOP STUDY

The material provided by Tetra Tech Coffey and MLPL supplemented by topographic and other relevant physical data and literature was sufficient to characterise the geomorphology and geomorphic processes of the study area and identify generalised potential impacts of the proposal on the physical landscape. The study area was initially divided into generalised units based on key characteristics of geology (geological zones), geomorphology (geomorphic domains) and soil-landform units. The soil-landform units were further divided along the main alignment into trench sectors (discrete lengths of trench) based on a variety of geomorphic form and processes. A total of 183 terrestrial trench sectors were identified, plus three additional trench sectors at the shore crossing and four additional trench sectors at the Driffield converter station connection site.

4.2.1 Data sources

Digital files showing the easement and buffer of the study corridor and existing and a preliminary alignment of proposed access tracks needed for construction and maintenance were supplied. Information regarding physical landscape components (topography, geology, hydrology, geoconservation sites, vegetation) and cultural features (infrastructure, cadastral and planning) was obtained via digital data sets. A key data source for geomorphology and slopes was a LiDAR-derived digital terrain model [DTM] with 0.5 m vertical resolution.

The key data sources are listed in Table 4-1.

Table 4-1 Key data sources

Application	Data sources
Overview	Aerial photography (client-supplied), Google Earth
Geology	Geological Survey of Victoria Seamless Geology 1:250,000 (2014), published and unpublished Parish Plans
Soil	1:100,000 Soil-landform Units Foster and Moe mapsheets
Topography	Project LiDAR 2021 (client-supplied), State-wide DEM 10 metre. State-wide 10 metre contour lines. LiDAR tiles: coastal (2008, 2011)
Geomorphology	Victorian Geomorphic Framework, 1:100,000 Soil-landform Units Foster and Moe mapsheets
Hydrology	Datasets Landata Vic: hydrographic areas, hydrographic lines, wetlands
Coastal	Smartline

4.2.2 Baseline characterisation

Baseline characteristics are the fundamental physical components of discrete areas of landscape recognised by their geomorphic attributes described below. They are comprised of geomorphological assets – landforms, geology, regolith, and soils – and geomorphological processes. The combined assets and processes constitute geomorphic attributes across the study area.

4.2.3 Geomorphic attributes

A geomorphic attribute is a physical property of landform or a geomorphic process that contributes to shaping the ground surface and shallow sub-surface of the study areas. The geomorphology of a discrete area is determined by combining geological and topographical information and inferred or recognised geomorphic processes. This produces landform areas with components described by geomorphological terminology commonly used in Australia (Grimes 1995).

The spatial unit that is the base for geomorphic description and impact assessment is a trench sector. Trench sectors range in length from 35 metres to several hundred metres.

Nine geomorphic attributes are identified across all the study area and outlined in Table 4-2. Single attributes or groups of attributes define the spatial extent of a discrete geomorphic unit. The attributes are then generalised and grouped to a degree to facilitate assessment of impacts of the project. Specific attributes that apply to the shore crossing—coastal erosion, coastal recession, and coastal inundation with sea-level rise, are assessed separately for the shore crossing section of the alignment.

The attribute properties are recognised based on their geomorphological characteristics. They do not necessarily represent engineering properties relating to for example excavatability and trench stability which will be dealt with under geotechnical investigations such as ground conditions assessment reports by other investigators.

Table 4-2 Geomorphic attributes

Geomorphic attribute no.	Geomorphic attribute	Definition
1	Relief and slope	Relative relief (range of elevation), maximum ground slope angle and shape.
2	Stability of Landform / Slope instability, landslides	Propensity of a surface to change by downslope movement of rock or soil without the direct aid of other media such as water or ice. Water is often important as a lubricant or loading on slope mass. Instability is determined by inherent properties such as slope, lithology, fractures, geological boundaries, depth of regolith and geomorphic processes and may be triggered by engineering or other anthropic activity.
3	Erosivity (hillslopes), slope wash, sheet wash, rilling and tunnel erosion	Propensity of a surface to change because of water-driven process such as slope wash, sheet wash, rilling and tunnel erosion
4	Hydrology, surface flows, waterlogging	Potential for run-on and run-off from precipitation, thaw, groundwater outcrop. Related to slope angle and form.
5	Riverine flood / inundation	Inundation from overbank flows.
6	Regolith	Stratigraphy of the substrate, such as thickness of soil and weathered rock, depth to rock, inclusion of cemented layers, swell-shrink potential and possibility of variations as they relate to trenching construction.
7	Soft soils	Geomorphic assessment of soil composition and ability to sustain loading and influence stability.
8	Acid sulfate soil	Actual and potential for acid sulfate development.
9	Geoheritage	Natural geoscience values worthy of conservation.

4.3 IMPACT ASSESSMENT PROCESS

4.3.1 Introduction

The potential initial impacts of the project on the geomorphology and soils were determined by combining the inherent sensitivity of each of the nine attributes described in Table 4-2 with the potential magnitude of impact of the project activities. The attributes and magnitude of impacts were combined using a matrix to produce a resultant significance of impact.

The sensitivity of each of the nine geomorphic attributes was determined on a five-fold scale (Table 4-3) for each trench sector. These are combined to produce an overall sensitivity rating for each trench sector. The rationale for assigning overall sensitivity is detailed for each trench sector. The magnitude of each impact and the significance of impact from project activities was then determined for each trench sector also on a five-part scale (Table 4-4). The initial significance of impact documented in this technical report assumes no mitigation of the potential impacts. Subsequent to the development and finalisation of EPRs, an assessment of the residual significance of impact was completed for this report.

4.3.2 Potential impacts

Potential impacts on geomorphic properties and processes can occur due to project activities including excavation, backfill, trenching and construction of hard standing (e.g., concrete pads for the converter stations) and buildings during construction and operation across the project area.

These include:

- Modification to relief and slope to facilitate tracks, laydowns and other building infrastructure requiring a level surface upon which to be constructed.
- Construction of the trench can alter slope stability through loading, spoil management and backfilling changing surface and sub-surface flows.
- The entry point of HDD at the shore crossing can cause instability of the seabed and changes to sediment pathways.
- Slope instability and changes to surface and groundwater pathways as a result of construction.
- Entry and exit HDD points at all terrestrial locations can change groundwater levels and pathways and have direct and indirect impact on surface features through changing vegetation and associated landforms.
- The removal of vegetation and the exposure of subsoils on tracks and site cuts may increase the potential for erosion and off-site sediment transport to the environment (including creeks and waterways) especially in susceptible ground conditions.
- The construction of trenching and tracks across watercourses may alter surface flows if not carefully designed. Redirection of water around infrastructure may also alter flow direction.
- Increase in hard stand surfaces may increase the volume of surface flows and collection and concentration of water may cause waterlogging, erosion and has potential to cause harm to receiving environments through increased flow and sediment transport.
- The excavation and backfill of the trench replaces regolith and soil with material of potentially different physical and hydraulic properties with potential impact on slope stability, foundation capacity and surface and subsurface flows.
- The project activities can expose and potentially activate acid sulfate soils.

4.3.3 Initial impact assessment method

Initial impact assessment was made for each of the 192 project trench sectors (comprising three shore crossing sectors, 183 main alignment sectors, four sectors for the offtake to the converter stations and one each for Driffield and Hazelwood) on a five-fold rating scale from very low to major. The impact rating was derived from a matrix combining the sensitivity of each geomorphic attribute within the sector and the magnitude of change associated with the project.

4.3.4 Geomorphic attributes

The nine geomorphic attributes are identified and defined in Section 4.2.3 and Table 4-2 above. All geomorphic attributes have been identified in each trench sector.

4.3.5 Sensitivity of geomorphic attributes

Sensitivity is the potential response, susceptibility, or vulnerability of a geomorphic attribute to disturbance occasioned by the construction and operation of the project. Sensitivity is related to the inherent characteristics of an attribute as expressed by the sensitivity rating in Table 4-3. The majority of the attributes are broadly evident and clearly recognisable in a desktop study. Regolith and soil properties are less evident and the rationale for the sensitivity rating for these attributes for the purposes of this report is defined as follows:

- Sensitivity of regolith is determined largely by thickness, i.e., high sensitivity when it is minimal thickness or has significant properties such as shrink-swell.
- The sensitivity of soil properties relates to the thickness and consolidated nature of soil horizons.

The sensitivity of each attribute in each geomorphic area was assessed to determine the overall sensitivity of each trench sector. The overall sensitivity for each sector was determined based on professional judgement and additional expert advice (Jacobs 2021, 2022a, 2022b, 2022c, 2023a) having regard to the attributes which most contribute to sensitivity in that sector.

Table 4-3 Sensitivity criteria of geomorphic attributes

Attribute	Sensitivity rating				
	Not sensitive	Not very sensitive	Sensitive	Very sensitive	Extremely sensitive
Relief and slope	Level ground and requires no cut and fill for construction or access roads (slopes 0 – 1º)	Gently inclined slopes around 2.6 m relief (slopes 1º – 6º)	Moderately inclined slopes with 8.5 m (slopes 6 – 18º)	Steeply inclined slopes with approx. 25 m relief (slopes 18º – 30º)	Very steep to precipitous / cliffed (slopes >30º)
Stability of Landforms	No evidence of instability in geological units not noted for landslides/rockfalls. Not close to landslide/rockfall susceptible features i.e., break of slope or geological boundaries.	No evidence of instability but geomorphic features (i.e., slope and form) suggest they may be possible under suitable trigger conditions.	Showing some signs of instability and with evidence of landslide activity in other areas of similar geology and slope.	Evidence from DEM of past landslides of unknown age and activity.	Mapped landslides of recent activity.
Erosivity (hillslopes), slope wash,	Level slopes with minimal vegetation removal or where	Gentle slopes, permeable non-dispersive soils.	Moderately inclined slopes	Steep slopes with susceptible	Where slopes are steep to very steep with minimal

Attribute	Sensitivity rating				
	Not sensitive	Not very sensitive	Sensitive	Very sensitive	Extremely sensitive
sheet wash, rilling and tunnel erosion	rock and non-dispersive soils exist.		with vegetation removal.	soils and long run-on runoffs.	infiltration and no surface storage. Composed of highly dispersible soils. Removal of vegetation may cause significant changes to run-on and runoff.
Hydrology, surface flow, waterlogging	Level and minimal slope terrain. Not waterlogged.	Gently inclined slopes around 2.6 m relief. Minimal upslope and downslope relief. Some waterlogging.	Moderate slopes with no drainage lines but potential flow paths to defined water courses. Frequently waterlogged.	Steeply inclined slopes with steep upslope and downslope run-on and runoff. Long periods of waterlogging.	Landscape with well-defined or declared watercourses and drainage lines. Complete and irreversible change to micro morphology. High groundwater levels.
Riverine Flood	Elevation and terrain beyond overbank flows.	Elevation and terrain allow minimal chance of reach by overbank flow.	At margins of floodplain and some chance of episodic inundation.	On floodplain with evidence of recurrent inundation.	On floodplain or channel experiencing frequent and sustained inundation.
Regolith	Not applicable.	Probable deep soil profile based on geology and soil landform unit information, and/or low potential for swell shrink.	Possible variation in soil profile which may contain rock floaters, very dense to hard soils, shallow weathered rock, and/or moderate swell shrink potential.	Probable shallow soil profile / or high swell shrink potential.	No regolith (rock exposure or artificial surface and sub-surface).
Soil Properties	Strongly consolidated deposits.	Variably consolidated deposits.	Weakly consolidated.	Very poorly consolidated.	Very soft unconsolidated, saturated.
ASS / PASS	No ASS or PASS detected. No causative factors noted.	Extremely Low with a probability of 1 – 5% of occurrence.	Low with a probability of 6 – 70% of occurrence.	High with a probability of >70% of occurrence.	High with a probability of >70% of occurrence.
Geoheritage	Not listed, no significant features recognised.	Local significance.	Regional significance.	State to national significance.	International (global) significance.

The overall sensitivity for a trench sector is based on the array of sensitivity of each of the key attribute(s) and differs between trench sectors as determined by the geomorphology. In some trench sectors, the sensitivity of some attributes can be high, but they may have minor interaction with the key components of the development. This relationship is defined by the magnitude of impact of the project and the significance of impact as explained in Section 4.3.6 and Section 4.3.7 below.

4.3.6 Magnitude of impact

The magnitude of impacts on the geomorphic attributes for each trench sector was determined using the definitions in the five-fold scale negligible to severe set out in Table 4-4.

Table 4-4 Magnitude of impact definitions

Magnitude	Definition
Severe	An impact that causes very significant permanent changes to a geomorphic area and irreversible harm to the geomorphic attributes. The impact may extend well beyond the project operational areas to surrounding land causing downstream and / or upslope impacts on supported environmental values.
Major	An impact that causes significant long-term change to a geomorphic area affecting multiple geomorphic attributes and supported environmental values downstream or upslope of the area. There is potential for some recovery of the geomorphic attributes over time with site specific remediation. The impact extends beyond the project operational area.
Moderate	An impact that causes moderate medium-term changes to a geomorphic area affecting one or more geomorphic attributes and associated and adjacent supported environmental values. The effect may extend beyond but is generally contained within the project operational area and can be addressed with standard remediation.
Minor	A localised short-term impact within the project operational area. The effects can be mitigated through standard environmental management controls.
Negligible	A localised impact that is temporary and does not extend beyond the project operational area. The impact does not affect the project operational area or land adjacent and supported environmental values. The effects can be managed with standard environmental management controls.

4.3.7 Significance of impact

The significance of impact is rated on a five-fold scale from very low to major as defined in Table 4-5.

Table 4-5 Interpretation of significance of impact

Significance	Definition
Major	The change is permanent with a number of geomorphic attributes substantially altered. The effects may extend well beyond the project operational area. Impacts will continue if substantial remediation is not implemented. Very difficult to reinstate affected geomorphic attributes and supported environmental values.
High	The change may be long-term or permanent for some geomorphic attributes and the effects extend beyond the project operational area. Substantial remediation is required to reinstate some affected geomorphic attributes and supported environmental values.
Moderate	The change is potentially medium-term generally contained within the project area. Remediation is required to avoid further degradation. Geomorphic attributes can be reinstated with standard mitigation.
Low	The change is localised (within the project operational area) and effectively remediated with standard mitigation. The geomorphic attributes are unlikely to change over time.
Very low	The change is minimal and localised within the project operational area and effectively managed with standard mitigation. The geomorphic attributes and supported environmental values are not expected to change over time.

Significance of impacts on geomorphic values was determined using a five-by-five matrix that evaluates the combinations of sensitivity and magnitude. The matrix adopted for this study is shown in Table 4-6.

Table 4-6 Significance of impact assessment matrix

Magnitude of impact	Sensitivity of geomorphic sector				
	Extremely Sensitive	**Very Sensitive**	**Sensitive**	**Not Very Sensitive**	**Non-Sensitive**
Severe	Major	Major	Major	High	Moderate
Major	Major	Major	High	Moderate	Low
Moderate	High	High	Moderate	Low	Low
Minor	Moderate	Moderate	Low	Low	Low
Negligible	Moderate	Low	Low	Low	Very low

4.4 CUMULATIVE IMPACT ASSESSMENT

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

To identify possible projects that could result in cumulative impacts, the International Finance Corporation (IFC) guidelines on cumulative impacts have been adopted. The IFC guidelines (IFC, 2013) define cumulative impacts as those that 'result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones.'

The approach for identifying projects for assessment of cumulative impacts considers:

- Temporal boundary: the timing of the relative construction, operation and decommissioning of other existing developments and/or approved developments that coincides (partially or entirely) with the project
- Spatial boundary: the location, scale and nature of the other approved or committed projects expected to occur in the same area of influence as Marinus Link. The area of influence is defined as the spatial extent of the impacts a project is expected to have.

Proposed and reasonably foreseeable projects were identified based on their potential to credibly contribute to cumulative impacts due to their temporal and spatial boundaries. Projects were identified based on publicly available information at the time of assessment. The projects considered for cumulative impact assessment in Victoria are:

- Delburn Wind farm
- Star of the South Offshore Wind farm
- Offshore wind development zone in Gippsland including Greater Gippsland Offshore Wind Project (BlueFloat Energy), Seadragon Project (Floatation Energy), Greater Eastern Offshore Wind (Corio Generation).
- Hazelwood Rehabilitation Project
- Wooreen Energy Storage System

Cumulative impacts associated with geomorphology and soils were not considered to be relevant to this assessment due to the localised nature of the impacts of this project and the geographically constrained boundaries of the other projects listed above. .

No significant cumulative intra-project or interproject effects on geomorphology and soils were identified.

4.5 ASSUMPTIONS AND LIMITATIONS

This technical report describes the geomorphology and soils of the study area incorporating other physical attributes that determine landscape and dynamics of the project area. The key geomorphic attributes including geomorphic processes are described in Section 5.1.2. The attribute properties are recognised on the basis of their geomorphological characteristics; they do not necessarily represent specific engineering properties relating to, for example, excavatability and trench stability.

The report draws on information from a preliminary vehicle-based and limited walkover reconnaissance field inspection from public roads and other public access areas for a previous geomorphology and soils descriptive report (Environmental GeoSurveys 2019). While providing useful geographic background, that study is of limited value for the specific details of impact assessment required for the present technical report, as much of the route across private land has not been sighted.

It is important to note that proponent-supplied LiDAR data and aerial photography were captured in early 2021 and do not necessarily represent the current (December 2022) conditions. The factual geotechnical and ground conditions investigation reports (Jacobs 2019, 2021, 2022a, 2022b) available at time of writing this report covered only part of the Marinus project area.

The Ground Condition Assessment (Jacobs 2021) is a desktop study. The Ground Conditions Factual Report Tranche 1 (Jacobs 2022a) covers only the northern part route. The Driffield Ground Investigation Geotechnical Interpretive Report (Jacobs August 2022c) provides specific details only of the proposed Driffield converter station. The Jacobs reports available for this report cover only part of the study area —as stated para 3 p. 21—and were used where relevant.

Access tracks to the construction corridor have not been assessed as part of the geomorphology scope because although they are required for the project, the preferred option is to use existing tracks and to upgrade these if necessary. In some instances, existing tracks will need to be extended from their current location to the construction corridor. The construction process by which existing access tracks will be extended involves laying geotextile mat and covering this with crushed rock, to be removed after construction (unless the landowner requests it to be retained). As construction of new access tracks to the construction corridor will not involve geomorphically sensitive activities such as topsoil stripping, installing drains and excavation or trenching, and because of the temporary nature of the access tracks, minimal impacts are anticipated.

Potential geomorphic impacts of the project during construction, operation and decommissioning are considered in Section 6 and formalised into two detailed tables of assessment – one for initial impact and one for residual impact assessment Appendix A: (Spreadsheet). A summary of this table showing unmitigated and residual impacts is shown as Table 6-4. Potential impacts have been developed by assessing the particular The project’s activity and the sensitivity of the attributes of the trench sector derived from the interpretation of images and literature.

The landscape properties described in this technical report are recognised on the basis of their geomorphological characteristics. They do not necessarily represent engineering properties relating to, for example, excavatability and trench stability, which will be dealt with under geotechnical investigations such as field-based ground conditions assessment reports by other investigators.

Assessment of geoheritage nature and sensitivity for the technical report was conducted by the Geological Society of Australia (Victorian Division) Geoheritage Subcommittee chair (Dr. Susan White) and her recommendations have been adopted in full.

The significance of impact of the construction and operation of the project on geomorphology and soils as documented in this technical report is in two parts. The first assessment of impact was made on the assumption no mitigating measures were applied. A set of EPRs was then developed and applied to each component of the project and a second assessment made to develop a residual impact.

Geomorphic instability in its most extreme form might result in events including land slips, landslides and subsidence. The consequences of land movement has not be assessed in this technical report, the focus of this assessment is the impact of project activities on land stability and geomorphic units.

5. EXISTING CONDITIONS

5.1 CONTEXT

This section describes the existing physical conditions of the project based on the sources documented in Section 4.2.1 above.

Landforms are comprised of two classes of component values (Rivas *et al*. 1997):

(a) Geomorphological assets.

(b) Geomorphological processes.

5.1.1 Geomorphological assets: landforms, geology, regolith, soil

Geomorphological assets are the geometric forms and materials that comprise landforms and are used directly as a resource by humans or form essential support for other ecosystems. Sand and gravel deposits in active river channels are consumable geomorphic assets. When quarried for construction materials they are depleted in the short term but become a renewable resource when replenished by ongoing fluvial processes. The same materials stranded as high terraces above a defined flood level are a non-renewable material resource when extracted. They also serve as a static or stable asset if used as a building site because of they reduce flood risk. This use is compatible with maintaining the integrity of the landform but may compromise its asset value in other ways e.g., as habitat, geoheritage value or visual landscape element.

Geomorphological assets are composite features composed of landforms, bedrock, surficial geology, regolith, and soil as defined below.

Landforms: Landforms are the physical framework on which the project will be constructed and operated. This framework is an assemblage of shapes (slopes) underlain by primary geological materials formed and modified over varied time periods producing regolith and soil.

Geology: Geology is the underlying material of landforms. Geological materials vary in composition, structure and mechanical strength and range from bedrock – composed of coherent resistant primary mineral material to highly modified unconsolidated disaggregated bodies of low strength referred to as regolith or soil. The character of a geological rock unit may vary vertically and laterally depending on a wide range of environmental factors. Landforms may directly or indirectly reflect these variations expressed as land surface elevation and slope and resistance to change by geomorphic processes.

Surficial Geology: Surficial geology has two meanings:

(a) geologically young sedimentary and volcanic bodies overlying bedrock.

(b) a zone of weathered materials with derived and residual minerals and variable content of organics, air, and water developed on rocks of any age or origin referred to as regolith by geomorphologists and soil by geotechnical engineers.

Regolith: Geomorphological literature since the 1980s typically replaces the term surficial geology with regolith. Regolith at a site is the composition and structure of the surface and subsurface materials extending to the base of the weathering zone and is comprised of two groups of materials:

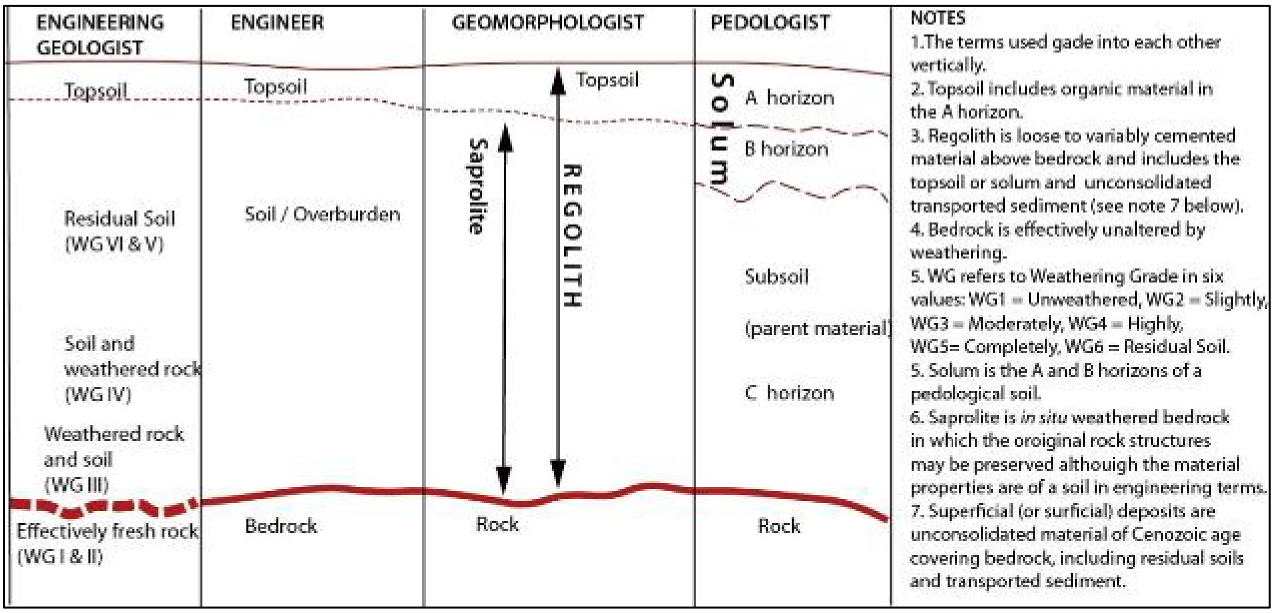
In situ weathered rock formed by the mechanical and chemical breakdown of bedrock by interaction with atmospheric processes and organisms.

Transported rock products derived from other sites and deposited as sediments overlying bedrock and existing in situ regolith by slope, fluvial and aeolian processes.

Several generations of regolith may occur in a vertical section at a site. In terrain of complex geology and slopes, regolith type and thickness can vary considerably. The nature, thickness, and geotechnical properties of all regolith is a factor in assessing constraints and impacts of building and maintaining the converter station and shore crossing HDD tunnels.

Soil: The term has different meanings in different disciplines (as noted in the surficial geology description above and summarized in Figure 5-1 below. Soil thickness – a measure of the A and B soil pedological horizons is relevant for biological establishment and restoration of disturbed ground. However, it is only one component in assessing ground stability for construction as the more relevant properties are thickness of regolith (in situ and transported) and depth to and strength of bedrock.

Figure 5-1 Definitions and uses of terminology for soil and regolith in different disciplines



5.1.2 Geomorphological processes

Landforms originate by the interaction of existing earth materials with geological and geomorphological processes and the mechanisms and rates by which land surfaces change has long been the focus of geomorphological research. Geomorphological processes operate at a range of spatial and temporal scales and energy levels. No surface or sub-surface landform is inert over geological time, but on millennial time scales geomorphological environments can be broadly classed on a continuum from passive to active. Passive environments are those where the geomorphological asset e.g., a discrete area of land is essentially static over some defined time scale e.g., the projected life of a proposed construction activity.

The driving forces of geomorphic processes are of four general origins: endogenic – produced inside Earth and expressed at the surface as tectonic (earthquakes), and volcanic activity; exogenic – produced above the surface and manifest as the climate-driven processes (e.g., rivers) of Earth's atmosphere; biogenic – the role of plants and animals (including humans) in creating and modifying materials, landforms and processes; extra-terrestrial events such as meteorite impacts.

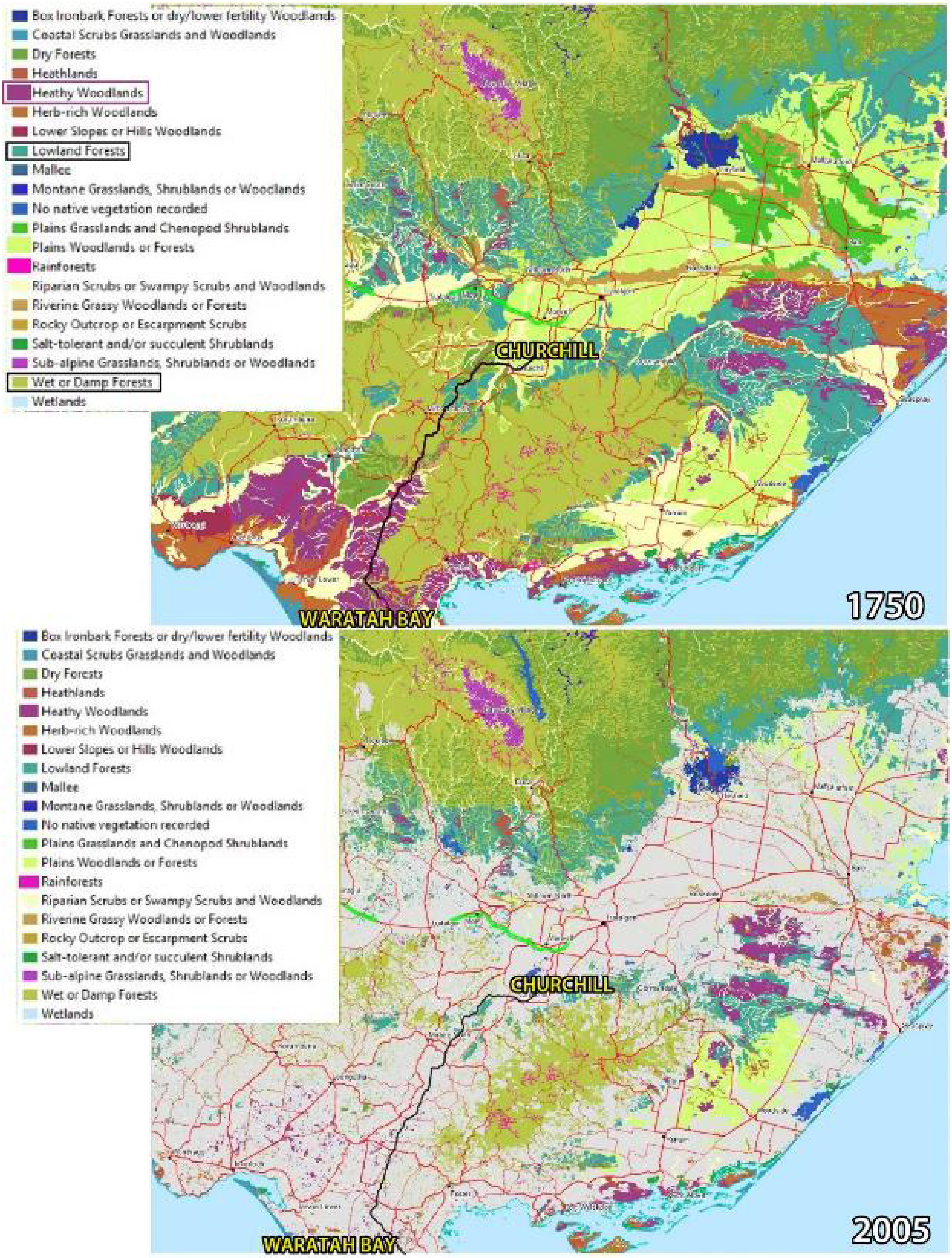
A background constant is the force of gravity that effectively drives the downslope movement of water, snow, ice, and earth materials. Slow lateral migration of a stream channel and gradual removal of basal slope material can generate a landslide. Irregular high energy events such as earthquakes, storm runoff and tsunami have direct geomorphic impact and may also be triggering mechanisms for gravity-driven movements.

5.1.3 Human impacts

The impact of human activity as a geomorphological process is local to global in extent and magnitude (Goudie 1990). Stone, gravel, and sand quarrying is a human activity with direct and obvious impact. More difficult to recognise and measure are delayed and secondary human impacts on soil and land surface stability such as removal and replacement of vegetation, reshaping land surfaces by cultivation, stream diversion and water storage, wetland draining and groundwater withdrawal.

The impact of Aboriginal people on the geomorphology of the project area is not known but will have been uneven and concentrated on the plains and coast. The forests of the Strzelecki ranges were less commonly used as they were wetter and supported less abundant food resources (Wedrowicz et al. 2017, Slotnick 2022). The main impact of Aboriginal people would have been by managed fire but episodic large uncontrolled fire from human and other causes would have occurred as experienced over the period of European occupation. European occupation beginning in the 1850's rapidly imposed substantive change, initially by removing almost all forest cover (Figure 5-2 Ecological vegetation class maps of changes in vegetation in south Gippsland 1750-2005 (post-European occupation). The main tree vegetation units along Marinus Link (Heathy Woodlands, Lowland Forests, and Wet or Damp Forests) are outlined in the legend (Source: Community Bushfire Connection).Figure 5-2) exposing soils on steep slopes and substantially altering surface and groundwater hydrology.

Figure 5-2 Ecological vegetation class maps of changes in vegetation in south Gippsland 1750-2005 (post-European occupation). The main tree vegetation units along Marinus Link (Heathy Woodlands, Lowland Forests, and Wet or Damp Forests) are outlined in the legend (Source: Community Bushfire Connection).

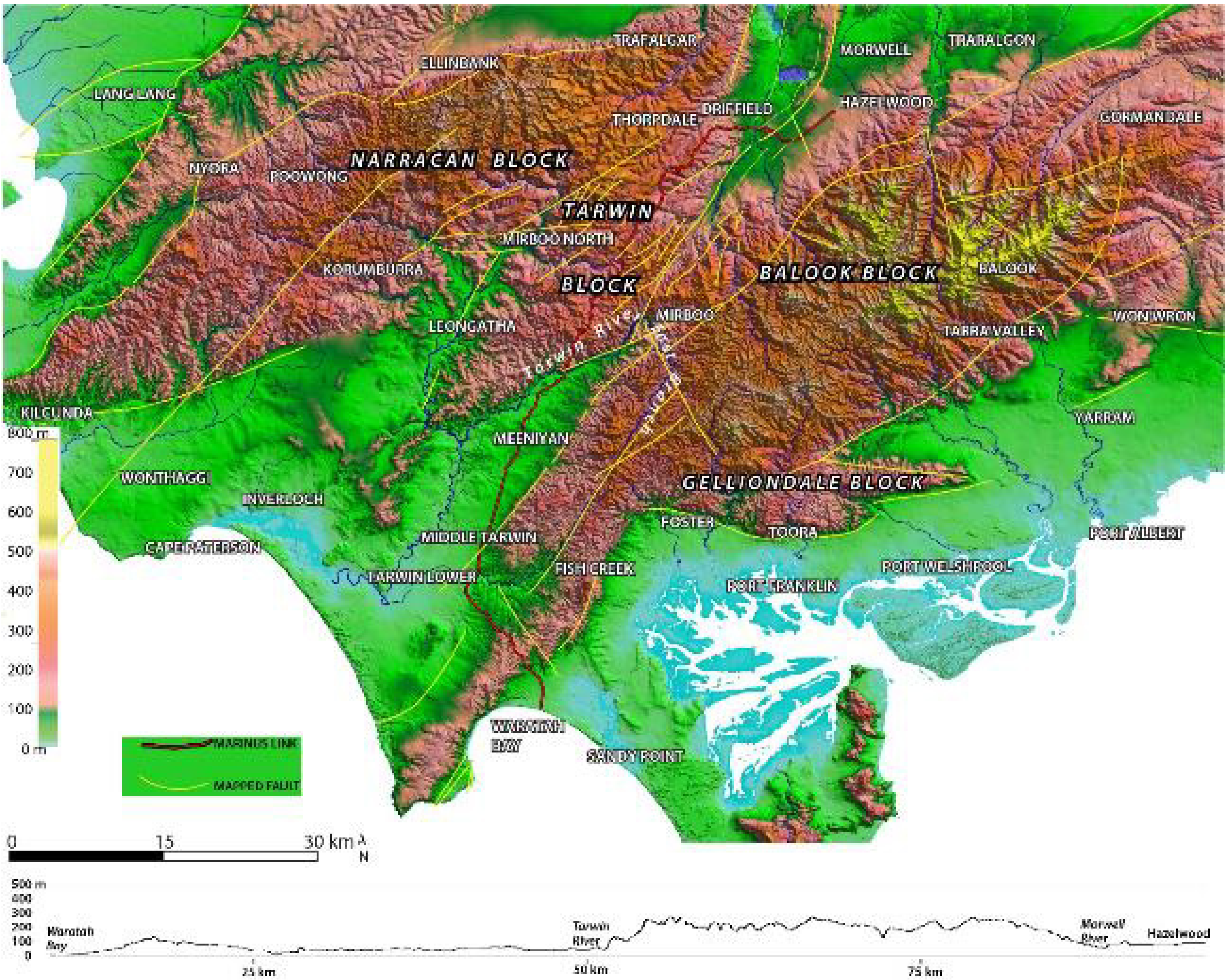


These changes may be a significant factor in contributing to the widespread slope instability in south Gippsland recorded since the early 1900's, decades after the original clearance (Brumley 1978, Webb et al. 2003). Landslides and other slope instability issues along the project are described in 5.1.5 below. While most of the project is inland, a shore crossing is required. Coastal processes including erosion, inundation and related geomorphic changes at the crossing site as a consequence of sea-level rise over the project life are relevant, and additional geomorphic attributes to account for these conditions are presented as a separate sensitivity assessment. The project is assuming between 59 and 61 cm of sea level rise by 2090 (Katestone 2023).

5.1.4 Physiography

West and south Gippsland has a complex tectonic and geomorphic history with varied drainage patterns reflecting the control of geology (lithology) and tectonics (Figure 5-3).

Figure 5-3 Physiography, faults. Profile (vertical exaggeration x 12) shows Marinus Link alignment.



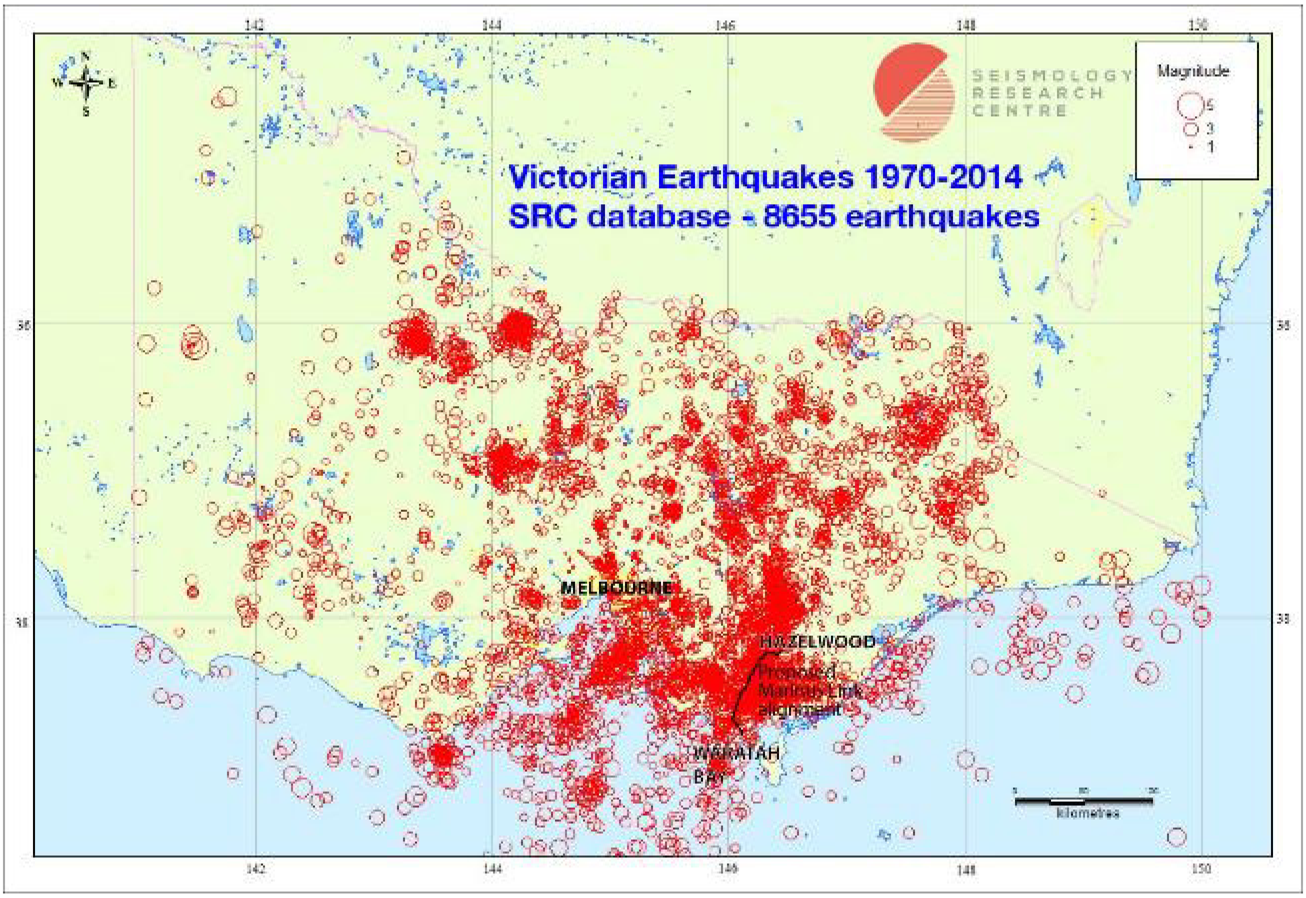
NNE-SSW aligned faulting has divided South Gippsland into tectonic blocks that show varied dissection related to the underlying geology. Close-spaced drainage lines with narrow interfluves and high relief occur in the Lower Cretaceous volcaniclastic rocks where deep weathering and the absence of repeated thick resistant beds reduces structural control of landform. By comparison, areas with an extensive remnant cover of Thorpdale Volcanics basalt have widely spaced valleys, broad planar divides, and fewer short tributary streams. This drainage pattern may be a function of the nature of the pre-volcanic terrain, the original emplacement thickness of the lavas and the subsequent tectonic history.

The orientation of the major valleys of South Gippsland shows strong influence of faulting. Stream capture has been a factor in producing some anomalous drainage directions such as the Tarwin River East Branch initially flowing south-north and turning 180 degrees at Mirboo to be north-south (Figure 5-3).

The southern half of the project area is low elevation. The terrain rises abruptly at the Tarwin Fault defining the alignment of the Tarwin River East Branch.

Palaeozoic basement rocks overlain by sequences of Mesozoic mainly sedimentary rocks several kilometres thick were covered by widespread lava flows and younger marine and non-marine deposits of limestone, coal, and gravel. Ongoing tectonic activity has compressed, folded, faulted and uplifted these rocks producing distinct the large fault bounded Narracan Block, Tarwin Block and Balook Block and Gelliondale Block (Figure 5-3). The faults strike NNE-SSW and define the margins of the blocks, both as fault scarps and deeply eroded valleys such as the Tarwin River East Branch and West Branch. Uplift is ongoing as evidenced by the high seismicity (Figure 5-4).

Figure 5-4 Earthquakes in SE Australia (1970-2014) in relation to Marinus Link Victoria terrestrial alignment (base map from McCue 2015).



5.1.5 Slope instability

Relatively high rainfall and deep regolith has facilitated mass movement processes as evidenced by the numerous landslides identified by Jacobs (2021, 2022a) and the present surveys. As outlined above, major changes in local geomorphic regimes have been experienced over the period of European occupation associated with the removal of forest cover, including loss of topsoil increased incidence of landslides and incision of drainage lines that were formerly chain-of-ponds waterways.

Mass movement is facilitated also by the interface between deeply weathered basalt and the underlying pre-basaltic surface, that also in places has a deep weathering profile.

This is a geomorphologically active and dynamic landscape indicated by landslides and other forms of slope instability identified from LiDAR and aerial photography at 44 trench sectors (Table 5-1, Figure 5-5, Appendix B:).

The following definitions have been used in this assessment.

Landslide – Existing:

Clearly defined and recognisable landslide through which the alignment passes. Showing strong geomorphic features and either previously mapped by Jacobs (2021, 2022a, 2022b, 2023a) or recognised in this study.

Landslide – Existing Adjacent:

Clearly defined and recognised landslide adjacent to and in close proximity to the alignment.

Possible Landslide:

A less well defined but coherent geomorphic feature interpreted as a possible and/or older feature displaying more subtle landslide features.

Slope Instability:

An area showing clear evidence of minor to moderate slope failures, shallow surficial slope failures, undulations, hummocks, creep, and shallow ground disturbance, through which the alignment passes.

Possible Slope Instability:

An area with less clear but some evidence of minor to moderate slope failures, shallow surficial slope failures, undulations, hummocks, creep, and shallow ground disturbance, through which the alignment passes.

Channel Slope Instability:

Steep to very steep slopes/banks along channels and have potential for failure under further disturbance. The alignment crosses such watercourses and will encounter these steep slopes on both sides of the crossing.

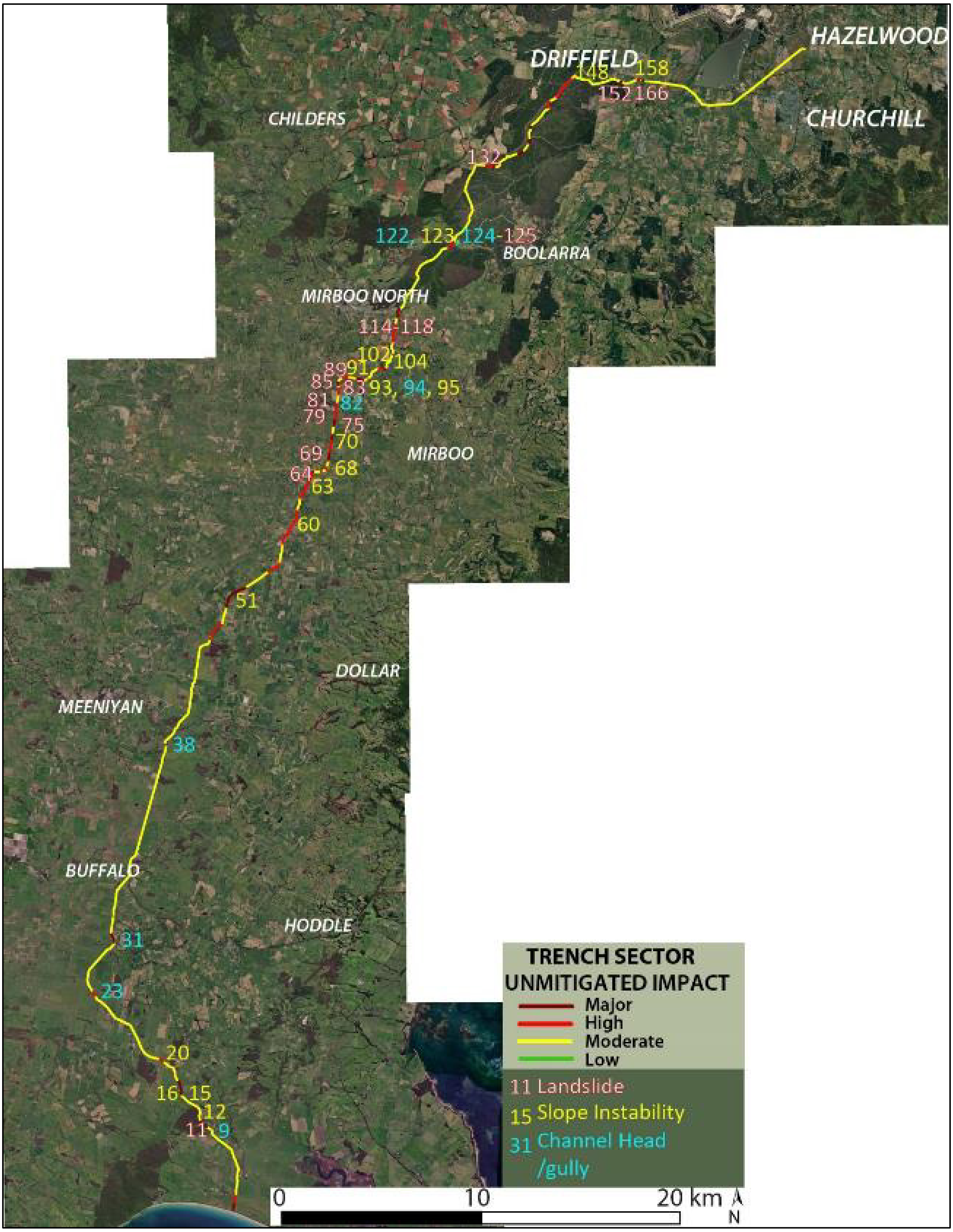
Table 5-1 Types of slope instability: Trench sectors and approximate chainage

Trench Sector	Approx. Chainage	Instability Type	Trench Sector	Approx. Chainage	Instability type
S9	4680	channel-slope instability	S89	50650	landslide-existing
S11	5050	landslide-existing	S91	51250	slope instability
S12	5250	slope instability	S93	52100	slope instability
S15	7200	slope instability	S94	52150	channel-slope instability
S16	7400	slope instability	S95	52180	slope instability
S20	9400	slope instability	S102	53400	slope instability
S23	14460	channel-slope instability	S104	53450	slope instability
S31	19150	channel-slope instability	S114	55100	landslide-existing
S38	28500	channel-slope instability	S115	55200	slope instability
S51	38100	slope instability	S116	56200	landslide-existing
S60	44400	slope instability	S117	56600	landslide-existing
S63	45200	slope instability	S118	57100	possible degraded landslide
S64	45500	landslide-existing	S122	61050	gully head instability adjacent
S68	46200	slope instability	S123	61500	possible slope instability
S69	46500	landslide-existing	S124	61560	channel-slope instability
S70	46900	slope instability	S125	61700	landslide-existing
S75	47900	landslide-existing	S132	66930	landslide-existing
S79	48600	landslide-existing	S148	74800	possible slope instability
S81	49300	landslide-existing	S152	75500	possible landslide
S82	49380	channel-slope instability	S154	76000	possible landslide
S83	49500	landslide-adjacent	S158	73370	possible slope instability
S85	50250	landslide-existing	S166	78400	landslide-existing

Gully Head Instability – Adjacent:

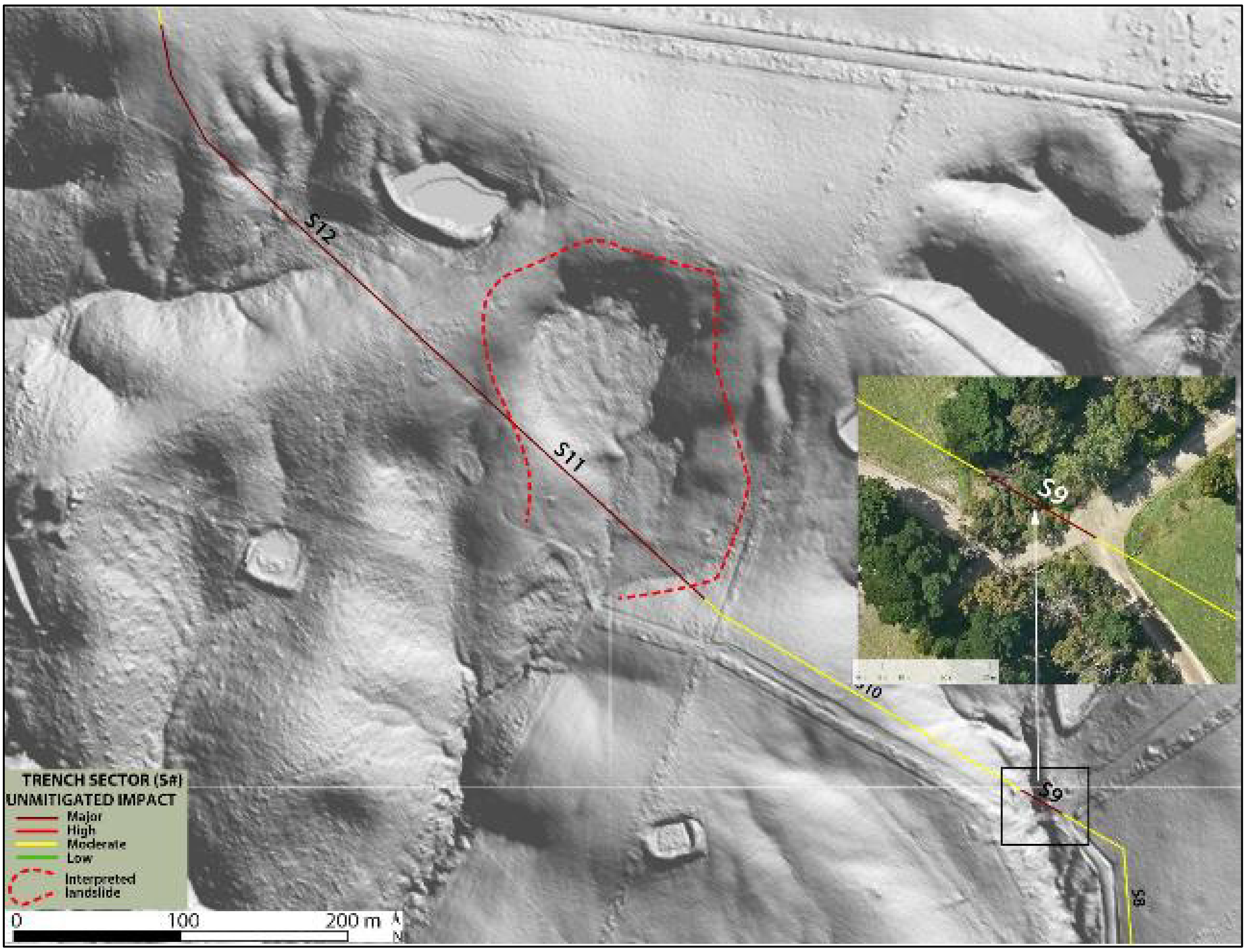
A moderate to steep gully head showing clear signs of instability and groundwater discharge – above or below the alignment.

Figure 5-5 Location of trench sectors with desktop recognition of unmitigated significance of impact of landslides, slope instability and channel-gully head instability



An example of identified landslides, slope instability and channel head and gully are shown in Figure 5-6. All identified landslides and other slope instability sectors are shown in Appendix B:.

Figure 5-6 Channel instability (S9), landslide (S11), slope instability (S12) (Base LiDAR DEM)



5.1.6 Shore crossing

The shore crossing at Waratah Bay entails traversing a narrow, elongate depression – a former tidal channel (now drained) of Shallow Inlet – and a zone of coastal sand dunes and sand beach. The tidal channel developed between the inner margins of the Holocene coastal dunes and a slightly elevated sandy terraced surface which is a remnant of a Pleistocene higher sea level barrier. The shore crossing is at the observed limit of tidal penetration, is in a zone of potential acid sulfate soils and within the 1 in 100-year flood layer.

Between the channel and the shore is a steep ridged foredune up to 80 metres wide and 15 metres high. The dune has dense cover of woody shrubs with some small areas of exposed sand but little evidence of landward transgression. Seaward, the dune terminates as a grass-covered terrace with a scarped edge and large root-bound blocks detaching from the dune face. Most of this Waratah Bay backshore is in a state of active recession with no incipient foredune development at the time of a field inspection (Nov 2018).

Plate 5-1 Waratah Bay beach and scarped foredune near the proposed Marinus Link shore crossing (N. Rosengren 09 November 2018)

Smith (1969) noted that a foredune terrace 2 metres high and 45 m wide extended along this backshore and had developed rapidly during the late 1940's to 1960's. Smith speculated this was possibly related to a surge of sand moving anti-clockwise around the bay triggered by shoreline changes at Walkerville associated with limestone mining in the 1800's to late 1920's. This terrace is now almost completely denuded resulting in the present state of shoreline recession.

5.2 GEOLOGY

The geological framework is the basis for the development of landforms and provides the context of detailed land surface and subsurface analysis. Uniform geological information across the project was sourced from Seamless Geology (Geological Survey Victoria 2014) at 1:250,000 scale supplemented by larger scale mainly unpublished older maps by the Geological Survey of Victoria. These were used to determine detail of some areas that appeared to be too generalised on the digital data.

The project has been divided into nine geological zones based on bedrock and surficial geology (Figure 5-5). The geological ages of the project areas range from Lower Devonian faulted marine sedimentary strata of the Liptrap Formation to Pleistocene-Holocene sediments transported and deposited in coastal, fluvial, lacustrine and hillslope environments. Although not the oldest rocks, effectively the widespread basement geology from the southern to central areas are Lower Cretaceous sedimentary rocks of the Strzelecki Group that crop out in the ranges and valleys from Waratah North to Mirboo North. These are overlain by a suite of deeply weathered basalt lava flows that form hill caps and undulating plateau surfaces and extend down valley side slopes. Variably consolidated beds of sand and gravel lie under the basalt and the complex of sediments including brown coals of the La Trobe Valley Subgroup are interbedded with and overlie the lava flows north of Mirboo North. The Haunted Hills Formation is a younger distinctive sediment body deposited by flooding streams, slope colluvium and alluvial fans and includes lenticular sometimes cemented gravel beds.

The distribution of the geological units is influenced by faulting and geological and topographical boundaries are abrupt. Tectonic activity is continuing and expressed as the highest concentration of earthquakes in Victoria.

The geological zones are briefly described from south to north and approximate boundaries shown by approximate chainage in metres from Waratah Bay shore crossing (these are also shown on Figure 5-7).. The zones correspond to the most frequent materials at the surface and shallow sub-surface.

Geological Zone 1: 0 to 3150m. Quaternary sediments.

Coastal, alluvial and lacustrine deposits of unconsolidated dune sand, swamp sediments and organic material, river terraces sands, silts and clay.

Geological Zone 2: 3150 to 17800m. Pliocene – Pleistocene Haunted Hills Formation sediments.

Poorly consolidated fluvial deposits – succession of cross-bedded and lenticular gravels, sands, and clays. May be locally ferruginous and siliceous cemented beds.

Geological Zone 3: 17800 to 35200m. Lower Cretaceous Strzelecki Formation volcaniclastic sediments. Sandstone, arkose, siltstone, conglomerate, partly overlain by river terraces sands, silts and clay.

Geological Zone 4: 35200 to 40600m. Palaeocene-Miocene Thorpdale Volcanics.

Basalt, tuff, and interbedded sandstone and silcrete. Basalts are weathered and no outcrop is likely to occur along the project areas. Depth to coherent rock generally greater than 1.5 metres. Widespread cover of colluvium and older terrace alluvium on lower areas.

Geological Zone 5: 40600 to 50000m. Lower Cretaceous Strzelecki Formation volcaniclastic sediments.

Strzelecki Group of lithic volcaniclastic sandstone, arkose, siltstone, conglomerate. The formation is deeply weathered, and no outcrop is likely along the project areas. Depth to coherent rock is 1.0 to 2 metres.

Geological Zone 6: 50000 to 56700. Palaeocene-Miocene Thorpdale Volcanics. Basalt, tuff, and interbedded sandstone and silcrete. Basalts are weathered and no outcrop is likely to occur along the project areas. Depth to coherent rock generally greater than 1.5 metres. Widespread cover of colluvium and older terrace alluvium on lower areas.

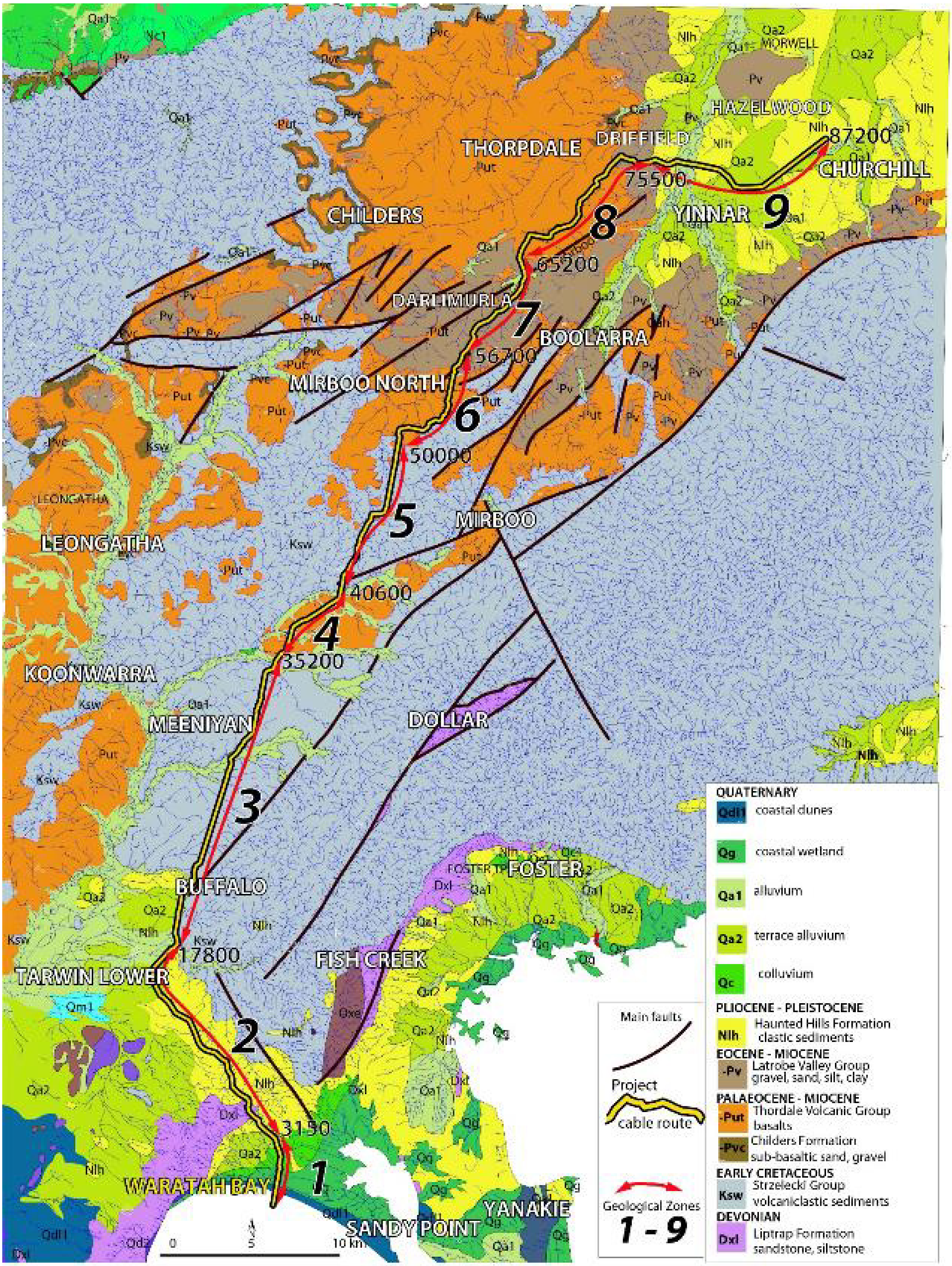
Geological Zone 7: 56700 to 65200m. Latrobe Valley Group Miocene-Pliocene sediments.

Quartzose and kaolinitic fluviatile-deltaic sediments. Relatively low resistance materials.

Geological Zone 8:65200 to 75500m. Palaeocene-Miocene Thorpdale Volcanics and La Trobe Valley Subroup sediments. Basalt, tuff, and interbedded sandstone and silcrete. Basalts are weathered and no outcrop is likely to occur along the project areas. Depth to coherent rock generally greater than 1.5 metres. Widespread cover of colluvium and older terrace alluvium on lower areas.

Geological Zone 9: 75500 to 87200m. Quaternary sediments, Haunted Hills Formation. Morwell River floodplain and terraces. Alluvial, river terraces and lacustrine deposits of unconsolidated sand, organic material, silts, and clay. Possibly unmapped Poorly consolidated fluvial deposits – succession of cross-bedded and lenticular gravels, sands, and clays. May be locally ferruginous and siliceous cemented beds.

Figure 5-7 Geological zones (From Seamless Geology 2014)



5.3 REGOLITH AND DEPTH TO BEDROCK

Aerial photograph interpretation, soil maps (Sargeant and Imhof 2003), depth to bedrock data from the land use impact model (LUIM) for West Gippsland (McNeill et al. 2007) and bore records show regolith and soil cover is continuous along the project area. The LUIM data indicates a minimum thickness between 1.0 m and 3.0 m is expected along the project area and in places may be much greater. Depth to bedrock in Cretaceous sediments (Zones 3 and 5) is expected to be between 1.0 m and 1.5 m and greater than 2.0 m in Thorpdale Volcanics (Zones 4, 6, 6). Depth to bedrock data is less relevant in areas of La Trobe Valley Formation (Zone 7) and Haunted Hills Formation (Zones 2 and 9) as these are consolidated sediments with local occurrences of cemented gravel rather than coherent rock. Bore logs for 14 localities along the Victorian area (GeoVic http://er-nfo.dpi.vic. Gov.au/sdweave/registered.htm) show depth to bedrock to be greater than 1.8 metres in the two bores on Cretaceous sediments and 4 m and 6 m to basalt on the two bores on basalt terrain. Over 20 m of sediments (described as clay, sandy clay) occur on the northern areas where surficial geology is Latrobe Valley Group and Haunted Hills Formation.

5.4 GEOMORPHOLOGY

The primary task of this technical report is to recognise the landforms of the project area in Victoria. This has been conducted at various scales as State-wide classifications (geomorphic domains), regional scale (soil-landform units) to the details of variation along the proposed trench alignment (trench sectors). Sections 5.4.1 to 5.4.4 below provide detailed definitions of these scales).

5.4.1 Geomorphic domains

A geomorphic classification of land (terrain evaluation) is developed by recognising areas that have a limited range of morphological and geological properties and behaviour. Terrain evaluation is a method of summarizing the physical aspects of a landscape by combining selected terrain attributes into groups with limited variation across defined areas. Landforms are comprised of repeated features at various scales. The smallest feature is a component – a discrete area of constant slope shape and angle that is a fundamental part of a recurring pattern across the landscape. That component has tangible information i.e., properties that are directly observable and mappable such as dimensions, shape, soil, surficial and bedrock geology and (with varying relevance) vegetation. The component also has intangible information of the terrestrial and geomorphological, pedological, hydrological and biogenic processes that have in the past and are currently shaping the tangible properties. Some processes are observable as they are instantaneous or of short duration, but the intangible processes are cryptic as they occur slowly or infrequently and must be inferred from limited temporal data. Of key importance in process inference is the spatial and temporal frequency of extreme events, as well as incremental, and long-term ongoing changes.

The project is highly terrain interactive and long-term. A positive outcome requires comprehensive understanding of the tangible and intangible properties of the terrain it is utilising. This technical report provides terrain information and interpretation relevant to the activities of the project as explained below.

The broadest spatial unit used to classify terrain along the project is here termed a geomorphological domain, defined as an area with limited range of elevation, slope form and stream density and with one geologically dominant type. The geomorphological domains represent the broad range of landforms and land-forming processes encountered along the project. Using proponent-supplied LiDAR, 10m state-wide DEM, watercourse, and water area layers (Landata Vic) and third tier units of the Victorian Geomorphology Framework, fourteen broad geomorphic domains were recognised along the project area (Figure 5-8).

Figure 5-8 Geomorphic domains (Base 10 m state-wide DEM, Landata Vic)

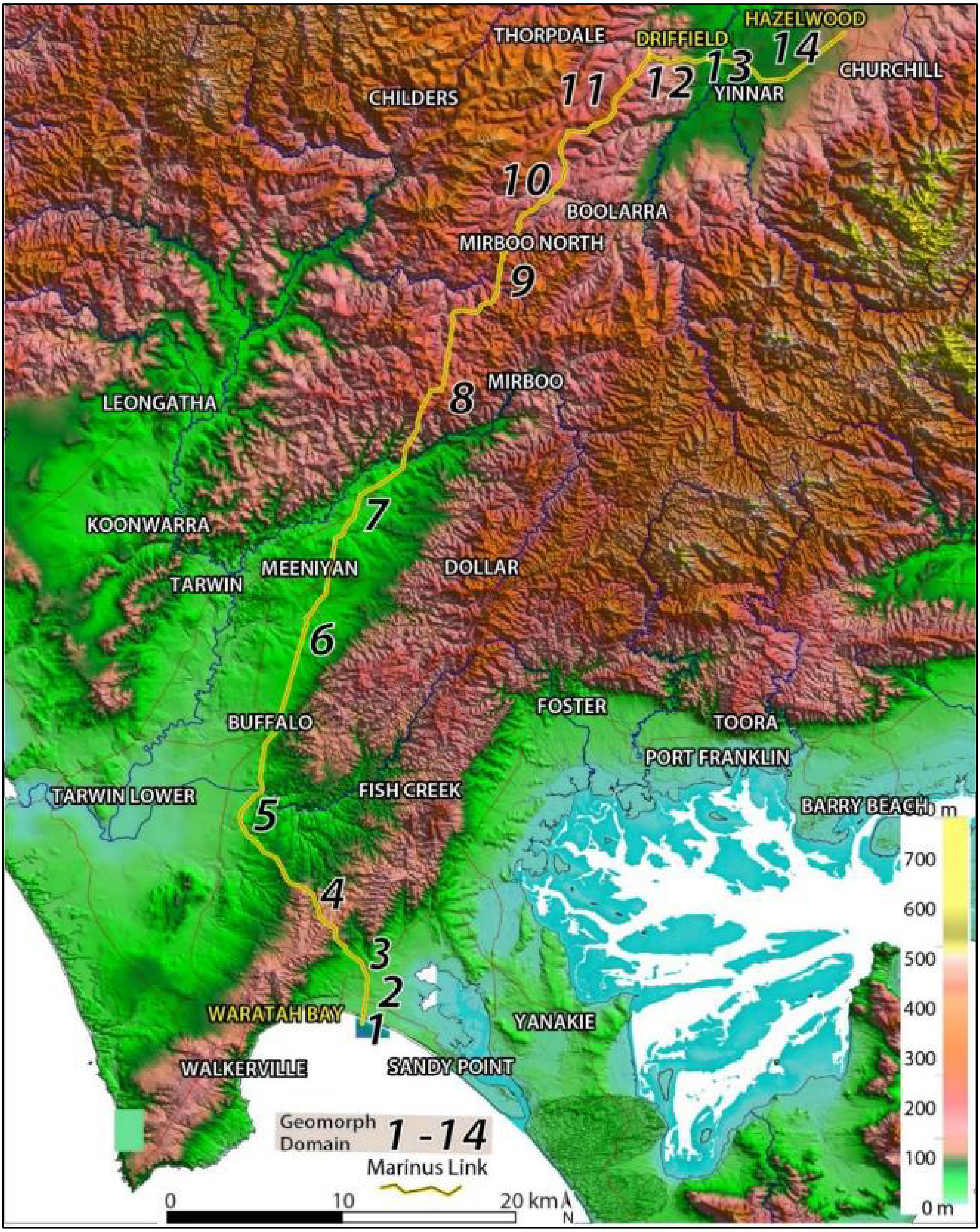


Table 5-2 Geomorphic domains along proposed Victorian land project alignment

Domain, chainage, location	Geology & regolith	Geomorphology	Geomorphic processes
1. Chainage – 300 to 400. Waratah Bay. Shore crossing, intertidal, beach and backshore proximal.	Holocene & Late Pleistocene sand – calcareous and siliceous. Silt, clay and fine sand lenses. Late Pleistocene dune and beach sand and clay. Unconsolidated medium to fine sand, possible calcarenite at depth (>3 metres) in high dune and seafloor below sand-shell cover. Holocene & Late Pleistocene silt, clay and fine sand lenses.	Sand beach, established high foredune ridges with relief >10 metre, strongly undulating to locally steep to very steep. Flat surface of former wide tidal channel with remnant channel now modified by drains. Low banks on drains and artificial levee. Relief <1 metre. Low broad Pleistocene sand ridges of stranded beaches and denuded foredunes. Relief <1 metre.	Wave action, wind, vegetation growth and die-back, topple, detachment of dune blocks. Runoff and possibly high spring tide inundation. Shoreline changes related to sea-level rise: erosion and inundation.
2. Chainage 400 to 1000. Inland from Waratah Bay beach to Fish Creek Waratah Road.	Pleistocene remnant barrier and coastal terrace. Weathered calcareous sand and shell overlying clay/silt bench of a now denuded higher sea-level shore platform. Late Pleistocene alluvium and minor colluvium.	Low broad Pleistocene sand ridges of stranded beaches and denuded foredunes. Relief <1 metre. Very gently inclined surface of higher sea-level estuary and floodplain.	Surface water ponding. Relict landform initially shaped by marine and aeolian processes. Subject to minor deflation. Waterlogging.
3. Chainage 1000 to 4300. Waratah North. Between Fish Creek Waratah Road and Waratah North.	Quaternary colluvium and alluvium. Sand, silt clay with minor gravels. Deposits stratified but indistinct boundaries.	Low rounded ridge crest between small channels. Smooth rectilinear slope of weakly dissected colluvial and alluvial fans downslope of more elevated terrain. Relief <4 metres	Sheetwash, soil creep. Flash flooding.
4. Chainage 4300 to 10600. Northwest from Waratah North to Duncans Road.	Haunted Hill Formation overlying Devonian sandstones. Fluvial deposits – succession of cross-bedded and lenticular gravels, sands and clays accumulated as fault apron on downthrow of NE-SW trending fault. Gravels, sands, and clays, stratified. Alluvium to 2 metres in drainage lines.	Weakly dissected slopes with relief 50-80 metres. Corridor crosses rounded ridge crests and valley slopes with shallow ephemeral stream channels. Gently undulating smooth ridge crest form an interfluve between west-draining Bridge Creek and north-draining Amber Creek.	Slope wash, wind action on exposed crests. Flash flooding. Possible landslides.
5. Chainage 10600 to 21600. Duncans Road to Bufflalo.	Quaternary alluvium and colluvium, overlying Strzelecki Formation sedimentary rock. Very thick deposits of unconsolidated sediments ranging from clay to gravel.	Undulating west-facing slopes – of colluvial and alluvial terraces south of Fish Creek. Weakly dissected by minor tributaries of Fish Creek and Tarwin River. Short steeper slopes on valley of Fish Creek. Interfluve and channels of several streams forming Buffalo Creek. Flat formerly swampy terrain now artificially drained.	Slope wash. Local channel incision. Flash flooding. Possible landslides. Channel incision and deposition. Overbank flow.
6. Chainage 21600 to 29600. Buffalo Creek to Stony Creek.	Quaternary alluvium and colluvium, Gravel, sand, and silt variably sorted and rounded. Basement of weathered. Strzelecki Group of Lithic volcaniclastic sandstone, arkose, siltstone. Very thick deposits of unconsolidated sediments ranging from clay to gravel.	Gently undulating west-facing slopes – of colluvial and alluvial terraces along valley of Tarwin River south of Stony Creek. Weakly dissected by minor tributaries of Stony Creek and Tarwin River.	Slope wash. Local channel incision.

Domain, chainage, location	Geology & regolith	Geomorphology	Geomorphic processes
7. Chainage 29600 to 40500. Between Stony Creek and Tarwin River East Branch.	Basement is Lower Cretaceous Strzelecki Group covered by deeply weathered remnants of Thorpdale Volcanics basalt and tuffaceous basalt. Widespread cover of colluvium and older terrace alluvium on lower areas. Variable depending on landscape position but typically ±1 metre overlying very weathered rock (either volcanic or sedimentary). Silt and clay dominant with lenses of gravel and some stony layers.	Plains with areas of very gently inclined surfaces. Low rounded-flattened rises are areas of Older Volcanics. Flat surfaces are alluvial of prior valley and floodplain of Tarwin River East Branch. Gently undulating surface with relief <15 metres. The landform is developed inside the Tarwin River Valley and includes high level river terraces and colluvial fans.	Slope wash. In Tarwin River Flood scour, flood deposition on floodplain. Bank recession. Fluvial channel deposits and scour.
8. Chainage 40500 to 50400. Tarwin River East Branch floodplain to east of Mardan.	Strzelecki Group Lower Cretaceous feldspathic and tuffaceous sandstone and chloritic mudstone. Some pebble beds. Close-spaced fractures. Previous cover of Older Volcanics basalt. Deeply but variably weathered sandstone and mudstones. Colluvium. Minor areas of rock outcrop.	Strongly undulating dissected terrain. Rolling to steep hills of narrow ridges, rounded crests above convex slopes. Narrow valleys. Mid-lower slopes with colluvial deposits.	Sheet wash, soil creep, soil slumping and localised soil flows and shallow and possibly deep landslides.
9. Chainage 50400 to 56400. East of Mardan to east of Mirboo North.	Widespread cover of deeply weathered Thorpdale Volcanics overlying Strzelecki Group Lower Cretaceous feldspathic sandstone and chloritic mudstone.	Strongly undulating dissected terrain. Steep ridges, rounded crests above convex slopes.	Multiple mass movement processes. Slope wash soil creep, shallow and possibly deep landslides. Groundwater outflow. Gully erosion.
10. Chainage 56400 to 65400. From east of Baromi (Mirboo North) to south of Delburn.	Latrobe Valley Group. Quartzose and kaolinitic fluviatile-deltaic sediments, sands and clays, minor gravel. Quaternary alluvium in valleys.	Strongly undulating hilly terrain of broad rounded crests and convex to rectilinear valley slopes.	Slope wash. Local channel incision.
11. Chainage 65400 to 73400 North Boundary Road to Kings Road (Driffield).	Widespread cover of Thorpdale Volcanics overlying Strzelecki Group Lower Cretaceous feldspathic sandstone and chloritic mudstone. Some pebble beds. Close-spaced fractures.	Undulating, low hills and plateau. Mainly broad rounded ridge crest.	Mass movement processes, landslides on steeper valley slopes.
12. Chainage 73400 to 76800. Smiths Road (Driffield) to Yinnar Driffield Road.	Latrobe Valley Group and Haunted Hills Formation. Quartzose and kaolinitic fluviatile-deltaic sediments. Lenticular sands and clays, minor gravel.	Undulating low rises. Bluff at valley margin west of Morwell River floodplain.	Slope wash. Shallow landslides.
13. Chainage 76800 to 83500. Morwell River floodplain and palaeochannels and palaeovalley of Yinnar-Driffield Road to Switchback Road.	Latrobe Valley Group and Haunted Hills Formation. Quaternary alluvium.	Valley-side bluff, alluvial terraces, floodplain, and channel. Palaeochannels and cut-offs. Steep alluvial banks. Channel incised ±5 metres below floodplain surface.	Overbank flows, bank erosion and meander migration.

Domain, chainage, location	Geology & regolith	Geomorphology	Geomorphic processes
14. Chainage 83500 to 87200. Switchback road to Hazelwood converter station.	Haunted Hills Formation. Quaternary (Pleistocene) alluvium.	Undulating Plain. Gently sloping surface to gently undulating surface. High terraces of Morwell River. Remnant palaeochannels.	Slope wash, Flood.

Figures 5-9 to 5-14 show the geomorphic domains (white arrows and upper-case label GD1 etc.), soil-landform units (upper-lower case letters Ag etc.), trench sectors (coloured line – each sector is shown in a different colour to differentiate from adjacent sectors and are not indicators of sensitivity of impact), representative chainage (3400 etc.) from Waratah Bay. Base is a LiDAR DEM and 10m DEM outside the alignment with a transparent aerial photograph overlay. The definitions of each of these different scale units is provided in Sections 5.4.1 to 5.4.3.

Figure 5-9 Location of geomorphic units GD1 to GD3 (Base: LiDAR DEM, aerial photograph, and soil-landform units transparent overlay)

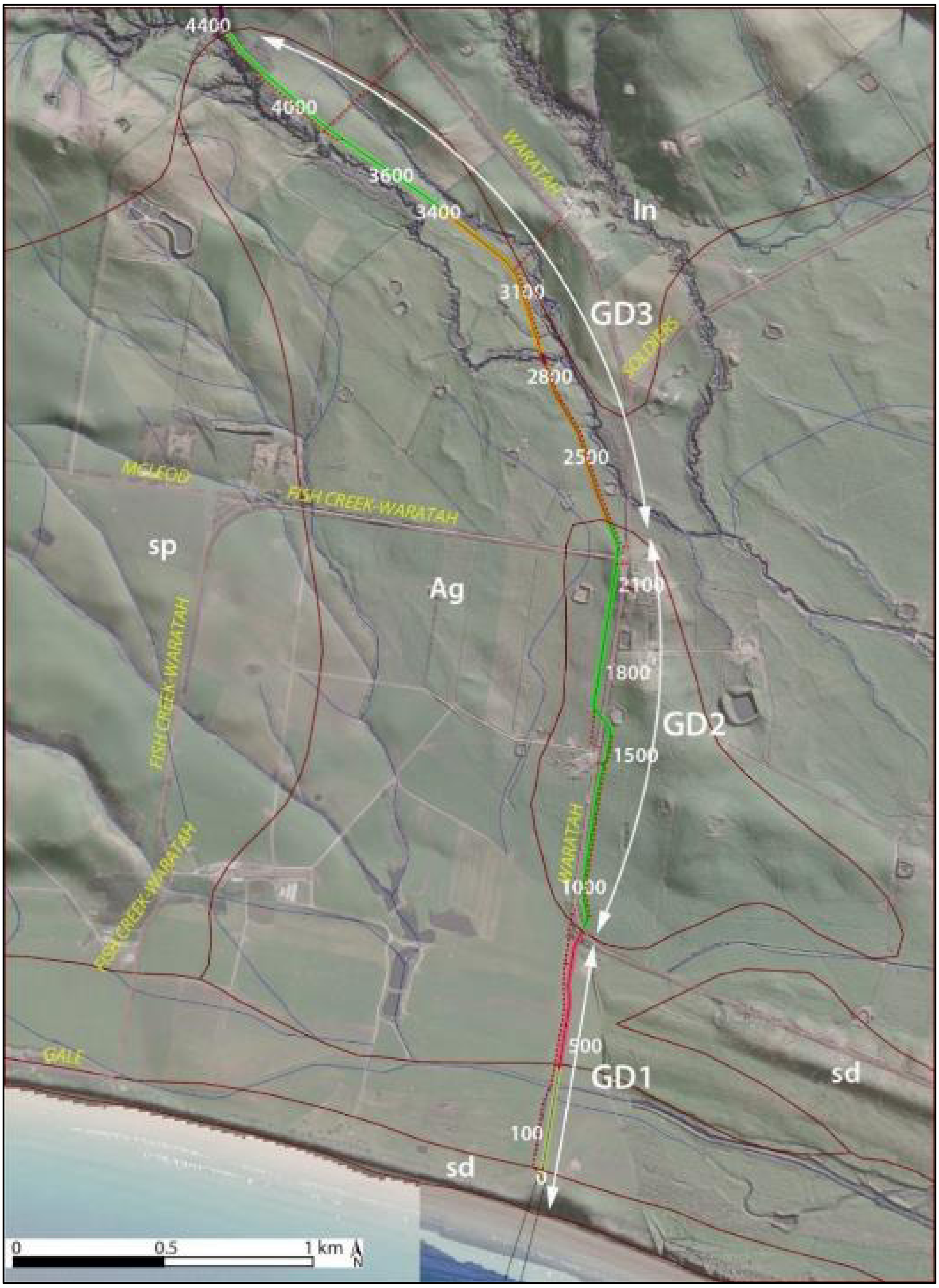


Figure 5-10 Location of geomorphic units GD4 to GD5
(Base: LiDAR DEM, aerial photograph, and soil-landform units transparent overlay)

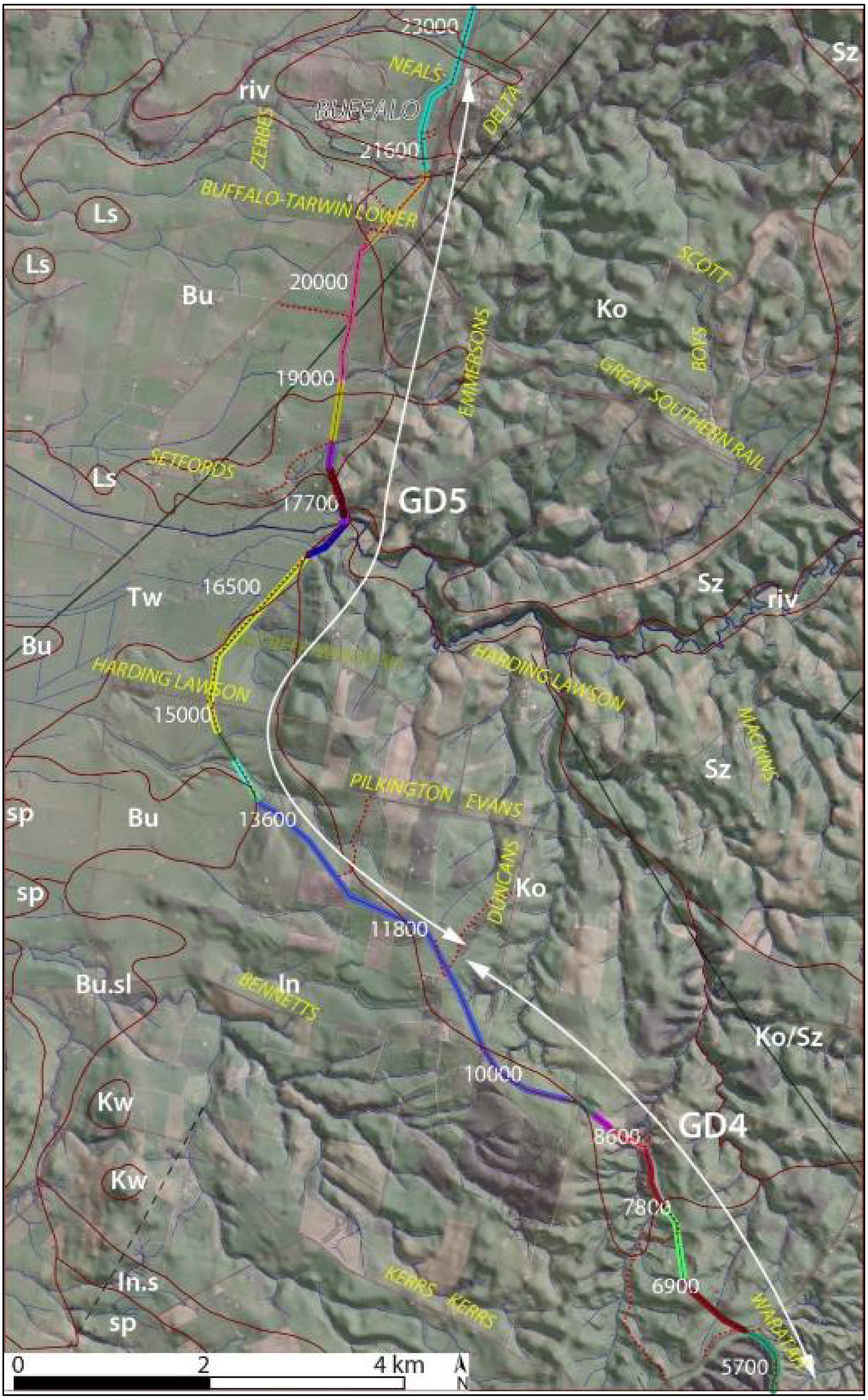


Figure 5-11 Location of geomorphic units GD6 and GD7
(Base: LiDAR DEM, aerial photograph, and soil-landform units transparent overlay)

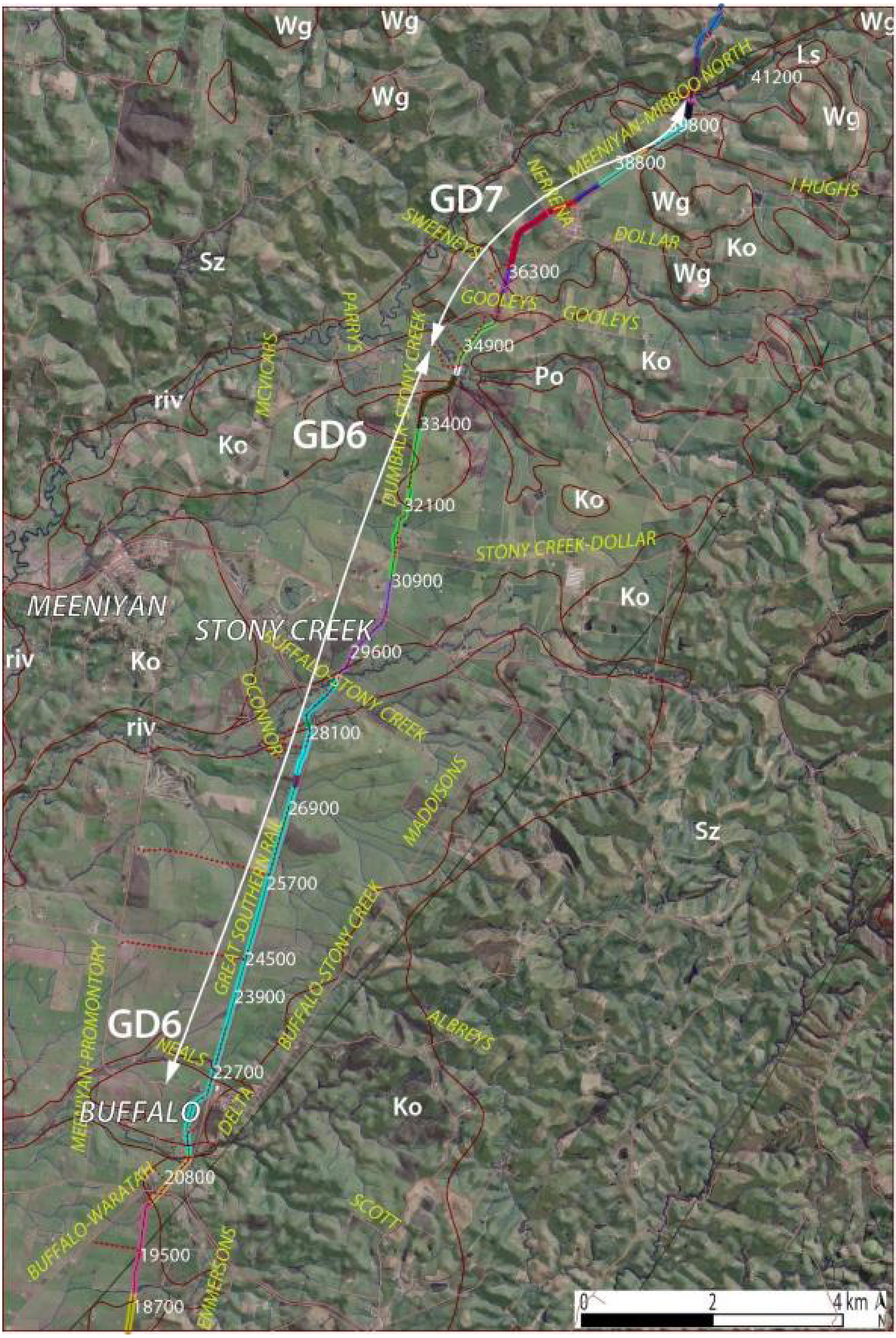


Figure 5-12 Location of geomorphic units GD8 to GD9
(Base: LiDAR DEM, aerial photograph, and soil-landform units transparent overlay)

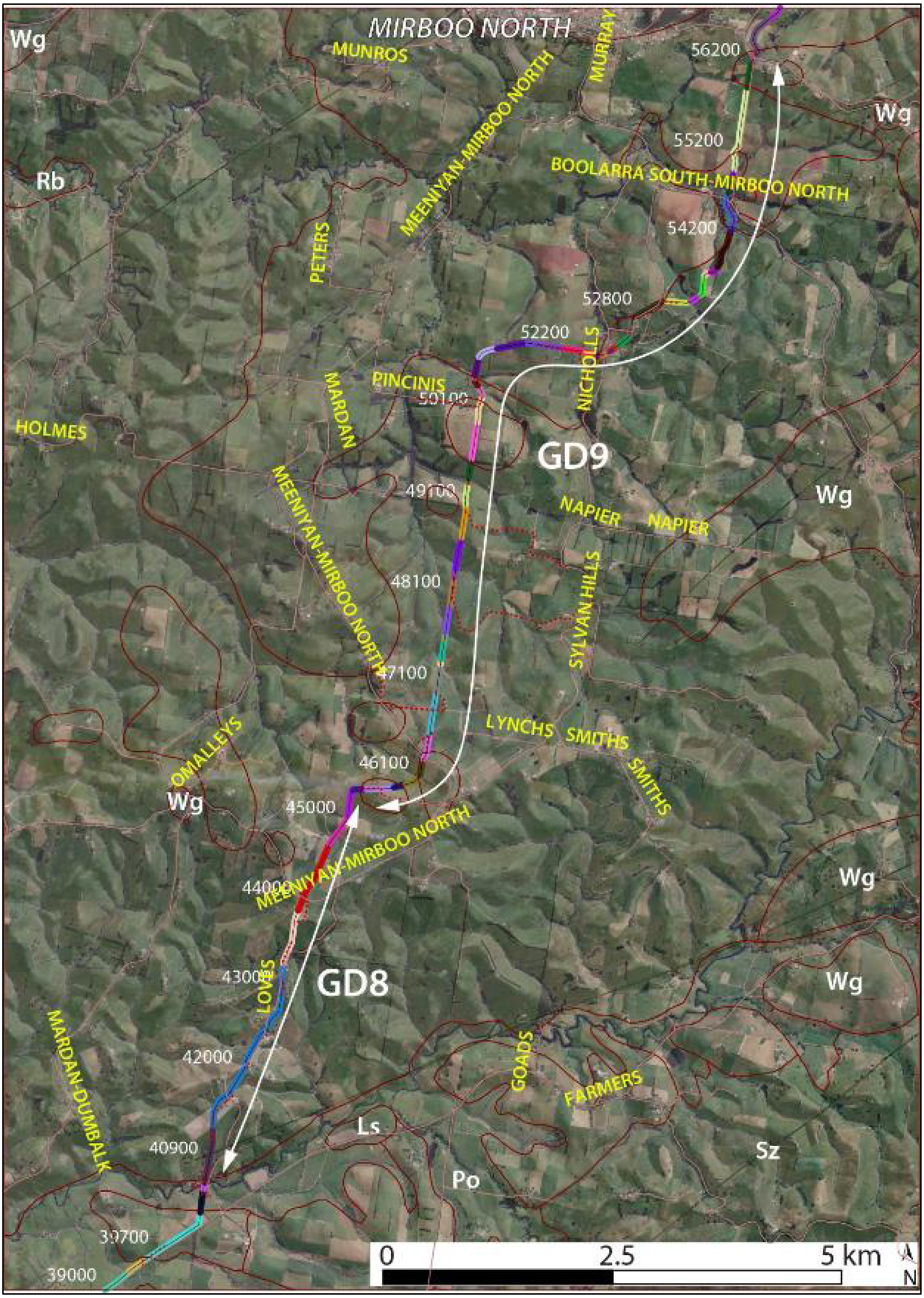


Figure 5-13 Location of geomorphic units GD10 to GD11
(Base: LiDAR DEM, aerial photograph, and soil-landform units transparent overlay)

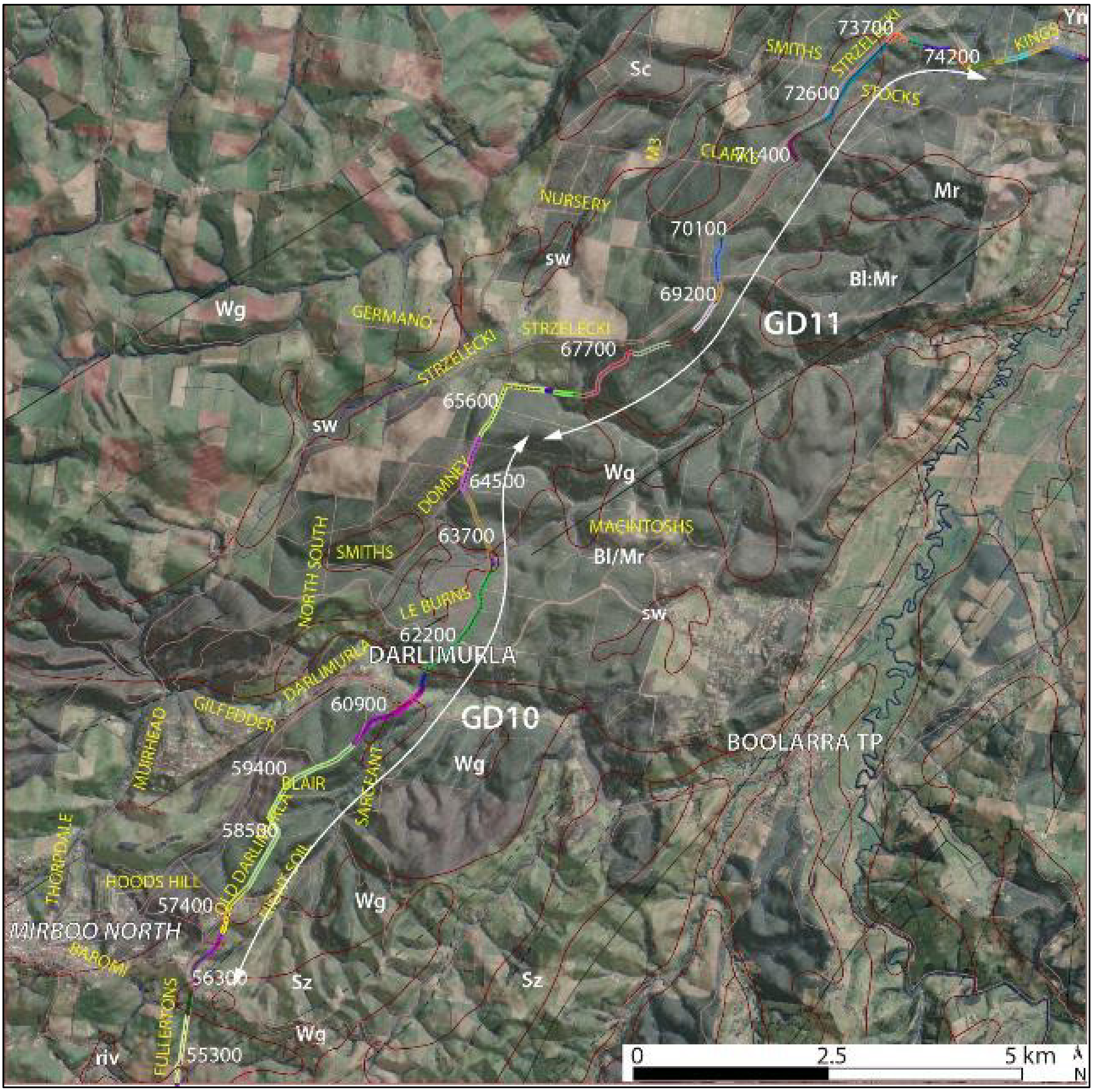
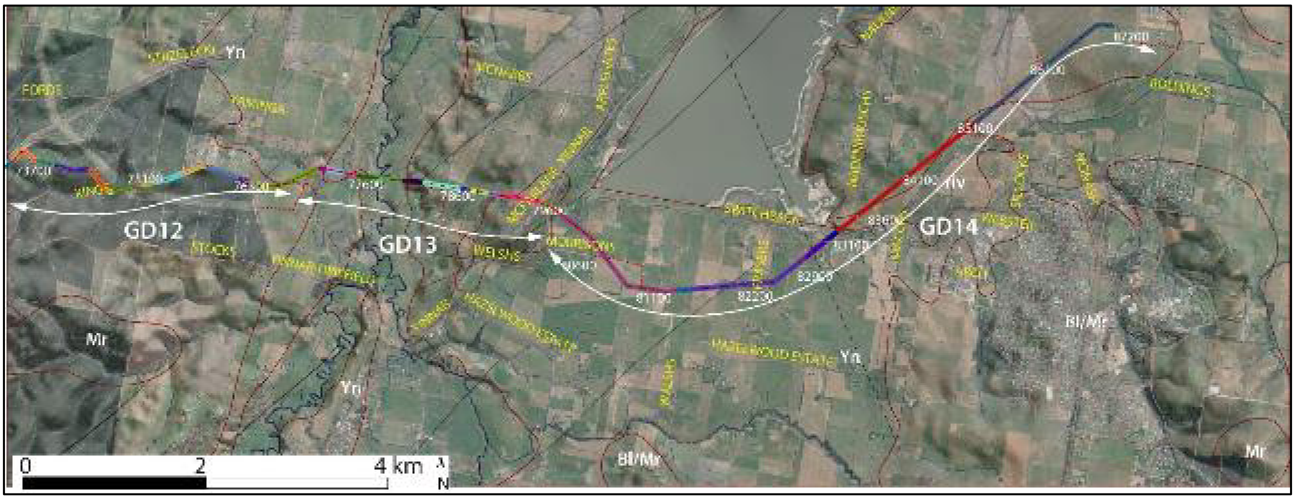


Figure 5-14 Location of geomorphic units GD12 to GD14
(Base: LiDAR DEM, aerial photograph, and soil-landform units transparent overlay)



5.4.2 Soil-landform units

The fourteen geomorphic units outlined above are further divided into soil-landform units. Soil-landform units are based on an ecosystem concept in which climate, geological material, landform, and soil are integrated as affect the inherent properties of the land, and its response to management (Charman & Murphy 1991). The soil-landform units used in this study were developed by Sargeant and Imhoff (2013) at a mapping scale of 1:100,000. Each soil-landform unit is an association of a specific landform pattern and its accompanying soils while considering other environmental variables, notably climate and drainage. The soil-landform unit boundaries were used because of the larger scale and field-based nature of the surveys (Sargeant and Imhof 2003) rather than mapped geological boundaries at 1:250,000 scale. Jacobs (2021, 2022a, 2022b) reports were consulted to verify soil descriptions.

Some soil-landform map units have only one land component and a limited range of geology and landforms, but many are complex having several components. Sixty-nine soil-landform units occur along the project alignment.

Figure 5-15 Soil-landform units (Sargeant and Imhof 2003)

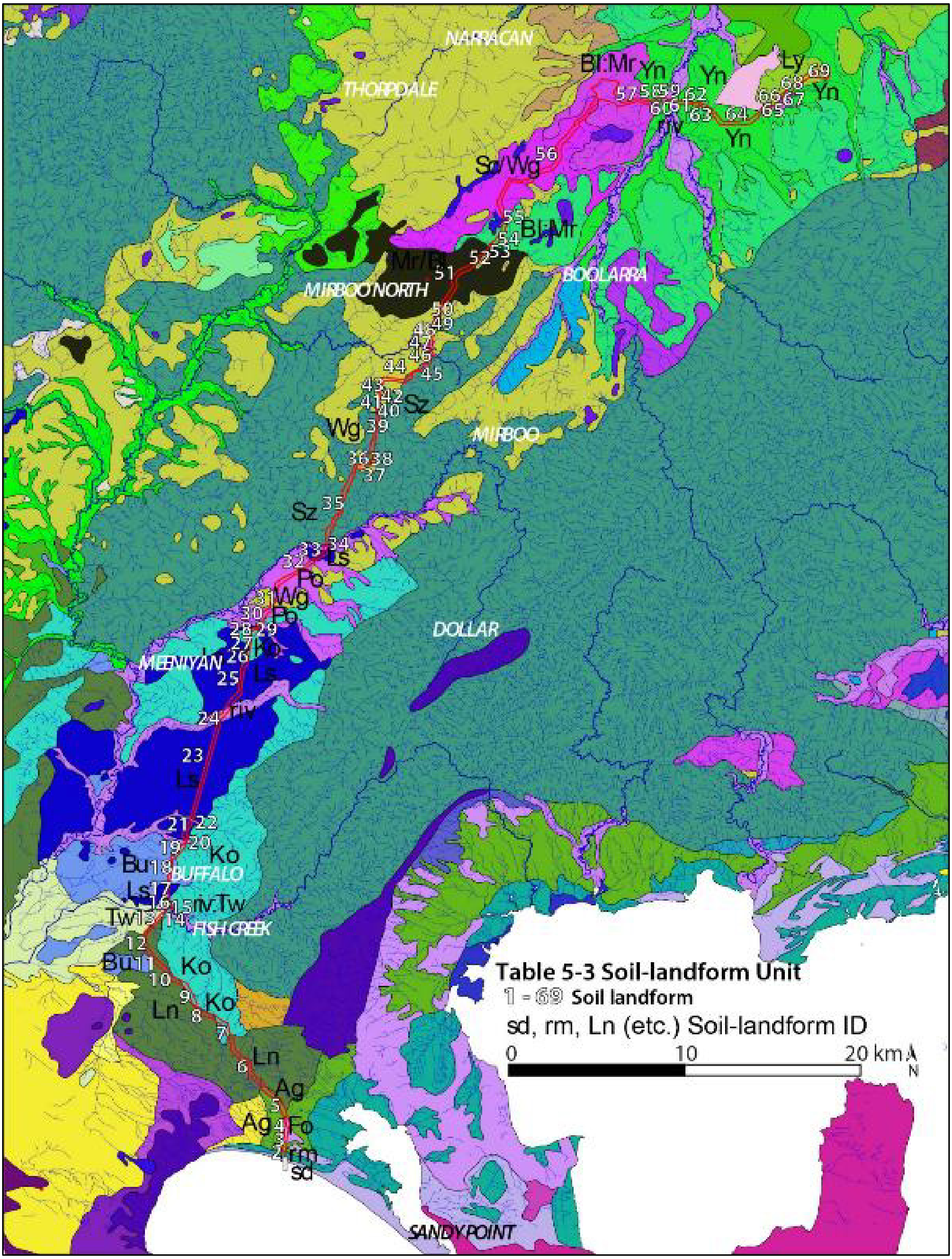


Table 5-3 Soil-landform units

Soil-landform number	ID	Approx. chainage	Soil-landform unit	Landform	Geology
1	sd	-120 to 20	Sand dune	Dunefield	Pleistocene to Recent aeolian sediments
2	rm	20 to 390	Recent marine	Marine Plain	Recent sediments (marine)
3	Ag	390 to 850	Agnes	Gently undulating Plain	Pleistocene (late) to recent alluvium & colluvium
4	Fo	850 to 2270	Foster	Undulating Rises	Tertiary sediments
5	Ag	2270 to 4450	Agnes	Gently undulating Plain	Pleistocene (late) to recent alluvium & colluvium
6	In	4450 to 8050	Inverloch	Undulating rises	Tertiary sediments
7	Ko	8050 to 9490	Koonwarra	Undulating hills	Cretaceous sediments
8	In	9490 to 10650	Inverloch	Undulating rises	Tertiary sediments
9	Ko	10650 to 12200	Koonwarra	Undulating hills	Cretaceous sediments
10	In	12200 to 14250	Inverloch	Undulating rises	Tertiary sediments
11	Bu	14250 to 14350	Buffalo	Gently undulating plain	Pleistocene (late)sediments
12	In	14350 to 16390	Inverloch	Undulating rises	Tertiary sediments
13	Tw	16390 to 17100	Tarwin	Flood plain	Recent alluvial sediments
14	Ko	17100 to 17650	Koonwarra	Undulating hills	Cretaceous sediments
15	Tw	17650 to 17840	Tarwin	Flood plain	Recent alluvial sediments
16	Ko	17840 to 18100	Koonwarra	Undulating hills	Cretaceous sediments
17	Ls	18100 to 19000	Leongatha South	Gently undulating rises	Tertiary sediments
18	Bu	19000 to 20600	Buffalo	Gently undulating plain	Pleistocene (late)sediments
19	Ko	20600 to 21490	Koonwarra	Undulating hills	Cretaceous sediments
20	riv	21490 to 21680	riverine	Narrow Alluvial Plains	Recent sediments
21	Ls	21680 to 22820	Leongatha South	Gently undulating rises	Tertiary sediments
22	riv	22820 to 22980	riverine	Narrow Alluvial Plains	Recent sediments
23	Ls	22980 to 28400	Leongatha South	Gently undulating rises	Tertiary sediments
24	riv	28400 to 29500	riverine	Narrow Alluvial Plains	Recent sediments
25	Ls	29500 to 32350	Leongatha South	Gently undulating rises	Tertiary sediments
26	Ko	32350 to 32890	Koonwarra	Undulating hills	Cretaceous sediments
27	Ls	32890 to 33180	Leongatha South	Gently undulating rises	Tertiary sediments
28	Ko	33180 to 34290	Koonwarra	Undulating hills	Cretaceous sediments
29	Ls	34290 to 34520	Leongatha South	Gently undulating rises	Tertiary sediments
30	Po	34520 to 35780	Powlett	Flood Plains	Recent sediments
31	Wg	35780 to 36330	Warragul	Rolling low hills to Undulating rises	Tertiary Basalts
32	Po	36330 to 39580	Powlett	Flood Plains	Recent sediments
33	Ls	39580 to 40370	Leongatha South	Gently undulating rises	Tertiary sediments
34	Po	40370 to 40705	Powlett	Flood Plains	Recent sediments

Soil-landform number	ID	Approx. chainage	Soil-landform unit	Landform	Geology
35	Sz	40705 to 45450	Strzelecki	Rolling to Steep Hills	Cretaceous sediments
36	Wg	45450 to 45870	Warragul	Rolling low hills to Undulating rises	Tertiary Basalts
37	Sz	45870 to 46090	Strzelecki	Rolling to Steep Hills	Cretaceous sediments
38	Wg	46090 to 46380	Warragul	Rolling low hills to Undulating rises	Tertiary Basalts
39	Sz	46380 to 49550	Strzelecki	Rolling to Steep Hills	Cretaceous sediments
40	Wg	49550 to 50220	Warragul	Rolling low hills to Undulating rises	Tertiary Basalts
41	Sz	50220 to 50510	Strzelecki	Rolling to Steep Hills	Cretaceous sediments
42	Wg	50510 to 52090	Warragul	Rolling low hills to Undulating rises	Tertiary Basalts
43	Sz	52090 to 52705	Strzelecki	Rolling to Steep Hills	Cretaceous sediments
44	Wg	52705 to 53090	Warragul	Rolling low hills to Undulating rises	Tertiary Basalts
45	Sz	53090 to 54300	Strzelecki	Rolling to Steep Hills	Cretaceous sediments
46	Wg	54300 to 54380	Warragul	Rolling low hills to Undulating rises	Tertiary Basalts
47	riv	54380 to 55205	riverine	Narrow Alluvial Plains	Recent sediments
48	Wg	55205 to 55950	Warragul	Rolling low hills to Undulating rises	Tertiary Basalts
49	Sz	55950 to 56380	Strzelecki	Rolling to Steep Hills	Cretaceous sediments
50	Wg	56380 to 57400	Warragul	Rolling low hills to Undulating rises	Tertiary Basalts
51	Mr/Bl	57400 to 60990	Morwell with Boolarra	Rolling Low Hills to Undulating Rises	Tertiary sediments
52	Wg	60990 to 61300	Warragul	Rolling low hills to Undulating rises	Tertiary Basalts
53	Mr/Bl	61300 to 61800	Morwell with Boolarra	Rolling Low Hills to Undulating Rises	Tertiary sediments
54	Bl/Mr	61800 to 63400	Boolarra with Morwell	Rolling Low Hills to Undulating Rises	Tertiary (Pliocene) sediments
55	Sw	63400 to 63695	swamp	Lacustrine Plain	Recent sediments
56	Sc/Wg	63695 to 73580	Silver Creek with Warragul	Rolling Low Hills	Tertiary sediments & Tertiary basalts
57	Bl/Mr	73580 to 76850	Boolarra with Morwell	Rolling Low Hills to Undulating Rises	Tertiary (Pliocene) sediments
58	Yn	76850 to 77370	Yinnar	Stagnant Alluvial Plain	Pleistocene (late) sediments
59	riv	77370 to 77650	riverine	Narrow Alluvial Plains	Recent sediments
60	Yn	77650 to 77820	Yinnar	Stagnant Alluvial Plain	Pleistocene (late) sediments
61	riv	77820 to 78270	riverine	Narrow Alluvial Plains	Recent sediments
62	Yn	78270 to 79400	Yinnar	Stagnant Alluvial Plain	Pleistocene (late) sediments

Soil-landform number	ID	Approx. chainage	Soil-landform unit	Landform	Geology
63	Bl/Mr	79400 to 79870	Boolarra with Morwell	Rolling Low Hills to Undulating Rises	Tertiary (Pliocene) sediments
64	Yn	79870 to 83520	Yinnar	Stagnant Alluvial Plain	Pleistocene (late) sediments
65	riv	83520 to 83900	riverine	Narrow Alluvial Plains	Recent sediments
66	Ly	83900 to 84905	Loy Yang	Undulating Plains	Tertiary sediments
67	riv	84905 to 85310	riverine	Narrow Alluvial Plains	Recent sediments
68	Yn	85310 to 85660	Yinnar	Stagnant Alluvial Plain	Pleistocene (late) sediments
69	Ly	85660 to 87200	Loy Yang	Undulating Plains	Tertiary sediments

5.4.3 Trench sectors

The highest resolution geomorphic division of the project area is a discrete length – termed trench sector – defined by a combination of soil-landform units, geology and a collection of geomorphic processes. A change in geomorphic attributes determines the boundary of a trench sector. A total of 183 terrestrial trench sectors was recognised along the project alignment, three additional at the Waratah Bay shore crossing and four additional at the offtake to the Driffield and Hazelwood converter stations (Figure 5-5).

The project area has been assessed by identifying geomorphic divisions, called trench sectors, for the changes in key landforms within the broader soil-landform units. The complexity of much of the dissected landscape and the density of stream incision combined with geological units gave rise to the high number of trench sectors recognised. This number must be regarded as minimal as it is based on desk study only. It is possible that a field study will distinguish features present that cannot be recognised from remote data or have developed since the imagery was procured in 2021.

5.5 GEOHERITAGE

A geoheritage review from the Geological Society of Australia (GSA) was commissioned by EGS in December 2022. The review was conducted by Dr. Susan White (Chair Geoheritage Sub-committee, GS (Victoria)). The findings are shown in Appendix E. The review identified two large sites listed in this corridor: Waratah Bay-Cape Liptrap and the La Trobe Valley Brown Coal Deposits with subsites that are of high significance. However, the easement does not affect these specific subsites. It was concluded there were no serious issues with sites of significance with the development of the project and construction activities will not degrade the inherent properties of the large sites.

6. IMPACT ASSESSMENT

The potential impacts of the project on the inherent geomorphic attributes of the project area were assessed for each of the 192 trench sectors, including the shore crossing and Driffield and Hazelwood converter station connections. The assessment was on the five-fold rating scale shown in Table 4-4 .and the methodology to arrive at each of impact assessment is discussed in Section 4.3 above.

6.1 MECHANISMS CAUSING IMPACTS

The core engineering activity of the project is excavation of a total of 87 km of excavated and bored (HDD) trench and associated infrastructure. The inherent nature of these activities will impact the ground surface and sub-surface and expose sub-surface materials for varying periods of time. The impacts include imposing subsurface materials and instantaneous, repeated, and long-term ground loading imposed by personnel, vehicles, construction materials and excavation spoil.

Geomorphology is impacted by the following project activities:

- vegetation clearing exposing soils to erosion and surface water infiltration.
- ground disturbance exposing soils to erosion.
- ground disturbance destabilising landforms.
- ground disturbance exposing excavated surfaces to surface water infiltration potentially causing increased groundwater loading and consequential slumping and / or slope failure of landforms.
- ground disturbance causing erosion and sedimentation of watercourses and/or drainage lines resulting in channel avulsion and / or watercourse form instability.
- ground disturbance causing watercourse / drainage line diversion or infill with consequential erosion, scour, sedimentation, and depleted groundwater resources.
- ground disturbance exposing actual and / or potential acid sulfate soils.

6.1.1 Potential impacts

Potential impacts on geomorphology are:

- Creation of unstable landforms in the short-term during construction.
- Potential for creation of long-term instability through changes to one or more of the geomorphic attributes of the present landscape.
- Potential change to channel dynamics of trenched waterways.
- Lost or degraded soil structure and other physical properties.
- Changed surface flow condition (run-on and runoff) and infiltration.
- Locally altered groundwater dynamics.
- Changed vegetation communities.

6.1.2 Actual impacts

Actual impacts on geomorphic attributes will be determined by:

- Inherent attributes (properties) of the ground surface and shallow sub-surface and the response to mechanical disturbance and loading.
- Engineering techniques and environmental management measures to minimise adverse outcomes to the project assets and the immediate and wider landscape. These apply during the construction phase and for the life of the project assets.

6.2 SIGNIFICANCE OF IMPACT ASSESSMENT

Significance of impact for each component of the project has been undertaken. The methodology of impact assessment is discussed in Section 4.3 above. The significance of impact assessment has been conducted in two different phases 1) in an unmitigated state and 2) with the application of EPRs. The assessment includes three groups of localities and activities. The main trench alignment is assessed in Table 6-4. The shore crossing is assessed in Table 6-5, Driffield converter station is assessed in Table 6-6 and Hazelwood converter station is assessed in Table 6-7.

Appendix A is an Excel Spreadsheet with details of the sensitivity and significance of impact assessment for the nine geomorphic attributes of each trench sector, the overall sensitivity of the sector, the unmitigated impact for each sector, the EPR to apply and the resultant residual impact for each sector.

6.2.1 Unmitigated significance of impact for trench sectors

A summary of potential significance of impact for each trench sector of the main alignment is presented in Table 6-4 below. This is an assessment of the initial impact of the project on geomorphology without consideration of mitigation measures. The methodology to arrive at the impact rating is described in Section 4 above.

6.2.2 Environmental performance requirements (EPRs)

EPRs set out the environmental outcomes that must be achieved during design, construction, operation and decommissioning of the project. The EPRs define conceptual management measures which must be applied to minimise the impact of the development on the geomorphology and soils. They allow a residual significance of impact assessment to be undertaken. Compliance with EPRs is intended to minimise impacts and the risk of harm to environmental values to within reasonable limits having regard to contextual factors and the practical delivery of the project.

A decommissioning management plan will be prepared to outline how activities will be undertaken and potential impacts managed and addressing the items outlined in these geomorphology EPRs. The EPR for the decommissioning management plan is provided in EIS/EES Volume 5, Chapter 2 – Environmental Management Framework.

A tolerable level of risk (referenced in GM02) is defined as a risk within a range that society can live with to secure certain net benefits. It is a range of risk regarded as non-negligible and needing to be kept under review and reduced further if possible (ASG, 2007). Determining the tolerable risk level for each location would consider factors such as:

- slow-moving landslides
- comprised of predominantly earth materials
- minimal to negligible occurrence of coherent rock materials or boulders

- moderate slope angles limit the runout potential
- moderate relief limits the runout potential
- rural location limits the potential for human targets and risk of loss of life
- rural location limits the nature and extent of damage or destruction to built structures and other, infrastructure
- disruption to rural agricultural activities will occur for restricted time periods and in some instances (not able to be identified here) some soil damage may be irrecoverable. The small area affected is seen to fall within tolerable risk.

Table 6-1 Environmental performance requirements

EPR ID	Environmental performance requirement	Project stage
GM01	**Assess ground conditions and landslide risks to inform design and construction methods** Prior to commencement of project works, complete surveys and site assessments along the project alignment, converter station, shore crossing and transition station to assess ground conditions to inform the design and site specific construction methods for the project components including above ground infrastructure, buildings, access roads, underground cables, joint bays, and laydown areas. The surveys and site assessments must be undertaken by a suitably qualified person and include, but not limited to: • Seismic assessment to assess seismic hazards. • Geotechnical testing to confirm geological conditions. • Groundwater levels. • Landslide risk assessment.	Design
GM02	**Develop designs that minimise construction induced ground movement** Prior to commencement of project works, develop a design for below and above ground infrastructure that: • Addresses areas of high landslide risk identified in EPR GM01 and implement design measures to reduce landslip risks to tolerable levels in accordance with Australian Geomechanics Society landslide management guidelines: o Landslide Risk Management Concepts and Guidelines (AGS 2000) o Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning (AGS 2007) o Commentary on Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning (AGS 2007) o Practice Note Guidelines for Landslide Risk Management (AGS 2007) o Commentary on Practice Note Guidelines for Landslide Risk Management (AGS 2007) o The Australian GeoGuides for Slope Management and Maintenance (AGS 2007) • Includes measures to stabilise construction areas using appropriate engineering techniques in particular where cuts and fills are required. • Responds to local soil and groundwater conditions including the potential for reactive soils such as in weathered volcanics and alluvial sediments and other clay rich soils. • Considers induced settlement through subsidence resulting from groundwater drawdown through construction. • Allows for ground movements (both lateral and vertical) within the design of cable joints and couplings, and any surface infrastructure. Where landslide risks cannot be addressed through design controls, the project alignment must be amended to reduce landslide risks to a tolerable level.	Design

EPR ID	Environmental performance requirement	Project stage
GM03	**Develop designs that minimise ground disturbance due to vegetation removal and disturbance of acid sulfate soils** Prior to commencement of project works, develop designs for below and above ground infrastructure that: • Are informed by investigations required in EPR GM01. • Includes measures to ensure ground disturbance is kept to a minimum following vegetation clearance. • Minimises disturbance of ASS as outlined in EPR CL03.	Design
GM04	**Undertake construction excavations in accordance with Australian Standards and informed by geotechnical investigations** Prior to commencement of project works, develop methods that: • Are in accordance with AS 3798-2007 Guidelines on earthworks for commercial and residential developments, and the Best Practice Erosion and Sediment Control Guidelines (IECA 2008). • Ensure all trenches are backfilled with suitable engineering materials to an appropriate design compaction standard to ensure long term trench and slope stability. • Include cut and fill batter angles that are commensurate with long term engineering designs. • Include measures for treating exposed faces in a manner to limit erosion and promote longer term vegetation growth. • Minimise the duration of open trenches in landscapes susceptible to movement. • Utilise excavation equipment that is suitable for the geological conditions and able to efficiently construct the proposed trench profile. • Include a program for inspections of excavations during construction. These measures must be documented in a sub plan to the CEMP and implemented during construction.	Construction
GM05	**Develop and implement methods for trenchless construction (HDD) that have considered ground conditions** Prior to commencement of project works, develop measures where trenchless construction methods will be implemented that addresses site conditions as determined through the assessments completed to comply with EPR GM01. • These methods must be specific to the location, geology, terrain and surrounding landscape stability. • These measures must be documented in a sub plan to the CEMP and implemented during construction.	Construction
GM06	**Develop and implement methods to provide trench stability during construction** Prior to commencement of project works, develop measures that provide trench stability and consider factors such as, but not limited to: • Measures that support the stability of the surrounding landscape to maintain lateral support. • Measures to support trench walls and prevent collapse in all ground conditions including unconsolidated and soft soils such as a result of presence of marine deposits, alluvial sediments and weathered, saturated basalts. • Methods to manage trench dewatering, where it is required, to avoid and/or minimise scouring and erosion. • Avoiding surface water from entering the trench during and after construction, and if not possible to avoid, install appropriate drainage with managed outlets. • Minimise the duration that trenches are kept open.	Construction

EPR ID	Environmental performance requirement	Project stage
	These measures must be documented in a sub plan to the CEMP and implemented during construction.	
GM07	**Develop and implement methods to provide slope stability during trenching** Prior to commencement of project works, develop measures that ensure stability on slopes and consider factors such as, but not limited to: • Avoid and minimise water being dammed in trenches which could then induce saturated slopes and initiate instability. • Avoid placement of spoil from trenches next to a trench on moderate to steep slopes to reduce impact on slope instability. • Implement measures so that the trench and the slope above is fully supported and the upslope is not undermined and initiates failures. • Minimise the duration that trenches are kept open. • Wherever possible, sequence trenching to work down the slope rather than up the slope to avoid undermining moderate to steep slopes from below. • Includes measures to ensure slope stability above and below the trench following vegetation clearance. These measures must be documented in a sub plan to the CEMP and implemented during construction.	Construction
GM08	**Develop and implement a site drainage plan to minimise site run off and avoid and/or minimise impacts to ground and slope stability** Prior to commencement of project works, develop measures to avoid and minimise impacts to ground and slope stability. The plan must document measures and where they will be applied to address: • The provision of drainage for any area of disturbed ground and construction of level areas. • Existing gullies or areas susceptible to gullying by avoiding the concentration of water flows into susceptible areas. • Avoid creating closed depressions so as to avoid ponding of runoff. These measures must be documented in a sub plan to the CEMP and implemented during construction	Construction
GM09	**Develop and implement a watercourse crossing plan to avoid and/or minimise impacts to existing fluvial geomorphology** Prior to commencement of project works, develop a plan for watercourse crossings that documents the measures and where they will be applied to avoid and minimise impacts to fluvial geomorphology. The plan should address: • Management of trenching across watercourses to avoid major damming and channel incision of watercourses. • Adopting trenchless construction methods for all significant watercourses. These measures must be documented in a sub plan to the CEMP and implemented during construction.	Construction

6.2.3 Assessment of residual impact

Residual impacts are the potential impacts remaining after the application of EPRs. The extent to which potential impacts have been reduced is determined by undertaking an assessment of the significance of the residual impacts. This is a measure of the effectiveness of the EPRs in reducing the magnitude of the potential impacts, as the sensitivity of the value does not change, but the magnitude of the impact can. The residual impact assessment assumes successful implementation of the EPRs.

6.2.4 Residual significance of impact for trench sectors

Following the application of what were the most appropriate EPRs in each trench section, an assessment of residual significance of impact was then conducted. Results are presented alongside the initial unmitigated assessment in Table 6-4 below. Figure 6-1 diagrammatically displays the results for unmitigated and residual significance of impact on geomorphology and soils.

The effectiveness of EPRs at some trench sectors is still uncertain due to the possible significance of some geomorphic processes, e.g., active landslides. The full nature of some of these processes is uncertain due to lack of field inspection of the site and absence of appropriate ground conditions and geotechnical assessment.

Site investigation by a geomorphologist (including collection of sub-surface cores down to at least trench/HDD depth to determine stratigraphy) of the 13 sectors of high residual impact is recommended to inform project design, including choice of construction methods. If site investigation reveals that ground conditions are unsuitable for construction or construction activities might impact slope stability or existing or potential landslides (i.e., geomorphic stability cannot be assured through design and application of EPRs), realignment is recommended In those sectors.

6.2.5 Explanation of residual significance of impact assessment

This section supplements Table 6-4 and Appendix A: and addresses all 71 trench sectors assessed as having a major or high unmitigated significance of impact. It divides these into two groups (residual high significance of impacts and residual moderate or low significance of impacts) and explains the reasons for determining the residual significance of impact rating.

The available data on site sensitivity was considered sufficient to determine that with appropriate design and construction/operation management measures, the suggested EPRs will reduce the residual significance of impact for 58 trench sectors from major or high to moderate or low (Table 6-2). A low impact means the area of impact is localised (within the project operational area) and effectively remediated with standard mitigation. A moderate impact means the area of impact due to a change in landform or landform processes is geographically limited and has a magnitude of impact that forms a tolerable and acceptable risk as defined by the Australian Geomechanics Society Landslide Taskforce “Commentary on Practice Note Guidelines for Landslide Risk Management 2007” Australian Geomechanics Vol 42 No 1 March 2007.

Measures expected to be implemented to comply with EPRs are generally intended to reduce the risk of impact to a “tolerable risk” level. Examples of these measures include timing trench construction and other site processes to take account of seasonal conditions, and avoid, minimise or otherwise manage activity during adverse ground and weather conditions such as recent, current or forecast heavy rainfall. Impacts fall within tolerable and acceptable risk classes due to the:

- landscape character - including limited local relief, moderate slope angle, substrate of regolith - soil rather than rock materials, and
- land use - rural land use reduces exposure of people to any hazard (such as a landslide) generated by the impact of the project activity.

Examples of tolerable risk impacts are provided in Table 6-2.

Table 6-2 Reasons for reductions in significance of impact across 58 trench sectors

Trench sector	Reasons for unmitigated major or high significance of impact	Reasons for residual moderate or low significance of impact	Description of moderate or low impacts (Tolerable impacts)
SC1, SC2	*Unconsolidated, saturated substrate*	Appropriate HDD protocols including sub-surface investigations prior to HDD	Minor and short-term surface subsidence that will be recovered by natural sand deposition
S1	*Inundation, surface flows and soft soils. Potential ASS*	Timing to avoid wet weather and extreme tide. Appropriate acid sulfate soil management	Minor subsidence and compaction that is not expected to extend beyond trench width.
S2	*Soft soils, sand blowouts*	Timing to avoid adverse weather and strong wind.	Minor subsidence and compaction. Potential for sand blowout that can be managed by earthworks, fill and revegetation.
S9, S23, S78 S94, S98	*Potential flooding and waterlogging*	Timing to avoid adverse stream flow and wet weather	Minor scouring of trench fill, recession of alluvial bank. Addressed by physical repair or replacement of lost soil.
S12, S20, S51, S55, S59, S61, S62, S63, S66, S68, S71, S73, S74, S91, S93, S95, S102, S123, S142	*Uncertain geology and geological structure, evidence of slope instability*	Appropriate site management to accommodate actual conditions encountered at time of construction	Shallow landslide of limited lateral extent. Damage could occur to fences and ground surface causing impediment to farm vehicle access, weakening of farm dam base.
S16, S80, S115, S144, S158, S162	*Dissected or steep terrain*	Appropriate site management of spoil and stockpiles	Shallow landslide of limited lateral extent. Damage could occur to fences and ground surfaces causing impediment to farm vehicle access.
S28, S70, S86, S104, S136, S138	*High groundwater or spring outflow*	Timing of construction to avoid adverse ground conditions	Shallow landslide of limited lateral extent. Damage could occur to fences and ground surfaces causing impediment to farm vehicle access, temporary impedance to stream flow.
S31, S38, S44, S46, S50, S53 S72, S88, S93, S103, S109, S113, S124, S131, S133, S140, S159, S161	*Active channel, flooding*	Timing of construction to avoid potential episodes of high stream flow	Short-term cessation of work and minor disruption to construction schedule.
D5	*Due to regolith, geology change and groundwater proximity to cuts significant relief and slope issue due to*	Detailed geotechnical report is available	Short-term cessation of work and minor disruption to construction schedule.

Trench sector	Reasons for unmitigated major or high significance of impact	Reasons for residual moderate or low significance of impact	Description of moderate or low impacts (Tolerable impacts)
	amount of cut and fill needed		
H1	*Due to regolith, possible significant relief and slope issue due to amount of cut and fill needed*	Stability assessment and geotechnical investigation required to confirm site character and stability	Short-term cessation of work and minor disruption to construction schedule.

A high residual impact means a change may be long-term or permanent for some geomorphic attributes and the effects extend beyond the project operational area. It is considered that at present, there is insufficient critical ground condition and subsurface data for 13 trench sectors to allow reduction in residual significance of impact below high (Table 6-3). These trench sectors require geotechnical assessment to confirm slope stability/instability, regolith and geological boundaries. LiDAR DEM images of these 13 trench sectors are presented in Appendix D: The EPRs require further site investigation and testing at these locations, to inform design measures to address ground conditions and maintain land stability, with the aim of preventing the project from causing geomorphological impacts such as a landslide or subsidence.

Table 6-3 Reasons for retaining high residual significance of impact across 13 trench sectors

Trench sector	Chainage	Reasons for residual significance of impact remaining high
SC3	**-120 to 0**	The coastal dunes are an inherently unstable landform subject to wave and wind erosion. The composition and structure of the underlying substrate is unknown including the depth of the sand mass overlying the proposed HDD and the potential for perched aquifers associated with organic material layers in the dunes and the inland swale and drain. The HDD could intercept perched aquifers and overpressure during drilling could saturate and weaken the substrate causing subsidence. Subsidence could extend to the surface in the form of sinkholes along the borehole alignment.
S11	**4950 to 5200**	Complex terrain, two watercourse channels, uncertainty as to surficial geology and spatial extent and type of slope movements in valley floor and western slopes. Trenching has the potential to initiate slope failure and subsequent displacement of the cable trenches.
S64	**45350 to 45500**	Evidence of landslide on the slopes obliquely crossed by the trench which is at the contact between deeply weathered Thorpdale Volcanics underlying weathered Strzelecki Group sedimentary rocks. It is likely that sub-volcanic sediments of low strength occurs between these two formations. The ground disturbance associated with trenching and backfill may initiate further slope failure.
S75	**47700 to 48000**	Trench traverses contour-parallel for 300 metres across slopes of 10 – 15 degrees with evidence of landslides above an incised stream channel. Potential to initiate slope failure, dislocating the cable trenches. Displaced material could block the channel.
S79	**48430 to 48740**	Trench crosses two active stream channels and ascends an 18 degree slope with evidence of small landslides and other slope instability in deeply weathered Thorpdale Volcanics and weathered Strzelecki Group sedimentary rocks. Possible sub-volcanic sediments of low strength occur between these two weathered units. The orientation of the trench may act as a groundwater conduit and in this low-strength materials could initiate ongoing land instability.

Trench sector	Chainage	Reasons for residual significance of impact remaining high
S81	**49100 to 49340**	Sectors 81 comprises of a group of potentially unstable surfaces that could be further comprised by trenching. Sector 81 has lopes of 12 to 16 degrees in weathered Strzelecki Group sedimentary rocks with evidence of a possible landslide. The orientation of the trench may act as a groundwater conduit and in this low-strength materials could initiate ongoing land instability. Trenching may introduce bank recession and undercut the slopes adjacent to sector 81.
S82	**49340 to 49380**	Sectors 82 comprises of a group of potentially unstable surfaces that could be further comprised by trenching. Trench crosses active channel with bank slopes around 20 degrees located below 12 to 16 degrees valley-side slopes in weathered Strzelecki Group sedimentary rock.
S83	**49380 to 49600**	Sectors 83 comprises of a group of potentially unstable surfaces that could be further comprised by trenching. Capping of deeply weathered Thorpdale Volcanics at ridge crests indicates deep regolith of weathered Strzelecki Group sedimentary rocks. Possible sub-volcanic sediments of low strength occurs between these two weathered units and may be a source of groundwater outflow. The orientation of the trench may act as a groundwater conduit and in this low-strength materials could initiate ongoing land instability. Trenching may introduce bank recession and undercut the slopes of adjacent sector 83.
S85	**50000 to 50300**	Existing landslides in deep regolith of weathered Strzelecki Group sedimentary rocks below deeply weathered Thorpdale Volcanics and sub-volcanic sediments. The orientation of the trench may act as a groundwater conduit and in this low-strength materials could initiate ongoing land instability
S89	**50540 to 50740**	Existing landslide in deeply weathered Thorpdale Volcanics. The orientation of the trench may act as a groundwater conduit and in this low-strength material could initiate ongoing land instability.
S114	**55010 to 55030**	Very steep slope/escarpment (22 to 35 degrees) and landslide in deeply weathered Thorpdale Volcanics. The orientation of the trench may act as a groundwater conduit and in this low-strength material could initiate ongoing land instability.
S117	**56250 to 56830**	Complex geology and regolith. Uncertain geological boundaries given existing small scale geological mapping. Significant landslide features need sub-surface assessment to allow determination of the potential response of the slopes when trenched and backfilled.
S132	**66640 to 66900**	Possible landslide in deeply weathered Thorpdale Volcanics and uncertain regolith on slope >18 degrees. Trench is slope-parallel and could result in slope instability becoming active.

Table 6-4 Summary of significance of impact assessment for trench sectors – unmitigated and mitigated by application of EPRs

Trench sector ID	Chainage in metres	Soil landform unit	Broad landform description	Factors affecting sector sensitivity	Significance of impact – unmitigated	Significance of Impact – residual (mitigated by EPRs)
S1	0 to 380	Recent Marine (rm)	Palaeo tideway	*Inundation, surface flows and soft soils. Potential ASS*	*Major*	*Moderate*
S2	380 to 850	Agnes (Ag)	Gently undulating ridge + swale plain	*Regolith / Trench stability and soft soils*	*High*	*Moderate*
S3	850 to 2270	Foster (Fo)	Plain	*Regolith / Trench stability and soft soils, possible waterlogging*	*Moderate*	*Low*
S4	2270 to 2850	Agnes (Ag)	Gently undulating plain	*Regolith/Trench stability and soft soils*	*Moderate*	*Low*
S5	2850 to 2890	Agnes (Ag)	Channel	*Very steep sided channel and soft materials*	*Moderate*	*Moderate*
S6	2890 to 3500	Agnes (Ag)	Gently undulating plain	*Regolith / Trench stability and soft soils*	*Moderate*	*Low*
S7	3500 to 4440	Agnes (Ag)	Gently undulating plain	*Potential for variable soil stratigraphy including gravel*	*Moderate*	*Low*
S8	4440 to 4690	Inverloch (In)	Undulating rises	*Proximity to the drainage line below*	*Moderate*	*Low*
S9	4690 to 4720	Inverloch (In)	Channel	*Mainly to do with drainage and flooding / surface flows. Base of a drainage line*	*Major*	*Moderate*
S10	4720 to 4950	Inverloch (In)	Undulating rises	*Potential for variable soil stratigraphy including gravel*	*Moderate*	*Low*
S11	4950 to 5200	Inverloch (In)	landslide	*Complex terrain and uncertainty as to spatial extent of slope movement*	*Major*	*High*
S12	5200 to 5450	Inverloch (In)	Undulating rises	*Uncertain geology and geological structure, evidence of slope instability*	*Major*	*Moderate*
S13	5450 to 6400	Inverloch (In)	Undulating rises to low hills	*Some relief and slope, possible excavation issues*	*Moderate*	*Low*
S14	6400 to 7100	Inverloch (In)	Undulating rises	*Crossing drainage line at 6700*	*Moderate*	*Low*
S15	7100 to 7250	Inverloch (In)	Undulating rises	*Proximity to a head of a drainage line*	*Moderate*	*Low*
S16	7250 to 8030	Inverloch (In)	Undulating rises	*Dissected landscape*	*Major*	*Moderate*
S17	8030 to 8650	Inverloch (In) (Adjusted)	Undulating rises	*No significant attributes*	*Moderate*	*Low*

Trench sector ID	Chainage in metres	Soil landform unit	Broad landform description	Factors affecting sector sensitivity	Significance of impact – unmitigated	Significance of Impact – residual (mitigated by EPRs)
S18	8650 to 9070	Koonwarra (Ko)	Undulating hills	*Mainly due to flood and hydrology plus erosivity*	*Moderate*	*Low*
S19	9070 to 9300	Inverloch (In) (Adjusted)	Gently undulating rises	*Due to uncertainty in ground conditions*	*Moderate*	*Low*
S20	9300 to 9600	Inverloch (In) (Adjusted)	Gently undulating rises	*Possible slope instability and uncertain ground conditions*	*High*	*Low*
S21	9600 to 14200	Inverloch (In) (Adjusted)	Gently undulating rises	*Due to uncertainty in ground conditions*	*Moderate*	*Low*
S22	14200 to 14370	Buffalo (Bu)	Alluvial plain	*Due to uncertainty in ground conditions*	*Moderate*	*Low*
S23	14370 to 14680	Buffalo (Bu)	Narrow alluvial plains (riverine)	*Due to incised channel and hydrology/ flood*	*High*	*Moderate*
S24	14680 to 15000	Buffalo (Bu)	Narrow alluvial plains (riverine)	*Hydrology and surface flows*	*Moderate*	*Low*
S25	15000 to 17150	Inverloch (In) (Adjusted)	Gently undulating plain	*Due to uncertain ground conditions*	*Moderate*	*Low*
S26	17150 to 17670	Tarwin (Tw)	Flood plain	*Due to ground conditions and hydrology. Some consideration for native vegetation*	*Moderate*	*Low*
S27	17670 to 17740	Tarwin (Tw)	Channel	*Due to flood and steep channel banks*	*Moderate*	*Low*
S28	17740 to 18270	Koonwarra (Ko)	Low steep hill	*Steep slopes and evidence of groundwater discharge*	*Major*	*Moderate*
S29	18270 to 18550	Leongatha South (Ls)	Gently undulating rises	*Erosivity, slopewash and hydrology*	*Moderate*	*Low*
S30	18550 to 19130	Leongatha South (Ls)	Gently undulating rises	*Due to uncertain ground conditions*	*Moderate*	*Low*
S31	19130 to 19180	Buffalo (Bu)	Channel	*Due to crossing active channel*	*Major*	*Moderate*
S32	19180 to 20600	Buffalo (Bu)	Alluvial plain	*Due to uncertain ground conditions*	*Moderate*	*Low*
S33	20600 to 21515	Koonwarra (Ko)	Low rise	*Due to possible Cretaceous rock at shallow depth*	*Moderate*	*Low*

Trench sector ID	Chainage in metres	Soil landform unit	Broad landform description	Factors affecting sector sensitivity	Significance of impact – unmitigated	Significance of Impact – residual (mitigated by EPRs)
S34	21515 to 21580	Riverine (Riv)	Channel / Narrow alluvial plains	*Due to hydrology, flood and uncertain soil conditions*	*Moderate*	*Low*
S35	21580 to 27500	Leongatha South (Ls)	Gently undulating rises	*Due to ground conditions, multiple shallow drainage lines*	*Moderate*	*Low*
S36	27500 to 27700	Leongatha South (Ls)	Rise	*Due to possible Cretaceous rock at shallow depth*	*Moderate*	*Low*
S37	27700 to 28470	Leongatha South (Ls)	Gently undulating rises	*Due to uncertain ground conditions*	*Moderate*	*Low*
S38	28470 to 28550	Riverine (Riv)	Channel	*Due to hydrology, flood and uncertain soil conditions*	*Major*	*Moderate*
S39	28550 to 29370	Riverine (Riv)	Alluvial plain	*Due to flood and uncertain ground conditions*	*Moderate*	*Low*
S40	29370 to 29450	Riverine (Riv)	Channel	*Due to hydrology, flood and uncertain soil conditions*	*Moderate*	*Low*
S41	29450 to 31200	Leongatha South (Ls)	Gently undulating rises	*Due to uncertain ground conditions*	*Moderate*	*Low*
S42	31200 to 33600	Koonwarra (Ko)	Low rises	*Due to possible Cretaceous rock at shallow depth / uncertain ground conditions*	*Moderate*	*Low*
S43	33600 to 34700	Koonwarra (Ko)	Low hills	*Due to slope and susceptibility to slope movements, possible rock at shallow depth*	*Moderate*	*Low*
S44	34700 to 34850	Powlett (Po)	Flood plain	*Due to hydrology, flood and ground conditions, active migrating channel*	*High*	*Moderate*
S45	34850 to 34880	Powlett (Po)	Channel	*Due to hydrology, flood and ground conditions, active migrating channel*	*Moderate*	*Low*
S46	34880 to 35780	Powlett (Po)	Flood plain	*Due to hydrology, flood and ground conditions, active migrating channel*	*High*	*Moderate*
S47	35780 to 36250	Warragul (Wg)	Ridge	*Due to weathered volcanics*	*Moderate*	*Low*
S48	36250 to 36580	Powlett (Po)	Alluvial plain	*Due to flood and uncertain ground conditions*	*Moderate*	*Low*
S49	36580 to 36620	Powlett (Po)	Channel	*Due to perched channel and levees, uncertain soils*	*Moderate*	*Low*

Trench sector ID	Chainage in metres	Soil landform unit	Broad landform description	Factors affecting sector sensitivity	Significance of impact – unmitigated	Significance of Impact – residual (mitigated by EPRs)
S50	36620 to 37800	Powlett (Po)	Flood plain	*Due to flood and river avulsion history, soft soil uncertainty*	*Major*	*Moderate*
S51	37800 to 38200	*Warragul (Wg) (Adjusted)*	Low rises	*Due to slope instability*	*Major*	*Moderate*
S52	38200 to 38620	*Warragul (Wg) (Adjusted)*	Low rises	*Due to low slopes in Thorpdale Volcanics*	*Moderate*	*Low*
S53	38620 to 39300	Powlett (Po)	Flood plain	*Due to hydrology and flood*	*Moderate*	*Moderate*
S54	39300 to 39550	Leongatha South (Ls)	Gently undulating rises	*Due to possible colluvial soils and trench stratigraphy*	*Moderate*	*Low*
S55	39550 to 40350	*Warragul (Wg) (Adjusted)*	Low ridge	*Due to relief and slope instability*	*High*	*Moderate*
S56	40350 to 40600	Powlett (Po)	Flood plain	*Due to uncertain ground conditions*	*Moderate*	*Low*
S57	40600 to 40675	Powlett (Po)	Channel	*Due to flood*	*Moderate*	*Moderate*
S58	40675 to 41300	Strzelecki (Sz)	Rolling to steep hills	*Due to relief and slope and possible shallow rock*	*Moderate*	*Moderate*
S59	41300 to 43300	Strzelecki (Sz)	Rolling to steep hills	*Due to uncertainty in ground conditions, stratigraphy*	*High*	*Moderate*
S60	43300 to 43900	Strzelecki (Sz)	Rolling to steep hills	*Due to steep slopes and adjacent scarp, uncertain nature of subsurface materials*	*Moderate*	*Moderate*
S61	43900 to 44700	Strzelecki (Sz)	Rolling to steep hills	*Due to soil profile uncertainty including possible shallow depth to rock*	*High*	*Moderate*
S62	44700 to 45080	Strzelecki (Sz)	Rolling to steep hills	*Due to soil profile uncertainty including possible shallow depth to rock plus Relief and slope*	*High*	*Moderate*
S63	45080 to 45350	Strzelecki (Sz)	Rolling to steep hills	*Due to soil profile including possible shallow depth to rock, relief and slope, and instability*	*High*	*Moderate*
S64	45350 to 45500	Warragul (Wg)	Hills	*Due to presence of landslide in Thorpdale Volcanics*	*Major*	*High*
S65	45500 to 45800	Warragul (Wg)	Summit	*Due to ground conditions*	*Moderate*	*Low*

Trench sector ID	Chainage in metres	Soil landform unit	Broad landform description	Factors affecting sector sensitivity	Significance of impact – unmitigated	Significance of Impact – residual (mitigated by EPRs)
S66	45800 to 45930	Strzelecki (Sz)	Rolling to steep hills	*Due to uncertain slope form and stability*	*High*	*Moderate*
S67	45930 to 46120	Strzelecki (Sz)	Rolling to steep hills	*Due to variable surface materials Possible deeper weathering in lower slopes*	*Moderate*	*Low*
S68	46120 to 46300	Warragul (Wg)	Hills	*Due to steeper slopes in Thorpdale Volcanics*	*High*	*Moderate*
S69	46300 to 46600	Strzelecki (Sz)	Rolling hills	*Due to landslides below*	*Moderate*	*Moderate*
S70	46600 to 47050	Strzelecki (Sz)	Rolling hills	*Due to stability, uncertain ground condition, potential groundwater discharge*	*Major*	*Moderate*
S71	47050 to 47350	Strzelecki (Sz)	Rolling hills	*due to uncertain ground conditions and depth to rock*	*High*	*Moderate*
S72	47350 to 47400	Strzelecki (Sz)	Channel	*Due to hydrology, flood and excavatability within Strzelecki*	*High*	*Moderate*
S73	47400 to 47620	Strzelecki (Sz)	Rolling hills	*Due to uncertain ground conditions and depth to rock*	*High*	*Moderate*
S74	47620 to 47700	Strzelecki (Sz)	Alluvial plains	*Due to varied regolith and drainage. Possible colluvium*	*High*	*Moderate*
S75	47700 to 48000	Strzelecki (Sz)	Rolling hills	*Due to existing landslides and slope*	*Major*	*High*
S76	48000 to 48300	Strzelecki (Sz)	Rolling hills	*Due to uncertain regolith composition*	*Moderate*	*Low*
S77	48300 to 48380	Strzelecki (Sz)	Rolling hills	*Due to regolith and moderate slope*	*Moderate*	*Low*
S78	48380 to 48395	Strzelecki (Sz)	Channel	*Due to erosivity and regolith uncertainty, possibly soft soils and ASS*	*Major*	*Moderate*
S79	48395 to 48740	Strzelecki (Sz)	Rolling hills	*Due to existing landslides and slope instability*	*Major*	*High*
S80	48740 to 49100	Strzelecki (Sz)	Ridge	*Due to regolith and proximity to valley head*	*High*	*Moderate*
S81	49100 to 49340	Strzelecki (Sz)	Rolling hills	*Due to possible landslide and uncertain regolith*	*High*	*High*

Trench sector ID	Chainage in metres	Soil landform unit	Broad landform description	Factors affecting sector sensitivity	Significance of impact – unmitigated	Significance of Impact – residual (mitigated by EPRs)
S82	49340 to 49380	Strzelecki (Sz)	Channel	*Due to landscape position in floodway*	*Major*	*High*
S83	49380 to 49600	Strzelecki (Sz)	Rolling hills	*Due to adjacent landslides and steep slopes*	*High*	*High*
S84	49600 to 50000	Warragul (Wg)	Ridge	*Due to regolith uncertainty*	*Moderate*	*Low*
S85	50000 to 50300	Warragul (Wg)	Rolling hills	*Due to existing landslide*	*High*	*High*
S86	50300 to 50420	Strzelecki (Sz)	Flood plain	*Due to flood, hydrology and regolith*	*High*	*Low*
S87	50420 to 50510	Strzelecki (Sz)	Low ridge	*Due to relief mainly*	*Moderate*	*Low*
S88	50510 to 50540	Strzelecki (Sz)	Channel	*Due to flood hydrology, regolith*	*Major*	*Moderate*
S89	50540 to 50740	Warragul (Wg)	Undulating hills	*Due to existing landslide*	*Major*	*High*
S90	50740 to 50970	Warragul (Wg)	Undulating hills	*Due to regolith*	*Moderate*	*Low*
S91	50970 to 51300	Warragul (Wg)	Undulating hills	*Due to existing slope instability and regolith uncertainty*	*High*	*Moderate*
S92	51300 to 51700	Warragul (Wg)	Undulating hills	*Due to regolith*	*Moderate*	*Low*
S93	51700 to 52050	Warragul (Wg)	Undulating hills	*Due to existing landslides*	*Major*	*Moderate*
S94	52050 to 52080	Warragul (Wg)	Channel	*Due to flood hydrology, regolith*	*Major*	*Moderate*
S95	52080 to 52120	Strzelecki (Sz)	Ridge	*due to possible slope instability*	*High*	*Moderate*
S96	52120 to 52220	Strzelecki (Sz)	Ridge	*Due to regolith uncertainty*	*Moderate*	*Low*
S97	52220 to 52290	Strzelecki (Sz)	Ridge	*Due to moderate slopes and regolith*	*Moderate*	*Low*

Trench sector ID	Chainage in metres	Soil landform unit	Broad landform description	Factors affecting sector sensitivity	Significance of impact – unmitigated	Significance of Impact – residual (mitigated by EPRs)
S98	52290 to 52340	Strzelecki (Sz)	Valley floor	*Due to hydrology and flood*	*High*	*Moderate*
S99	52340 to 52500	Strzelecki (Sz)	Rolling hills	*Due to moderate slopes and regolith*	*Moderate*	*Moderate*
S100	52500 to 52700	*Warragul (Wg) Adjusted*	Undulating hills	*Due to possible Thorpdale and regolith*	*Moderate*	*Low*
S101	52700 to 53100	Warragul (Wg)	Ridge	*Due to regolith*	*Moderate*	*Low*
S102	53100 to 53370	*Warragul (Wg) Adjusted*	Undulating hills	*Due to existing slope instability and regolith uncertainty*	*High*	*Moderate*
S103	53370 to 53390	*Warragul (Wg) Adjusted*	Valley floor	*Due to hydrology and flood*	*High*	*Moderate*
S104	53390 to 53500	Contact Warragul with Strzelecki	Undulating hills	*Due to springs and existing slope instability*	*Major*	*Moderate*
S105	53500 to 53720	Contact Warragul with Strzelecki	Undulating hills	*Due to regolith*	*Moderate*	*Low*
S106	53720 to 53800	Contact Warragul with Strzelecki	Undulating hills	*Due to hydrology and flood*	*Moderate*	*Moderate*
S107	53800 to 53900	Contact Warragul with Strzelecki	Undulating hills	*Due to moderate slopes in Thorpdale*	*Moderate*	*Low*
S108	53900 to 54330	Contact Warragul with Strzelecki	Ridge and undulating slopes	*Due to regolith*	*Moderate*	*Low*
S109	54330 to 54370	Riverine (Riv)	Channel	*Due to flood and hydrology plus regolith*	*Major*	*Moderate*
S110	54370 to 54770	Riverine (Riv)	Alluvial terrace	*Due to regolith uncertainty, Varied in floodplain*	*Moderate*	*Low*
S111	54770 to 54810	Riverine (Riv)	Channel	*Due to flood, regolith erosion*	*Moderate*	*Moderate*
S112	54810 to 54970	*Warragul (Wg) Adjusted*	spur	*Due to regolith*	*Moderate*	*Low*
S113	54970 to 55010	Riverine (Riv)	Channel	*Due to flood and hydrology, regolith*	*High*	*Moderate*

Trench sector ID	Chainage in metres	Soil landform unit	Broad landform description	Factors affecting sector sensitivity	Significance of impact – unmitigated	Significance of Impact – residual (mitigated by EPRs)
S114	55010 to 55030	Warragul (Wg)	Undulating rises	*Due to very steep slope/ escarpment and landslide*	*Major*	*High*
S115	55030 to 55940	Warragul (Wg)	Undulating rises	*due to undulating terrain and evidence of instability*	*High*	*Moderate*
S116	55940 to 56250	Warragul (Wg)	Undulating rises	*Due to regolith and landslide to the west*	*Moderate*	*Moderate*
S117	56250 to 56830	Warragul (Wg)	Landslide slopes	*Due to significant landslide features*	*Major*	*High*
S118	56830 to 57180	Warragul (Wg)	Landslide slopes	*Due to older degraded landslide and regolith*	*Moderate*	*Low*
S119	57180 to 57530	Morwell with Boolarra (Mr/Bl)	Rolling low hills to undulating rises.	*Due to regolith*	*Low*	*Low*
S120	57530 to 57900	Morwell with Boolarra (Mr/Bl)	Rolling low hills to undulating rises.	*Due to proximity to valley head*	*Moderate*	*Low*
S121	57900 to 60400	Morwell with Boolarra (Mr/Bl)	Rolling low hills to undulating rises.	*Due to regolith uncertainty*	*Moderate*	*Low*
S122	60400 to 61100	Morwell with Boolarra (Mr/Bl)	Rolling low hills to undulating rises.	*Due to proximity to gully heads*	*Moderate*	*Low*
S123	61100 to 61500	Uncertain Contact Morwell with Boolarra (Mr/Bl) and Warragul	Rolling low hills to undulating rises	*Due to possible landslides and uncertain regolith*	*High*	*Moderate*
S124	61500 to 61530	Uncertain Contact Morwell with Boolarra (Mr/Bl) and Warragul	Channel	*Due to hydrology and flood*	*Major*	*Moderate*
S125	61530 to 61800	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low hills.	*Due to slope instability*	*Moderate*	*Moderate*
S126	61800 to 63500	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low hills	*Due to regolith uncertainty*	*Moderate*	*Low*

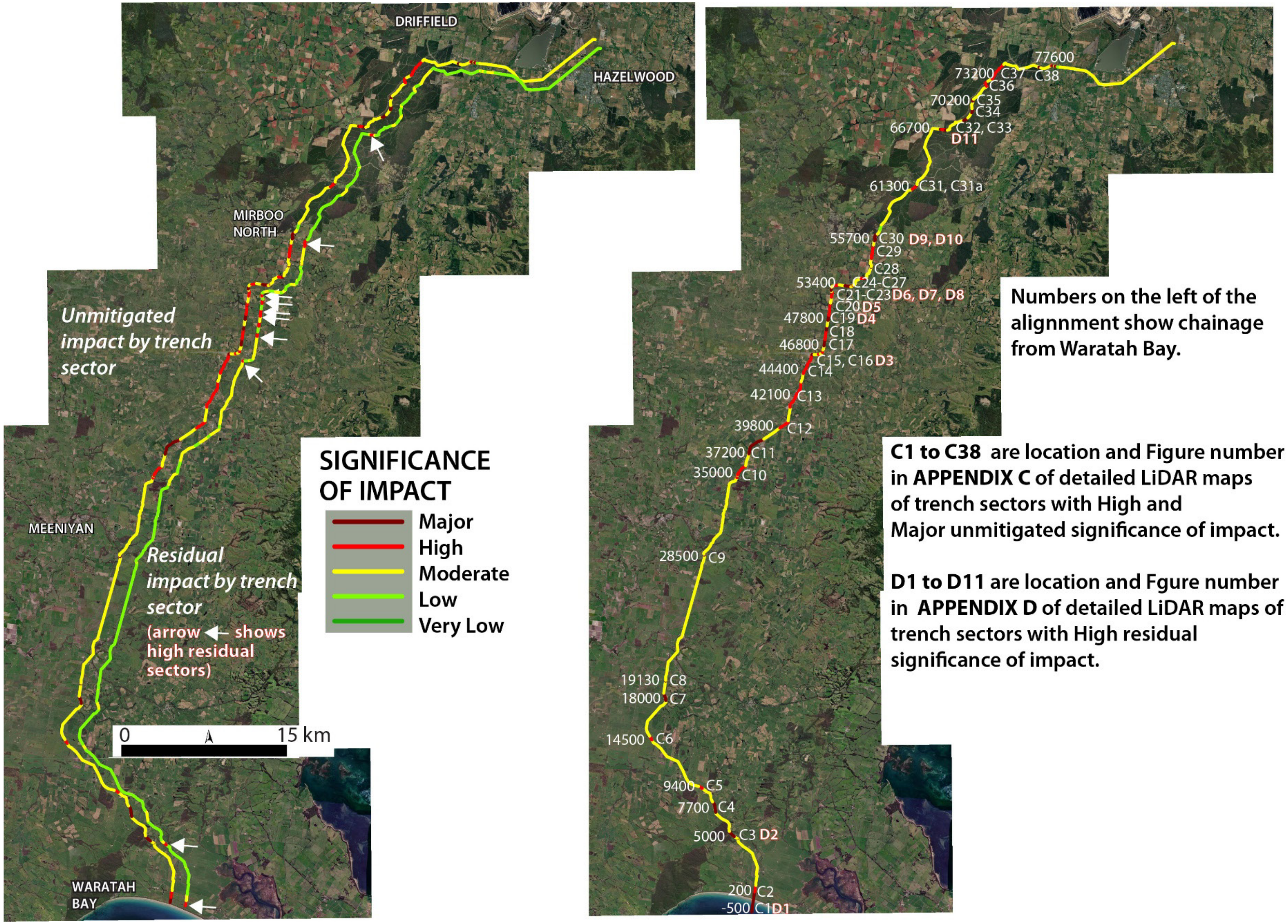
Trench sector ID	Chainage in metres	Soil landform unit	Broad landform description	Factors affecting sector sensitivity	Significance of impact – unmitigated	Significance of Impact – residual (mitigated by EPRs)
S127	63500 to 63600	Swamp (sw)	Swamp	*Due to low lying wetland, hydrology, flood*	*Moderate*	*Moderate*
S128	63600 to 64500	Silver Creek with Warragul (Sc/Wg)	Rolling low hills	*Due to regolith and possible erosivity*	*Moderate*	*Low*
S129	64500 to 65300	Silver Creek with Warragul (Sc/Wg)	Rolling low hills	*Due to slope and relief and possible uncertain regolith*	*Moderate*	*Low*
S130	65300 to 66530	Silver Creek with Warragul (Sc/Wg)	Rolling low hills	*Due to regolith*	*Moderate*	*Low*
S131	66530 to 66640	Silver Creek with Warragul (Sc/Wg)	Valley floor	*Due to proximity to watercourse, flood and regolith*	*Major*	*Moderate*
S132	66640 to 66900	Silver Creek with Warragul (Sc/Wg)	Ridge	*Due to possible landslides and uncertain regolith*	*High*	*High*
S133	66900 to 67030	Silver Creek with Warragul (Sc/Wg)	Channel	*Due to flood hydrology and uncertain regolith*	*Major*	*Moderate*
S134	67030 to 68000	Silver Creek with Warragul (Sc/Wg)	Rolling low hills	*Due to regolith*	*Moderate*	*Low*
S135	68000 to 68500	Silver Creek with Warragul (Sc/Wg)	Rolling low hills	*Due to regolith and moderate slopes*	*Moderate*	*Low*
S136	68500 to 68850	Silver Creek with Warragul (Sc/Wg)	Rolling low hills	*Due to slope and proximity to gully head, groundwater outflow*	*Major*	*Moderate*
S137	68850 to 69300	Silver Creek with Warragul (Sc/Wg)	Rolling low hills	*Due to slope and regolith*	*Moderate*	*Low*
S138	69300 to 69600	Silver Creek with Warragul (Sc/Wg)	Rolling low hills	*Due to slope and proximity to gully head, groundwater outflow*	*Major*	*Moderate*
S139	69600 to 70140	Silver Creek with Warragul (Sc/Wg)	Rolling low hills	*Due to regolith*	*Moderate*	*Low*
S140	70140 to 70300	Silver Creek with Warragul (Sc/Wg)	Rolling low hills	*Due to slope, hydrology, and flood*	*Major*	*Moderate*
S141	70300 to 71600	Silver Creek with Warragul (Sc/Wg)	Rolling low hills	*Due to slope and regolith*	*Moderate*	*Low*
S142	71600 to 72050	Silver Creek with Warragul (Sc/Wg)	Rolling low hills	*Due to slope and regolith*	*High*	*Moderate*

Trench sector ID	Chainage in metres	Soil landform unit	Broad landform description	Factors affecting sector sensitivity	Significance of impact – unmitigated	Significance of Impact – residual (mitigated by EPRs)
S143	72050 to 72400	Silver Creek with Warragul (Sc/Wg)	Rolling low hills	*Due to regolith*	*Moderate*	*Low*
S144	72400 to 73700	Silver Creek with Warragul (Sc/Wg)	Rolling low hills	*Due to proximity to numerous active gully heads*	*High*	*Moderate*
S145	73700 to 74050	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low hills	*Due to regolith uncertainty*	*Moderate*	*Low*
S146	74050 to 74250	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low hills	*Due to regolith uncertainty*	*Moderate*	*Low*
S147	74250 to 74620	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low hills	*Due to regolith uncertainty*	*Moderate*	*Low*
S148	74620 to 74930	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low hills	*Due to relief and slope and regolith*	*Moderate*	*Low*
S149	74930 to 74980	Boolarra with Morwell (Bl/Mr)	Valley floor	*Due to hydrology and flood*	*Moderate*	*Low*
S150	74980 to 75230	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low hills	*Due to regolith uncertainty*	*Moderate*	*Low*
S151	75230 to 75300	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low hills	*Due to regolith uncertainty*	*Moderate*	*Low*
S152	75300 to 75450	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low hills	*Due to possible landslide in small gully below*	*Moderate*	*Low*
S153	75450 to 75750	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low hills	*Due to regolith uncertainty*	*Moderate*	*Low*
S154	75750 to 76050	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low hills	*Due to complex regolith stratigraphy and proximity to large landslide below*	*Moderate*	*Low*

Trench sector ID	**Chainage in metres**	**Soil landform unit**	**Broad landform description**	**Factors affecting sector sensitivity**	**Significance of impact – unmitigated**	**Significance of Impact – residual (mitigated by EPRs)**
S155	76050 to 76400	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low hills	*Due to complex regolith stratigraphy*	*Moderate*	*Low*
S156	76400 to 76530	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low hills	*Due to slope and regolith stratigraphy plus adjacent landslide*	*Low*	*Low*
S157	76530 to 77320	Yinnar (Yn) (adjusted)	Stagnant alluvial plain	*Due to complex soil stratigraphy*	*Moderate*	*Low*
S158	77320 to 77400	Riverine (Riv)	Alluvial plain	*Due to steep slopes and soft soil, stability*	*High*	*Low*
S159	77400 to 77520	Riverine (Riv)	Alluvial plain	*Due to hydrology, flood, soft soils, and potential ASS*	*Major*	*Moderate*
S160	77520 to 77580	Riverine (Riv)	Alluvial plain	*Due to relief and slope and regolith*	*Moderate*	*Low*
S161	77580 to 77680	Riverine (Riv)	Alluvial plain	*Due to hydrology, flood, soft soils, and potential ASS*	*Major*	*Moderate*
S162	77680 to 77740	Riverine (Riv)	Alluvial plain	*Due to steep slopes and regolith*	*High*	*Moderate*
S163	77740 to 77920	Riverine (Riv)	Alluvial plain	*Due to regolith uncertainty*	Low	Low
S164	77920 to 77950	Riverine (Riv)	Alluvial plain	*Due to relief and slope and stability*	*Moderate*	*Moderate*
S165	77950 to 78230	Riverine (Riv)	Flood plain and channel	*Due to flood and hydrology plus regolith*	*Moderate*	*Moderate*
S166	78230 to 78450	Yinnar (Yn)	Alluvial plain	*Due to landslide presence*	*Moderate*	*Moderate*
S167	78450 to 78870	Yinnar (Yn)	Alluvial plain	*Due to complex regolith stratigraphy*	*Moderate*	Low
S168	78870 to 78920	Yinnar (Yn)	Alluvial plain	*Due to moderate slopes, regolith and hydrology*	*Moderate*	Low
S169	78920 to 78930	Yinnar (Yn)	Alluvial plain	*Due to hydrology and flood*	*Moderate*	Low

Trench sector ID	Chainage in metres	Soil landform unit	Broad landform description	Factors affecting sector sensitivity	Significance of impact – unmitigated	Significance of Impact – residual (mitigated by EPRs)
S170	78930 to 78970	Yinnar (Yn)	Alluvial plain	*Due to relief and slopes and regolith uncertainty/ complex stratigraphy*	*Moderate*	Low
S171	78970 to 79040	Yinnar (Yn)	Alluvial plain	*Due to complex regolith stratigraphy*	*Moderate*	Low
S172	79040 to 79060	Yinnar (Yn)	Alluvial plain	*Due to moderate slopes, regolith and hydrology*	*Moderate*	Low
S173	79060 to 79170	Yinnar (Yn)	Alluvial plain	*Due to hydrology flood and regolith*	*Moderate*	Low
S174	79170 to 79300	Yinnar (Yn)	Alluvial plain	*Due to moderate slopes, regolith hydrology*	*Moderate*	Low
S175	79300 to 79720	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low hills	*Due to regolith variable stratigraphy*	*Moderate*	Low
S176	79720 to 79950	Yinnar (Yn)	Alluvial plain	*Due to relief and slope and regolith uncertainty*	*Moderate*	Low
S177	79950 to 81550	Yinnar (Yn)	Alluvial plain	*Due to flood and regolith uncertainty*	*Moderate*	Low
S178	81550 to 81730	Yinnar (Yn)	Alluvial plain	*Due to nature of paleo channel and regolith*	*Moderate*	Low
S179	81730 to 83070	Yinnar (Yn)	Alluvial plain	*Due to floodplain nature, regolith hydrology and flood*	*Moderate*	Low
S180	83070 to 83350	Yinnar (Yn)	Alluvial plain	*Due to regolith uncertainty*	*Moderate*	Low
S181	83350 to 83500	Riverine (Riv)	Alluvial plain and channel	*Due to flood*	*Moderate*	Low
S182	83500 to 85400	Uncertain Loy Yang (Ly) possible spoil.	Undulating low rises	*Due to regolith uncertainty*	*Moderate*	Low
S183	85400 to 87200	Loy Yang (Ly)	Plain	*Due to complex regolith stratigraphy*	*Moderate*	Low

Figure 6-1 Unmitigated and residual significance of impact on geomorphology and soils (Base: World Imagery 2018)



6.2.6 Significance of impact assessment for shore crossing and other infrastructure

Significance of impact assessment has been carried out for all other project components: shore crossing, Waratah Bay transition station, HDD pads, laydown areas, joining pits and the Driffield and Hazelwood converter stations.

6.2.6.1 Shore crossing

The detailed assessment of the shore crossing HDD is provided in the main table of impact assessment (Appendix A:) and summarised in Table 6-5 below.

Table 6-5 Summary of significance of impact assessment for shore crossing sectors – unmitigated and mitigated by application of EPRs

ID	Chainage in metres	Soil landform unit	Broad landform description	Factors affecting sector sensitivity	Significance of impact – unmitigated	Significance of Impact – mitigated / EPRs
SC1	*-1100 to -450*	*N/A*	*Subtidal*	*Stability of landforms and erosivity within a subtidal area. Difficult conditions for HDD*	*Major*	*Moderate*
SC2	*-450 to -120*	*N/A*	*Intertidal*	*Stability of landforms and erosivity within a subtidal area. Difficult conditions for HDD*	*Major*	*Moderate*
SC3	*-120 to 0*	*Sand Dunes (sd)*	*Foredunes*	*Stability of landforms and erosivity by waves and wind*	*Major*	*High*

Note: the “High” mitigated significance of impact in SC3 in Table 6-3 is based on an incident during the Basslink shore crossing HDD at McGaurans Beach, Victoria in May 2004 that resulted in four ground subsidence sinkholes and drilling fluid discharge (Enesar Consulting 2004, Environmental GeoSurveys 2004). The location is a coastal barrier and backshore depression of the Ninety Mile Beach of similar geomorphology and age to the proposed Waratah Bay crossing. Confirmation of sub-surface materials and appropriate HDD implementation is required to minimise the risk of an HDD incident occurring at this shore crossing, as required by EPRs GM01, GM02 and GM05.

6.2.6.2 Other infrastructure

All other infrastructure is located along the trench alignments. As such the significance of impact assessment given for that trench sector can be applied to the other components, given the magnitude of impact will generally be equivalent or less than for trench construction.

6.2.6.3 Driffield converter station

The converter station at Driffield has been assessed separately and is included in the main impact assessment table with the trench sectors (Appendix A:) and reproduced in summary form in Table 6-6 below. The site is the subject of a detailed geotechnical study (Jacobs 2022b).

Table 6-6 Driffield Converter Station: Summary of significance of impact assessment for trench sectors and overall converter station site – unmitigated and mitigated by application of EPRs

ID	Chainage in metres	Soil landform unit	Broad landform description	Factors affecting sector sensitivity	Significance of impact – unmitigated	Significance of impact – mitigated / EPRs
D1	0 to 270	Boolarra with Morwell (Bl/Mr)	Ridge crest	*Due to regolith*	*Moderate*	Low
D2	270 to 340	Boolarra with Morwell (Bl/Mr)	Valley slope	*Due to moderate slopes and regolith variability*	*Moderate*	Low
D3	340 to 510	Boolarra with Morwell (Bl/Mr)	Gentle valley and low ridge	*Due to regolith*	*Moderate*	Low
D4	510 to 720	Boolarra with Morwell (Bl/Mr)	Gentle valley and low ridge	*Due to regolith and geology change*	*Moderate*	Low
D5	Overall Converter Station Site	Boolarra with Morwell (Bl/Mr)	Gentle valley and low ridge	*Due to regolith, geology change and groundwater proximity to cuts, significant relief and slope issue due to amount of cut and fill needed*	*Major*	*Moderate*

6.2.6.4 Hazelwood Converter Station

The converter station at Driffield has been assessed separately and is included in the main impact assessment table with the trench sectors (Appendix A:) and reproduced in summary form in Table 6-7 below. No geotechnical information is available.

Table 6-7 Hazelwood Converter Station: Summary of significance of impact – unmitigated and mitigated by application of EPRs

ID	Chainage in metres	Soil landform unit	Broad landform description	Factors affecting sector sensitivity	Significance of impact – unmitigated	Significance of impact – mitigated / EPRs
H1	Overall Converter Station Site	Loy Yang (Ly)	Broad low hill	*Due to regolith and extensive cut and fill needed*	*Major*	*Moderate*

6.3 DISCUSSION OF SIGNIFICANCE OF IMPACT ASSESSMENT

The major impacts on geomorphology and soils relate to the proposed Marinus Link trench crossing landscapes that are locally steep with evidence of existing slope instability, have numerous drainage lines, areas of deeply weathered rock and unconsolidated and often complex regolith and experience locally high rainfall. The shore crossing HDD is below deep accumulations of unconsolidated coastal beach and dune sand.

The detailed assessment of the sensitivity of geomorphic attributes and magnitude of impact of the proposed project's engineering activities identified a number of sectors of the trench with potential for a high unmitigated significance of impact on geomorphology and soils. Residual impacts, assuming the successful application of EPRs, generally results in a significant reduction of these high impacts.

The potential unmitigated impacts are those that stem directly from trench excavation and other ground disturbance that:

- exposes sub-surface materials of variable strength at angles steeper than natural stable repose.
- intersects slopes that display active or incipient landslides or other forms of slope instability.
- crosses stream channels with exposed regolith on bed and banks and incised thread channels.
- alters local surface and groundwater conditions.

Design and construction methods that can be applied to accommodate these impacts are outlined in the EPRs specified in Table 6-1 in Section 6.2.2 above. These encompass a wide range of procedures including timing construction to avoid immediate and seasonal wet weather and being cognisant of groundwater levels to avoid construction in ground conditions of standing or flowing surface water and soil saturation. A program must be developed for inspection of excavations during construction. The purpose of these inspections is to confirm that trenches are excavated in accordance with AS 3798-2007 *Guidelines on earthworks for commercial and residential developments, and the Best Practice Erosion and Sediment Control Guidelines* (IECA 2008), and in a manner that results in long-term stability.

When carrying out the design, consideration should be given to loading imposed on the open trench. Such loading may be associated with construction traffic or may be imposed by pre–existing structures such as buildings, fills, roadways. Mobile equipment and other construction material stored close to the trench also add a surcharge that will affect trench stability and must be avoided. Powered mobile plant should not operate or travel near the edge of an excavation unless the ground support system installed has been designed to carry such loads. Physical barriers, such as wheel stoppers, can be one way of restricting plant movement near an excavation. Spoil from excavation should be managed to avoid undue ground loading near excavations and covered to avoid rainwash dispersal. Drainage measures must be implemented to prevent surface runoff into excavations, cause local inundation or initiate slope-soil wash.

Site investigation by a geomorphologist, including collection of sub-surface cores down to at least trench/HDD depth in order to determine stratigraphy, of the 13 sectors of high residual impact is recommended to inform project design, including choice of construction methods. If site investigation reveals that ground conditions are unsuitable for construction or construction activities might impact slope stability or existing or potential landslides (i.e., geomorphic stability cannot be assured through design and application of EPRs), realignment is recommended in those sectors.

A summary of the assessment results for both unmitigated and those with EPRs applied (residual impact) is shown in tables Table 6-8 and Table 6-9 below.

Table 6-8 Unmitigated significance of impact

Area	Unmitigated significance of impact assessment – number within each area			
	Major	High	Moderate	Low
Shore Crossing	3	0	0	0
Main Alignment	32	34	114	3
Driffield/Hazelwood Offtake	2	0	4	

Table 6-9 Residual significance of impact

Area	Residual significance of impact assessment – number within each area			
	Major	High	Moderate	Low
Shore Crossing	0	1	2	0
Main Alignment	0	12	66	105
Driffield/Hazelwood Offtake	0	0	2	4

7. CONCLUSION

This technical report presents the results of a desktop assessment of existing conditions of geomorphology and soils for the shore crossing and terrestrial component of the project in Victoria. The project crosses a varied landscape with reaches of gently undulating low elevation terrain alternating with dissected elevated hillslopes with close-spaced drainage lines and moderate to locally steep slopes. There is minimal rock outcrop, and the surface has a continuous soil cover over a regolith of decomposed rock typically metres thick. Many slopes, notably with an underlying geology of weathered Cenozoic basalt and thick colluvium display landslides and other forms of slope instability. The upper reaches of many drainage lines are flanked by alluvium with groundwater outflow as the channel source. The shore crossing is an area of unconsolidated subaqueous and subaerial beach backed by unconsolidated dune sand and relict tideway sediments.

The desktop study identified four groups of existing slope instability: landslides, slope mass movement, channel incision, gully heads.

The potential impacts of the project on geomorphology and soils were evaluated using a significance of impact approach. The highest initial impact occurs due to the 1.5 m deep excavations for the two cable trenches, several HDD tunnels, and cable joint pits at nominal intervals of between 800 m to 1200 m along the alignment which will include buried infrastructure to 3 m below ground surface.

Using the 192 trench sectors as the basic landform unit, the initial desktop assessment of unmitigated construction impact of identified:

- 37 sectors of major impact
- 34 sectors of high impact
- 118 sectors of moderate impact
- 3 sectors of low impact

EPRs were developed to address the potential impacts from construction of the project. An assessment of residual impact after application of the EPRs identified:

- 13 sectors of high impact
- 69 sectors of moderate impact
- 105 sectors of low impact

As stated previously, this technical report is a desktop study only. In consequence, details of ground conditions are uncertain and inferred from the remote sources and literature cited. This is a considerable constraint as the existing status of surfaces and subsurface of areas identified as landslides or other forms of slope instability has not been verified.

It is concluded that the engineering activities of the project without mitigation has the potential for major, high, and moderate impact on much of the terrain which has a number of significantly sensitive geomorphic attributes. This residual impact can be reduced and managed to varying degrees by applying appropriate design, construction, and operational strategies implemented to comply with the EPRs.

Site investigation by a geomorphologist (including collection of sub-surface cores down to at least trench/HDD depth to determine stratigraphy) of the 13 sectors of high residual impact is recommended to inform project design, including choice of construction methods. If site investigation reveals that ground conditions are unsuitable for construction or construction activities might impact slope stability or existing or potential landslides (i.e., geomorphic stability cannot be assured through design and application of EPRs), realignment is recommended in those sectors.

Unforeseen events (e.g., landslides) will be covered in EIS/EES Volume 5, Chapter 2 – Environmental Management Framework.

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APPENDIX A: SIGNIFICANCE OF IMPACT ASSESSMENT DETAILS

Mitigated Impacts

Shore Crossing

Trench Sector ID	chainages	soil landform unit	Broad Landform 1:100K scale	Site geomorphic description	Slope Class within study area	Geology (1;100K soil mapping)	Geology (1;250K GSV mapping)	overalls sensitivity of sector	Unmitigated significance of impact	Factors determining sensitivity of sector	Standard Environmental Performance Requirements (as per Coffey List)	Unmitigated Magnitude of Impact	Mitigated Magnitude of impact	Mitigated Significance of Impact	Factor determining Residual Impact after EPR's and other comments
SC1	-1100 to -450	N/A	subtidal		Gently inclined (2-6°)			ES	Major	Stability of landforms and erosivity within a subtidal area. Difficult conditions for HDD	GM01, GM05	Severe	Minor	Moderate	Using HDD
SC2	-450 to -120	N/A	intertidal		Gently inclined (2-6°)			ES	Major	Stability of landforms and erosivity within a subtidal area. Difficult conditions for HDD	GM01, GM05	Severe	Minor	Moderate	Using HDD
SC3	-120 to 0	Sand Dunes (sd)	Foredunes	dune crest and swales	Steep (18-30°)	Pleistocene to recent aeolian sediments	coastal dune deposits (Qdl1): generic	ES	Major	Unconsolidated soils. stability of landforms and erosivity by waves and wind	GM01, GM05	Severe	Moderate	High	Detailed geotechnical investigation and stability analysis required to confirm conditions for HDD

Trench Alignment

S1	0 to 380	Recent Marine (rm)	Palaeo tideway		Very gently inclined (0.5-2°)	Recent marine sediments.	coastal lagoon deposits (Qg): generic	ES	Major	Inundation, surface flows and soft soils. Potential ASS	GM01,GM02,GM03,GM04, GM06,GM08, GM09	Major	Minor	Moderate	care taken with ASS needed
S2	380 to 850	Agnes (Ag)	Gently undulating ridge and swale plain		Gently inclined (2-6°)	Late Pleistocene to Recent alluvium and colluvium derived from the Gip	coastal lagoon deposits (Qg): generic	VS	High	Regolith stability and soft/unconsolidated soils	GM01,GM02,GM04, GM06, GM07,GM08	Moderate	Minor	Moderate	Possible costal impacts to be confirmed
S3	850 to 2270	Foster (Fo)	Plain		Very gently inclined (0.5-2°)	Tertiary sediments, probably derived from the Mount Hoddle Range	coastal lagoon deposits (Qg): generic/colluvium(Qc1): g	S	Moderate	Regolith and soft soils , possible waterlogging	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S4	2270 to 2850	Agnes (Ag)	Gently undulating plain		Gently inclined (2-6°)	Late Pleistocene to Recent alluvium and colluvium derived from the Gip	coastal lagoon deposits (Qg): generic/colluvium(Qc1): g	S	Moderate	Regolith and soft soils	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S5	2850 to 2890	Agnes (Ag)	Channel		Very steep (30-45°)	Late Pleistocene to Recent alluvium and colluvium derived from the Gip	Haunted Hills Formation(Nlh): generic/alluvial terrace d	ES	Moderate	Very steep sided channel and soft materials	GM01, GM05 ,GM09	Minor	Negligible	Moderate	Already using HDD
S6	2890 to 3500	Agnes (Ag)	Gently undulating plain	some shallow channels	Gently inclined (2-6°)	Late Pleistocene to Recent alluvium and colluvium derived from the Gip	generic/colluvium(Qc1): generic/Haunted Hills Formatio	S	Moderate	Regolith and soft soils	GM01,GM02,GM04,GM06, GM08,GM09	Moderate	Minor	Low	
S7	3500 to 4440	Agnes (Ag)	Gently undulating plain	lower valley slopes above creek	Gently inclined (2-6°)	Late Pleistocene to Recent alluvium and colluvium derived from the Gip	Haunted Hills Formation(Nlh): generic	S	Moderate	Potential for variable soil stratigraphy including gravel	GM01,GM02,GM03, GM04,GM06, GM08	Moderate	Minor	Low	
S8	4440 to 4690	Inverloch (In)	Undulating rises	lower valley slopes above creek	Moderately inclined (6-18°)	Mostly Tertiary sediments, some Early Pleistocene sediments	Haunted Hills Formation(Nlh): generic	S	Moderate	Proximity to the drainage line below	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	Ensure slope stability
S9	4690 to 4720	Inverloch (In)	Channel		Very steep (30-45°)	Mostly Tertiary sediments, some Early Pleistocene sediments	Haunted Hills Formation(Nlh): generic	ES	Major	Mainly to do with drainage and flooding/ surface flows. Base of a drainage line	GM01, GM02, GM03, GM04,GM06,GM07, GM08, GM09	Major	Minor	Moderate	Consider HDD as better alternative
S10	4720 to 4950	Inverloch (In)	Undulating rises	crest/ divide between two shallov	Moderately inclined (6-18°)	Mostly Tertiary sediments, some Early Pleistocene sediments	Haunted Hills Formation(Nlh): generic	S	Moderate	Potential for variable soil stratigraphy including gravel	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S11	4950 to 5200	Inverloch (In)	landslide		Moderately inclined (6-18°)	Mostly Tertiary sediments, some Early Pleistocene sediments	Haunted Hills Formation(Nlh): generic	ES	Major	Complex terrain and uncertainty as to spatial extent of slope movement	GM01, GM02,GM04,GM06, GM07, GM08	Major	Moderate	High	Needs landslide assessment and detailed geo investigation
S12	5200 to 5450	Inverloch (In)	Undulating rises	Valley head/ possible area of inst	Moderately inclined (6-18°)	Mostly Tertiary sediments, some Early Pleistocene sediments	Liptrap Formation(Dxl): generic	VS	Major	Uncertain geology and geological structure, evidence of slope instability	GM01, GM02,GM04,GM06, GM07, GM08	Major	Minor	Moderate	Confirm slope stability - Landslide assessment
S13	5450 to 6400	Inverloch (In)	Undulating rises to low hills	Crest above series of gully heads s	Moderately inclined (6-18°)	Mostly Tertiary sediments, some Early Pleistocene sediments	Liptrap Formation(Dxl): generic/Haunted Hills Formation	S	Moderate	Some relief and slope, possible excavation issues	GM01,GM02,GM04,GM06, GM07, GM08, GM09	Moderate	Minor	Low	Care need crossing gullies
S14	6400 to 7100	Inverloch (In)	Undulating rises		Gently inclined (2-6°)	Mostly Tertiary sediments, some Early Pleistocene sediments	Haunted Hills Formation(Nlh): generic	S	Moderate	Crossing drainage line at 6700	GM01,GM02,GM04,GM06, GM08, GM09	Moderate	Minor	Low	
S15	7100 to 7250	Inverloch (In)	Undulating rises	Valley head with gully fill	Moderately inclined (6-18°)	Mostly Tertiary sediments, some Early Pleistocene sediments	Haunted Hills Formation(Nlh): generic	S	Moderate	Proximity to a head of a drainage line	GM01,GM02,GM04,GM06, GM07, GM08, GM09	Moderate	Minor	Low	Care needed crossing gully heads -landslide assessment
S16	7250 to 8030	Inverloch (In)	Undulating rises	Shallow valley heads	Moderately inclined (6-18°)	Mostly Tertiary sediments, some Early Pleistocene sediments	Haunted Hills Formation(Nlh): generic	VS	Major	Dissected landscape	GM01, GM02,GM04,GM06, GM07, GM08, GM09	Major	Minor	Moderate	undertake landslide assessment to confirm conditions
S17	8030 to 8650	Inverloch (In) (Adjusted)	Undulating rises	Ridge (haunted Hills)	Gently inclined (2-6°)	Mostly Tertiary sediments, some Early Pleistocene sediments	Haunted Hills Formation(Nlh): generic	S	Moderate	No significant attributes	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S18	8650 to 9070	Koonwarra (Ko)	Undulating hills.	Inlier of Cretaceous. Valley slopes	Moderately inclined (6-18°)	Mesozoic sediments (Cretaceous) - consisting of sandstones, siltstone	Haunted Hills Formation(Nlh): generic	S	Moderate	Mainly due to flood and hydrology plus erosivity	GM01,GM02,GM04,GM05, GM06, GM07, GM08, GM09	Moderate	Minor	Low	Consider extending HDD for entire sector
S19	9070 to 9300	Inverloch (In) (Adjusted)	Gently undulating rises	Narrow flat divide between ambe	Gently inclined (2-6°)	Mostly Tertiary sediments, some Early Pleistocene sediments	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to uncertainty in ground conditions	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S20	9300 to 9600	Inverloch (In) (Adjusted)	Gently undulating rises	Narrow flat divide between ambe	Gently inclined (2-6°)	Mostly Tertiary sediments, some Early Pleistocene sediments	Haunted Hills Formation(Nlh): generic	S	High	Possible slope instability and uncertain ground conditions	GM01, GM02,GM04,GM06, GM07, GM08,GM09	Major	Minor	Low	Uncertain ground conditions need confirming - landslide assessment
S21	9600 to 14200	Inverloch (In) (Adjusted)	Gently undulating rises		Gently inclined (2-6°)	Mostly Tertiary sediments, some Early Pleistocene sediments	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to uncertainty in ground conditions	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S22	14200 to 14370	Buffalo (Bu)	Alluvial plain	alluvial /colluvial fan from scarp	Gently inclined (2-6°)	Pleistocene to recent alluvium	alluvial terrace deposits(Qa2): generic	S	Moderate	Due to uncertainty in ground conditions	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S23	14370 to 14680	Buffalo (Bu)	Narrow alluvial plains (riverine)	floodplain and channel	Steep (18-30°)	Pleistocene to recent alluvium	alluvial terrace deposits(Qa2): generic	VS	High	Due to incised channel and hydrology/ flood	GM01, GM02,GM04,GM06, GM07, GM08, GM09	Moderate	Minor	Moderate	Consider HDD as a better alternative
S24	14680 to 15000	Buffalo (Bu)	Narrow alluvial plains (riverine)		Gently inclined (2-6°)	Pleistocene to recent alluvium	alluvial terrace deposits(Qa2): generic	S	Moderate	Hydrology and surface flows	GM01,GM02,GM04,GM06, GM08, GM09	Moderate	Minor	Low	
S25	15000 to 17150	Inverloch (In) (Adjusted)	Gently undulating plain	Low angle colluvial fan slope with	Gently inclined (2-6°)	Mostly Tertiary sediments, some Early Pleistocene sediments	alluvial terrace deposits(Qa2): generic/ alluvium(Qa1):	S	Moderate	Due to uncertain ground conditions	GM01,GM02,GM04,GM06, GM08, GM09	Moderate	Minor	Low	
S26	17150 to 17670	Tarwin (Tw)	Flood Plain	Colluvium and floodplain	Gently inclined (2-6°)	Recent to Pleistocene alluvial sediments, mostly derived from the basal	Haunted Hills Formation(Nlh): generic/ alluvium(Qa1):	S	Moderate	vegetation	GM01,GM02,GM04,GM05, GM06, GM08	Moderate	Minor	Low	Using HDD under veg and watercourse
S27	17670 to 17740	Tarwin (Tw)	Channel	Fish Creek	Steep (18-30°)	Recent to Pleistocene alluvial sediments, mostly derived from the basal	Wonthaggi Formation(Ksw): generic	VS	Moderate	Due to flood and steep channel banks	GM01, GM05 ,GM09	Minor	Negligible	Low	Using HDD
S28	17740 to 18270	Koonwarra (Ko)	Low steep hill	Truncated spur with steep (borde	Steep (18-30°)	Mesozoic sediments (Cretaceous) - consisting of sandstones, siltstone	Wonthaggi Formation(Ksw): generic	VS	Major	Steep slopes and evidence of groundwater discharge	GM01,GM02, GM03, GM04,GM06, GM07, GM08	Major	Minor	Moderate	Confirm groundwater discharges
S29	18270 to 18550	Leongatha South (Ls)	Gently undulating rises.	Dissected colluvial fan includes ch	Moderately inclined (6-18°)	Tertiary and Early Pleistocene sediments	Wonthaggi Formation(Ksw): generic/ alluvium(Qa1): ger	S	Moderate	Erosivity, slopewash and hydrology	GM01,GM02,GM03, GM04,GM06, GM08, GM09	Moderate	Minor	Low	
S30	18550 to 19130	Leongatha South (Ls)	Gently undulating rises.	Alluvial/ colluvial fan	Gently inclined (2-6°)	Tertiary and Early Pleistocene sediments	alluvium(Qa1): generic/ Wonthaggi Formation(Ksw): ge	S	Moderate	Due to uncertain ground conditions	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S31	19130 to 19180	Buffalo (Bu)	Channel		Steep (18-30°)	Pleistocene to recent alluvium	alluvial terrace deposits(Qa2): generic	VS	Major	Due to crossing active channel	GM01, GM02,GM04,GM06, GM07, GM08, GM09	Major	Minor	Moderate	Consider HDD as a better alternative
S32	19180 to 20600	Buffalo (Bu)	Alluvial plain	Downwash alluvium/ colluvium fr	Gently inclined (2-6°)	Pleistocene to recent alluvium	alluvial terrace deposits(Qa2): generic	S	Moderate	Due to uncertain ground conditions	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S33	20600 to 21515	Koonwarra (Ko)	Low rise	Possible ridge of cretaceous Kw	Gently inclined (2-6°)	Mesozoic sediments (Cretaceous) - consisting of sandstones, siltstone	Haunted Hills Formation(Nlh): generic/ alluvium(Qa1):	S	Moderate	Due to possible Cretaceous rock at shallow depth	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S34	21515 to 21580	Riverine (Riv)	Channel/ Narrow Alluvial Plains	Buffalo Creek	Steep (18-30°)	Recent (contemporary) alluvium sediments deposited by various stream	alluvium(Qa1): generic	VS	Moderate	Due to hydrology, flood and uncertain soil conditions	GM01, GM05 ,GM09	Minor	Negligible	Low	Using HDD
S35	21580 to 27500	Leongatha South (Ls)	Gently undulating rises.	Alluvial/ colluvial fan with numer	Gently inclined (2-6°)	Tertiary and Early Pleistocene sediments	Wonthaggi Formation(Ksw): generic	S	Moderate	Due to ground conditions, multiple shallow drainage lines	GM01,GM02, GM03, GM04,GM06, GM08, GM09	Moderate	Minor	Low	Multiple watercourse crossings
S36	27500 to 27700	Leongatha South (Ls)	Rise	Steppe with relief of 8m. Possible	Moderately inclined (6-18°)	Tertiary and Early Pleistocene sediments	Wonthaggi Formation(Ksw): generic	S	Moderate	Due to possible Cretaceous rock at shallow depth	GM01,GM02,GM03, GM04,GM06, GM08	Moderate	Minor	Low	
S37	27700 to 28470	Leongatha South (Ls)	Gently undulating rises.	Southern valley slope of Stony Cr	Gently inclined (2-6°)	Tertiary and Early Pleistocene sediments	Wonthaggi Formation(Ksw): generic/ alluvium(Qa1): ger	S	Moderate	Due to uncertain ground conditions	GM01,GM02,GM03, GM04,GM06, GM08, GM09	Moderate	Minor	Low	
S38	28470 to 28550	Riverine (Riv)	Channel	Tributary of Stony Creek, incised i	Steep (18-30°)	Recent (contemporary) alluvium sediments deposited by various stream	alluvium(Qa1): generic	VS	Major	Due to hydrology, flood and uncertain soil conditions	GM01, GM02,GM04,GM06, GM07, GM08, GM09	Major	Minor	Moderate	Consider HDD as a better alternative
S39	28550 to 29370	Riverine (Riv)	alluvial plain	alluvial terrace of Stony Creek	Gently inclined (2-6°)	Recent (contemporary) alluvium sediments deposited by various stream	alluvium(Qa1): generic	S	Moderate	Due to flood and uncertain ground conditions	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	2 x HDD under roads
S40	29370 to 29450	Riverine (Riv)	Channel	Channel and terrace of Stony Cre	Steep (18-30°)	Recent (contemporary) alluvium sediments deposited by various stream	Wonthaggi Formation(Ksw): generic	VS	Moderate	Due to hydrology, flood and uncertain soil conditions	GM01, GM05 ,GM09	Minor	Negligible	Low	Using HDD
S41	29450 to 31200	Leongatha South (Ls)	Gently undulating rises.	Lack of shallow drainage lines	Gently inclined (2-6°)	Tertiary and Early Pleistocene sediments	Wonthaggi Formation(Ksw): generic	S	Moderate	Due to uncertain ground conditions	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S42	31200 to 33600	Koonwarra (Ko)	Low rises	gentle low rises	Gently inclined (2-6°)	Mesozoic sediments (Cretaceous) - consisting of sandstones, siltstone	Wonthaggi Formation(Ksw): generic	S	Moderate	Due to possible Cretaceous rock at shallow depth /uncertain ground conditions	GM01,GM02,GM04, GM05, GM06, GM08	Moderate	Minor	Low	HDD under road and creek
S43	33600 to 34700	Koonwarra (Ko)	Low Hills	More relief than previous section	Moderately inclined (6-18°)	Mesozoic sediments (Cretaceous) - consisting of sandstones, siltstone	Wonthaggi Formation(Ksw): generic	S	Moderate	Due to slope and susceptibility to possible slope movements, possible Cretaceous ro	GM01,GM02, GM03, GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S44	34700 to 34850	Powlett (Po)	Floodplain	Terrace and floodplain	Gently inclined (2-6°)	Recent alluvium, mostly derived from the Cretaceous hills to the north	alluvium(Qa1): generic	VS	High	Due to hydrology, flood and ground conditions , active migrating channel	GM01,GM02,GM03, GM04,GM05, GM06, GM08	Moderate	Minor	Moderate	Only partial HDD
S45	34850 to 34880	Powlett (Po)	Channel	incised	Steep (18-30°)	Recent alluvium, mostly derived from the Cretaceous hills to the north	alluvium(Qa1): generic	VS	Moderate	Due to hydrology, flood and ground conditions , active migrating channel	GM01, GM05 ,GM09	Minor	Negligible	Low	Using HDD
S46	34880 to 35780	Powlett (Po)	Floodplain	Terrace and floodplain	Gently inclined (2-6°)	Recent alluvium, mostly derived from the Cretaceous hills to the north	alluvium(Qa1): generic	VS	High	Due to hydrology, flood and ground conditions , active migrating channel	GM01,GM02,GM04, GM05, GM06, GM08, GM09	Moderate	Minor	Moderate	Partial HDD
S47	35780 to 36250	Warragul (Wg)	Ridge	flat topped low ridge in Thorpdal	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to weathered volcanics	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	Confirm slope stability in Thorpdale
S48	36250 to 36580	Powlett (Po)	Alluvial Plain		Gently inclined (2-6°)	Recent alluvium, mostly derived from the Volcanics	Thorpdale Volcanic Group (-Put): Generic / alluvium(Qa1	S	Moderate	Due to flood and uncertain ground conditions	GM01,GM02,GM03, GM04,GM05, GM06, GM08	Moderate	Minor	Low	Only partial HDD
S49	36580 to 36620	Powlett (Po)	Channel	Tributary of the Tarwin River , low	Steep (18-30°)	Recent alluvium, mostly derived from the Cretaceous hills to the north	alluvium(Qa1): generic	VS	Moderate	Due to perched channel and levees, uncertain soils	GM01, GM05 ,GM09	Minor	Negligible	Low	Using HDD
S50	36620 to 37800	Powlett (Po)	Flood plain	Tributary flood plain with some c	Gently inclined (2-6°)	Recent alluvium, mostly derived from the Cretaceous hills to the north	alluvium(Qa1): generic /Thorpdale Volcanic Group (-Put	VS	Major	Due to flood and river avulsion history, soft soil uncertainty	GM01,GM02, GM03, GM04, GM05, GM06, GM08, GM09	Major	Minor	Moderate	Partial HDD under road
S51	37800 to 38200	Warragul (Wg) (Adjusted)	Low rises	Slope instability in suspected Tho	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	ES	Major	Due to slope instability	GM01, GM02,GM04,GM06, GM07, GM08	Major	Minor	Moderate	needs further landslide assessment
S52	38200 to 38620	Warragul (Wg) (Adjusted)	Low rises	Gentle slopes in suspected Thorp	Gently inclined (2-6°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to low slopes in Thorpdale Volcanics	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S53	38620 to 39300	Powlett (Po)	Flood plain	Flood plain with numerous shallo	Gently inclined (2-6°)	Recent alluvium, mostly derived from Thorpdale Volcanics	Thorpdale Volcanic Group (-Put): Generic / alluvium(Qa1	VS	Moderate	Due to hydrology and flood	GM01,GM02,GM04,GM06, GM08, GM09	Moderate	Minor	Moderate	
S54	39300 to 39550	Leongatha South (Ls)	Gently undulating rises.	Potentially colluvial soils	Moderately inclined (6-18°)	Tertiary and Early Pleistocene sediments	alluvium(Qa1): generic	S	Moderate	Due to possible colluvial soils and trench stratigraphy	GM01,GM02,GM03, GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S55	39550 to 40350	Warragul (Wg) (Adjusted)	Low ridge	Thorpdale volcanics, hummocky s	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	alluvium(Qa1): generic /Thorpdale Volcanic Group (-Put	VS	High	Due to relief and slope instability	GM01,GM02,GM04,GM06, GM07, GM08	Major	Minor	Moderate	
S56	40350 to 40600	Powlett (Po)	Flood plain	Flood plain/ Terrace Tarwin River	Gently inclined (2-6°)	Recent alluvium, mostly derived from the Cretaceous hills to the north	alluvium(Qa1): generic	S	Moderate	Due to uncertain ground conditions	GM01,GM02,GM04,GM06, GM08, GM09	Moderate	Minor	Low	
S57	40600 to 40675	Powlett (Po)	Channel	Tarwin River East Branch	Steep (18-30°)	Recent alluvium, mostly derived from the Cretaceous hills to the north	Wonthaggi Formation(Ksw): generic	ES	Moderate	due to flood	GM01, GM05 ,GM09	Minor	Negligible	Moderate	Using HDD
S58	40675 to 41300	Strzelecki (Sz)	Rolling to steep Hills	Spur	Steep (18-30°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	Moderate	Due to relief and slope and possible shallow rock	GM01,GM02,GM04, GM05, GM06,GM07, GM08	Minor	Minor	Moderate	Mostly HDD but some trenching
S59	41300 to 43300	Strzelecki (Sz)	Rolling to steep Hills	Ridgeline in rolling to steep hills	Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	High	Due to uncertainty in ground conditions., stratigraphy	GM01,GM02,GM04,GM05, GM06, GM07, GM08	Moderate	Minor	Moderate	HDD under road
S60	43300 to 43900	Strzelecki (Sz)	Rolling to steep Hills	Possible scarp above ridge and be	Steep (18-30°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	Moderate	Due to steep slopes and adjacent scarp , uncertain nature of subsurface materials (r	GM01, GM02,GM04, GM05 GM06, GM07, GM08	Minor	Minor	Moderate	Mostly HDD but some trenching- needs further landslide assessment
S61	43900 to 44700	Strzelecki (Sz)	Rolling to steep Hills	Ridge on a plateau surface	Gently inclined (2-6°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	High	Due to soil profile uncertainty including possible shallow depth to rock	GM01,GM02, GM04,GM06, GM08	Moderate	Minor	Moderate	Profile uncertainty to be resolved
S62	44700 to 45080	Strzelecki (Sz)	Rolling to steep Hills	Valleys and ridge	Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	High	Due to soil profile uncertainty including possible shallow depth to rock plus Relief a	GM01,GM02,GM03, GM04,GM06, GM07, GM08,GM09	Moderate	Minor	Moderate	2 x watercourses and steep slope
S63	45080 to 45350	Strzelecki (Sz)	Rolling to steep Hills	shallow slope instability	Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	High	Due to soil profile including possible shallow depth to rock plus Relief and slope, an	GM01, GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Moderate	Confirm shallow slope instability- landslide assessment
S64	45350 to 45500	Warragul (Wg)	Hills	Landslide in Thorpdale Volcanics	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	ES	Major	Due to presence of landslide in Thorpdale Volcanics	GM01, GM02,GM04,GM06, GM07,GM08	Major	Moderate	High	Needs landslide assessment and detailed geo investigation
S65	45500 to 45800	Warragul (Wg)	Summit	Rounded crest / summit in Thorp	Gently inclined (2-6°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to ground conditions	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S66	45800 to 45930	Strzelecki (Sz)	Rolling to steep Hills		Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	High	Due to uncertain slope form and stability	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Moderate	
S67	45930 to 46120	Strzelecki (Sz)	Rolling to steep Hills	Shallow valley	Gently inclined (2-6°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	S	Moderate	Due to variable surface materials Possible deeper weathering in lower slopes	GM01,GM02,GM03, GM04,GM06, GM07, GM08, GM09	Moderate	Minor	Low	
S68	46120 to 46300	Warragul (Wg)	Hills	Valley slope in suspected Thorpda	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	VS	High	Due to steeper slopes in Thorpdale Volcanics	GM01, GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Moderate	needs landslide assessment
S69	46300 to 46600	Strzelecki (Sz)	Rolling Hills	Possible slope instability/ landslic	Gently inclined (2-6°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	Moderate	Due to landslides below	GM01, GM02,GM04,GM05, GM06, GM07, GM08	Minor	Minor	Moderate	Mostly HDD above slide
S70	46600 to 47050	Strzelecki (Sz)	Rolling Hills	Valley head and erosion gullies/ g	Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	Major	Due to stability, uncertain ground condition, potential groundwater discharge	GM01, GM02,GM04,GM06, GM07, GM08, GM09	Major	Minor	Moderate	Broad valley head with groundwater discharge?/ landslide assessment
S71	47050 to 47350	Strzelecki (Sz)	Rolling Hills	Hillslope	Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	High	due to uncertain ground conditions and depth to rock	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Moderate	
S72	47350 to 47400	Strzelecki (Sz)	Channel	Valley base and shallow channel	Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	High	Due to hydrology, flood and excavatability within Strzelecki	GM01,GM02,GM04,GM06, GM08, GM09	Moderate	Minor	Moderate	
S73	47400 to 47620	Strzelecki (Sz)	Rolling Hills	Spur end	Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	High	Due to uncertain ground conditions and depth to rock	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Moderate	
S74	47620 to 47700	Strzelecki (Sz)	Alluvial plains	Valley floor with traces of several	Gently inclined (2-6°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	High	Due to varied regolith and drainage. Possible colluvium	GM01,GM02,GM04,GM06, GM08, GM09	Moderate	Minor	Moderate	
S75	47700 to 48000	Strzelecki (Sz)	Rolling Hills	Valley side slope, landslide and sl	Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	ES	Major	Due to existing landslides and slope	GM01,GM02,GM04,GM06, GM07, GM08	Major	Moderate	High	Needs landslide assessment and detailed geo investigation
S76	48000 to 48300	Strzelecki (Sz)	Rolling Hills	Broad ridge, gently undulating	Gently inclined (2-6°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	S	Moderate	Due to uncertain regolith composition	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S77	48300 to 48380	Strzelecki (Sz)	Rolling Hills	Valley slope	Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	S	Moderate	Due to regolith and moderate slope	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S78	48380 to 48430	Strzelecki (Sz)	Channel		Steep (18-30°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	Major	Due to erosivity and regolith uncertainty, possibly soft soils and ASS	GM01,GM02,GM04,GM06, GM07, GM08, GM09	Major	Minor	Moderate	Consider HDD as a better alternative
S79	48430 to 48740	Strzelecki (Sz)	Rolling Hills	Valley side slope, landslide and sl	Steep (18-30°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic/Thorpdale Volcanic	ES	Major	Due to existing landslides and slope instability	GM01, GM02,GM04,GM06, GM07, GM08, GM09	Major	Moderate	High	Needs further landslide assessment and investigation. Consider HDD
S80	48740 to 49100	Strzelecki (Sz)	Ridge	Edge of ridge with channel head/	Gently inclined (2-6°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Thorpdale Volcanic Group (-Put): Generic	VS	High	Due to regolith and proximity to valley head	GM01, GM03, GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Moderate	
S81	49100 to 49340	Strzelecki (Sz)	Rolling Hills	Landslide slope	Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	High	Due to possible landslide and uncertain regolith	GM01, GM02,GM04,GM06, GM07, GM08	Moderate	Moderate	High	Needs landslide risk assessment . Consider HDD as better alternative
S82	49340 to 49380	Strzelecki (Sz)	Channel		Steep (18-30°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	Major	Due to landscape position in floodway	GM01, GM02,GM04,GM06, GM07, GM08, GM09	Major	Moderate	High	Consider HDD as a better alternative
S83	49380 to 49600	Strzelecki (Sz)	Rolling Hills	Valley slopes , sl instability??	Steep (18-30°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic/Thorpdale Volcanic	VS	High	Due to adjacent landslides and steep slopes	GM01, GM02,GM04,GM06, GM07, GM08	Moderate	Moderate	High	Needs landslide risk assessment . Consider HDD as better alternative
S84	49600 to 50000	Warragul (Wg)	Ridge	Flattened ridge in Thorpdale Volc	Gently inclined (2-6°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to regolith uncertainty	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S85	50000 to 50300	Warragul (Wg)	Rolling Hills	Landslide slope in Thorpdale Volc	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic / Wonthaggi Fo	VS	High	Due to existing landslide	GM01, GM03, GM02,GM04,GM06, GM07, GM08, GM09	Moderate	Moderate	High	Needs landslide assessment and detailed geo investigation
S86	50300 to 50420	Strzelecki (Sz)	Flood plain	Multiple channels	Gently inclined (2-6°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	S	High	Due to flood , hydrology a and regolith	GM01,GM02,GM04,GM06, GM07, GM08, GM09	Major	Minor	Low	
S87	50420 to 50510	Strzelecki (Sz)	Low ridge		Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	S	Moderate	Due to relief mainly	GM01,GM02,GM04,GM06, GM07, GM08	moderate	Minor	Low	
S88	50510 to 50540	Strzelecki (Sz)	Channel		Steep (18-30°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	Major	Due to flood hydrology, regolith	GM01,GM02,GM04,GM06, GM07, GM08	Major	Minor	Moderate	
S89	50540 to 50740	Warragul (Wg)	Undulating Hills	Landslide	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	ES	Major	Due to existing landslide	GM01, GM02,GM04,GM06, GM07, GM08	Major	Moderate	High	Needs landslide assessment and detailed geo investigation
S90	50740 to 50970	Warragul (Wg)	Undulating Hills	Broad slopes below ridge	Gently inclined (2-6°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to regolith	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S91	50970 to 51300	Warragul (Wg)	Undulating Hills	Broad drainage line, possible slop	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	VS	High	Due to existing slope instability and regolith uncertainty	GM01, GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Moderate	Needs landslide assessment
S92	51300 to 51700	Warragul (Wg)	Undulating Hills	Broad ridge crest	Gently inclined (2-6°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to regolith	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S93	51700 to 52050	Warragul (Wg)	Undulating Hills	Landslide slope	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	ES	Major	Due to existing slope instability and possible landslides	GM01, GM02,GM04,GM06, GM07, GM08	Major	Minor	Moderate	Needs landslide assessment to confirm
S94	52050 to 52080	Warragul (Wg)	Channel		Gently inclined (2-6°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	VS	Major	Due to flood hydrology, regolith	GM01, GM02,GM04,GM06, GM07, GM08, GM09	Major	Minor	Moderate	Consider HDD as a better alternative
S95	52080 to 52120	Strzelecki (Sz)	Ridge	Valley slope, possible shallow ins	Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	High	due to possible slope instability	GM01, GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Moderate	Needs landslide assessment
S96	52120 to 52220	Strzelecki (Sz)	Ridge	Ridge crest	Gently inclined (2-6°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	S	Moderate	Due to regolith uncertainty	GM01,GM05	Minor	Negligible	Low	
S97	52220 to 52290	Strzelecki (Sz)	Ridge	Valley slope	Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	S	Moderate	Due to moderate slopes and regolith	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S98	52290 to 52340	Strzelecki (Sz)	Valley floor	Valley floor with channel	Gently inclined (2-6°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	VS	High	Due to hydrology and flood	GM01,GM02,GM04,GM06, GM07, GM08, GM09	Moderate	Minor	Moderate	Consider HDD as a better alternative
S99	52340 to 52500	Strzelecki (Sz)	Rolling Hills	Valley slope	Moderately inclined (6-18°)	Cretaceous sediments (sandstone, siltstone and mudstone).	Wonthaggi Formation(Ksw): generic	S	Moderate	Due to moderate slopes and regolith	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Moderate	
S100	52500 to 52700	Warragul (Wg) Adjusted	Undulating Hills	Valley slope possible instability	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to possible Thorpdale and regolith	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	Partial HDD
S101	52700 to 53100	Warragul (Wg)	Ridge		Gently inclined (2-6°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to regolith	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S102	53100 to 53370	Warragul (Wg) Adjusted	Undulating Hills	Valley slope possible instability	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	VS	High	Due to existing slope instability and regolith uncertainty	GM01, GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Moderate	

Trench Sector ID	chainages	soil landform unit	Broad Landform 1:100K scale	Site geomorphic description	Slope Class within study area	Geology (1;100K soil mapping)	Geology (1;250K GSV mapping)	overalls sensitivity of sector	Unmitigated significance of impact	Factors determining sensitivity of sector	Standard Environmental Performance Requirements (as per Coffey List)	Unmitigated Magnitude of Impact	Mitigated Magnitude of Impact	Mitigated Significance of Impact	Factor determining Residual Impact after EPR's and other comments
S103	53370 to 53390	Warragul (Wg) Adjusted	Valley floor		Gently inclined (2-6°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	VS	High	Due to hydrology and flood	GM01,GM02,GM04,GM06, GM08,GM09	Moderate	Minor	Moderate	No evident incision
S104	53390 to 53500	Uncertain ?? Contact Warragu	Undulating Hills	Valley side slopes with spring and	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic / Wonthaggi Fo	VS	Major	Due to springs and existing slope instability	GM01, GM02,GM04,GM06, GM07, GM08	Major	Minor	Moderate	
S105	53500 to 53720	Uncertain ?? Contact Warragu	Undulating Hills	Valley side slopes	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic / Wonthaggi Fo	S	Moderate	Due to regolith	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S106	53720 to 53800	Uncertain ?? Contact Warragu	Undulating Hills	Valley Floor	Gently inclined (2-6°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic / Wonthaggi Fo	S	Moderate	Due to hydrology and flood	GM01,GM02,GM04,GM06, GM08, GM09	Moderate	Minor	Moderate	Non incised channel
S107	53800 to 53900	Uncertain ?? Contact Warragu	Undulating Hills	valley side slope	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic / Wonthaggi Fo	S	Moderate	Due to moderate slopes in Thorpdale	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	Side slope but no evidence of any significant instability
S108	53900 to 54330	Uncertain ?? Contact Warragu	Ridge and undulating slopes	Low narrow ridge between two d	Gently inclined (2-6°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic / Wonthaggi Fo	S	Moderate	Due to regolith	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	Ridge slope with open shallow depression geo conditions to be confirmed
S109	54330 to 54385	Riverine (Riv)	Channel	Berry's Creek	Gently inclined (2-6°)	Recent (contemporary) alluvium sediments deposited by various strean	Thorpdale Volcanic Group (-Put): Generic	VS	Major	Due to flood and hydrology plus regolith	GM01,GM02,GM04,GM06, GM07, GM08, GM09	Major	Minor	Moderate	Not steeply sided
S110	54385 to 54770	Riverine (Riv)	Alluvial terrace	broad alluvial terrace and materi	Gently inclined (2-6°)	Recent (contemporary) alluvium sediments deposited by various strean	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to regolith uncertainty, Varied in floodplain	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	partial HDD under road at northern end
S111	54770 to 54810	Riverine (Riv)	Channel		Moderately inclined (6-18°)	Recent (contemporary) alluvium sediments deposited by various strean	Thorpdale Volcanic Group (-Put): Generic	VS	Moderate	Due to flood, regolith erosion	GM01,GM05, GM09	Minor	Negligible	Moderate	Using HDD
S112	54810 to 54970	Warragul (Wg) Adjusted ??	spur	spur	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to regolith	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S113	54970 to 55010	Riverine (Riv)	Channel	Alluvial valley floor	Gently inclined (2-6°)	Recent (contemporary) alluvium sediments deposited by various strean	Thorpdale Volcanic Group (-Put): Generic	VS	High	Due to flood and hydrology, regolith	GM01,GM03, GM02,GM04,GM06, GM08, GM09	Moderate	Minor	Moderate	No steep slopes on channel
S114	55010 to 55030	Warragul (Wg)	Undulating rises	very steep valley slope and possib	Steep (18-30°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	ES	Major	Due to very steep slope/ escarpment and landslide	GM01, GM02, GM03, GM04,GM06, GM07, GM08	Major	Moderate	High	Requires landslide assessment and detailed geotechnical investigation
S115	55030 to 55940	Warragul (Wg)	Undulating rises		Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic	VS	High	due to undulating terrain and evidence of instability	GM01, GM02,GM04,GM06,GM07, GM08	Moderate	Minor	Moderate	Landslide assessment to confirm conditions
S116	55940 to 56250	Warragul (Wg)	Undulating rises	Backscarp of landslide below to t	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Wonthaggi Formation(Ksw): generic	VS	Moderate	Due to regolith and landslide to the west	GM01,GM05	Minor	Negligible	Moderate	Using HDD
S117	56250 to 56830	Warragul (Wg)	Landslide slopes	large landslide feature	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Thorpdale Volcanic Group (-Put): Generic / Latrobe Valley	ES	Major	Due to significant landslide features	GM01, GM02,GM04,GM06, GM07, GM08	Major	Moderate	High	Detailed landslide assessment and investigation. Consider moving to west
S118	56830 to 57180	Warragul (Wg)	Landslide slopes ??	Older degraded landslide	Moderately inclined (6-18°)	Mid-Tertiary basalts commonly called "Older Volcanics"	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to older degraded landslide and regolith	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	Possible older degraded landslide
S119	57180 to 57530	Morwell with Boolarra (Mr/Bl)	Rolling low hills to undulating rises	Low rise	Gently inclined (2-6°)	Late Tertiary (Pliocene) sediments	Latrobe Valley Group (-Pv): generic	S	Low	Due to regolith	GM01,GM02,GM04,GM06, GM08	Minor	Minor	Low	
S120	57530 to 57900	Morwell with Boolarra (Mr/Bl)	Rolling low hills to undulating rises	Valley head possible instability??	Moderately inclined (6-18°)	Late Tertiary (Pliocene) sediments	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to proximity to valley head	GM01,GM02,GM03, GM04,GM06, GM07, GM08	Moderate	Minor	Low	Proximity to valley head
S121	57900 to 60400	Morwell with Boolarra (Mr/Bl)	Rolling low hills to undulating rises	Ridge/divide	Gently inclined (2-6°)	Late Tertiary (Pliocene) sediments	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to regolith uncertainty	GM01,GM02,GM03, GM04,GM06, GM08	Moderate	Minor	Low	
S122	60400 to 61100	Morwell with Boolarra (Mr/Bl)	Rolling low hills to undulating rises	Ridge/divide but with landslides i	Gently inclined (2-6°)	Late Tertiary (Pliocene) sediments	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to proximity to gully heads	GM01,GM02, GM03, GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S123	61100 to 61500	Uncertain Contact Morwell wit	Rolling low hills to undulating rises	Valley side slopes of Little Morwe	Moderately inclined (6-18°)	Late Tertiary (Pliocene) sediments	Latrobe Valley Group (-Pv): generic / Thorpdale Volcanic G	VS	High	Due to possible landslides and uncertain regolith	GM01,GM02,GM03, GM04,GM05, GM06, GM07, GM08	Moderate	Minor	Moderate	Partial HDD already employed
S124	61500 to 61570	Uncertain Contact Morwell wit	Channel	Floodplain and terrace. Little Mo	Gently inclined (2-6°)	Late Tertiary (Pliocene) sediments	Latrobe Valley Group (-Pv): generic / Thorpdale Volcanic G	VS	Major	Due to hydrology and flood	GM01,GM02,GM04,GM06, GM07, GM08, GM09	Major	Minor	Moderate	Consider HDD as a better alternative
S125	61570 to 61800	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low h	Steep Valley slope with landslides	Steep (18-30°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Latrobe Valley Group (-Pv): generic	ES	Moderate	Due to slope instability	GM01,GM05	Minor	Negligible	Moderate	Using HDD. Ensure drilled under slide
S126	61800 to 63500	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low h	Gently undulating ridge crest	Gently inclined (2-6°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Latrobe Valley Group (-Pv): generic / alluvium(Qa1): gen	S	Moderate	Due to regolith uncertainty	GM01,GM02, GM03, GM04, GM05, GM06, GM08	Moderate	Minor	Low	Partial HDD under a road
S127	63500 to 63600	Swamp (sw)	Swamp	wetland with native vegetation	Gently inclined (2-6°)	This map unit delineates low-lying areas which are permanent or semi-p	alluvium(Qa1): generic	VS	Moderate	Due to low lying wetland, hydrology, flood	GM01,GM05, GM09	Minor	Negligible	Moderate	Using HDD under swamp
S128	63600 to 64500	Silver Creek with Warragul (Sc	Rolling low hills.	Ridge crest	Gently inclined (2-6°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to regolith and possible erosivity	GM01,GM02, GM03, GM04,GM06, GM08	moderate	Minor	Low	
S129	64500 to 65300	Silver Creek with Warragul (Sc	Rolling low hills.	Narrow ridge above broad valley	Moderately inclined (6-18°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Latrobe Valley Group (-Pv): generic / Thorpdale Volcanic G	S	Moderate	Due to slope and relief and possible uncertain regolith	GM01,GM02,GM03, GM04,GM06, GM08	Moderate	Minor	Low	
S130	65300 to 66530	Silver Creek with Warragul (Sc	Rolling low hills.	Ridge crest end and low valley slo	Gently inclined (2-6°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to regolith	GM01,GM02,GM03, GM04,GM06, GM08	Moderate	Minor	Low	
S131	66530 to 66640	Silver Creek with Warragul (Sc	Valley floor	Broad valley floor with trace of ch	Gently inclined (2-6°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	VS	Major	Due to proximity to watercourse, flood and regolith	GM01,GM02, GM03, GM04,GM06, GM08, GM09	Major	Minor	Moderate	
S132	66640 to 66900	Silver Creek with Warragul (Sc	Ridge	moderately sided ridge between	Moderately inclined (6-18°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	VS	High	Due to possible landslides and uncertain regolith	GM01, GM02, GM03, GM04, GM06, GM07, GM08	Moderate	Moderate	High	Requires landslide assessment and detailed geotechnical investigation
S133	66900 to 67030	Silver Creek with Warragul (Sc	Channel	Valley floor and Channel	Moderately inclined (6-18°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	VS	Major	Due to flood hydrology and uncertain regolith	GM01,GM02, GM03< GM04,GM06, GM08, GM09	Major	Minor	Moderate	Dam to north . Consider HDD as a better alternative
S134	67030 to 68000	Silver Creek with Warragul (Sc	Rolling low hills.	Valley side slope	Gently inclined (2-6°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to regolith	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S135	68000 to 68500	Silver Creek with Warragul (Sc	Rolling low hills.	side valley slope	Moderately inclined (6-18°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to regolith and moderate slopes	GM01,GM02, GM03, GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S136	68500 to 68850	Silver Creek with Warragul (Sc	Rolling low hills.	side valley slope above a gullied	Moderately inclined (6-18°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	VS	Major	Due to slope and proximity to gully head, groundwater outflow	GM01,GM02, GM03, GM04,GM06, GM07, GM08	Major	Minor	Moderate	
S137	68850 to 69300	Silver Creek with Warragul (Sc	Rolling low hills.	below ridge crest	Moderately inclined (6-18°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to slope and regolith	GM01,GM02,GM03, GM04,GM06, GM08	Moderate	Minor	Low	
S138	69300 to 69600	Silver Creek with Warragul (Sc	Rolling low hills.	below ridge crest above gullied d	Moderately inclined (6-18°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	VS	Major	Due to slope and proximity to gully head, groundwater outflow	GM01,GM02, GM03, GM04,GM06, GM07, GM08	Major	Minor	Moderate	
S139	69600 to 70140	Silver Creek with Warragul (Sc	Rolling low hills.	Ridge above valley (Thorpdale)	Gently inclined (2-6°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to regolith	GM01,GM02,GM03, GM04,GM06, GM08	Moderate	Minor	Low	
S140	70140 to 70300	Silver Creek with Warragul (Sc	Rolling low hills.	valley head drainage line and we	Moderately inclined (6-18°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	VS	Major	Due to slope, hydrology and flood	GM01,GM02, GM03, GM04,GM06, GM07, GM08, GM09	Major	Minor	Moderate	
S141	70300 to 71600	Silver Creek with Warragul (Sc	Rolling low hills.	below ridge crest	Moderately inclined (6-18°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to slope and regolith	GM01,GM02, GM03, GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S142	71600 to 72050	Silver Creek with Warragul (Sc	Rolling low hills.	Valley head with slope instability	Moderately inclined (6-18°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	VS	High	Due to slope and regolith	GM01, GM02, GM03, GM04,GM06, GM07, GM08, GM09	Moderate	Minor	Moderate	Needs landslide assessment for slopes
S143	72050 to 72400	Silver Creek with Warragul (Sc	Rolling low hills.	Ridge crest	Gently inclined (2-6°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to regolith	GM01,GM02,GM04,GM06, GM08	moderate	Minor	Low	
S144	72400 to 73700	Silver Creek with Warragul (Sc	Rolling low hills.	Ridge crest with numerous valley	Gently inclined (2-6°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic / Latrobe Valley	VS	High	Due to proximity to numerous active gully heads	GM01,GM02, GM03, GM04,GM06, GM07, GM08	Moderate	Minor	Moderate	
S145	73700 to 74050	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low h	Local hill top	Gently inclined (2-6°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to regolith uncertainty	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S146	74050 to 74250	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low h	Ridge crest above south facing va	Gently inclined (2-6°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to regolith uncertainty	GM01,GM02,GM03, GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S147	74250 to 74620	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low h	Below ridge crest above north fac	Gently inclined (2-6°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to regolith uncertainty	GM01,GM02, GM03, GM04,GM06, GM08	Moderate	Minor	Low	
S148	74620 to 74930	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low h	Valley slopes with possible instab	Moderately inclined (6-18°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to relief and slope and regolith	GM01,GM02,GM03, GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S149	74930 to 74980	Boolarra with Morwell (Bl/Mr)	Valley floor	Channel within valley floor	Gently inclined (2-6°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to hydrology and flood	GM01,GM02, GM03, GM04,GM06, GM08, GM09	Moderate	Minor	Low	
S150	74980 to 75230	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low h	Valley slope	Gently inclined (2-6°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to regolith uncertainty	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S151	75230 to 75300	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low h	Ridge top	Gently inclined (2-6°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to regolith uncertainty	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S152	75300 to 75450	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low h	Ridge top above valley head with	Gently inclined (2-6°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to possible landslide in small gully below	GM01, GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	Needs assessment of possible landslide below
S153	75450 to 75750	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low h	Ridge top	Gently inclined (2-6°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to regolith uncertainty	GM01,GM02, GM03, GM04,GM06, GM08	Moderate	Minor	Low	
S154	75750 to 76050	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low h	Ridge crest above south facing va	Gently inclined (2-6°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to complex regolith stratigraphy and proximity to large landslide below	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	Possible degraded landslide below
S155	76050 to 76400	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low h	Broad flattened ridge crest	Gently inclined (2-6°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to complex regolith stratigraphy	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S156	76400 to 76530	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low h	Broad flattened ridge crest with p	Moderately inclined (6-18°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Haunted Hills Formation(Nlh): generic	S	Minor	Due to slope and regolith stratigraphy plus adjacent landslide	GM01,GM05	Minor	Negligible	Low	
S157	76530 to 77320	Yinnar (Yn) (adjusted)	Stagnant alluvial plain.	High alluvial terrace plus colluviu	Gently inclined (2-6°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to complex soil stratigraphy	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S158	77320 to 77400	Riverine (Riv)	Alluvial plain	Palaeo Channel bluff (steep in pa	Steeply inclined (> 18 °)	Recent (contemporary) alluvium sediments deposited by various strean	alluvium(Qa1): generic	VS	High	Due to steep slopes and soft soil, stability	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	Possible slope instability below
S159	77400 to 77520	Riverine (Riv)	Alluvial plain	Palaeo flood plain with trace of p	Very gently inclined (0.5-2°)	Recent (contemporary) alluvium sediments deposited by various strean	alluvium(Qa1): generic	VS	Major	Due to hydrology, flood , soft soils and potential ASS	GM01,GM02,GM03, GM04,GM06, GM08, GM09	Major	Minor	Moderate	
S160	77520 to 77580	Riverine (Riv)	Alluvial plain	Terrace remnant	Moderately inclined (6-18°)	Recent (contemporary) alluvium sediments deposited by various strean	alluvium(Qa1): generic	S	Moderate	Due to relief and slope and regolith	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S161	77580 to 77680	Riverine (Riv)	Alluvial plain	Palaeo flood plain with trace of p	Gently inclined (2-6°)	Recent (contemporary) alluvium sediments deposited by various strean	alluvium(Qa1): generic	VS	Major	Due to hydrology, flood , soft soils and potential ASS	GM01,GM02,GM03, GM04,GM06, GM08	Major	Minor	Moderate	
S162	77680 to 77740	Riverine (Riv)	Alluvial plain	Bluff on palaeo channel	Moderately inclined (6-18°)	Recent (contemporary) alluvium sediments deposited by various strean	alluvium(Qa1): generic	S	High	Due to steep slopes and regolith	GM01,GM02,GM04,GM06, GM07, GM08	Major	Minor	Moderate	steep slopes on bluff
S163	77740 to 77920	Riverine (Riv)	Alluvial plain	Palaeo terrace remnant	Very gently inclined (0.5-2°)	Recent (contemporary) alluvium sediments deposited by various strean	alluvium(Qa1): generic	S	Low	Due to regolith uncertainty	GM01,GM05, GM09	Minor	Negligible	Low	
S164	77920 to 77950	Riverine (Riv)	Alluvial plain	River bluff of Morwell River (mod	Steep (18-30°)	Recent (contemporary) alluvium sediments deposited by various strean	alluvium(Qa1): generic	VS	Moderate	Due to relief and slope and stability	GM01,GM05, GM09	Minor	Negligible	Moderate	Using HDD
S165	77950 to 78230	Riverine (Riv)	Flood plain and channel	Modern active channel (steep ba	Gently inclined (2-6°)	Recent (contemporary) alluvium sediments deposited by various strean	alluvium(Qa1): generic	ES	Moderate	Due to flood and hydrology plus regolith	GM01,GM05, GM09	Minor	Negligible	Moderate	Using HDD
S166	78230 to 78450	Yinnar (Yn)	Alluvial plain	Valley slopes with large landslide	Moderately inclined (6-18°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	alluvium(Qa1): generic / Haunted Hills Formation(Nlh)	VS	Moderate	Due to landslide presence	GM01,GM05	Minor	Negligible	Moderate	Using HDD
S167	78450 to 78870	Yinnar (Yn)	Alluvial plain	uplifted terrace high level	Gently inclined (2-6°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to complex regolith stratigraphy	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S168	78870 to 78920	Yinnar (Yn)	Alluvial plain	mod slopes Palaeo channels on u	Moderately inclined (6-18°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to moderate slopes, regolith and hydrology	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S169	78920 to 78930	Yinnar (Yn)	Alluvial plain	palaeo channel floor	Gently inclined (2-6°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to hydrology and flood	GM01,GM02,GM04,GM06, GM08, GM09	Moderate	Minor	Low	
S170	78930 to 78970	Yinnar (Yn)	Alluvial plain	mod slopes Palaeo channels on u	Moderately inclined (6-18°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to relief and slopes and regolith uncertainty/ complex stratigraphy	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S171	78970 to 79040	Yinnar (Yn)	Alluvial plain	remnant terrace surface	Very gently inclined (0.5-2°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to complex regolith stratigraphy	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S172	79040 to 79060	Yinnar (Yn)	Alluvial plain	mod slopes Palaeo channels on u	Moderately inclined (6-18°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to moderate slopes, regolith and hydrology	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S173	79060 to 79170	Yinnar (Yn)	Alluvial plain	palaeo channel floor	Gently inclined (2-6°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to hydrology flood and regolith	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S174	79170 to 79300	Yinnar (Yn)	Alluvial plain	mod slopes Palaeo channels on u	Moderately inclined (6-18°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to moderate slopes, regolith hydrology	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S175	79300 to 79720	Boolarra with Morwell (Bl/Mr)	Undulating low hills to rolling low h	higher level terrace	Gently inclined (2-6°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to regolith variable stratigraphy	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S176	79720 to 79950	Yinnar (Yn)	Alluvial plain	Bluff	Moderately inclined (6-18°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	alluvial terrace deposits(Qa2): generic	S	Moderate	Due tor relief and slope and regolith uncertainty	GM01,GM02,GM04, GM05, GM06, GM07, GM08	Moderate	Minor	Low	Partial HDD under road
S177	79950 to 81550	Yinnar (Yn)	Alluvial plain	Palaeo floodplain	Gently inclined (2-6°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	alluvial terrace deposits(Qa2): generic	S	Moderate	Due to flood and regolith uncertainty	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S178	81550 to 81730	Yinnar (Yn)	Alluvial plain	Palaeo levee and channel	Gently inclined (2-6°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	alluvial terrace deposits(Qa2): generic	S	Moderate	Due to nature of paleo channel and regolith	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S179	81730 to 83070	Yinnar (Yn)	Alluvial plain	Palaeo floodplain with traces of c	Gently inclined (2-6°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	alluvial terrace deposits(Qa2): generic	S	Moderate	Due to floodplain nature, regolith hydrology and flood	GM01,GM02,GM04,GM06, GM08	Moderate	Minor	Low	
S180	83070 to 83350	Yinnar (Yn)	Alluvial plain	Terrace of tributary	Gently inclined (2-6°)	Late Pleistocene alluvial sediments (most likely outwash from nearby hi	alluvial terrace deposits(Qa2): generic	S	Moderate	Due to regolith uncertainty	GM01,GM02,GM04,GM06, GM07, GM08	Moderate	Minor	Low	
S181	83350 to 83500	Riverine (Riv)	Alluvial plain and channel	Tributary leading into Hazelwood	Moderately inclined (6-18°)	Recent (contemporary) alluvium sediments deposited by various strean	alluvial terrace deposits(Qa2): generic	Vs	Moderate	Due to flood	GM01,GM05 GM09	Minor	Negligible	Low	Using HDD under channel
S182	83500 to 85400	Uncertain ??- Loy Yang (Ly) p	Undulating low rises	undulating surface	Gently inclined (2-6°)	Alluvial sediments believed to have been deposited in the late Pliocene	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to regolith uncertainty	GM01,GM02,GM04, GM05, GM06, GM08	Moderate	Minor	Low	Partial HDD under road
S183	85400 to 87200	Loy Yang (Ly)	Plain	alluvial plain	Very gently inclined (0.5-2°)	Alluvial sediments believed to have been deposited in the late Pliocene	Haunted Hills Formation(Nlh): generic	S	Moderate	Due to complex regolith stratigraphy	GM01,GM02,GM04, GM07, GM06, GM08	Moderate	Minor	Low	Partial HDD sections

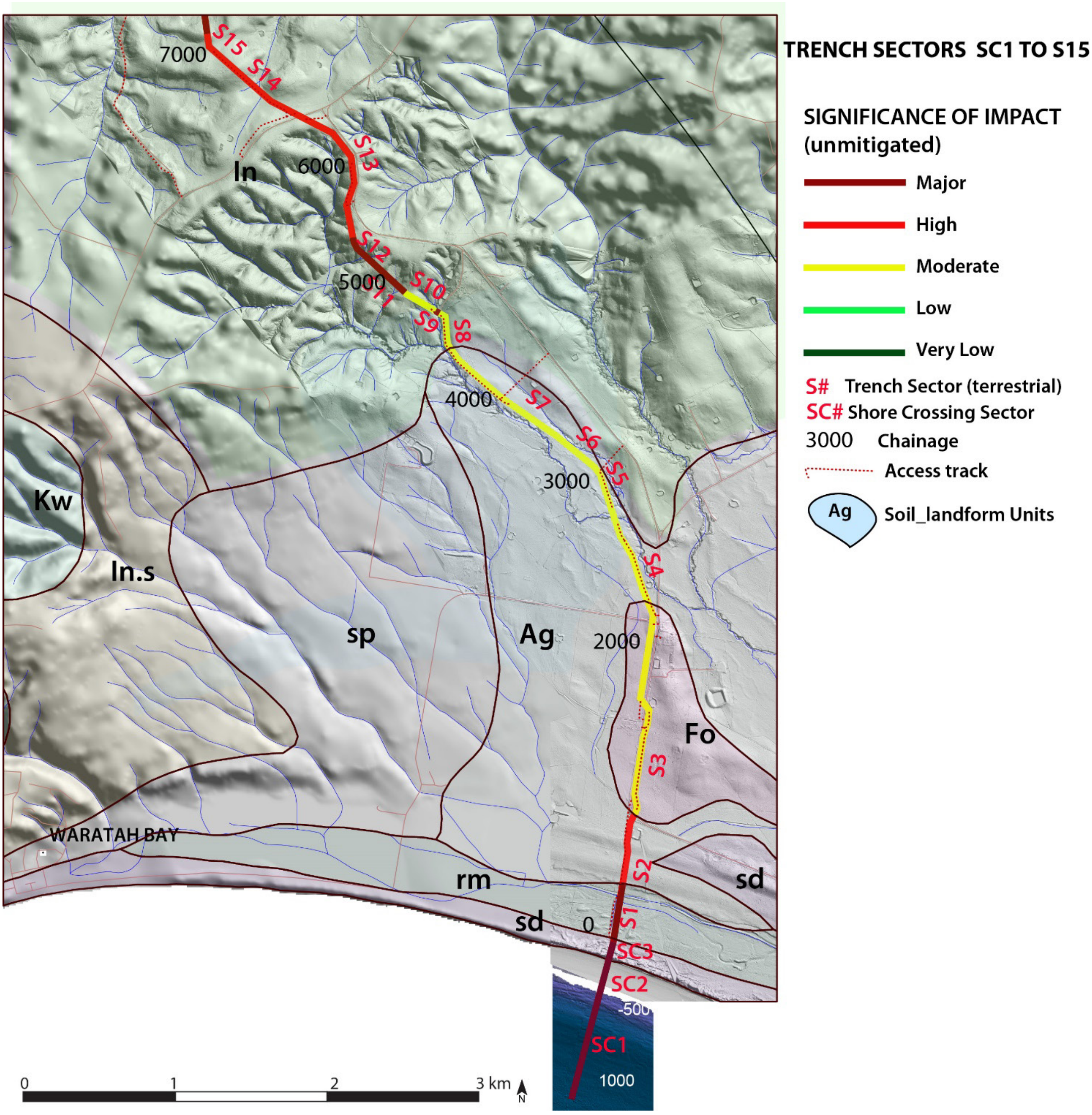
Driffield Converter Station

D1	0 to 270	Boolarra with Morwell (Bl/Mr)	Ridge crest		Gently inclined (2-6°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to regolith	GM01,GM02,GM03, GM04,GM06, GM08	Moderate	Minor	Low	
D2	270 to 340	Boolarra with Morwell (Bl/Mr)	Valley slope		Moderately inclined (6-18°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to moderate slopes and regolith variability	GM01,GM02, GM03, GM04,GM06, GM08	Moderate	Minor	Low	
D3	340 to 510	Boolarra with Morwell (Bl/Mr)	Gentle valley and low ridge		Gently inclined (2-6°)	Tertiary sediments, mostly late Tertiary - including the Haunted Hills gra	Latrobe Valley Group (-Pv): generic	S	Moderate	Due to regolith	GM01,GM02, GM03, GM04,GM06, GM07, GM08	Moderate	Minor	Low	
D4	510 to 720	Boolarra with Morwell (Bl/Mr)	Gentle valley and low ridge		Gently inclined (2-6°)	Predominantly pre-basaltic Tertiary sediments, including basalt colluviur	Thorpdale Volcanic Group (-Put): Generic	S	Moderate	Due to regolith and geology change	GM01,GM02, GM03, GM04,GM06, GM07, GM08	Moderate	Minor	Low	
D5	Overall Converter Station Site	Boolarra with Morwell (Bl/Mr)	Gentle valley and low ridge		Moderately inclined (6-18°)	predominantly Tertiary sediments, mostly late Tertiary - including the Haunted Hills gravels.	/Latrobe Valley Group/Thorpdale Volcanic Group (-Put): Generic	VS	Major	Due to regolith , geology change and groundwater proximity to cuts significant relief and slope issue due to amount of cut and fill needed.	GM01, GM02, GM03, GM04,GM06, GM07, GM08	Major	Moderate	Moderate	Detailed geotechnical report is available

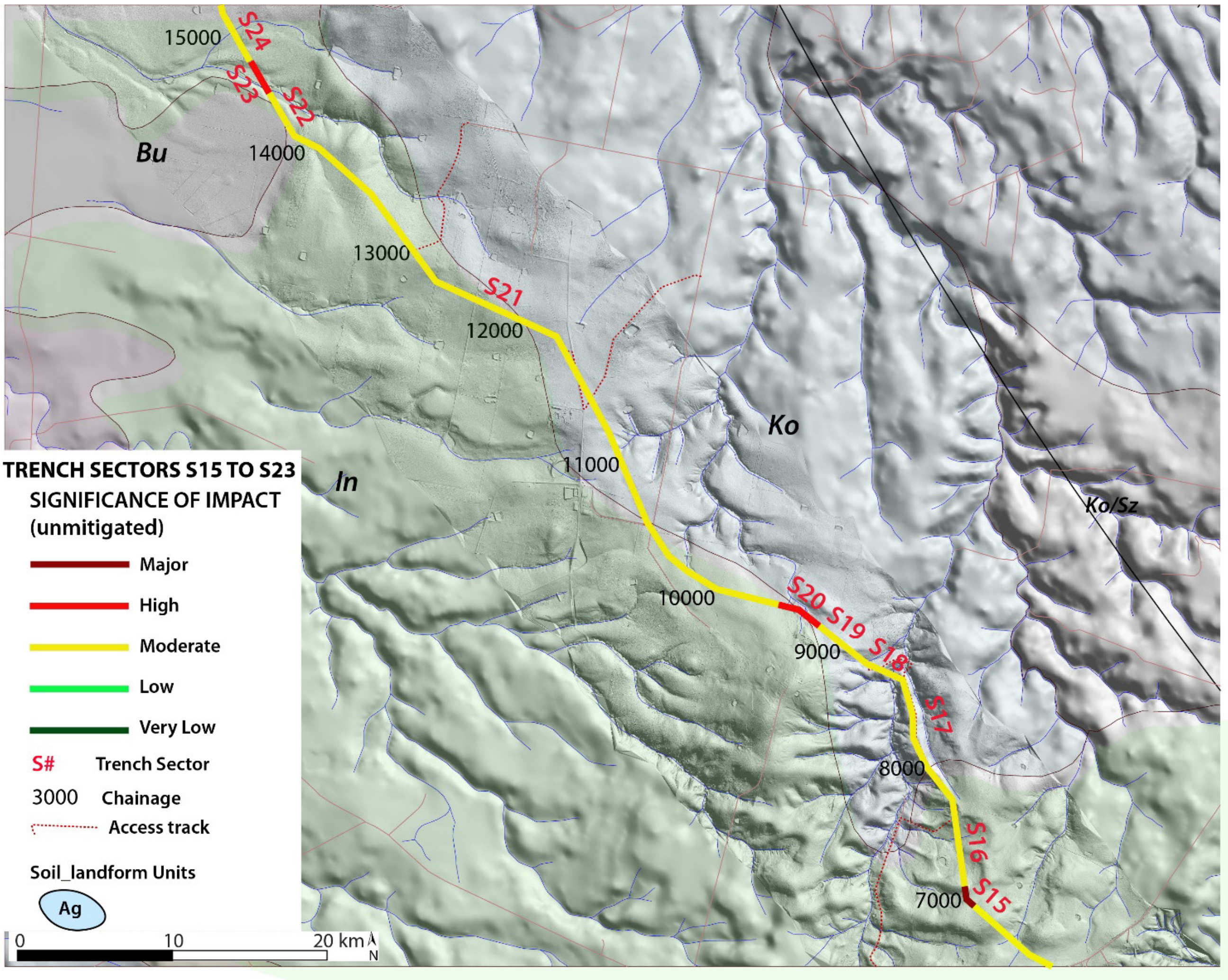
Hazelwood Converter Station

H1	Overall Converter Station Site	Loy Yang (Ly)	Undulating low rises	Broad low hill with cut on northern side for existing facility	Moderately inclined (6-18°)	Haunted Hills Formation including gravel	Haunted Hills Formation(Nlh): generic	S/VS	Major	Due to regolith , proximity to cut, relief and slope issue due to probable amount of cut and fill needed.	GM01, GM02, GM03, GM04,GM06, GM07, GM08	Major	Modrate	Modrate	Stability assessment and geotechnical investigation required to confirm site character and stability

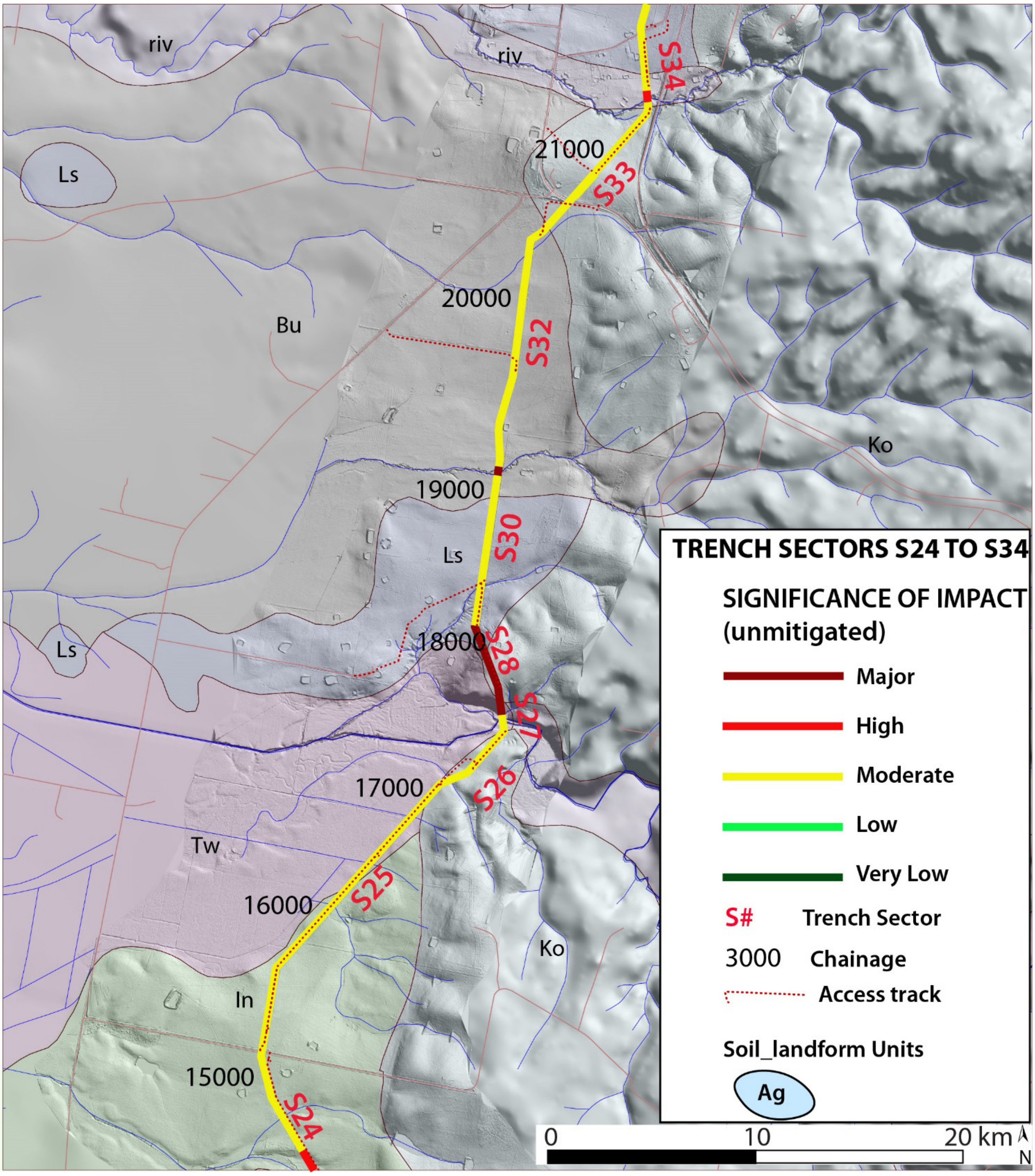
APPENDIX B: IMPACT MAPS



Date: May 2024



TRENCH SECTORS S15 TO S23
SIGNIFICANCE OF IMPACT
(unmitigated)
Major
High
Moderate
Low
Very Low
S# Trench Sector
3000 Chainage
Access track
Soil_landform Units
Ag
0
10
20 km
N
15000
14000
13000
12000
11000
10000
9000
8000
7000
S24
S23
S22
S21
S20
S19
S18
S17
S16
S15
Bu
In
Ko
Ko/Sz



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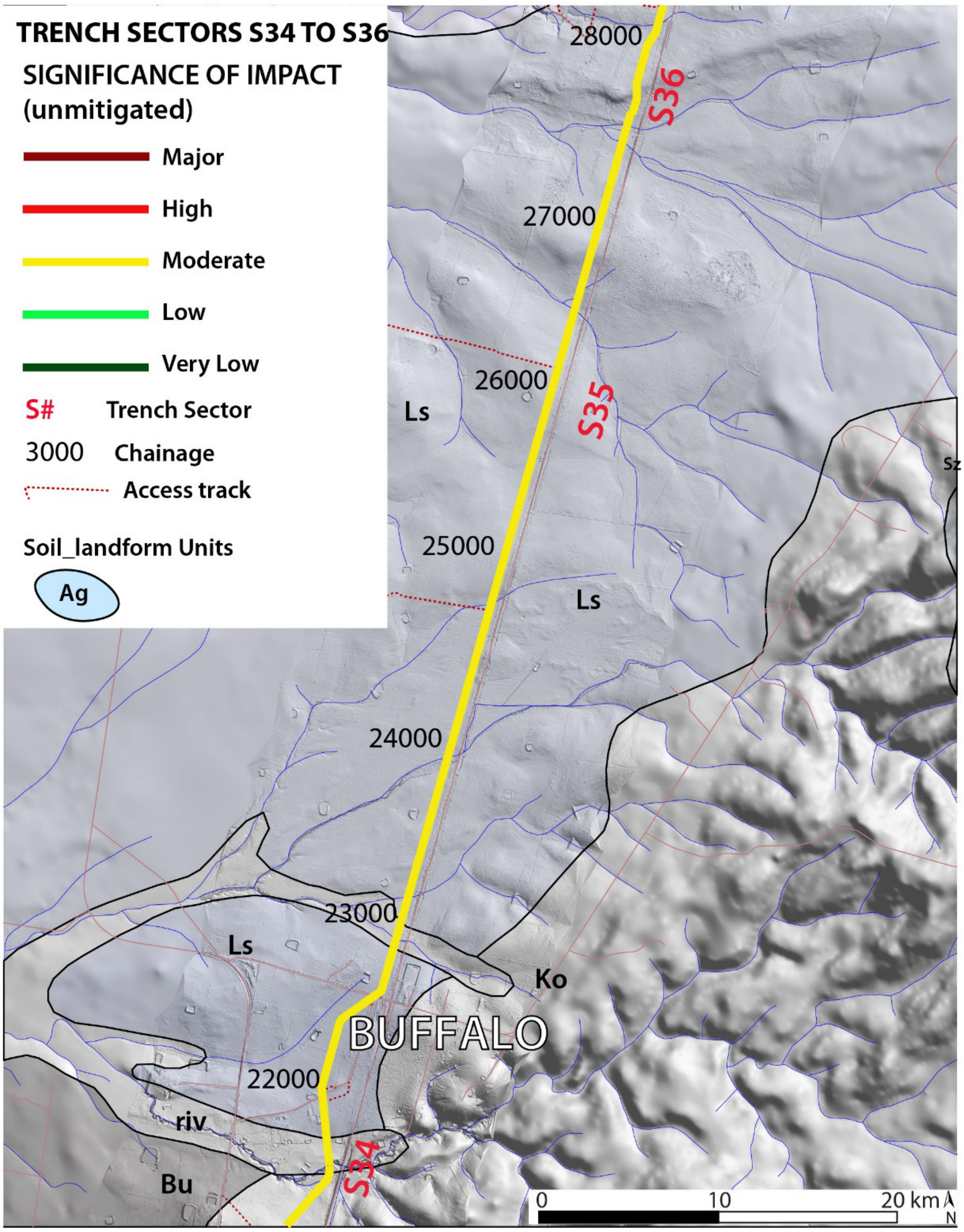
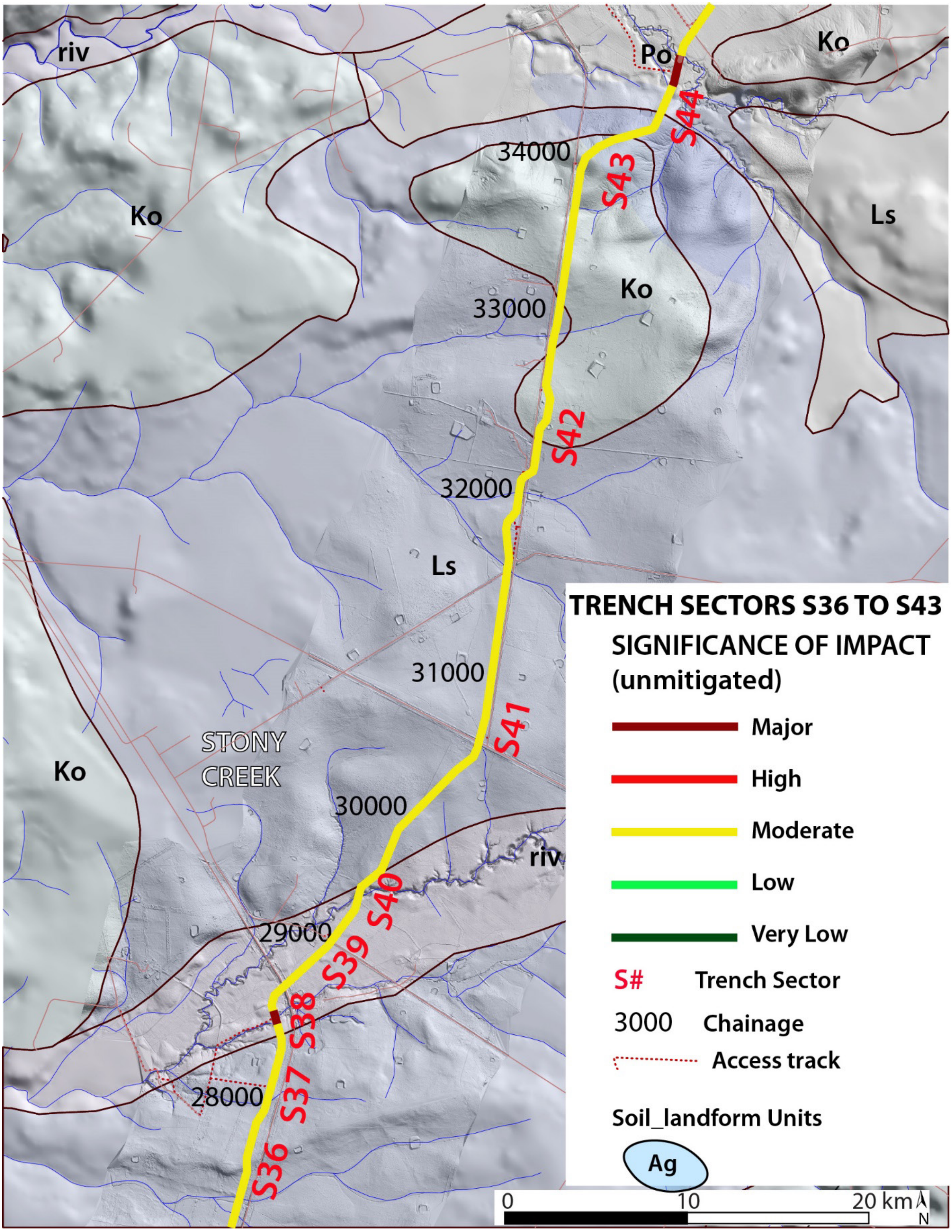
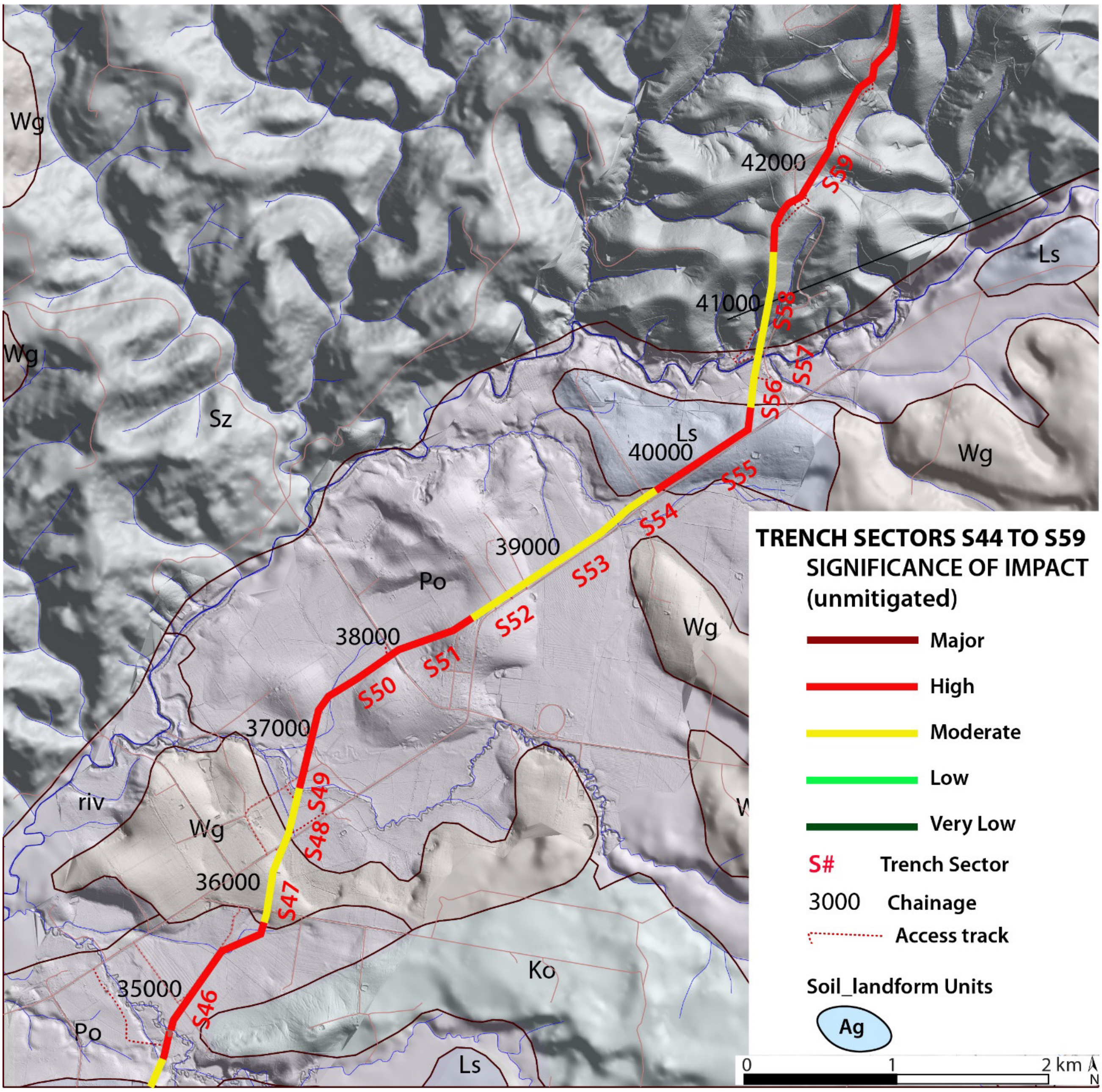
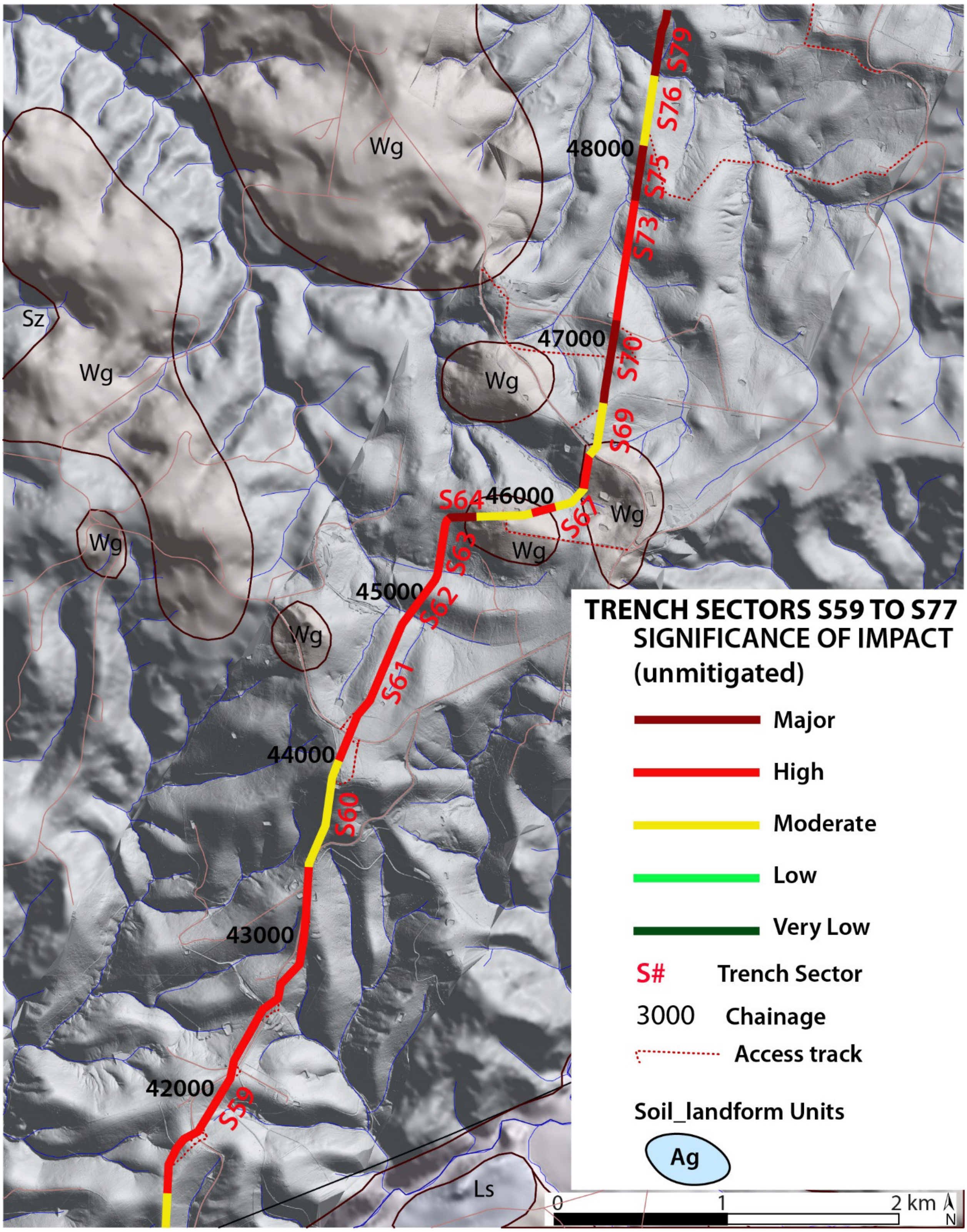
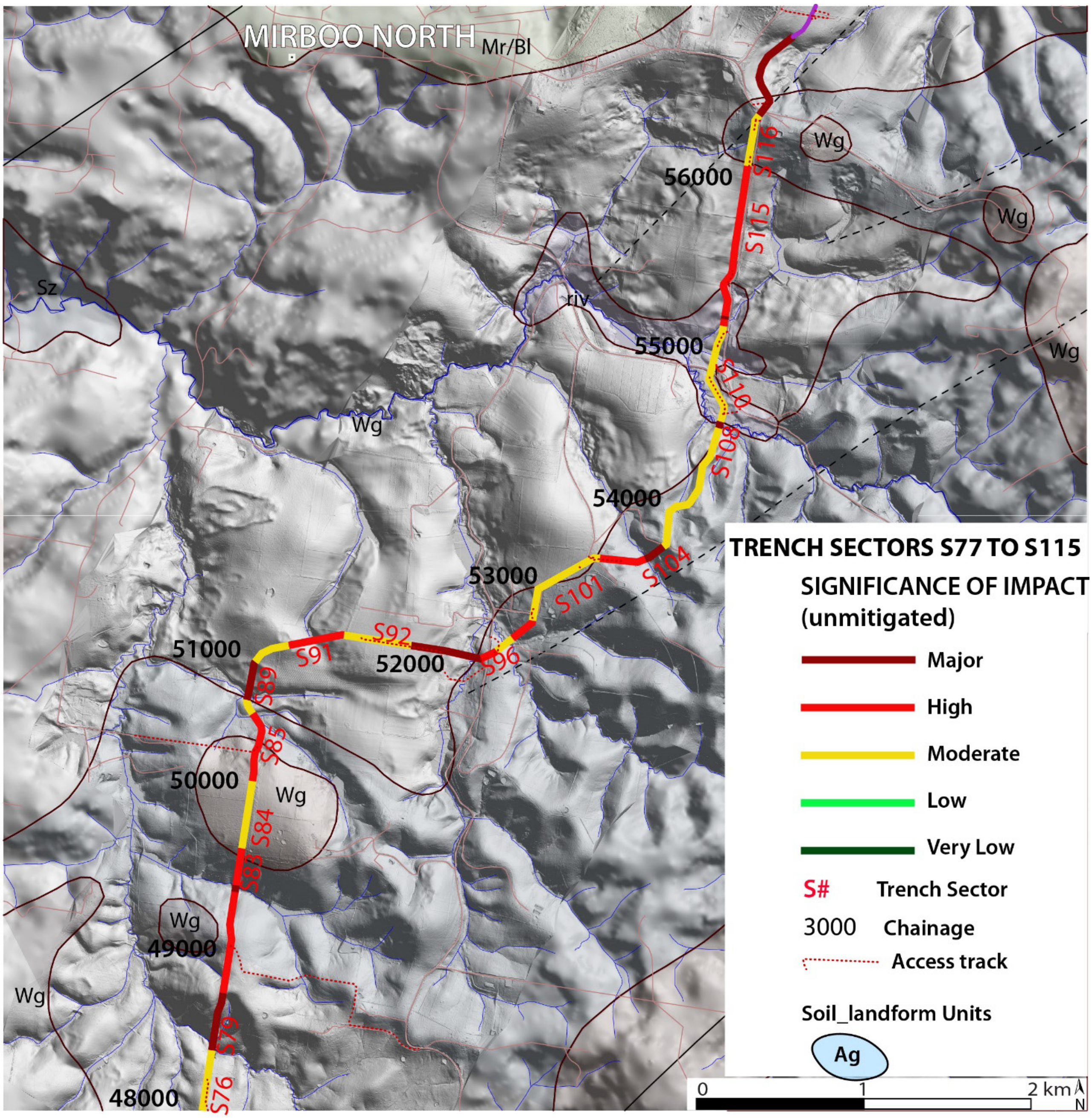
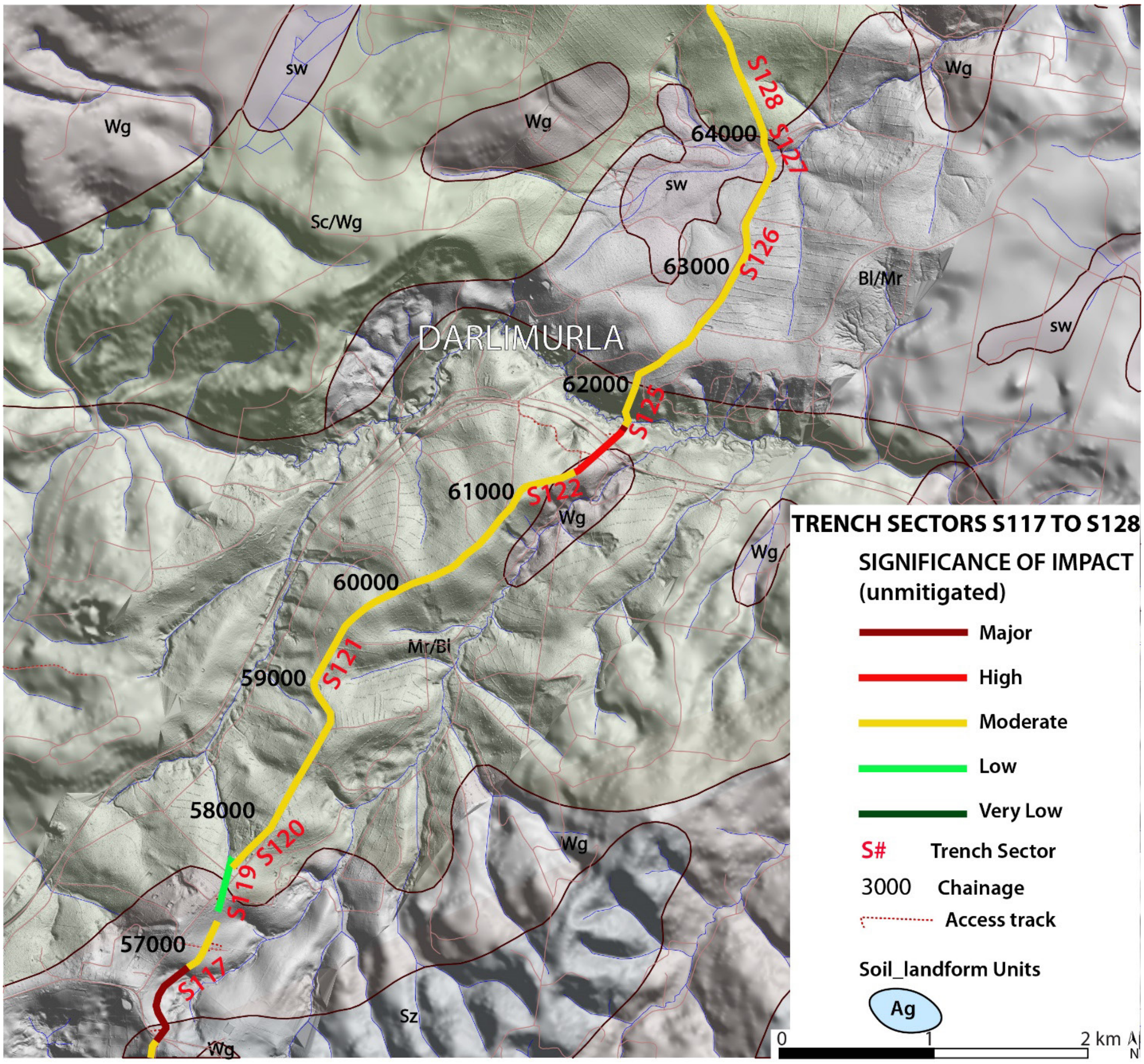

TRENCH SECTORS S34 TO S36
SIGNIFICANCE OF IMPACT
(unmitigated)
Major
High
Moderate
Low
Very Low
S# Trench Sector
3000 Chainage
Access track
Soil_landform Units
Ag
28000
S36
27000
26000
S35
Ls
25000
Ls
24000
23000
Ls
Ko
BUFFALO
22000
riv
S34
Bu
Sz
0
10
20 km
N


riv
Po
Ko
S44
34000
S43
Ko
Ls
Ko
33000
S42
32000
Ls
TRENCH SECTORS S36 TO S43
SIGNIFICANCE OF IMPACT
(unmitigated)
Major
High
Moderate
Low
Very Low
S# Trench Sector
3000 Chainage
Access track
Soil_landform Units
Ag
31000
S41
STONY
CREEK
Ko
30000
riv
S40
29000
S39
S38
28000
S37
S36
0
10
20 km
N

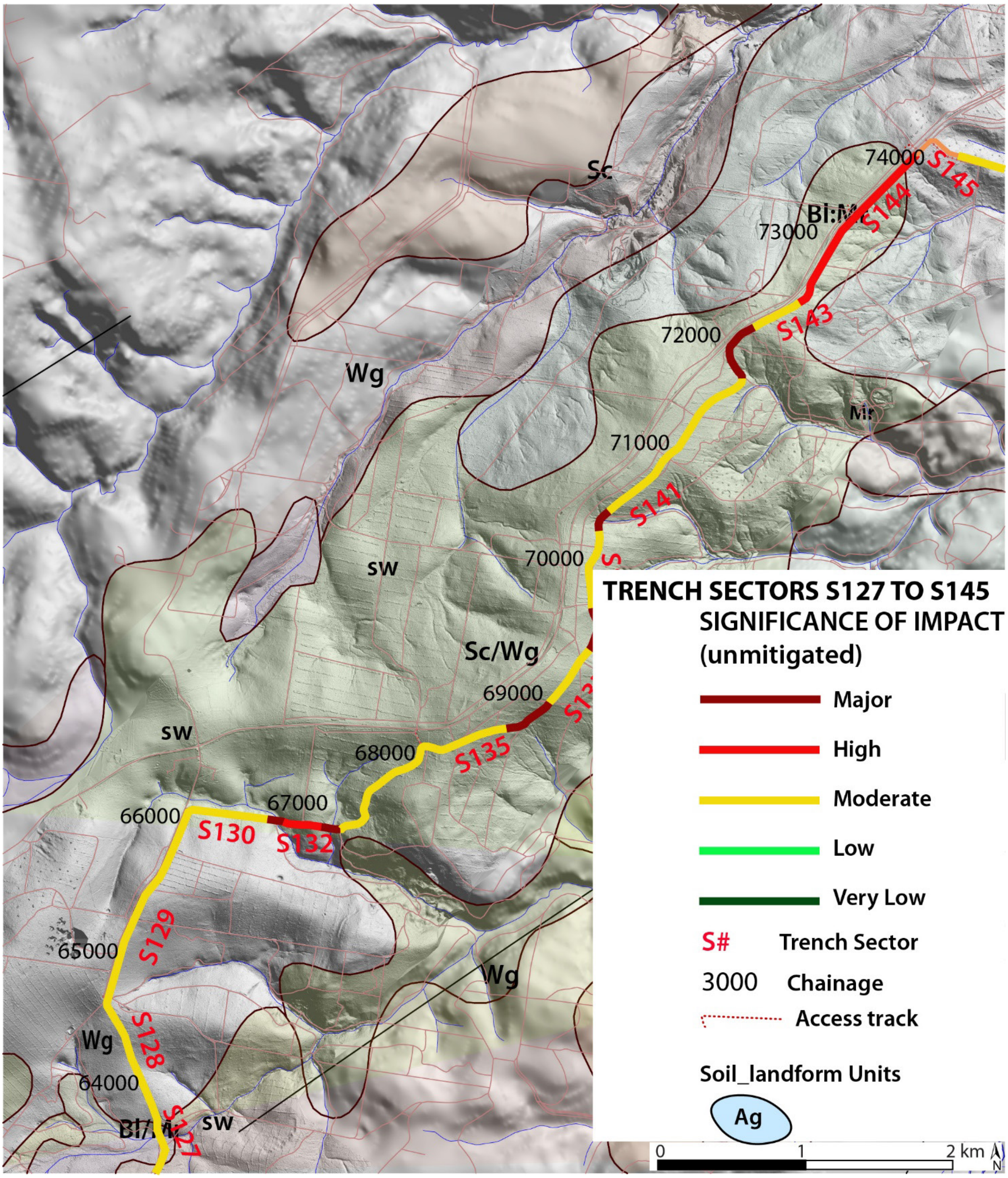

TRENCH SECTORS S44 TO S59
SIGNIFICANCE OF IMPACT
(unmitigated)
Major
High
Moderate
Low
Very Low
S#
Trench Sector
3000
Chainage
Access track
Soil_landform Units
Ag
0
1
2 km
N
Wg
Wg
Sz
Ls
40000
Wg
Ls
42000
41000
S59
S58
S57
S56
S55
S54
S53
S52
S51
S50
S49
S48
S47
S46
39000
38000
37000
36000
35000
Po
Wg
riv
Wg
Ko
Po
Ls


TRENCH SECTORS S59 TO S77
SIGNIFICANCE OF IMPACT
(unmitigated)
Major
High
Moderate
Low
Very Low
S# Trench Sector
3000 Chainage
Access track
Soil_landform Units
Ag
Wg
Sz
Ls
S59
S60
S61
S62
S63
S64
S67
S69
S70
S73
S75
S76
S79
42000
43000
44000
45000
46000
47000
48000
0
1
2 km
N


MIRBOO NORTH
Mr/Bl
Wg
56000
S116
S115
Sz
riv
55000
S110
S108
54000
TRENCH SECTORS S77 TO S115
SIGNIFICANCE OF IMPACT
(unmitigated)
Major
High
Moderate
Low
Very Low
S# Trench Sector
3000 Chainage
Access track
Soil_landform Units
Ag
53000
S101
S104
51000
S91
S92
52000
S96
S89
S85
50000
S84
S83
49000
S79
48000
S76
0
1
2 km
N



TRENCH SECTORS S117 TO S128
SIGNIFICANCE OF IMPACT (unmitigated)
Major
High
Moderate
Low
Very Low
S# Trench Sector
3000 Chainage
Access track
Soil_landform Units
Ag
0
1
2 km
DARLIMURLA
S117
S119
S120
S121
S122
S125
S126
S127
S128
57000
58000
59000
60000
61000
62000
63000
64000
Wg
sw
Sc/Wg
Bl/Mr
Mr/Bl
Sz


TRENCH SECTORS S127 TO S145
SIGNIFICANCE OF IMPACT
(unmitigated)
Major
High
Moderate
Low
Very Low
S# Trench Sector
3000 Chainage
Access track
Soil_landform Units
Ag
0
1
2 km
Sc
Wg
sw
Sc/Wg
Mr
S127
S128
S129
S130
S132
S135
S141
S143
S144
S145
64000
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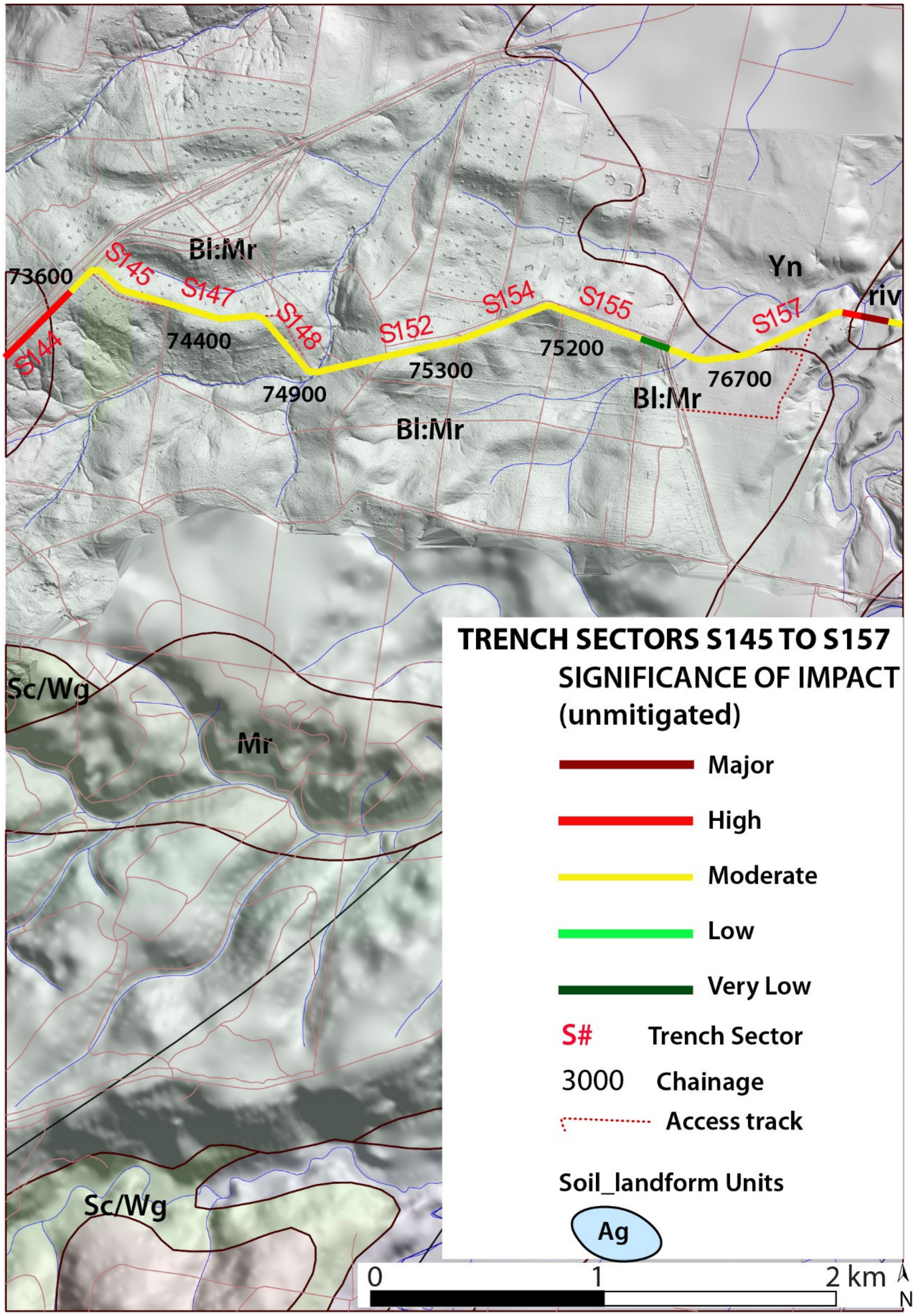
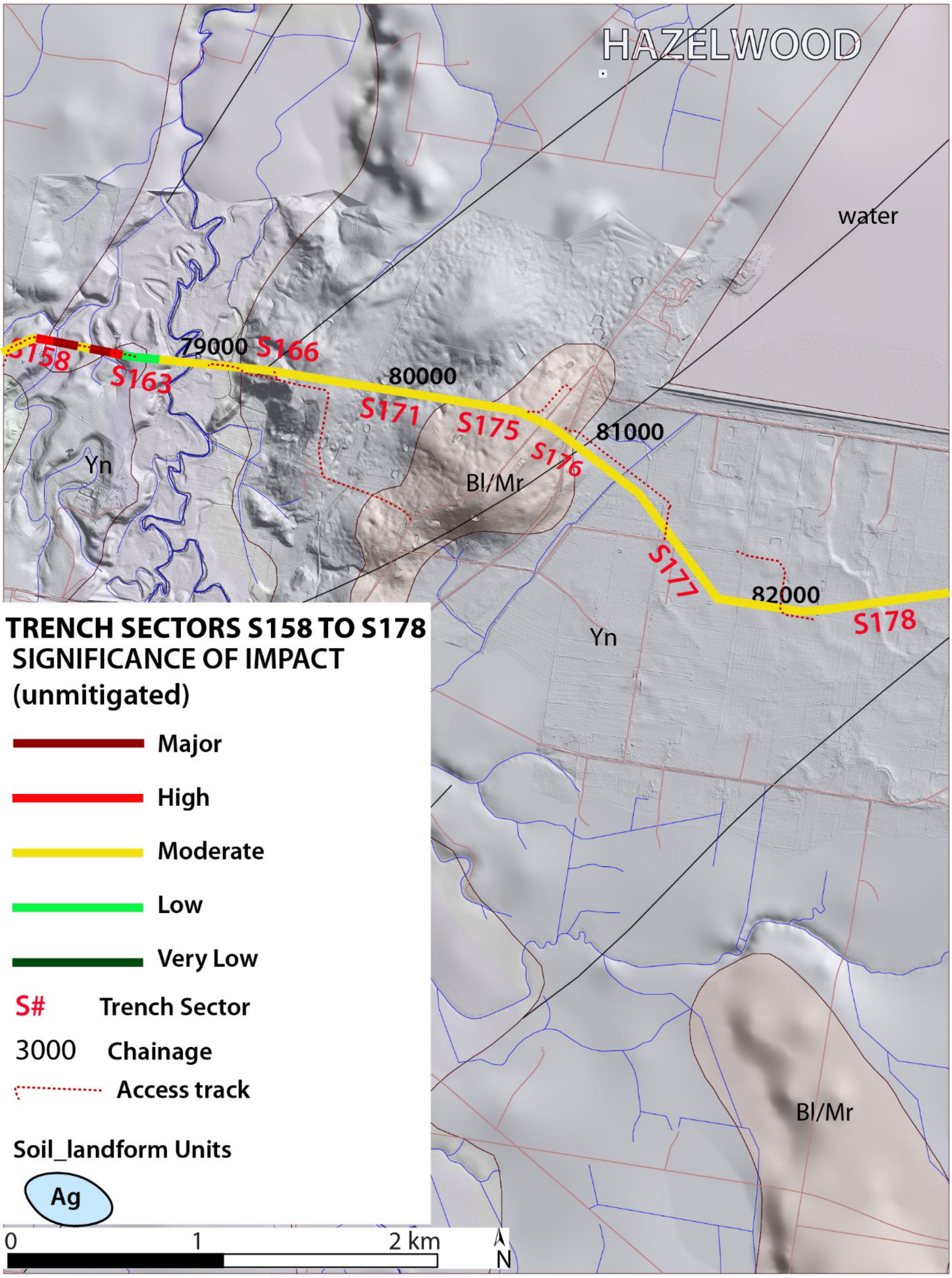
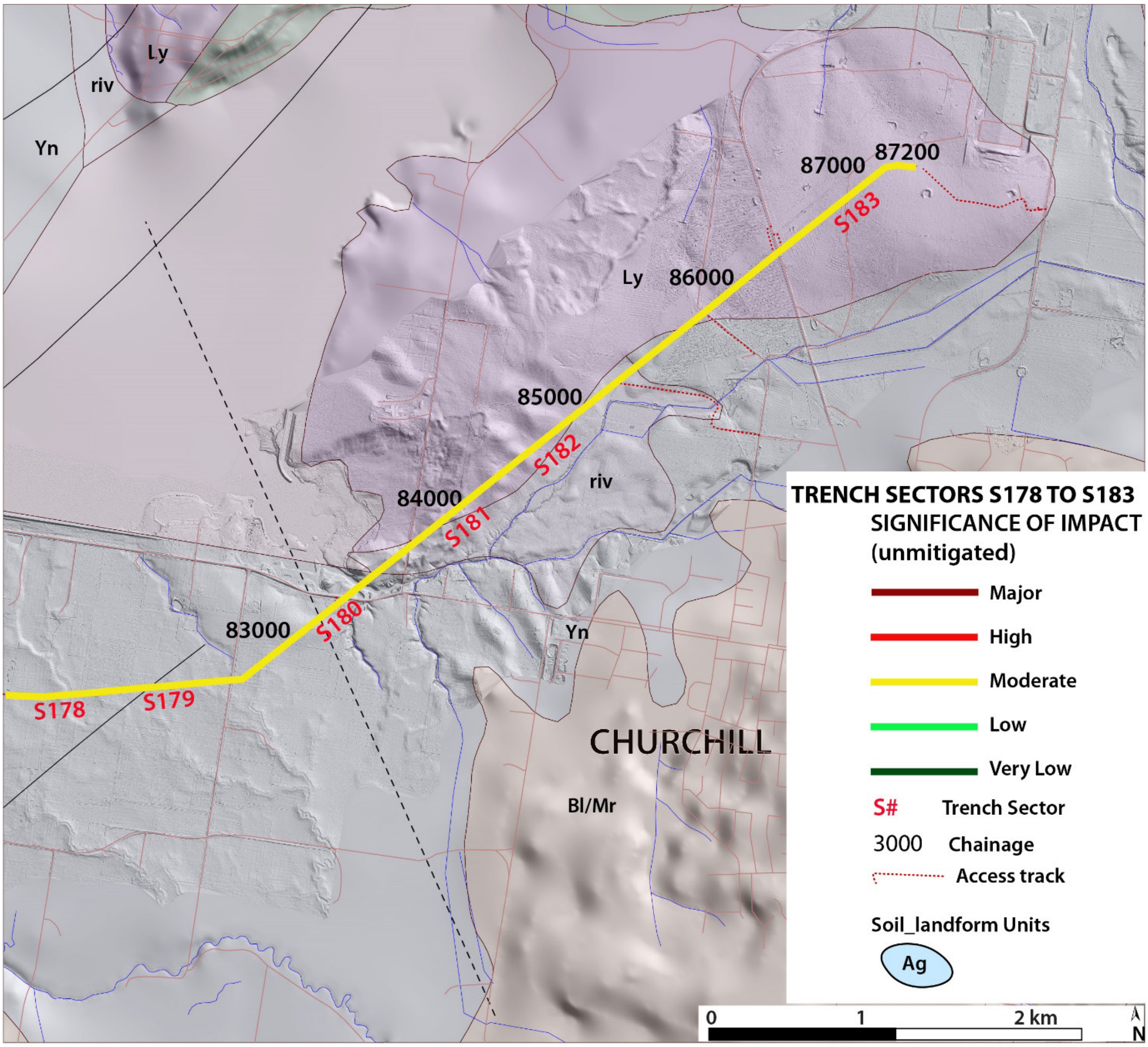
67000
68000
69000
70000
71000
72000
73000
74000



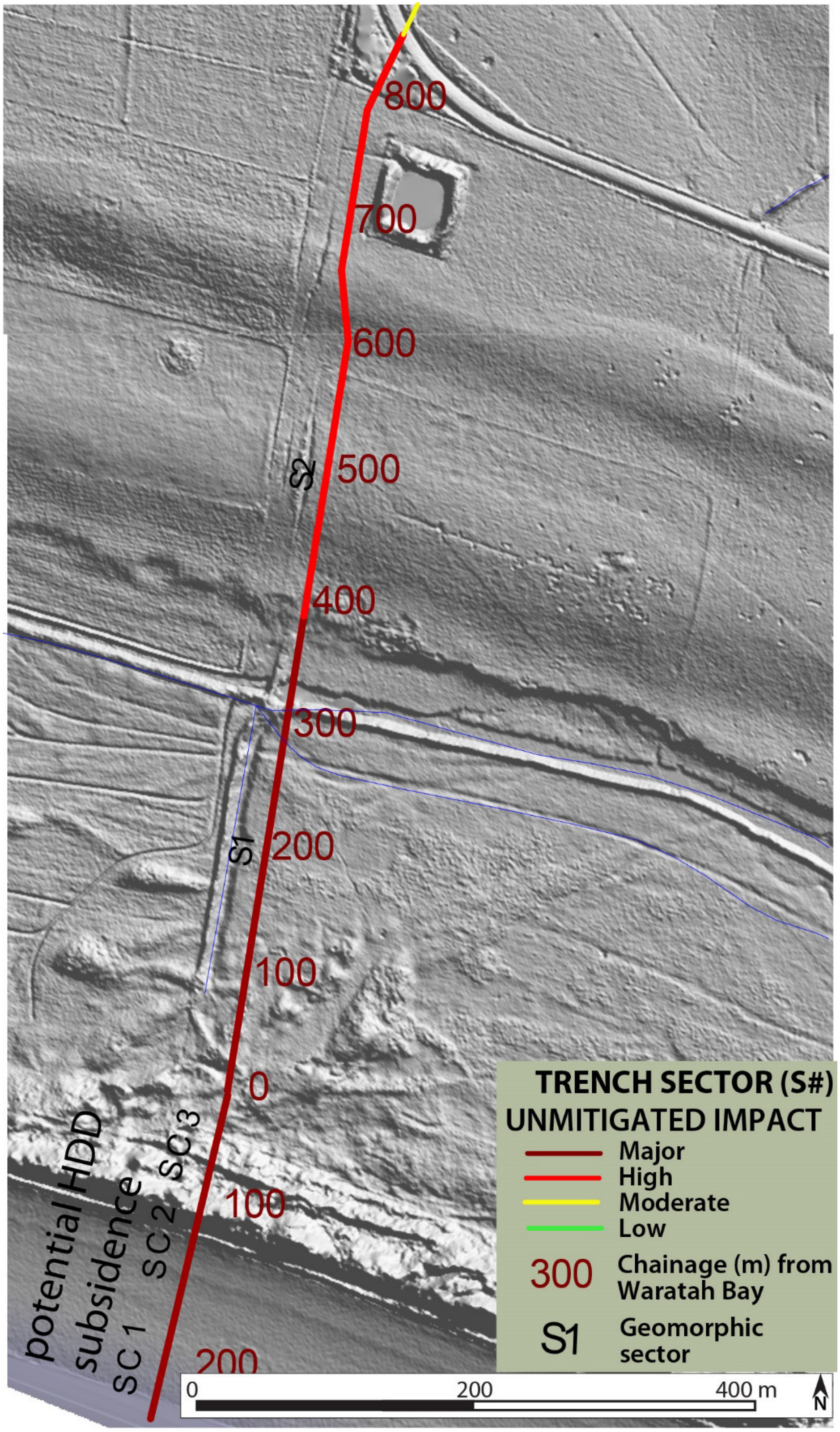
73600
S144
S145
S147
Bl:Mr
74400
S148
74900
S152
75300
S154
S155
75200
Bl:Mr
Bl:Mr
76700
S157
Yn
riv
Sc/Wg
Mr
Sc/Wg
TRENCH SECTORS S145 TO S157
SIGNIFICANCE OF IMPACT
(unmitigated)
Major
High
Moderate
Low
Very Low
S# Trench Sector
3000 Chainage
Access track
Soil_landform Units
Ag
0
1
2 km
N


HAZELWOOD
water
79000
S166
80000
S158
S163
S171
S175
S176
81000
Yn
Bl/Mr
S177
82000
S178
Yn
Bl/Mr
TRENCH SECTORS S158 TO S178
SIGNIFICANCE OF IMPACT
(unmitigated)
Major
High
Moderate
Low
Very Low
S# Trench Sector
3000 Chainage
Access track
Soil_landform Units
Ag
0
1
2 km
N

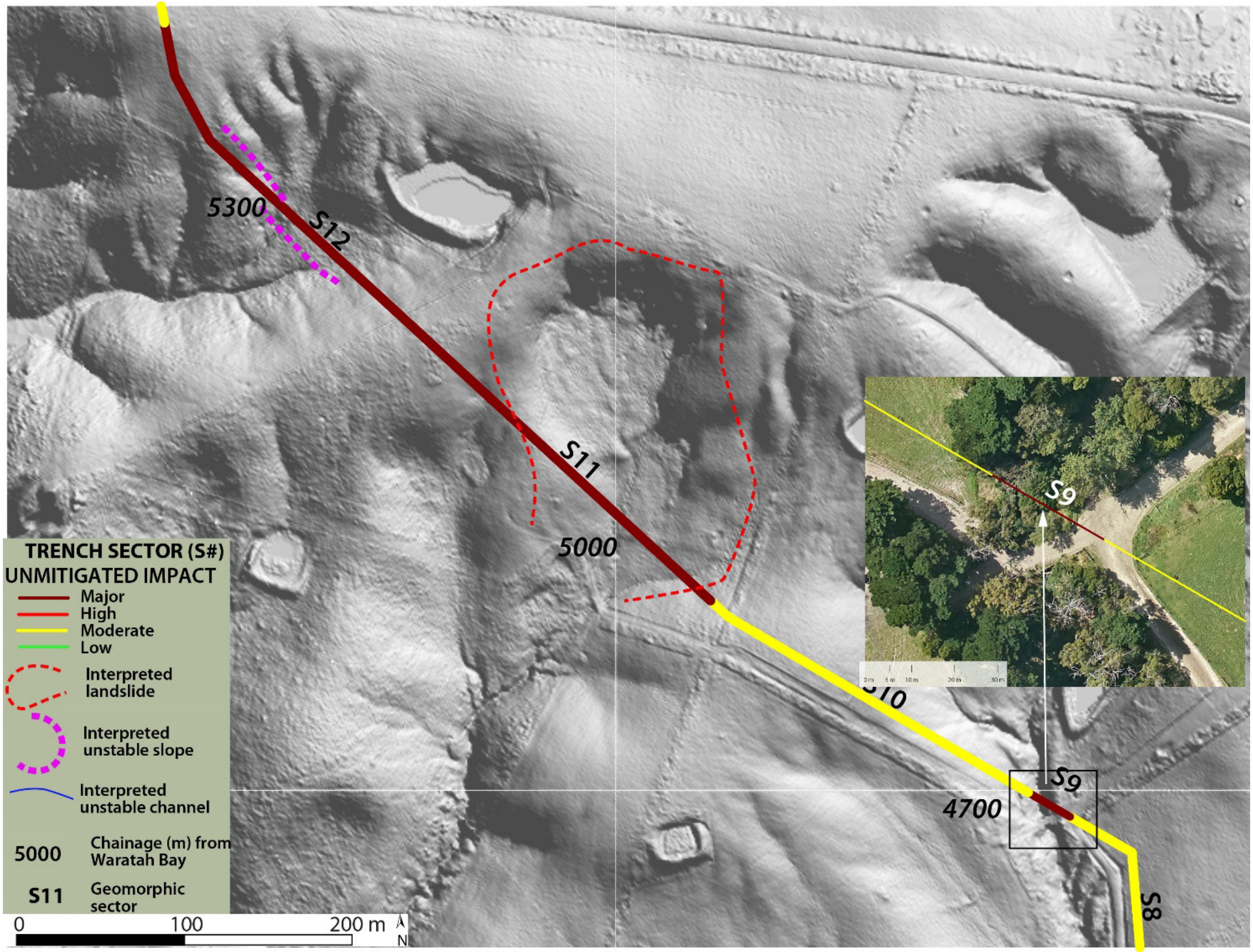


Ly
riv
Yn
87000
87200
S183
Ly
86000
85000
S182
riv
84000
S181
83000
S180
Yn
S178
S179
CHURCHILL
Bl/Mr
TRENCH SECTORS S178 TO S183
SIGNIFICANCE OF IMPACT
(unmitigated)
Major
High
Moderate
Low
Very Low
S# Trench Sector
3000 Chainage
Access track
Soil_landform Units
Ag
0
1
2 km
N

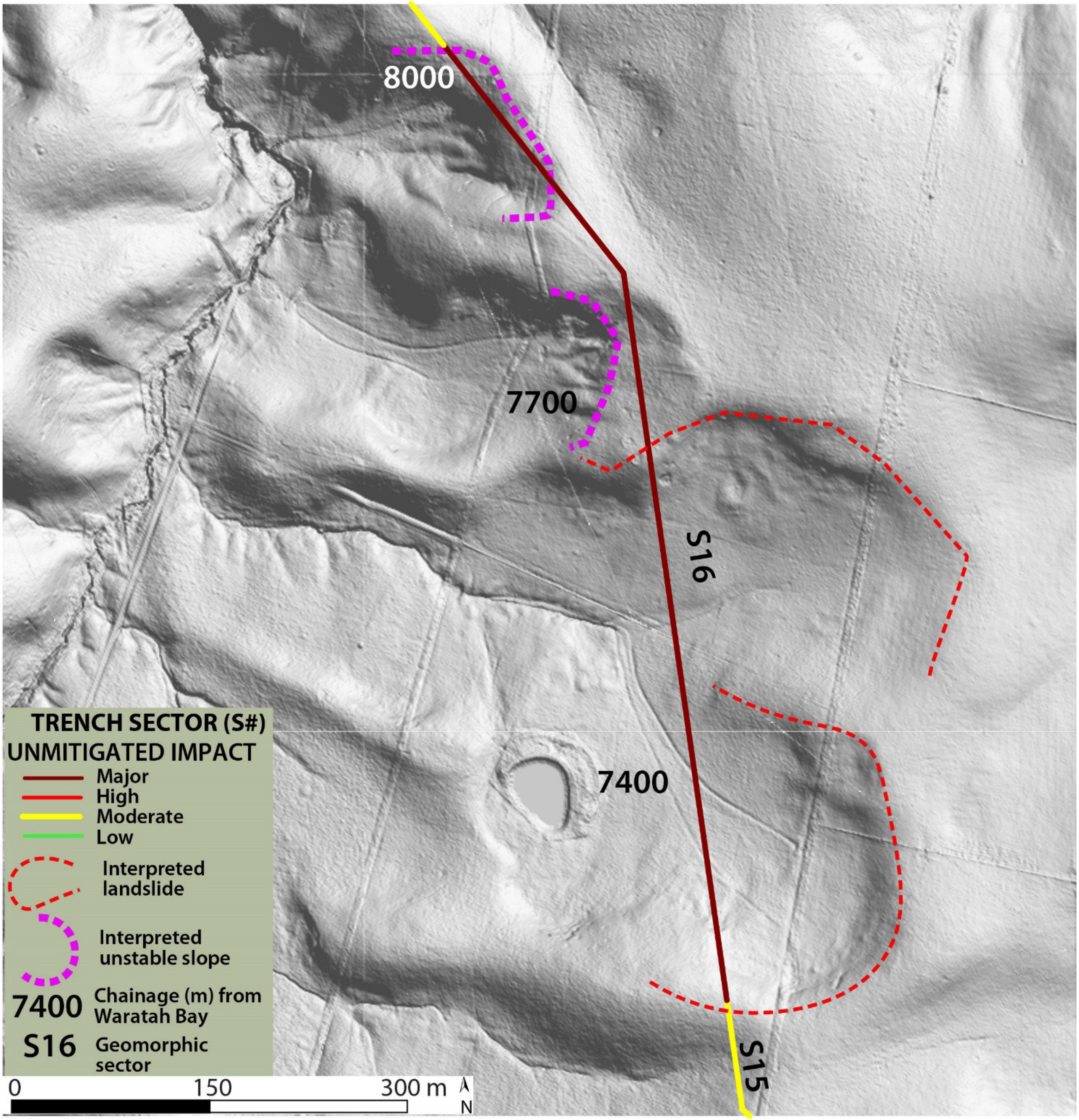
APPENDIX C: UNMITIGATED MAJOR AND HIGH SIGNIFICANCE OF IMPACT MAPS



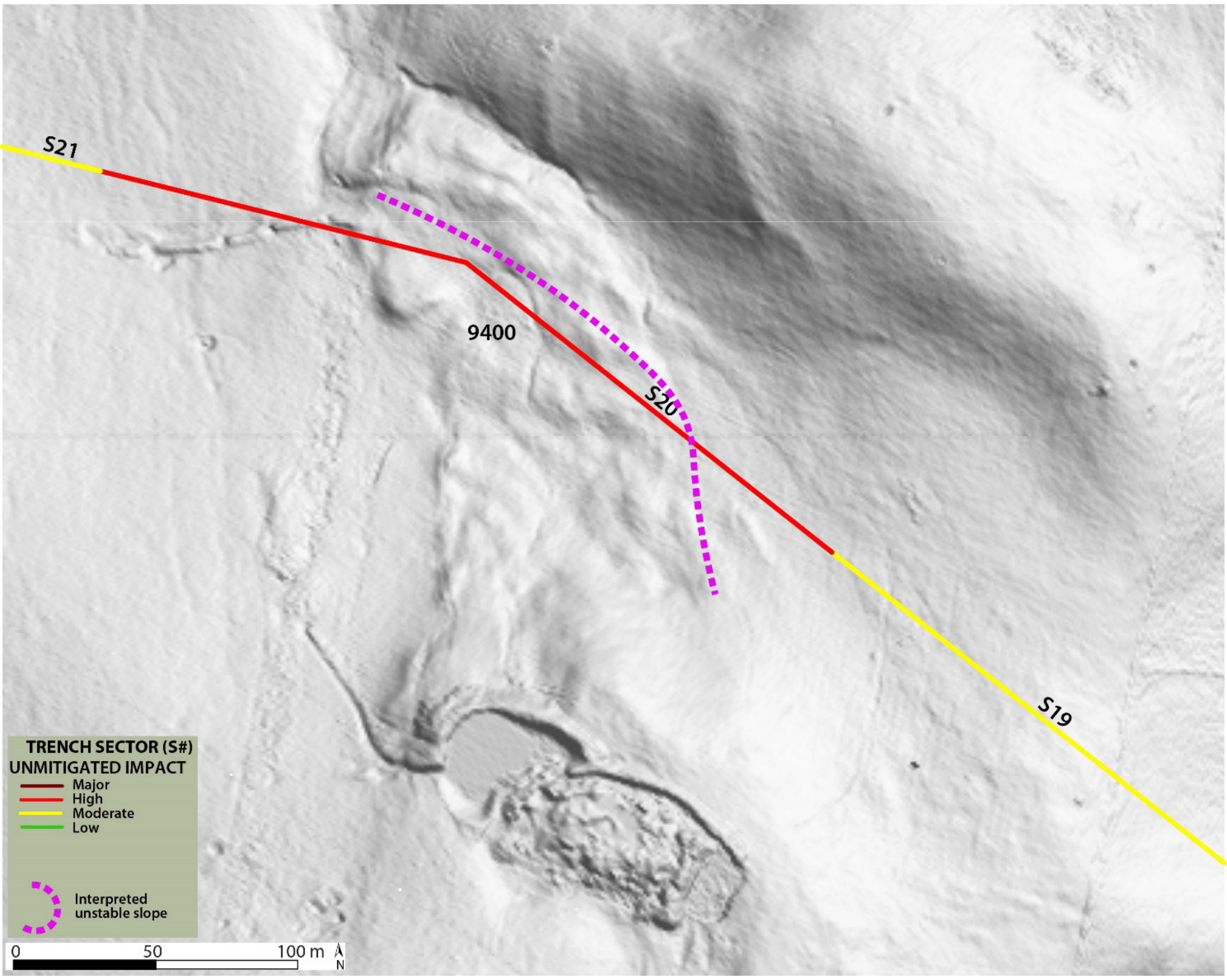
800
700
600
S2
500
400
300
S1
200
100
0
100
200
potential HDD subsidence
SC 1
SC 2
SC 3
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
300
Chainage (m) from Waratah Bay
S1
Geomorphic sector
0
200
400 m
N

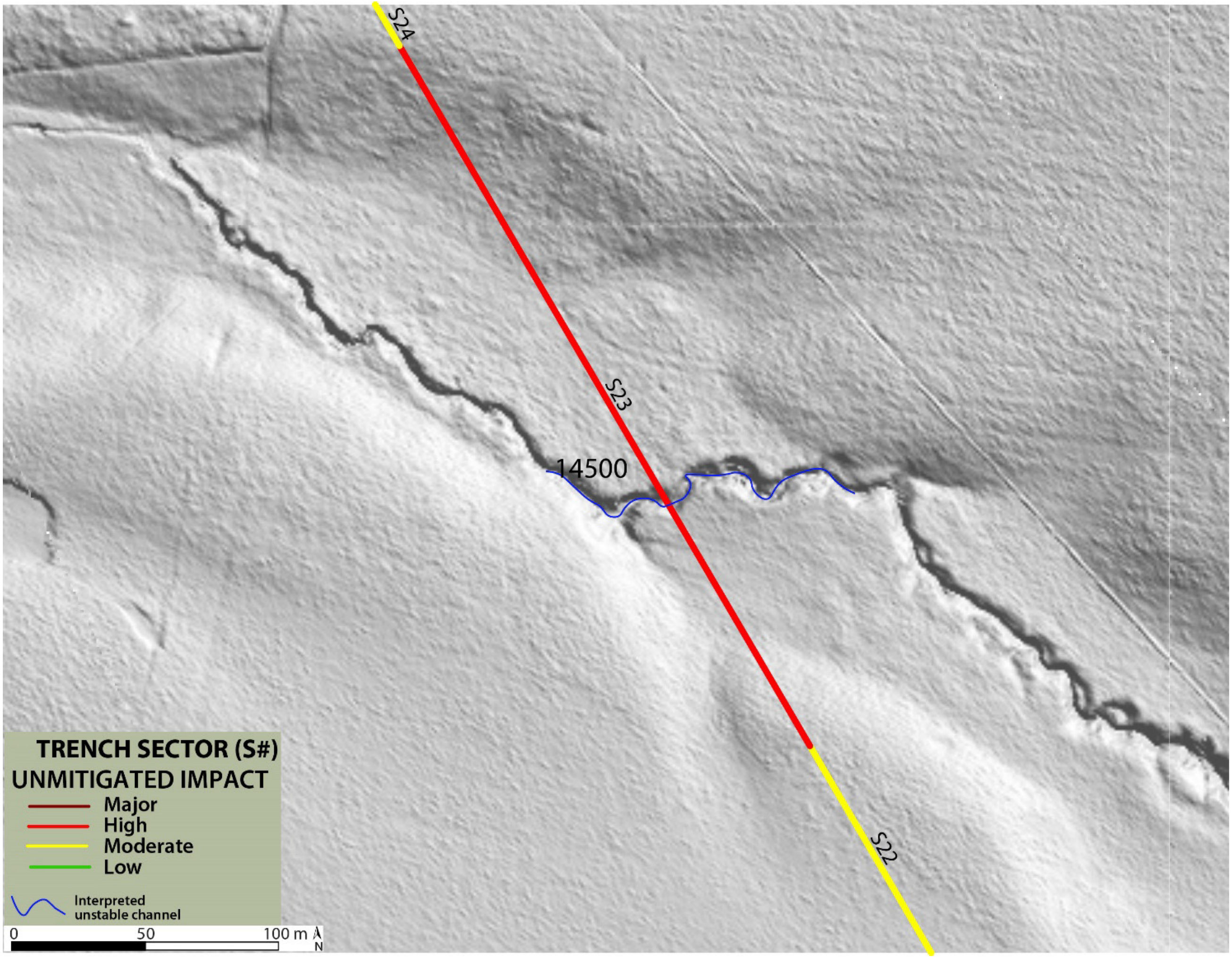


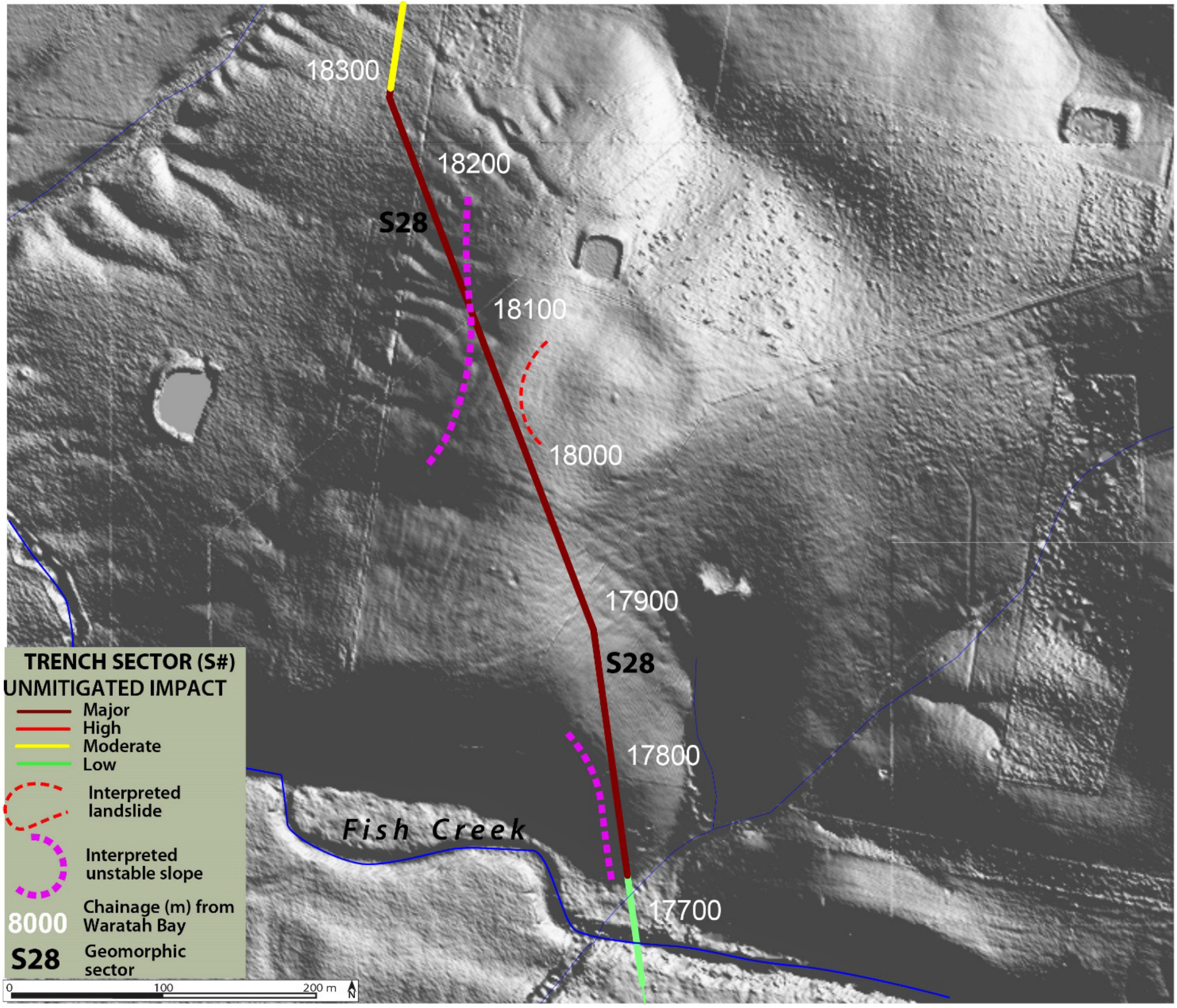
5300
S12
S11
5000
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
Interpreted unstable channel
5000
Chainage (m) from Waratah Bay
S11
Geomorphic sector
0
100
200 m
N
S9
S9
4700
S8

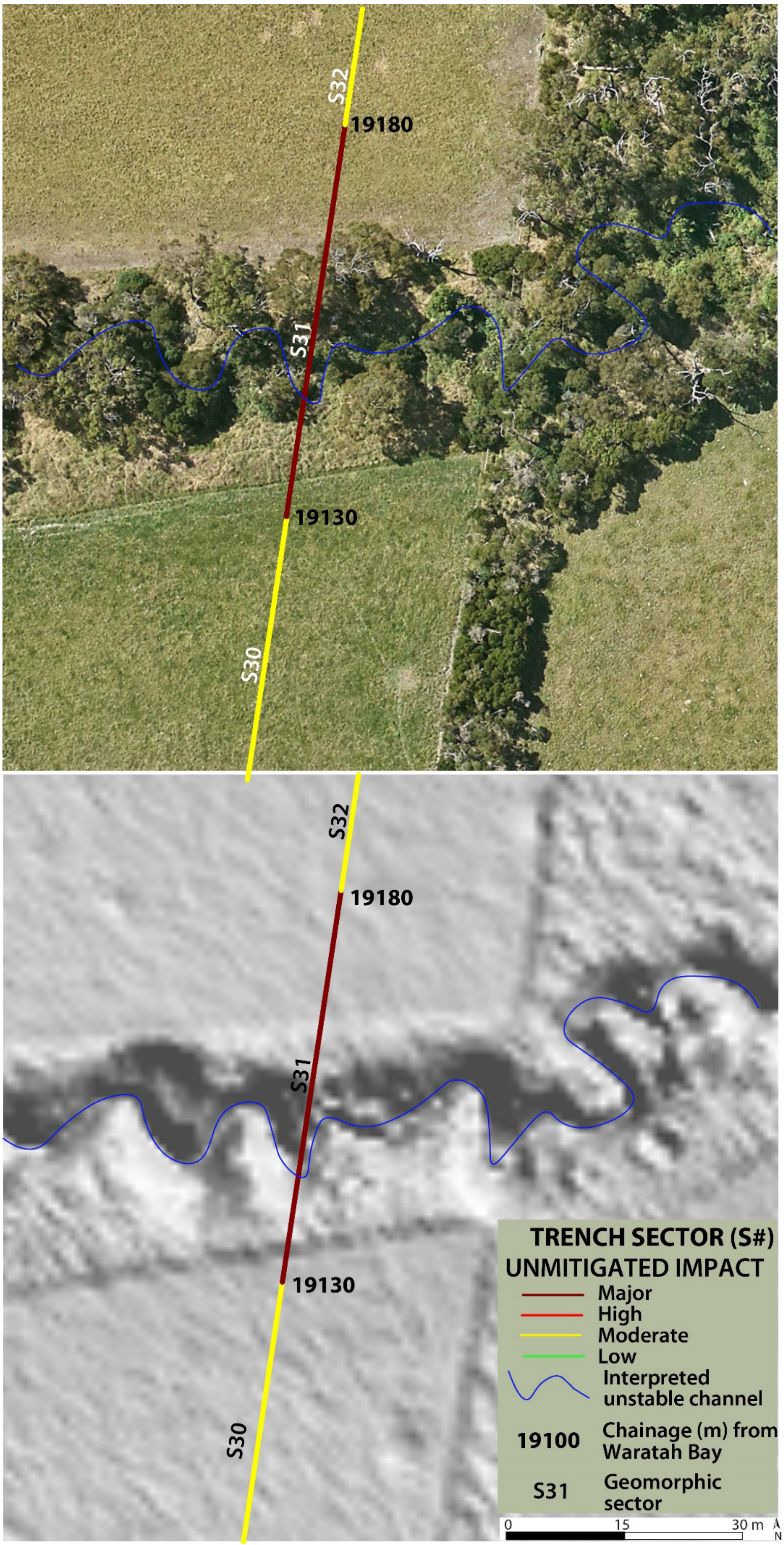


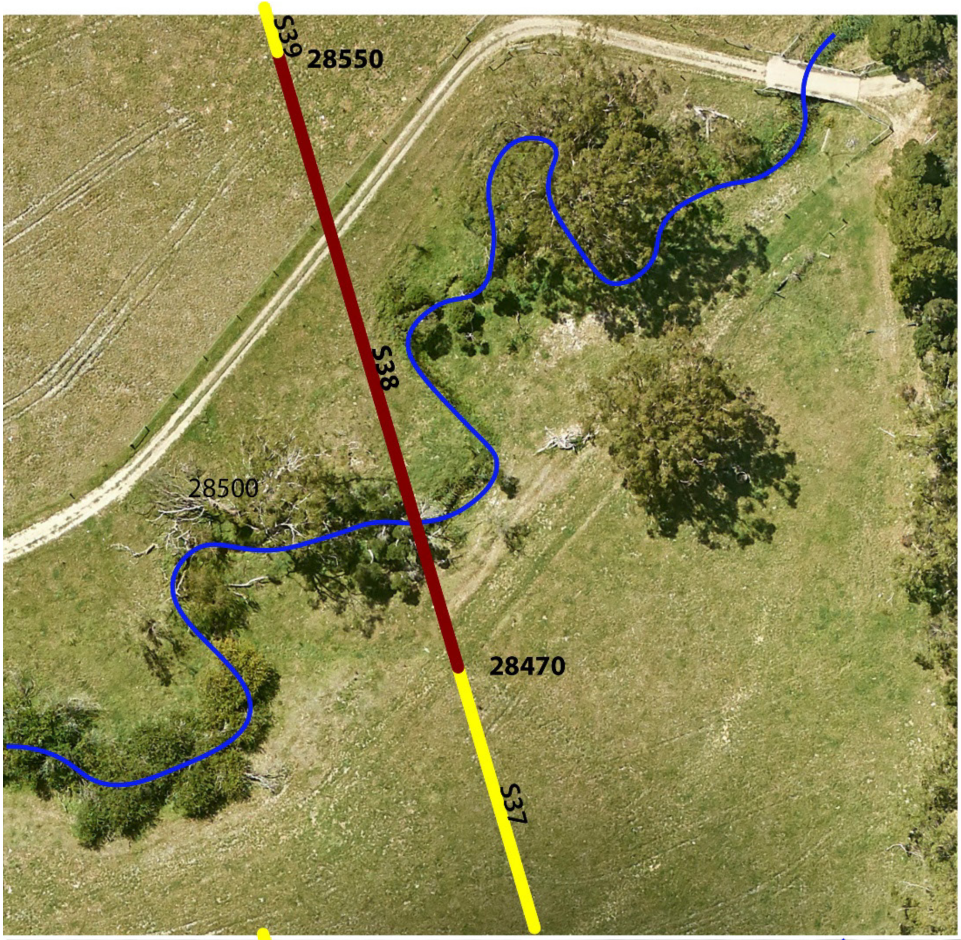
8000
7700
S16
7400
S15
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
7400 Chainage (m) from Waratah Bay
S16 Geomorphic sector
0
150
300 m
N

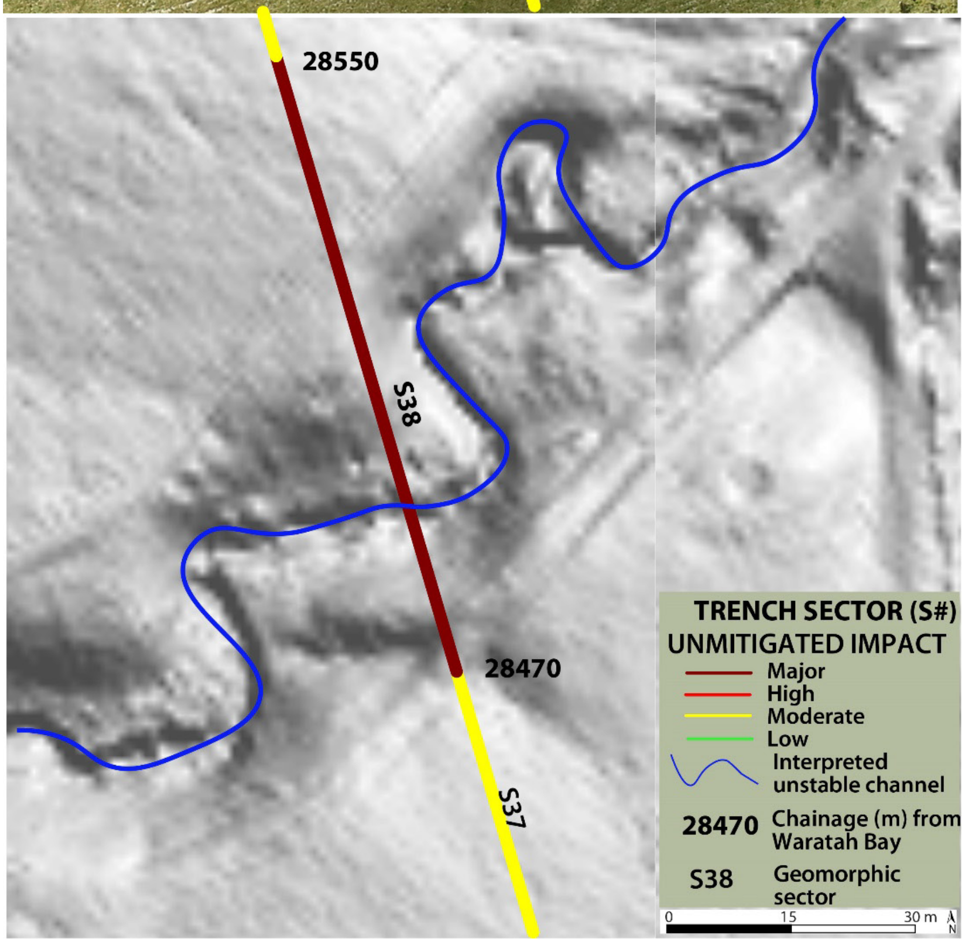

S21
9400
S20
S19
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted unstable slope
0
50
100 m
N

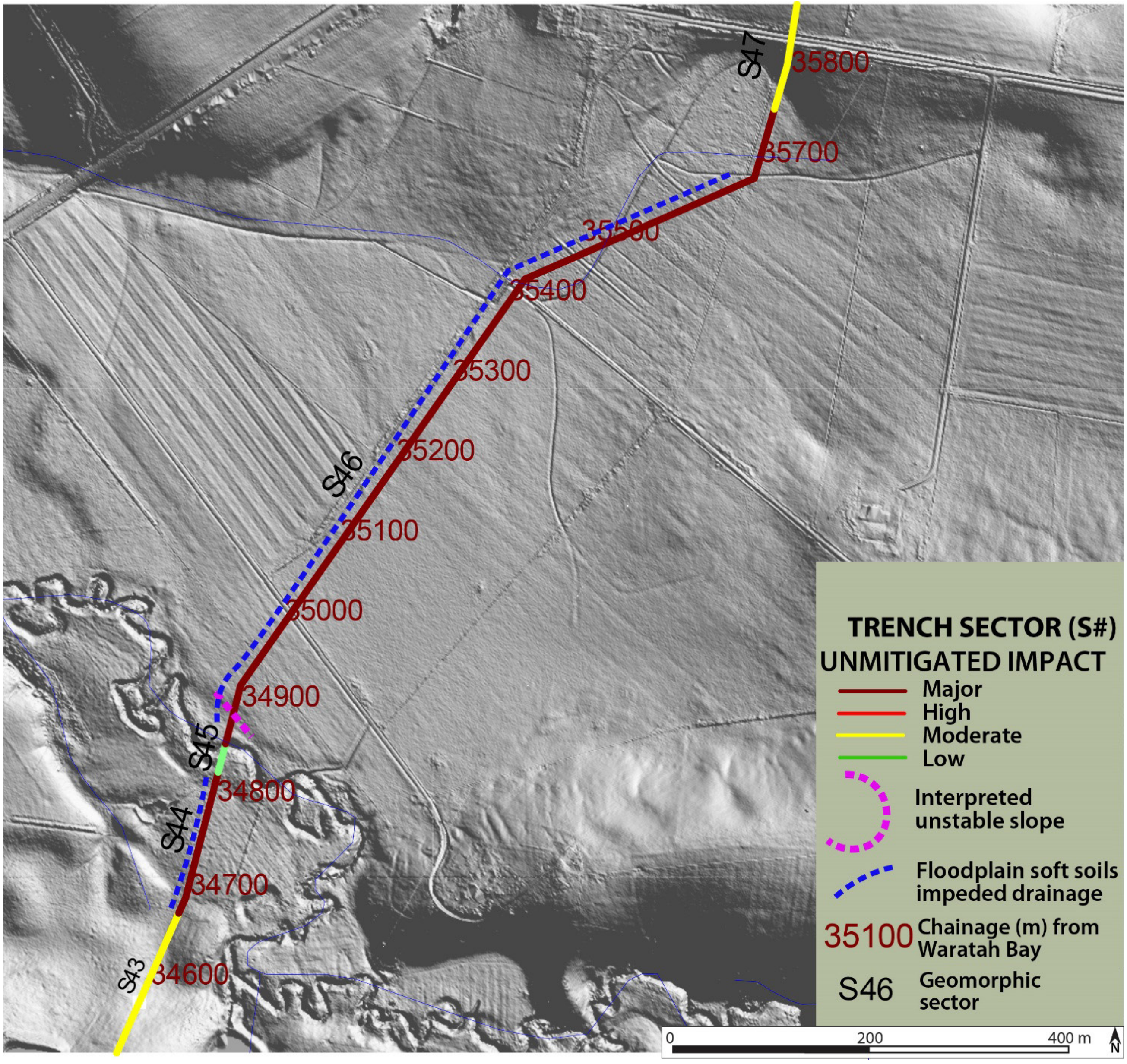

S24
S23
14500
S22
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted unstable channel
0
50
100 m
N

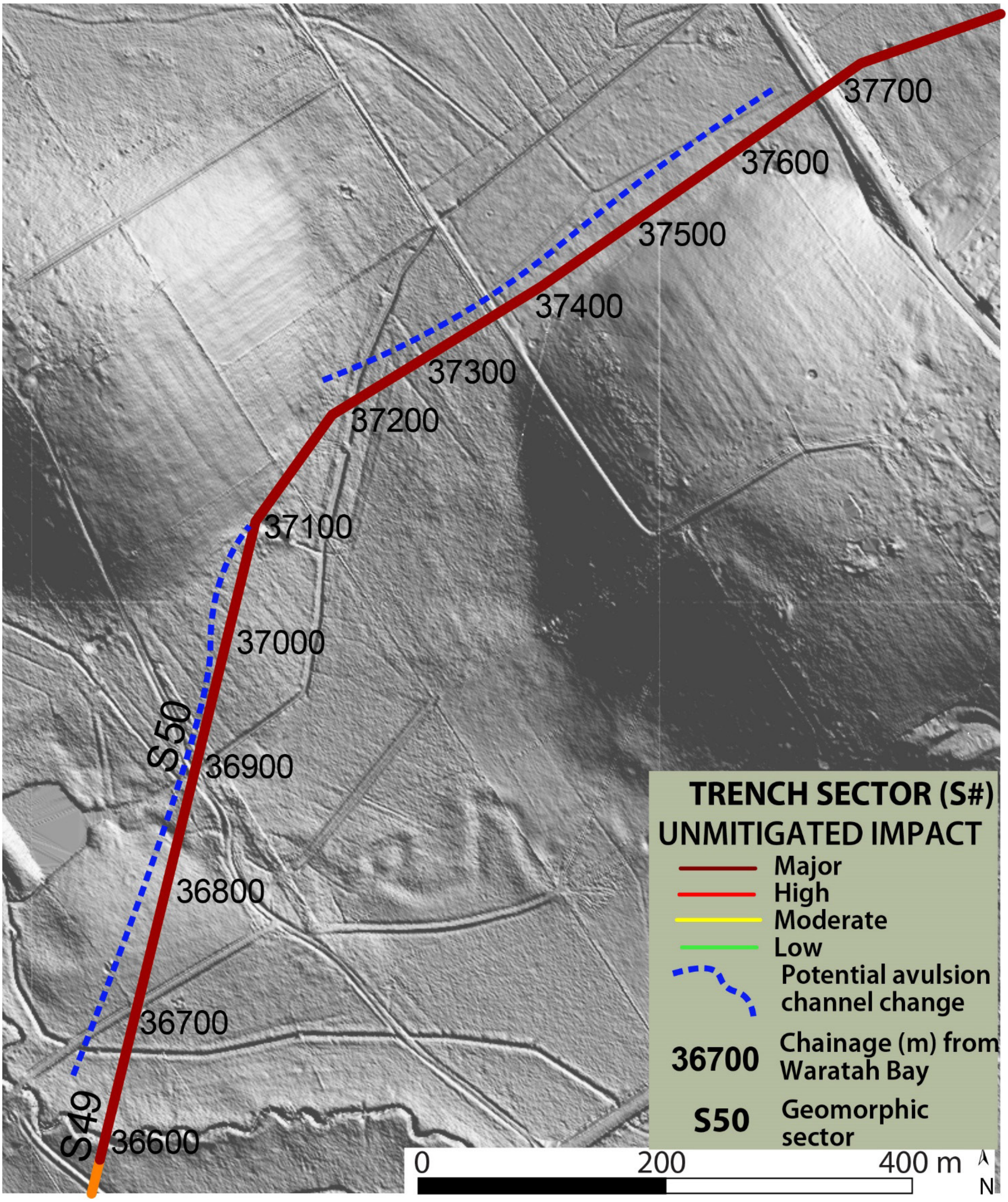

18300
18200
S28
18100
18000
17900
S28
17800
Fish Creek
17700
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
8000 Chainage (m) from Waratah Bay
S28 Geomorphic sector
0
100
200 m
N

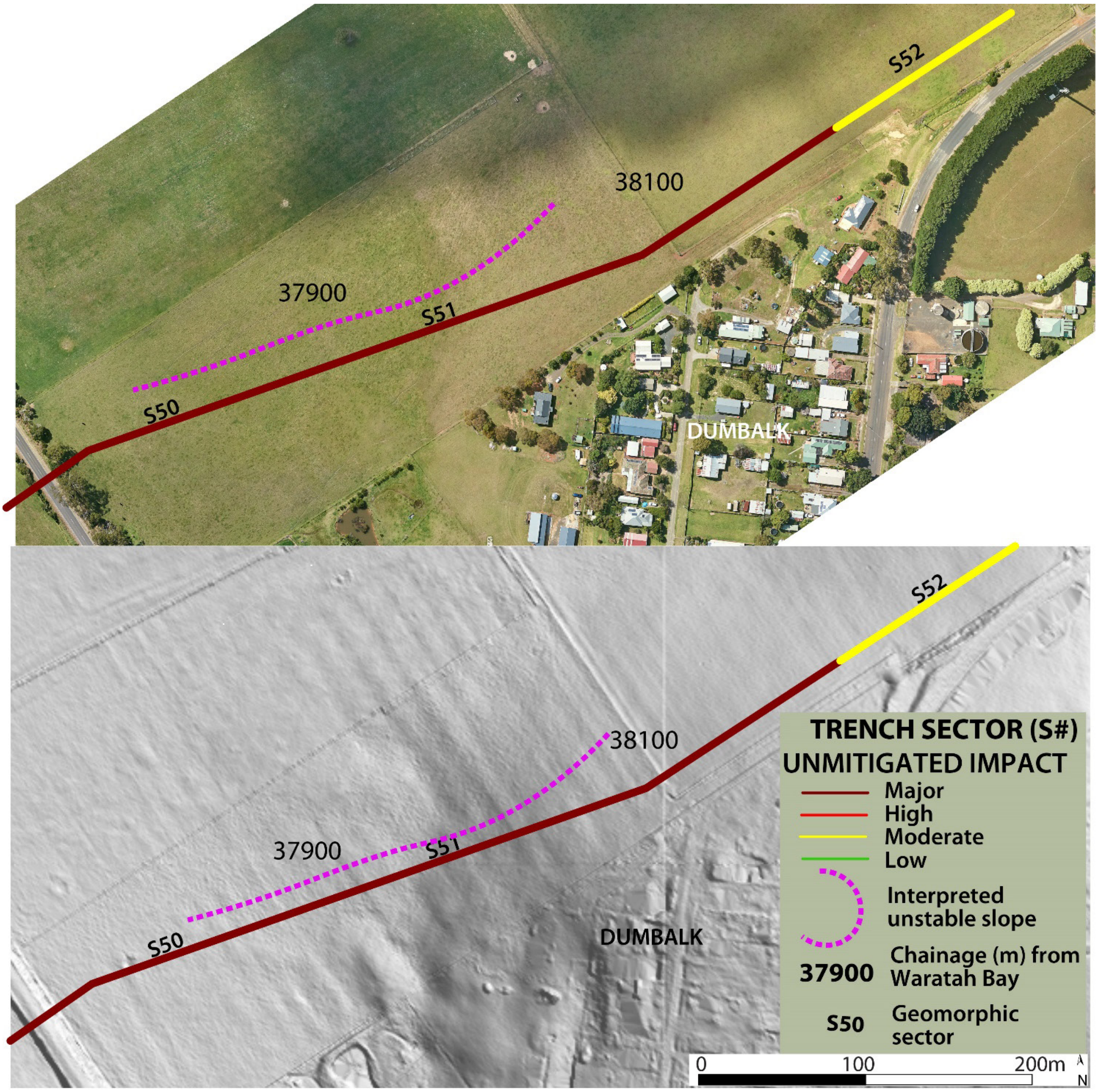

S32
19180
S31
19130
S30
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted unstable channel
19100
Chainage (m) from Waratah Bay
S31
Geomorphic sector
0
15
30 m
N

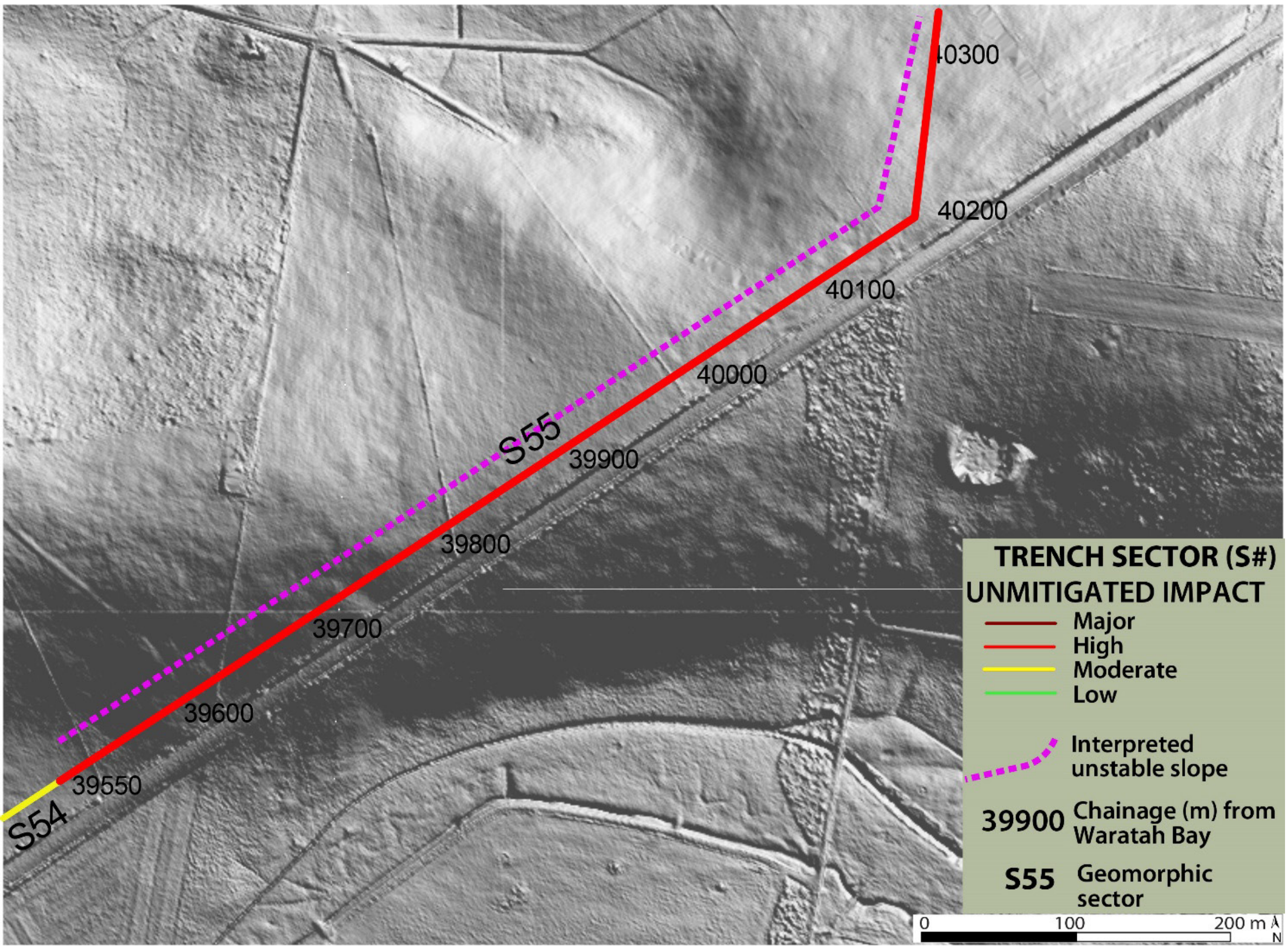

S39
28550
S38
28500
28470
S37


28550
S38
28470
S37
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted unstable channel
28470 Chainage (m) from Waratah Bay
S38 Geomorphic sector
0
15
30 m
N

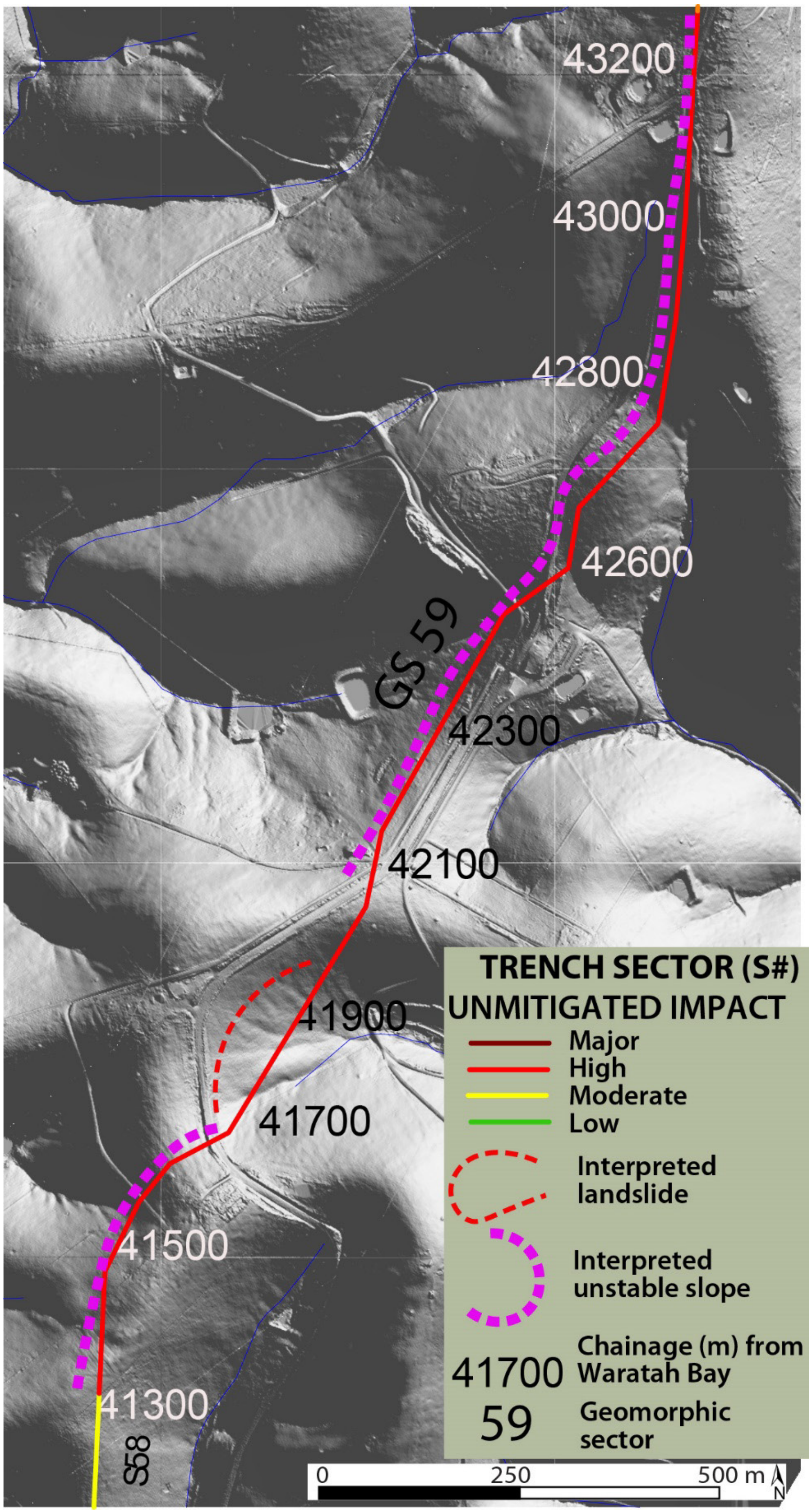

S47
35800
35700
35500
35400
35300
S46
35200
35100
35000
34900
S45
34800
S44
34700
S43
34600
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted unstable slope
Floodplain soft soils impeded drainage
35100 Chainage (m) from Waratah Bay
S46 Geomorphic sector
0
200
400 m
N

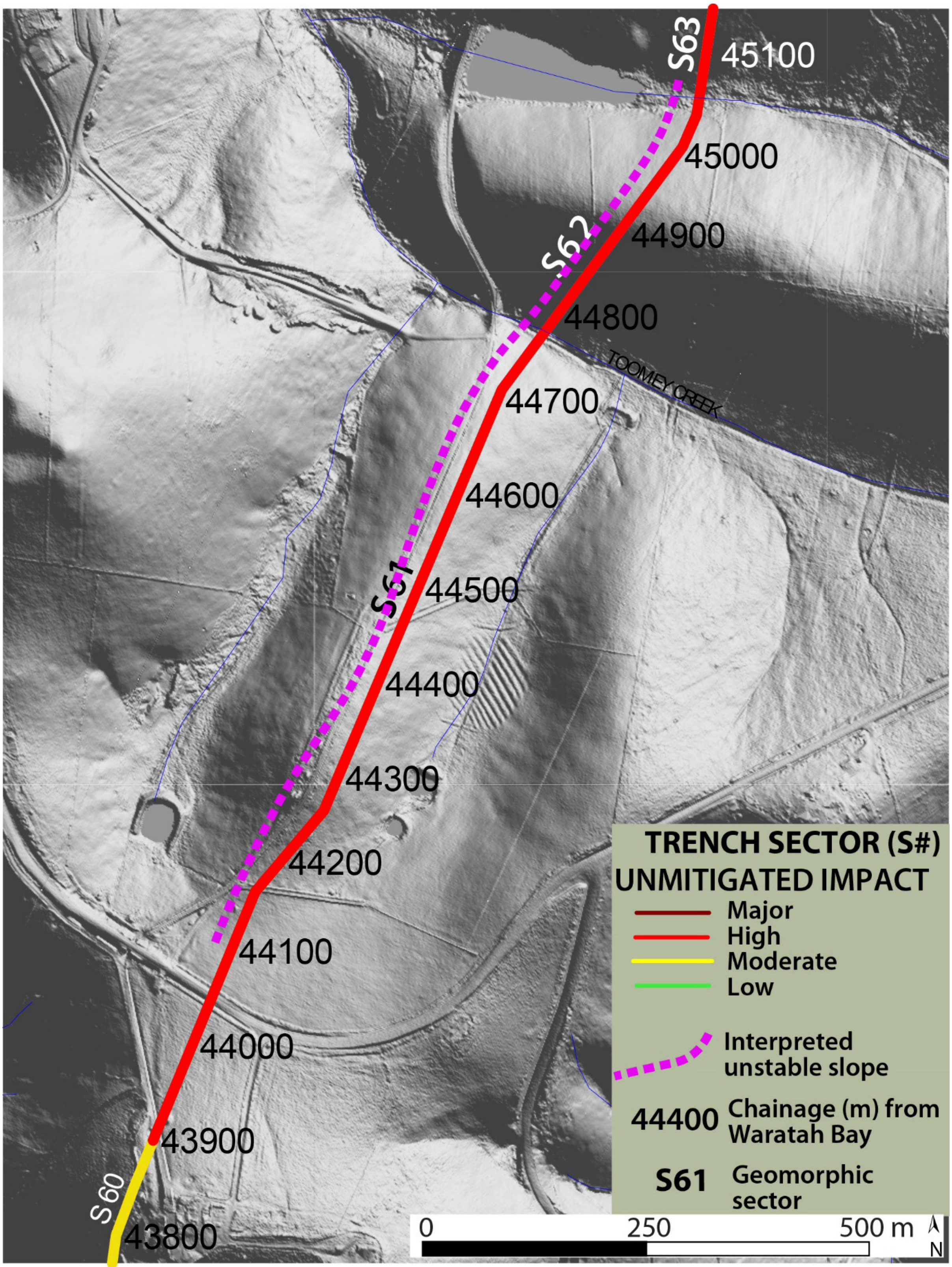

37700
37600
37500
37400
37300
37200
37100
37000
S50
36900
36800
36700
S49
36600
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Potential avulsion channel change
36700
Chainage (m) from Waratah Bay
S50
Geomorphic sector
0
200
400 m
N

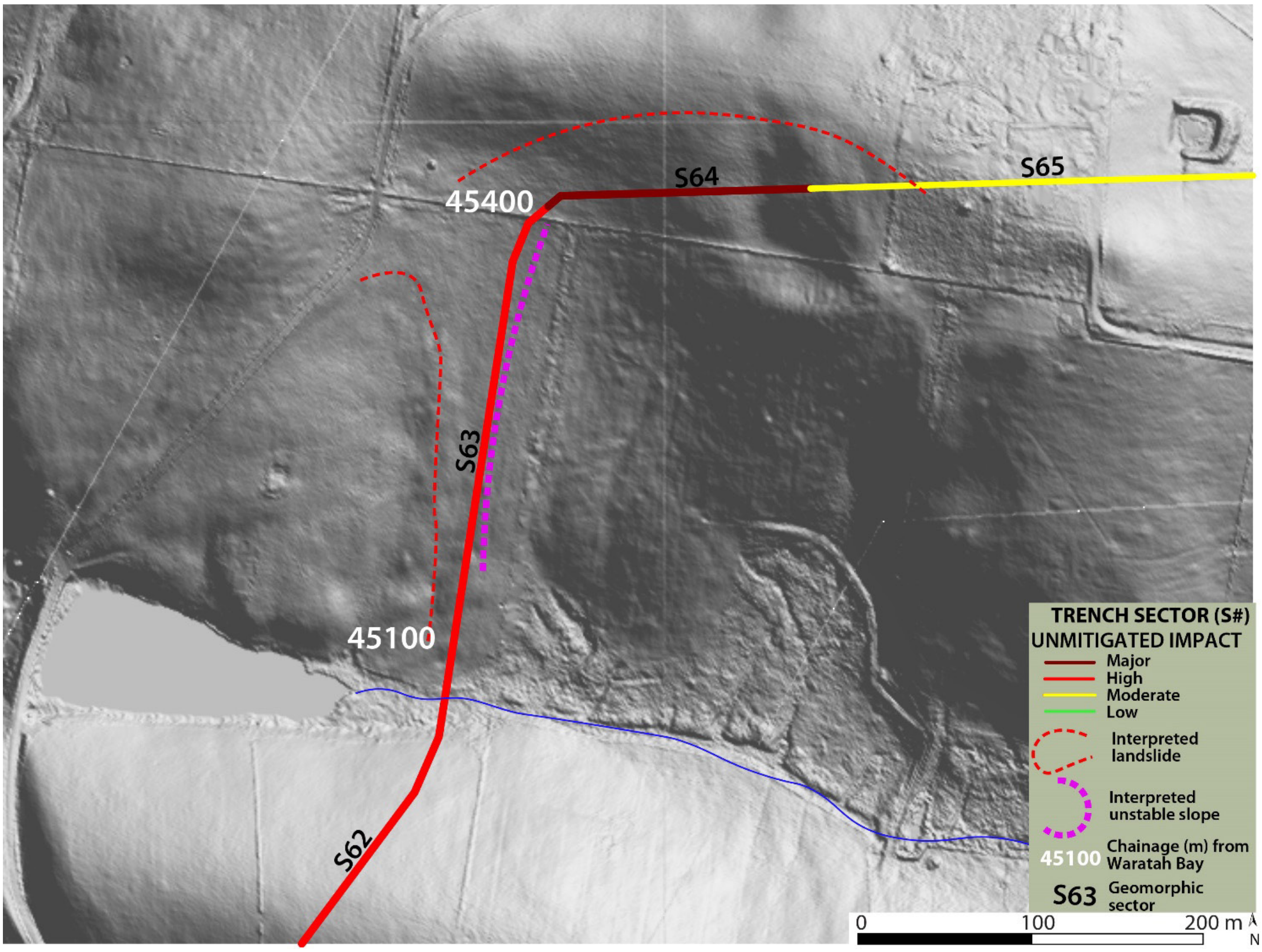

S52
38100
37900
S51
S50
DUMBALK
S52
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted unstable slope
37900 Chainage (m) from Waratah Bay
S50 Geomorphic sector
38100
37900
S51
S50
DUMBALK
0
100
200m
N

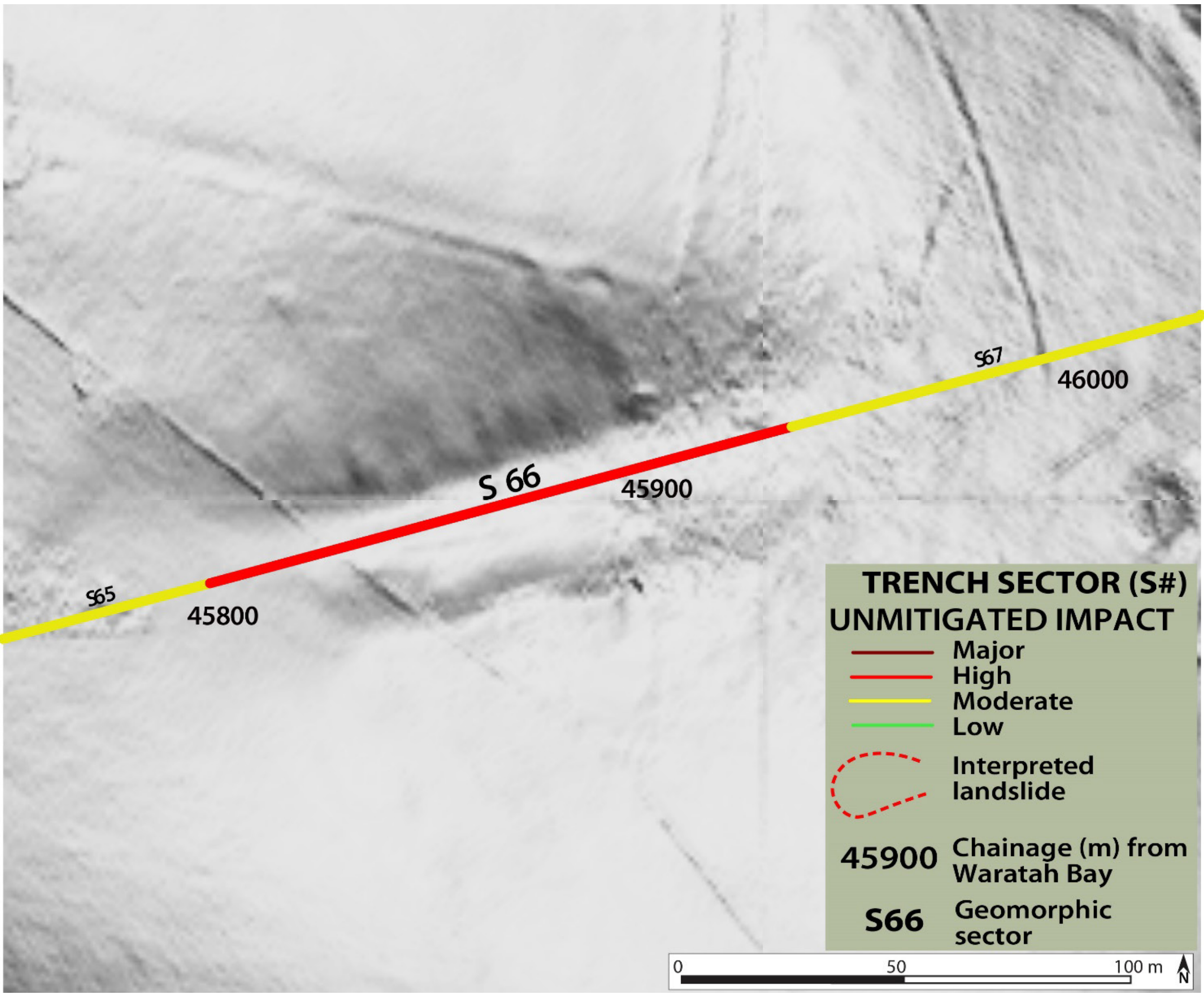


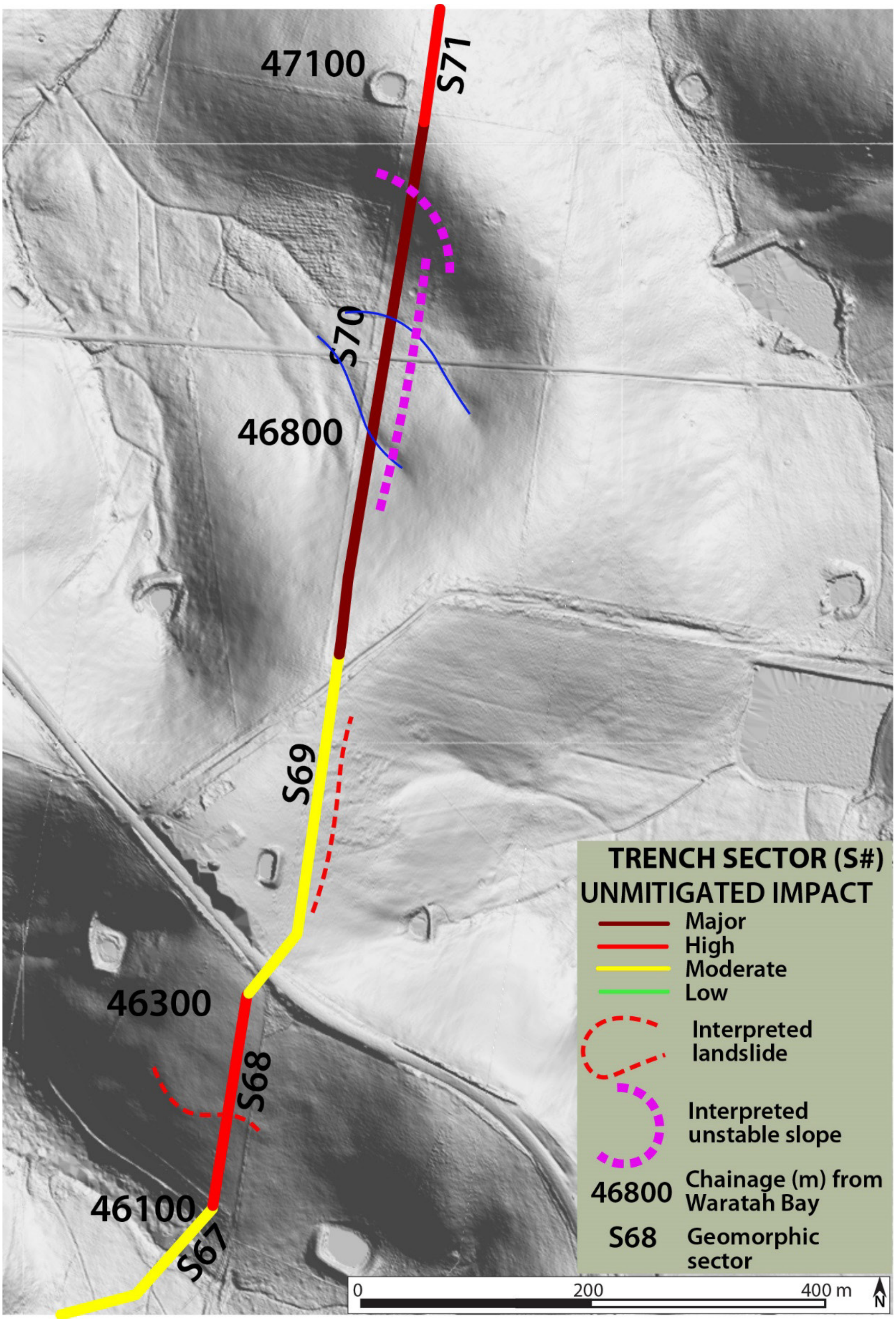
40300
40200
40100
40000
39900
S55
39800
39700
39600
39550
S54
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted unstable slope
39900 Chainage (m) from Waratah Bay
S55 Geomorphic sector
0
100
200 m
N


43200
43000
42800
42600
GS 59
42300
42100
41900
41700
41500
41300
S58
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
41700
Chainage (m) from Waratah Bay
59
Geomorphic sector
0
250
500 m
N

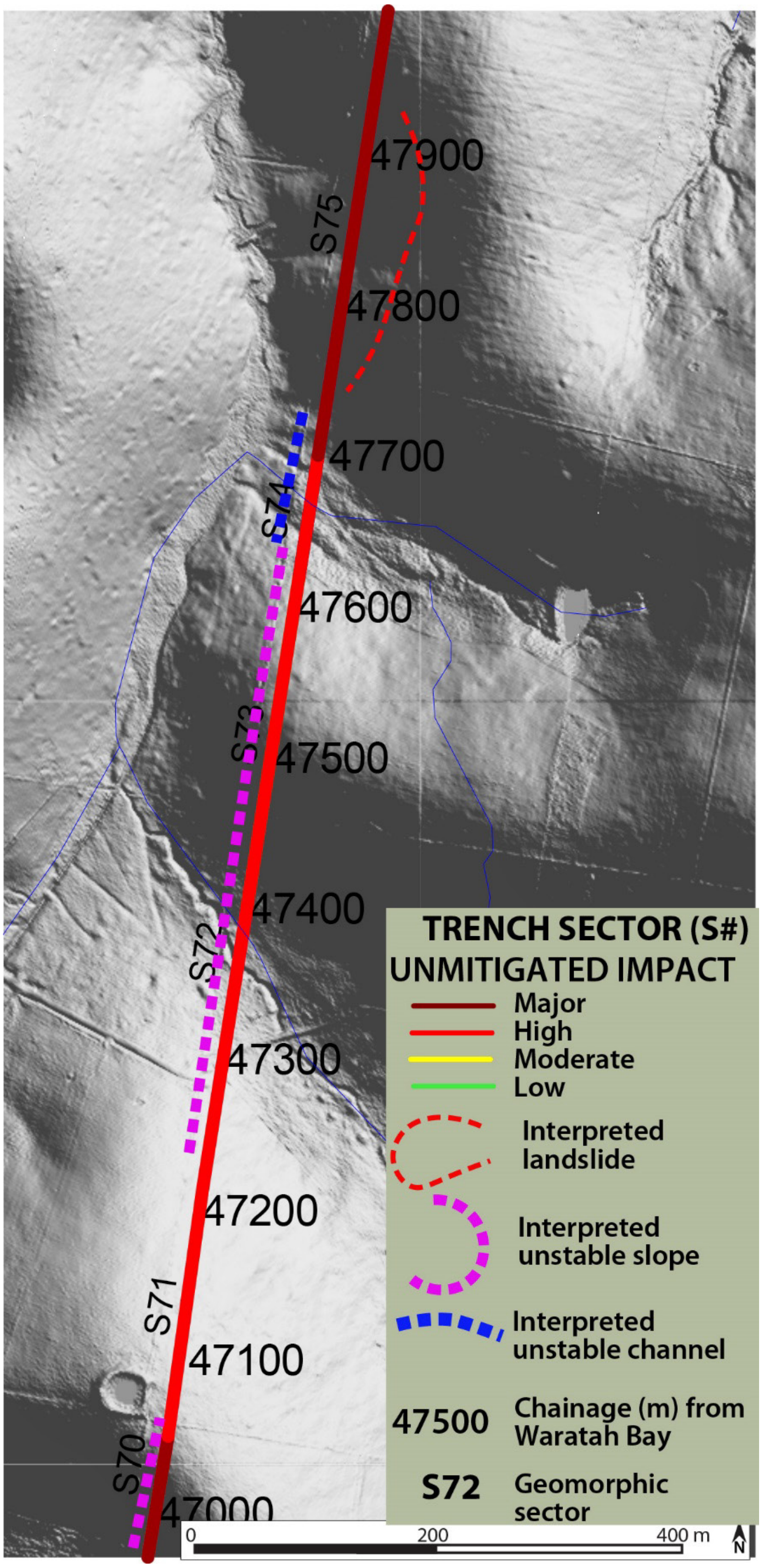

S63
45100
45000
S62
44900
44800
TOOMEY CREEK
44700
44600
S61
44500
44400
44300
44200
44100
44000
43900
S60
43800
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted unstable slope
44400 Chainage (m) from Waratah Bay
S61 Geomorphic sector
0
250
500 m
N

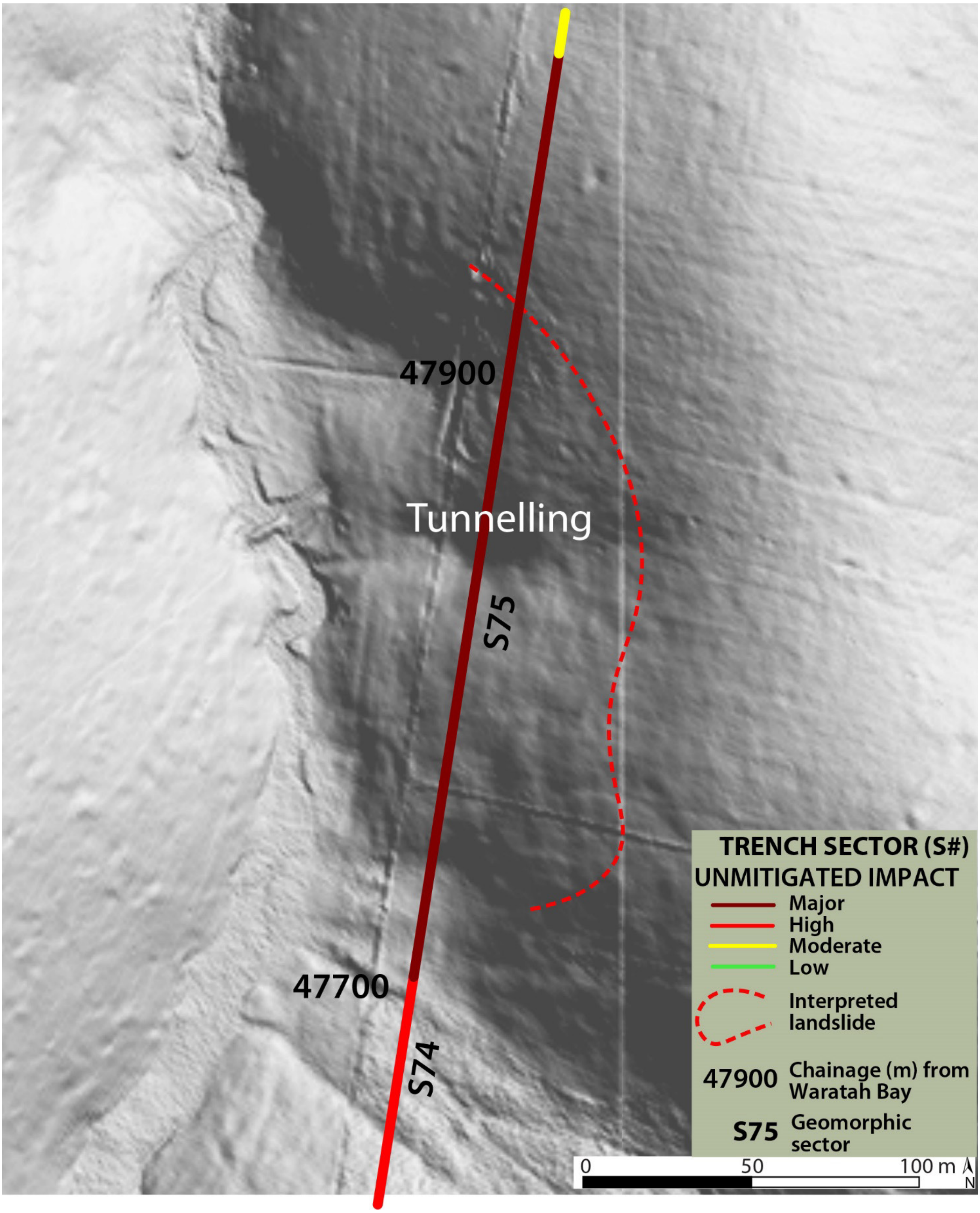

S64
S65
45400
S63
45100
S62
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
45100 Chainage (m) from Waratah Bay
S63 Geomorphic sector
0
100
200 m
N


S65
45800
S 66
45900
S67
46000
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
45900 Chainage (m) from Waratah Bay
S66 Geomorphic sector
0
50
100 m
N

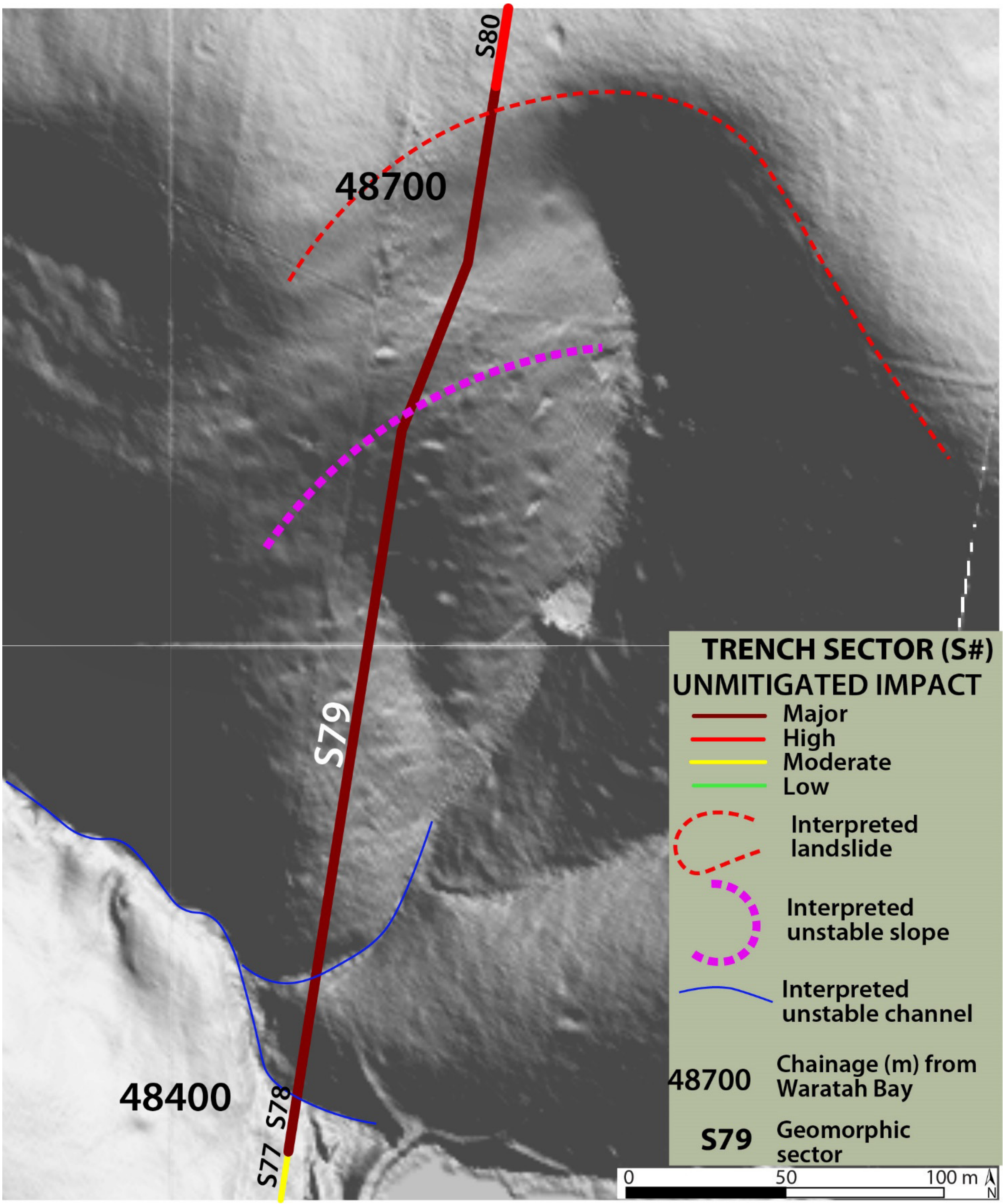


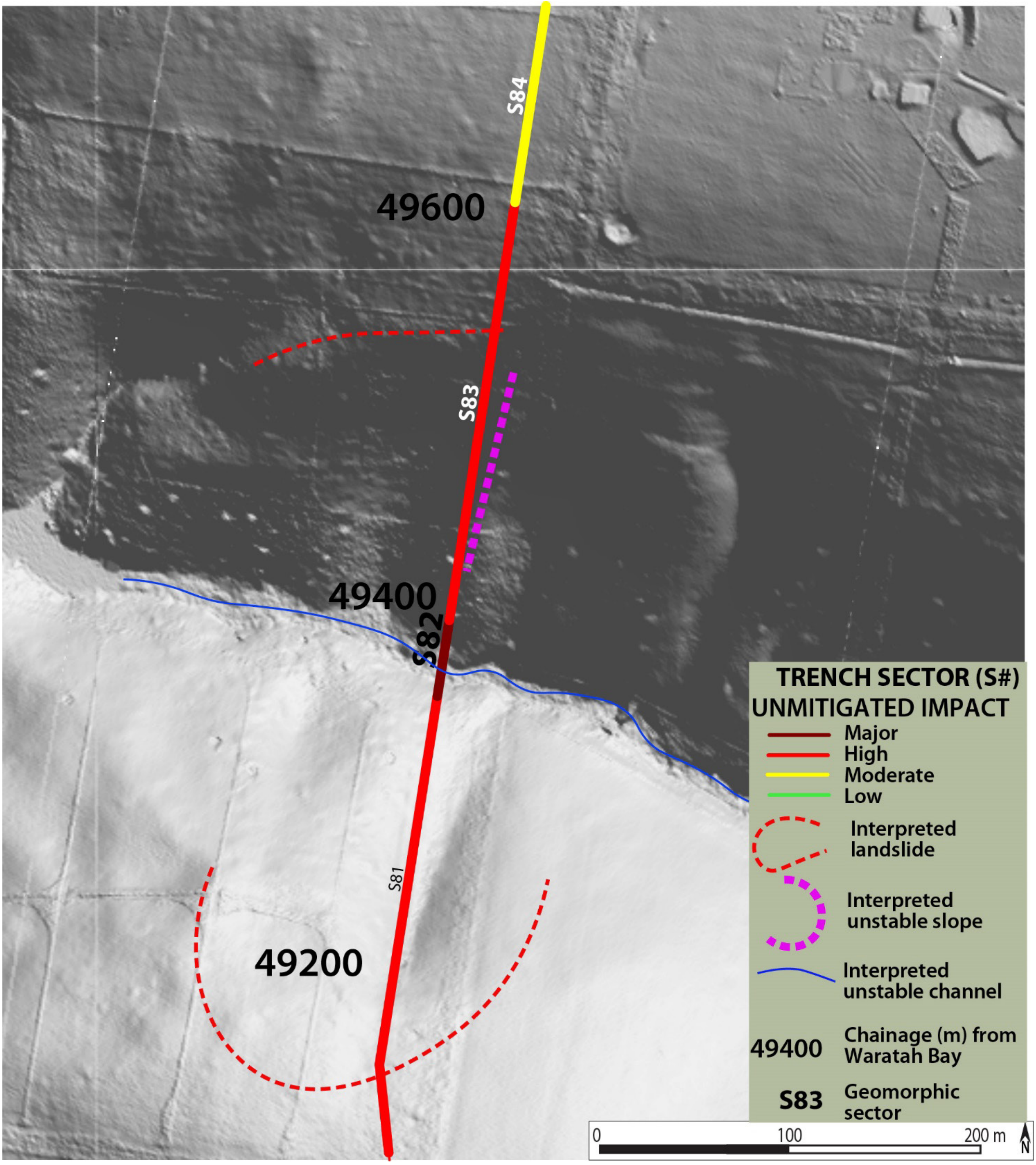
47100
S71
S70
46800
S69
46300
S68
46100
S67
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
46800
Chainage (m) from Waratah Bay
S68
Geomorphic sector
0
200
400 m
N

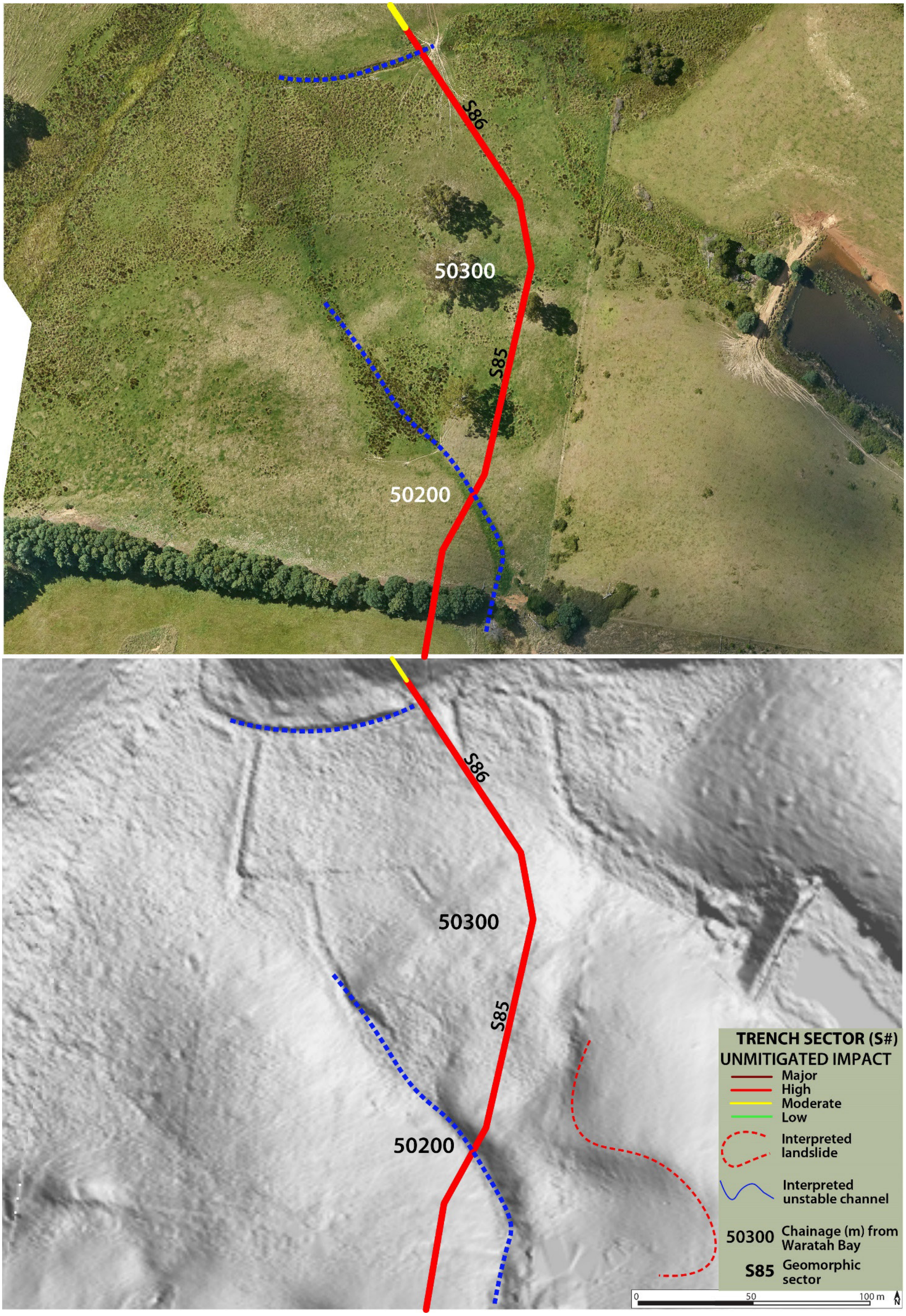

47900
S75
47800
47700
S74
47600
S73
47500
47400
S72
47300
47200
S71
47100
S70
47000
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
Interpreted unstable channel
47500 Chainage (m) from Waratah Bay
S72 Geomorphic sector
0
200
400 m
N

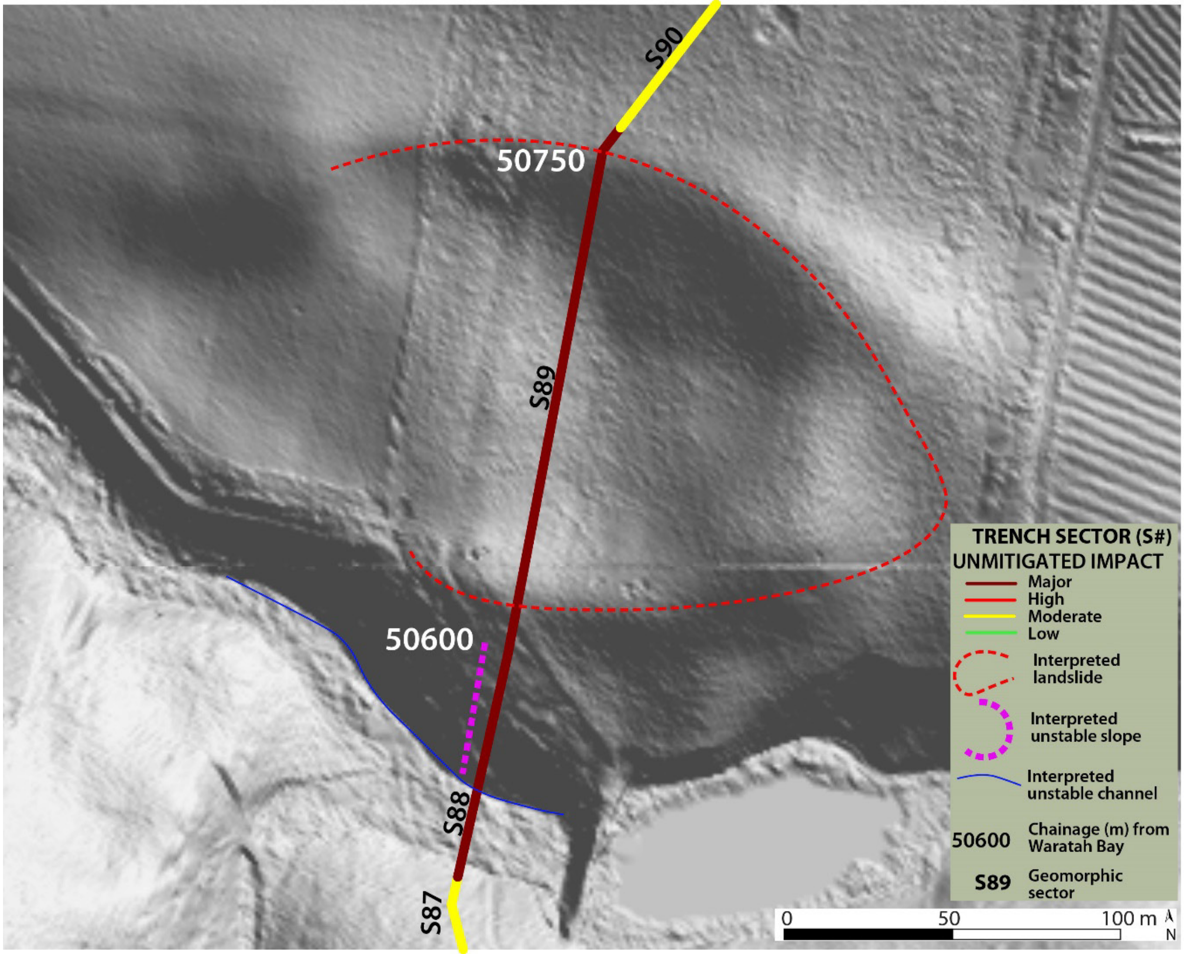


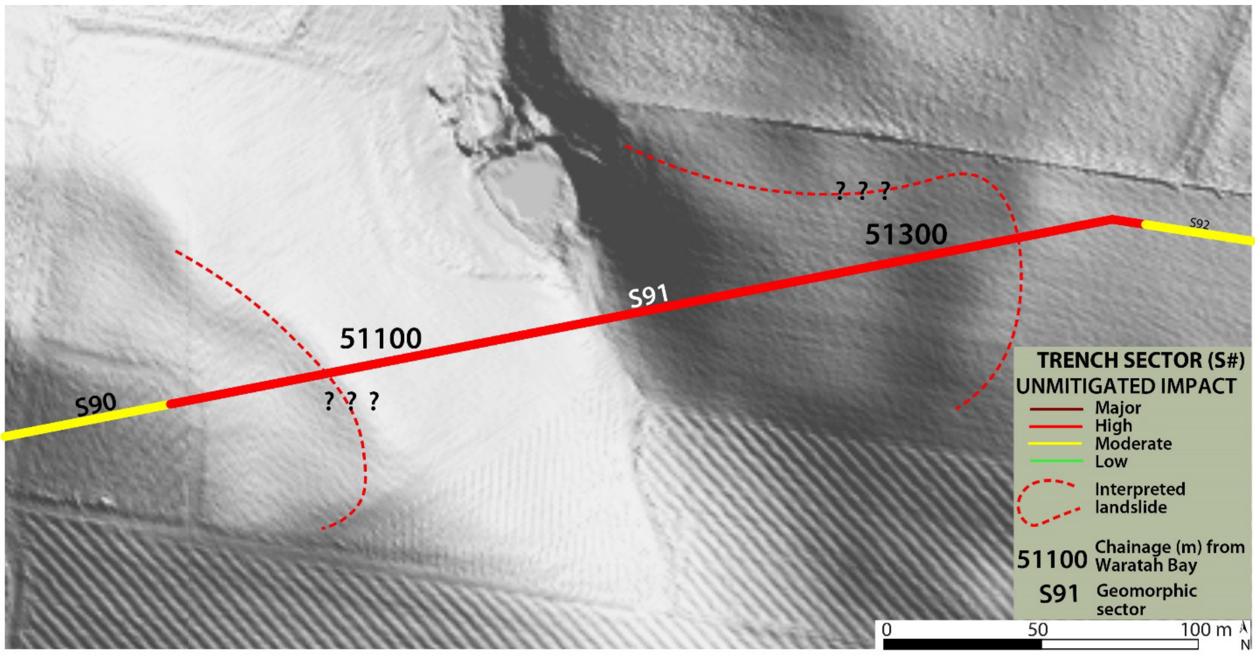
47900
Tunnelling
S75
47700
S74
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
47900 Chainage (m) from Waratah Bay
S75 Geomorphic sector
0
50
100 m
N

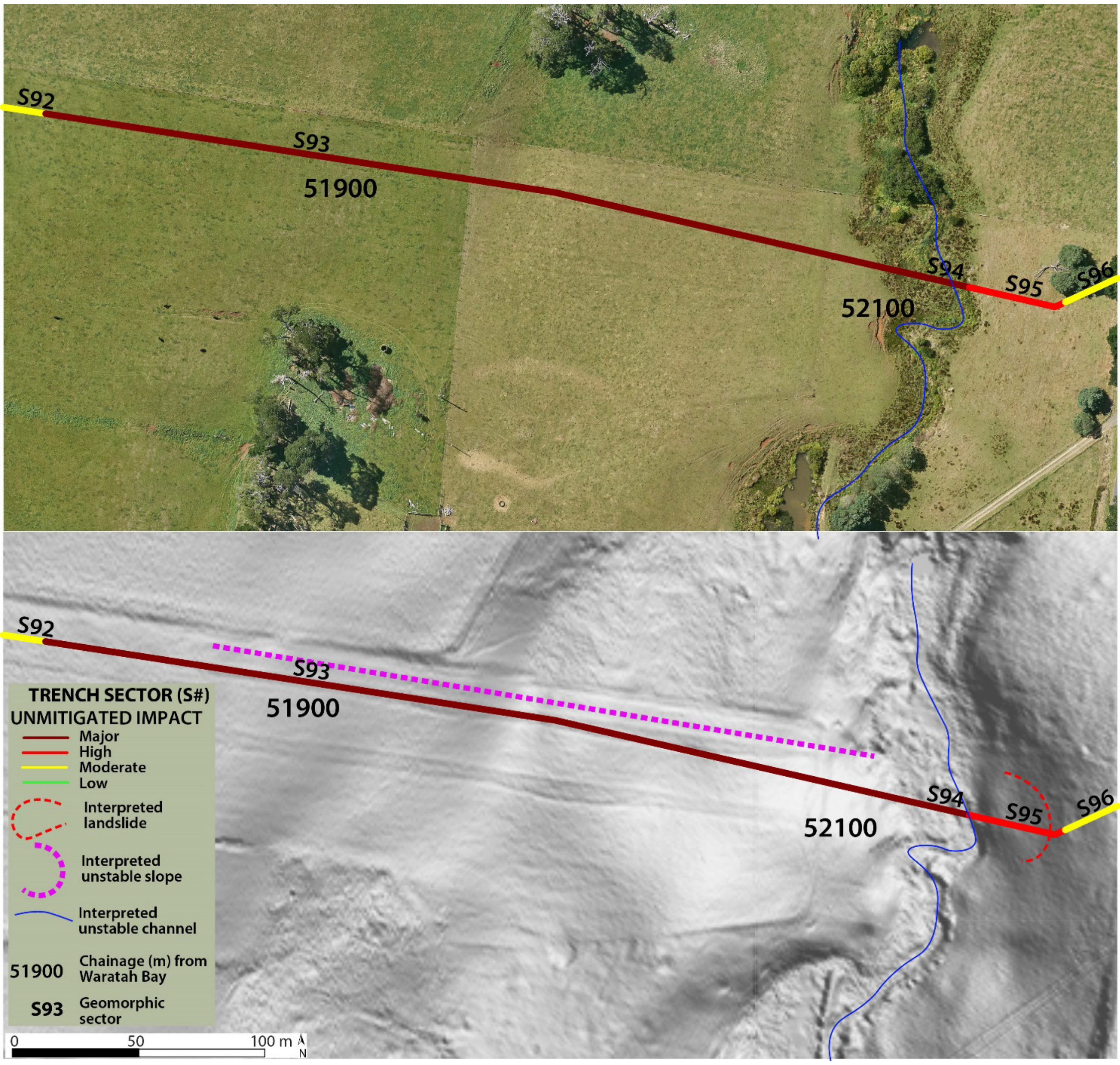

S80
48700
S79
48400
S78
S77
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
Interpreted unstable channel
48700
Chainage (m) from Waratah Bay
S79
Geomorphic sector
0
50
100 m
N


S84
49600
S83
49400
S82
S81
49200
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
Interpreted unstable channel
49400
Chainage (m) from Waratah Bay
S83
Geomorphic sector
0
100
200 m
N

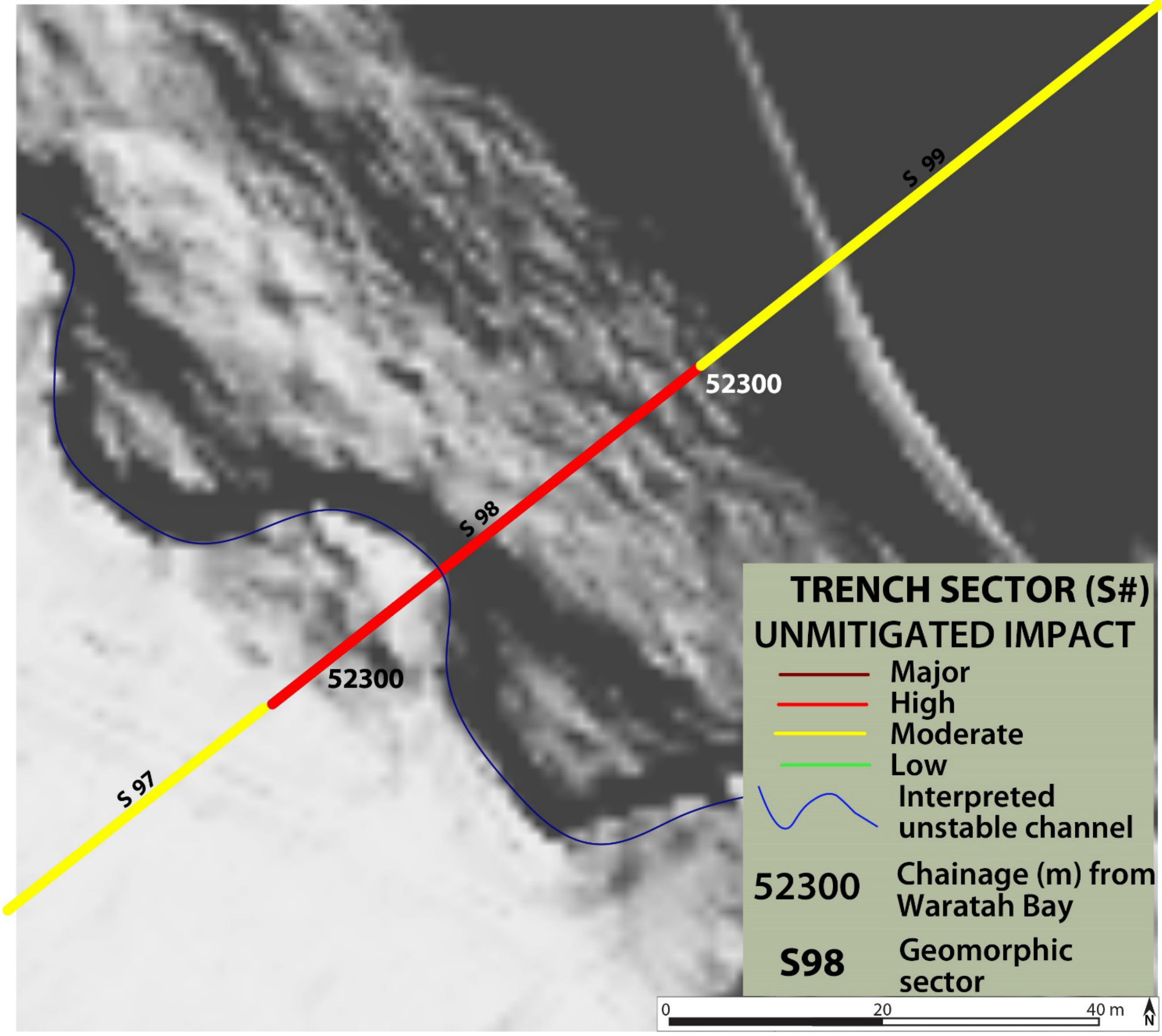

S86
50300
S85
50200
S86
50300
S85
50200
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable channel
50300 Chainage (m) from Waratah Bay
S85 Geomorphic sector
0
50
100 m

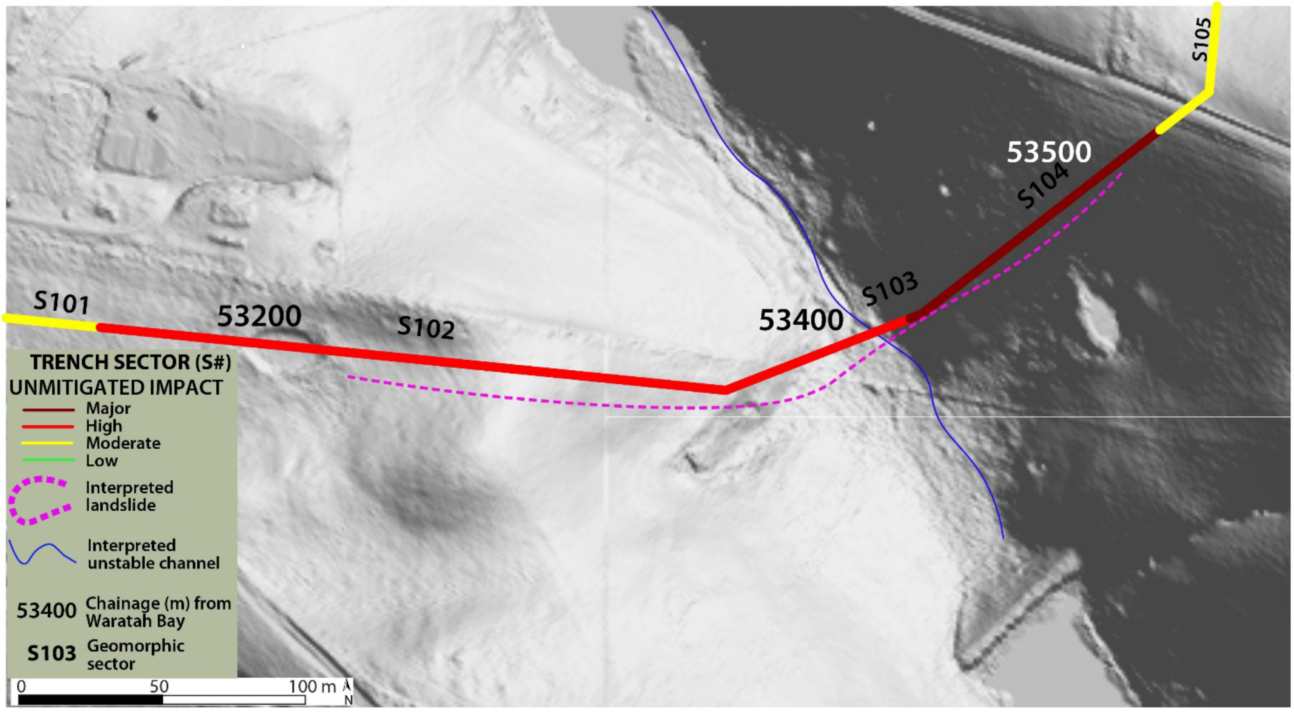

S90
50750
S89
50600
S88
S87
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
Interpreted unstable channel
50600 Chainage (m) from Waratah Bay
S89 Geomorphic sector
0
50
100 m
N

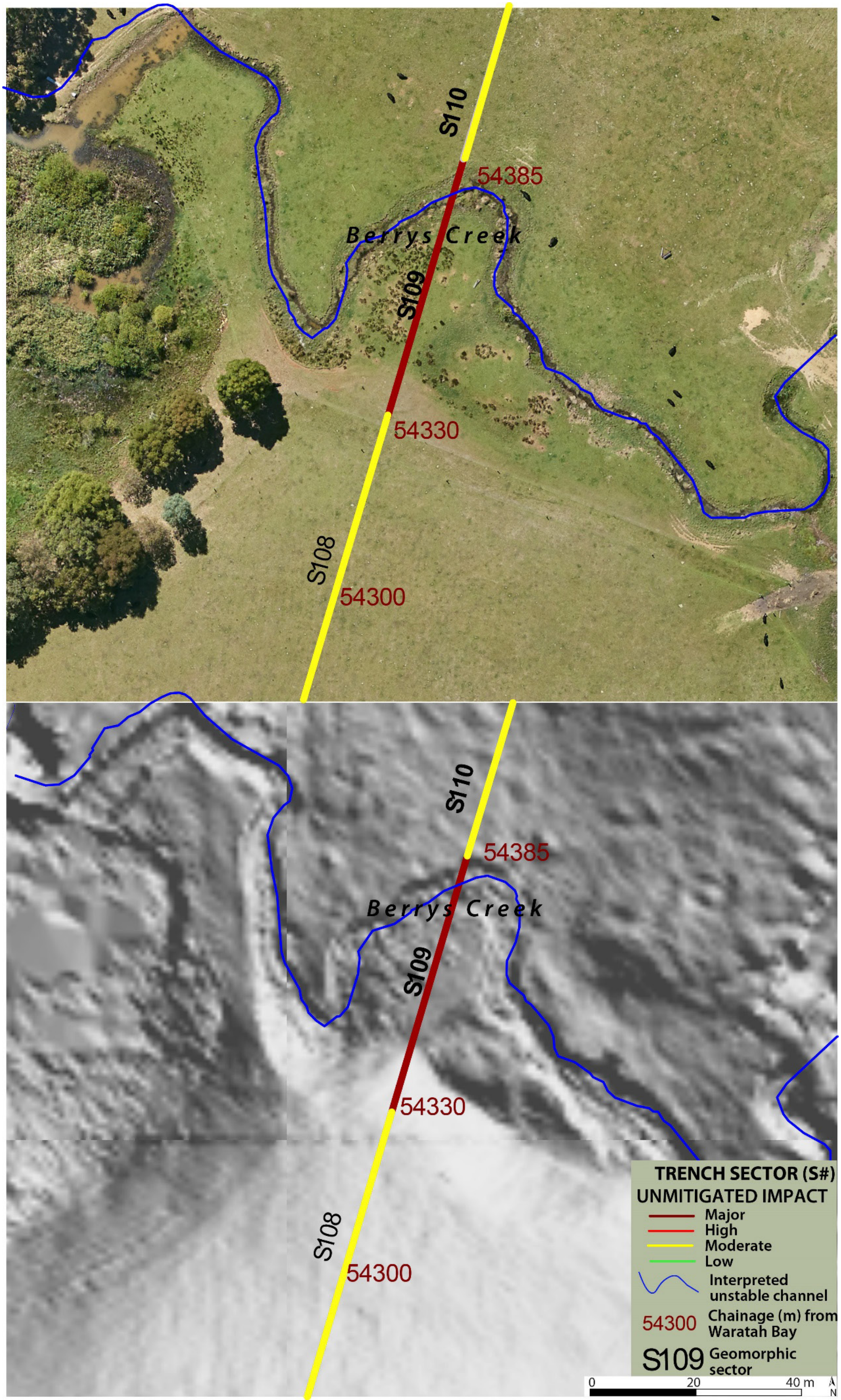

? ? ?
51300
S92
S91
51100
S90
? ? ?
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
51100 Chainage (m) from Waratah Bay
S91 Geomorphic sector
0
50
100 m
N



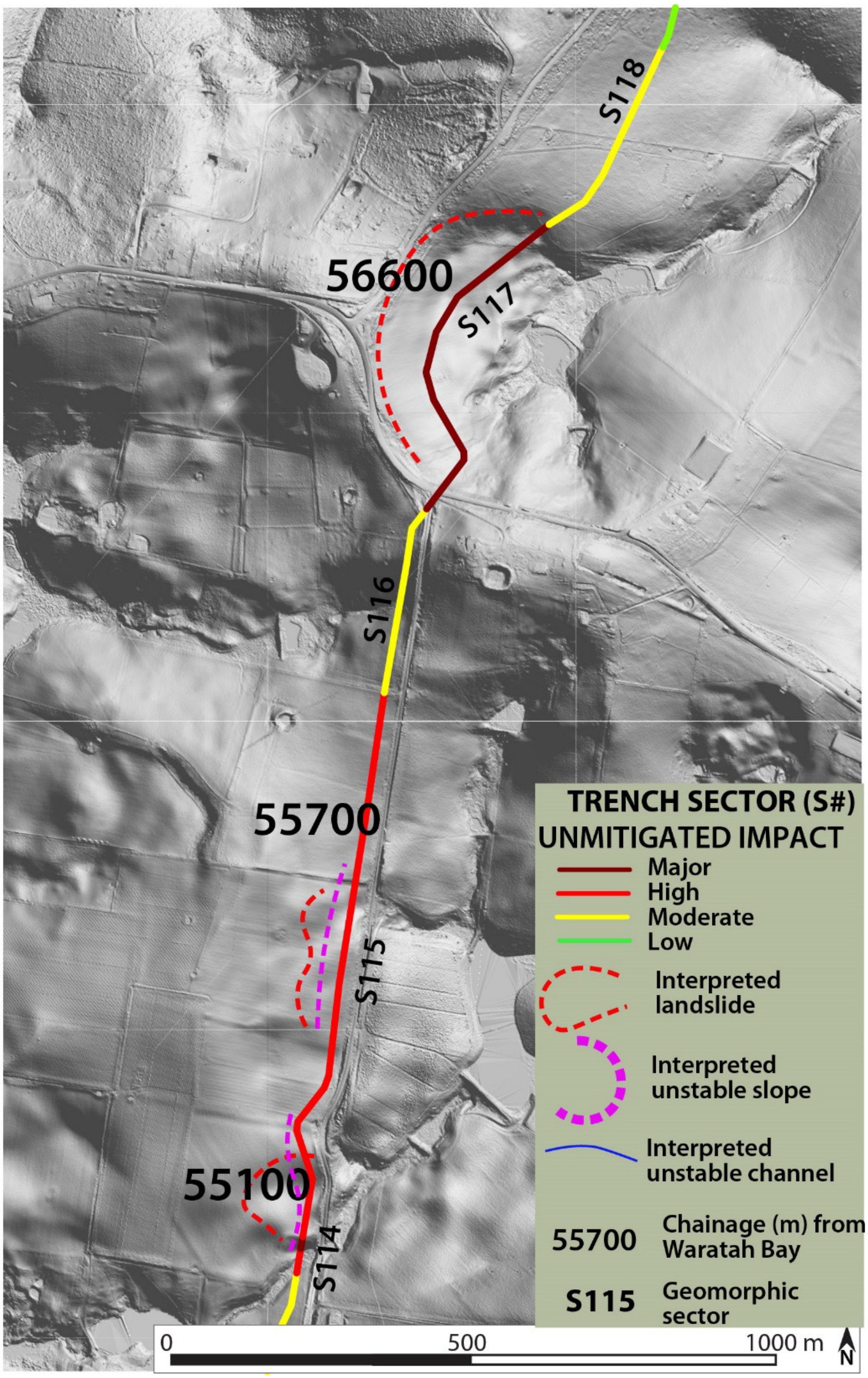
S92
S93
51900
S94
S95
S96
52100
S92
S93
51900
S94
S95
S96
52100
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
Interpreted unstable channel
51900 Chainage (m) from Waratah Bay
S93 Geomorphic sector
0
50
100 m
N

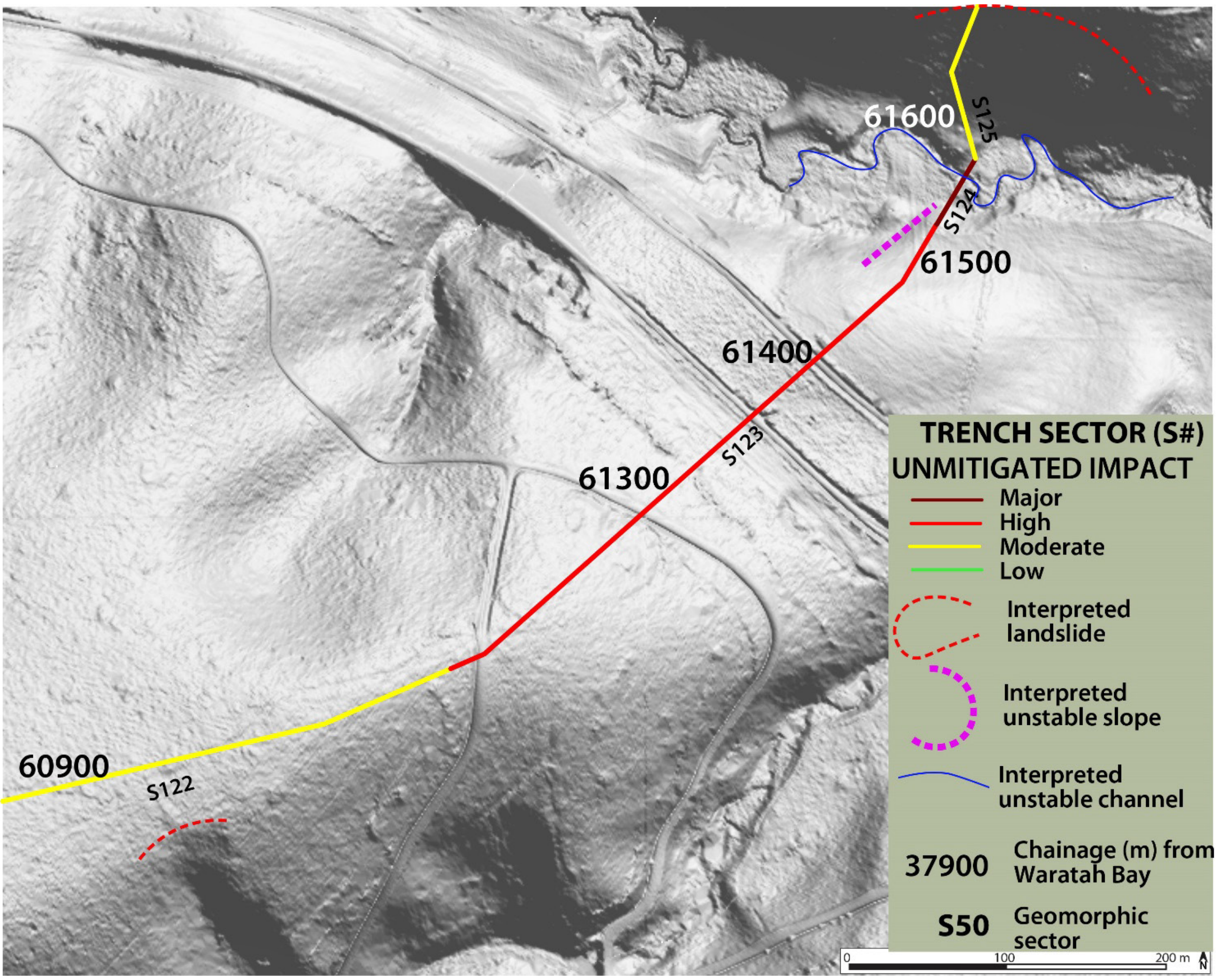

S 99
52300
S 98
52300
S 97
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted unstable channel
52300
Chainage (m) from Waratah Bay
S98
Geomorphic sector
0
20
40 m
N


S101
53200
S102
53400
S103
53500
S104
S105
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable channel
53400 Chainage (m) from Waratah Bay
S103 Geomorphic sector
0
50
100 m
N

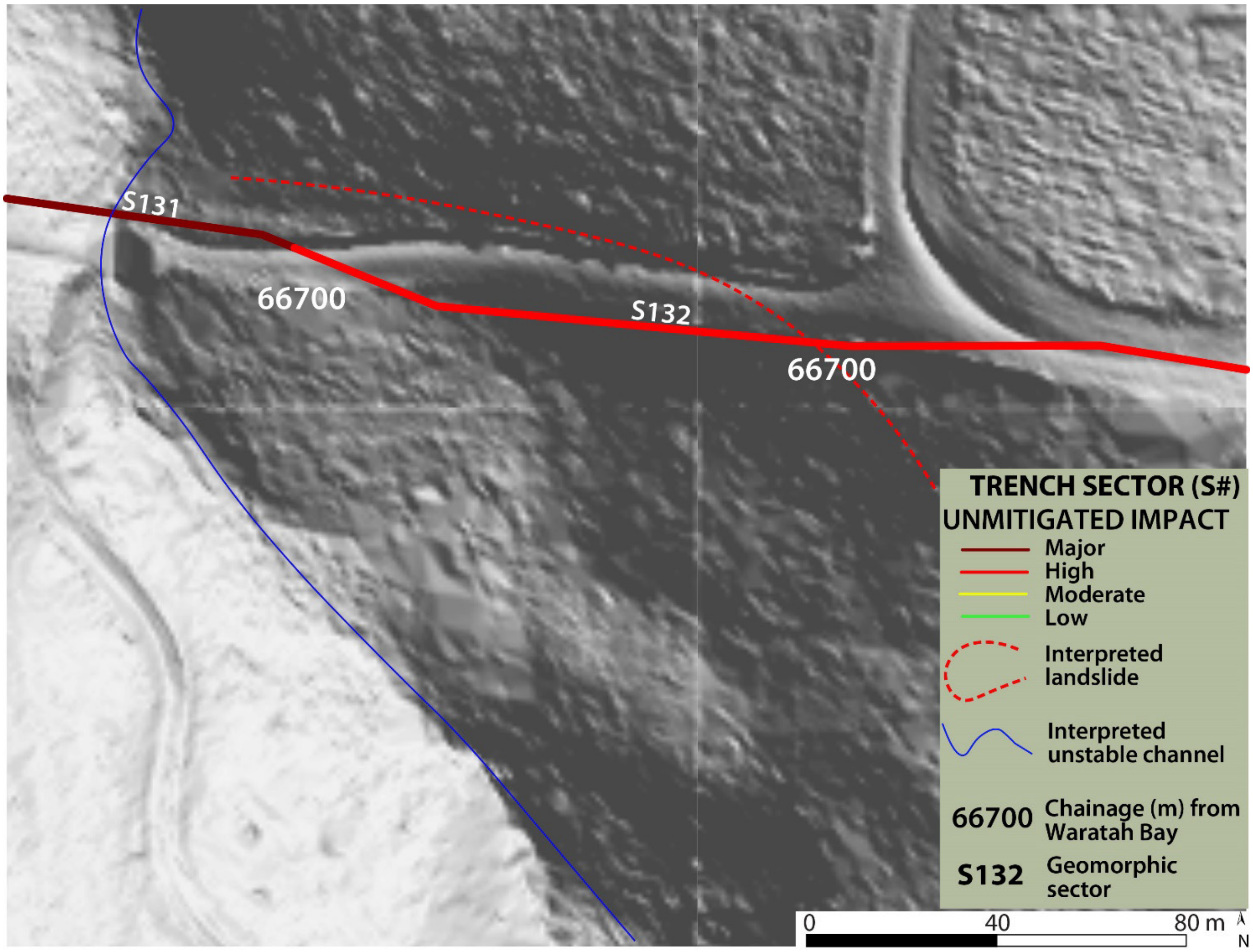

S110
54385
Berrys Creek
S109
54330
S108
54300
S110
54385
Berrys Creek
S109
54330
S108
54300
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted unstable channel
54300 Chainage (m) from Waratah Bay
S109 Geomorphic sector
0
20
40 m
N

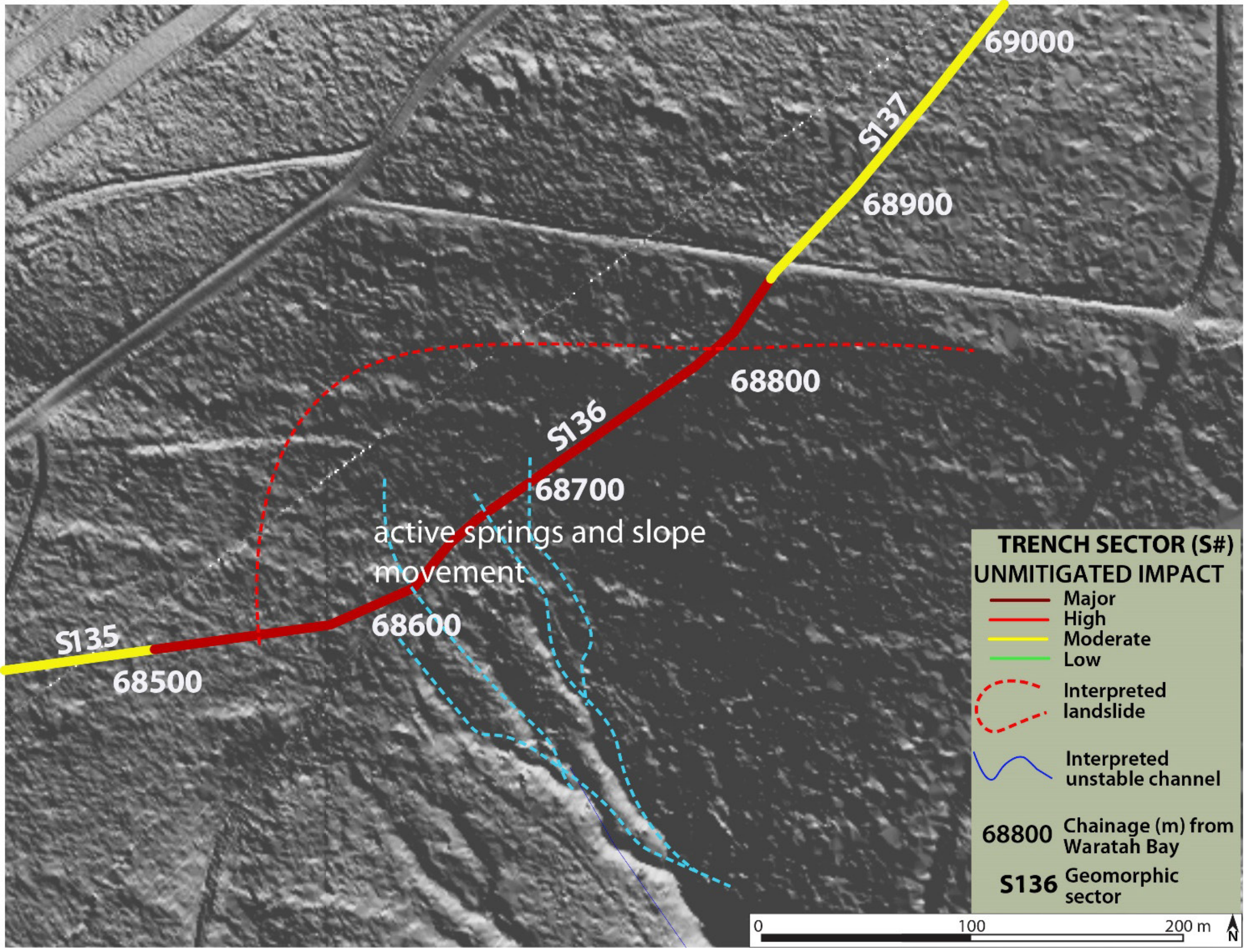

S115
S114
very steep slope
55500
S113
S112
S115
S114
very steep slope
55500
S113
S112
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Chainage (m) from Waratah Bay
Geomorphic sector
0
15
30 m
N

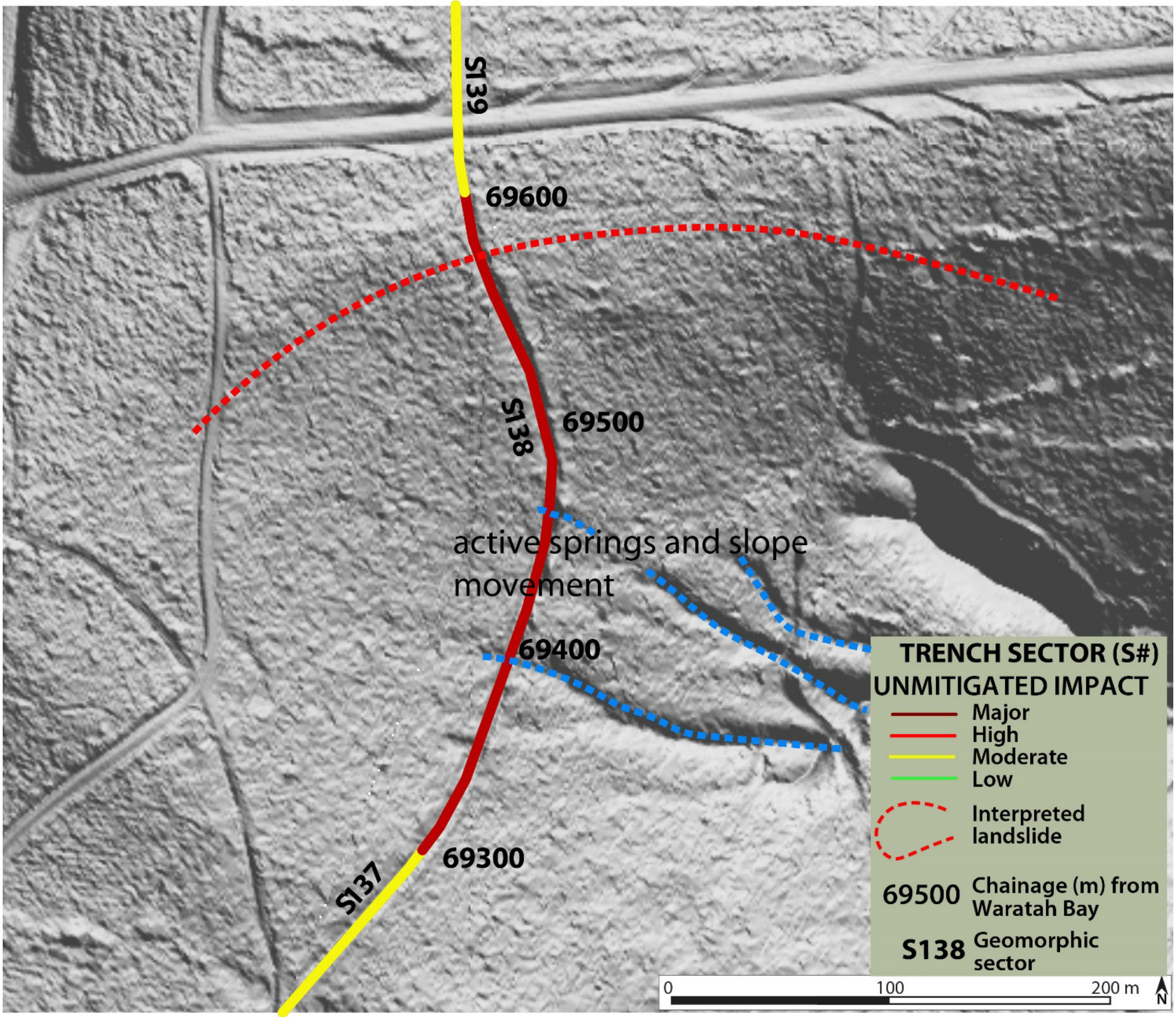

S118
56600
S117
S116
55700
S115
55100
S114
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
Interpreted unstable channel
55700 Chainage (m) from Waratah Bay
S115 Geomorphic sector
0
500
1000 m
N

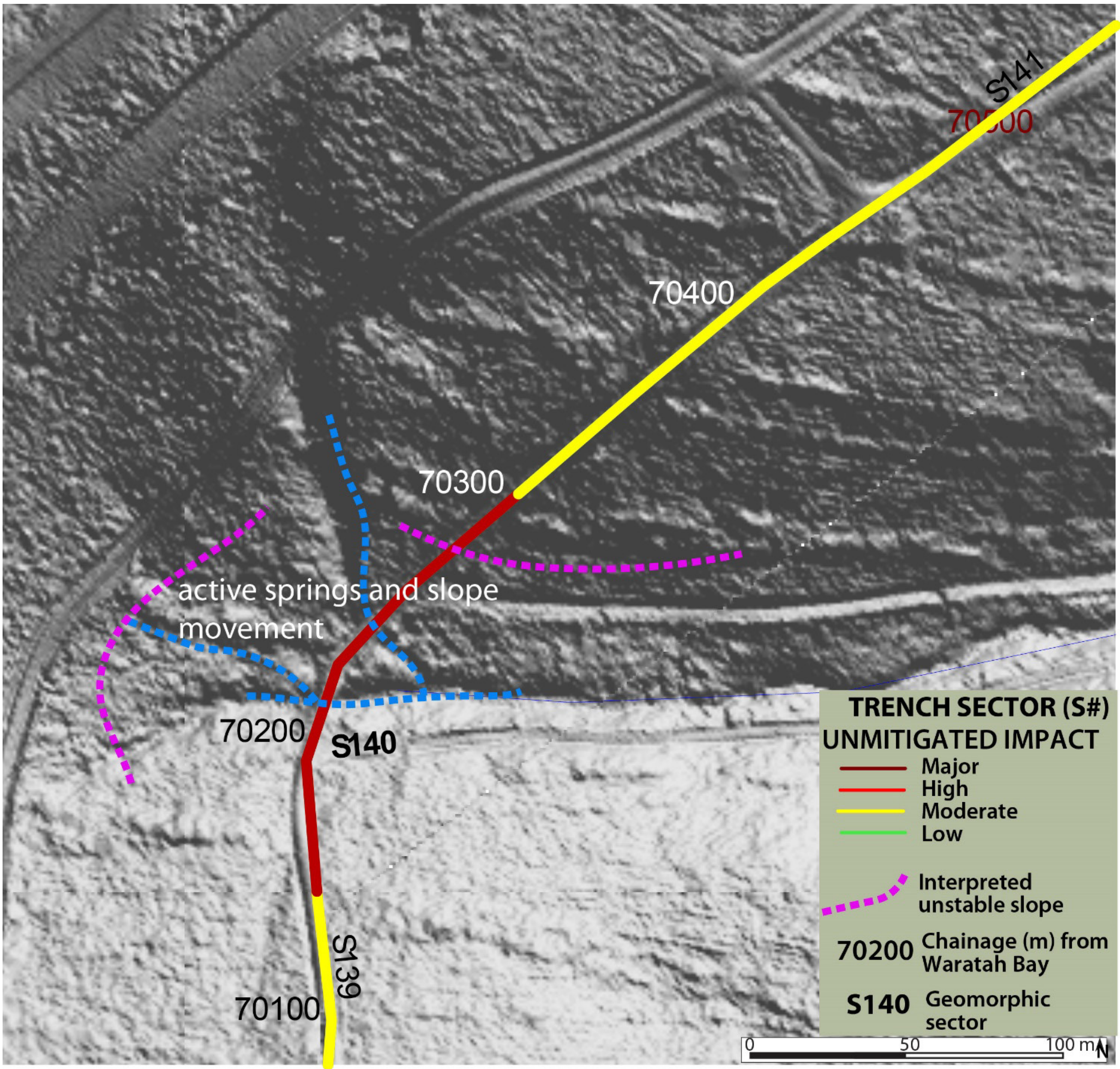

61600
S125
S124
61500
61400
S123
61300
60900
S122
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
Interpreted unstable channel
37900
Chainage (m) from Waratah Bay
S50
Geomorphic sector
0
100
200 m
N

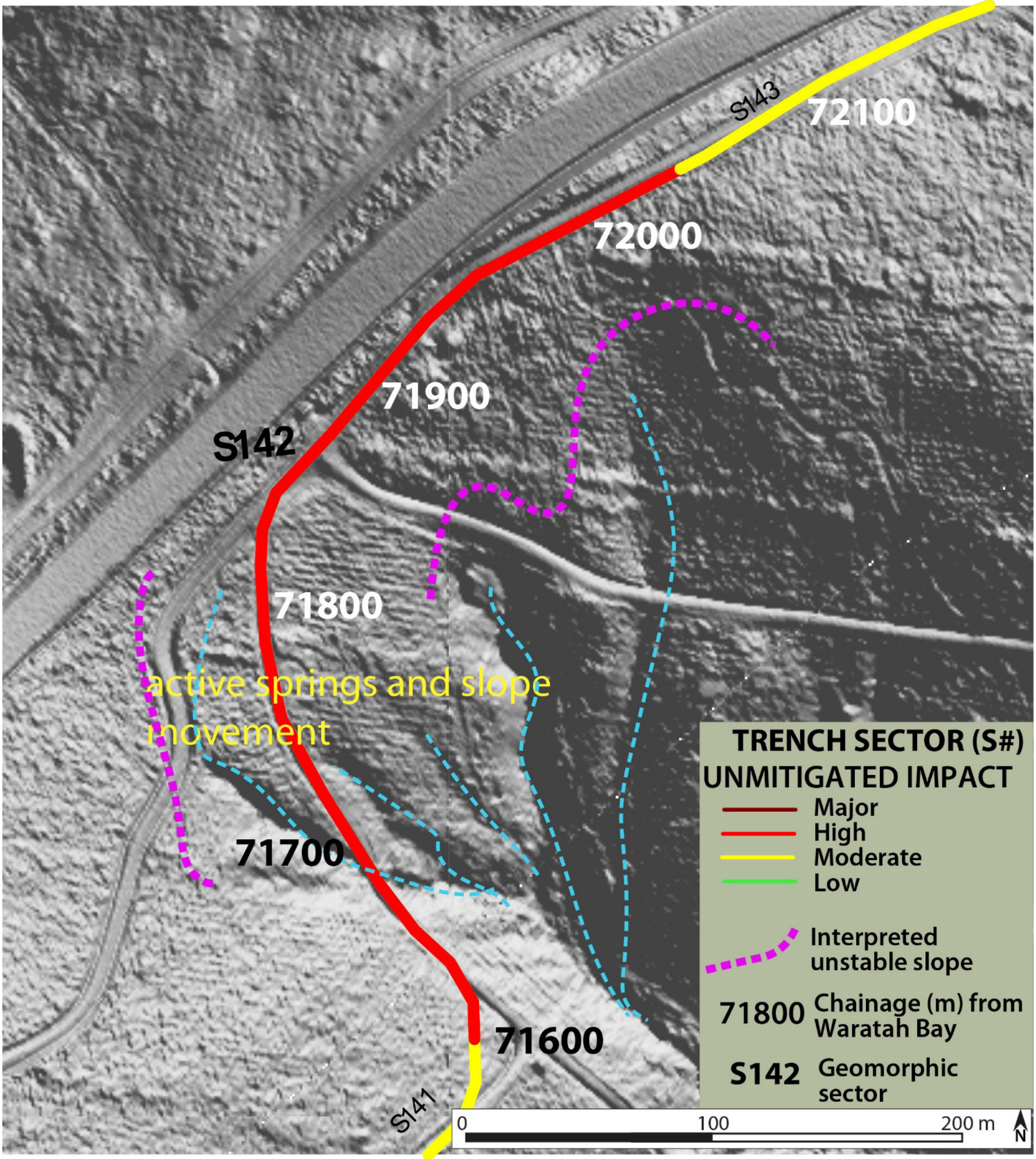

S125
61600
unstable active channel
S124
0
10
20 m
N


S131
66700
S132
66700
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable channel
66700 Chainage (m) from Waratah Bay
S132 Geomorphic sector
0
40
80 m
N

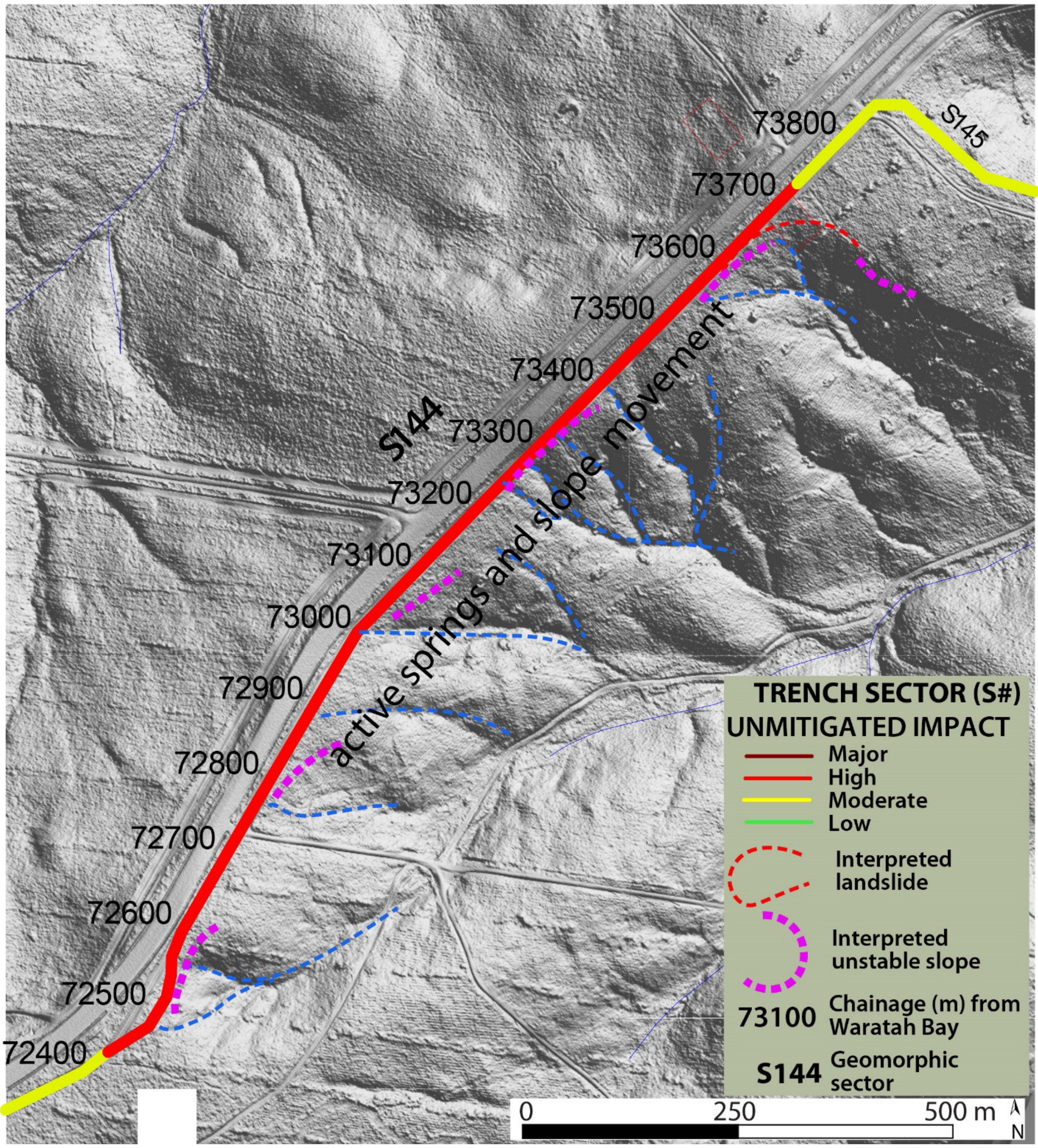

69000
S137
68900
68800
S136
68700
active springs and slope movement
68600
S135
68500
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable channel
68800 Chainage (m) from Waratah Bay
S136 Geomorphic sector
0
100
200 m
N

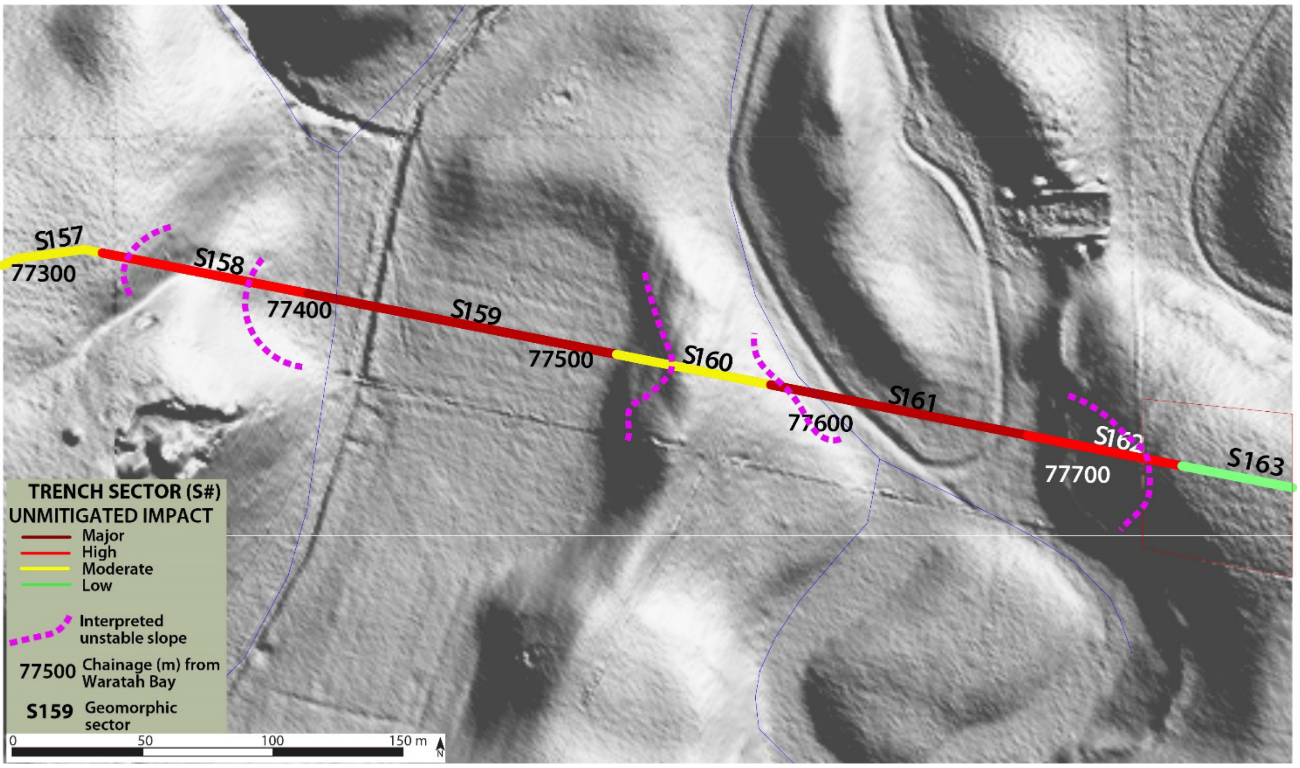

S139
69600
S138
69500
active springs and slope movement
69400
69300
S137
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
69500 Chainage (m) from Waratah Bay
S138 Geomorphic sector
0
100
200 m
N


S141
70500
70400
70300
active springs and slope movement
70200
S140
S139
70100
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted unstable slope
70200 Chainage (m) from Waratah Bay
S140 Geomorphic sector
0
50
100 m
N

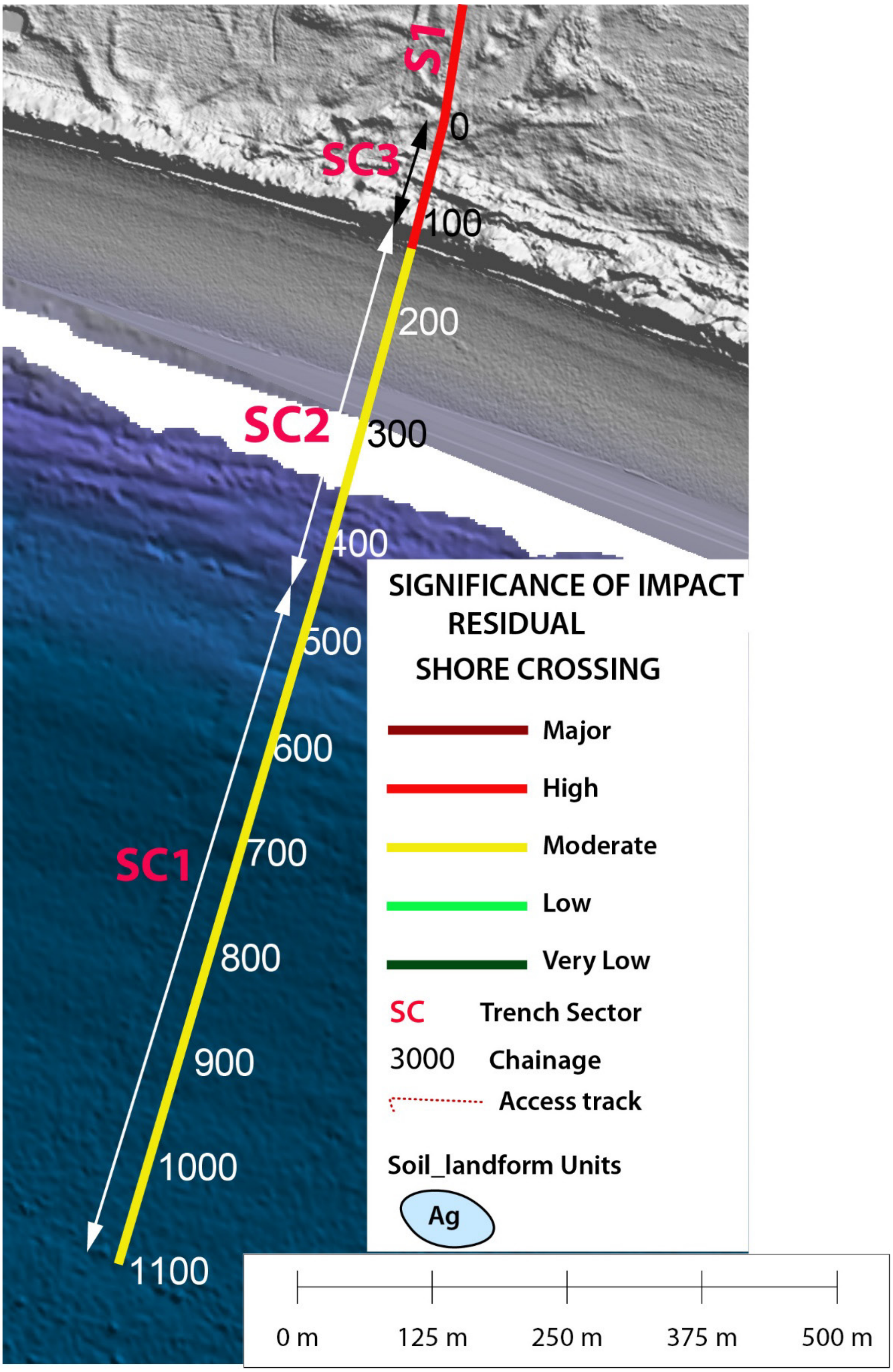


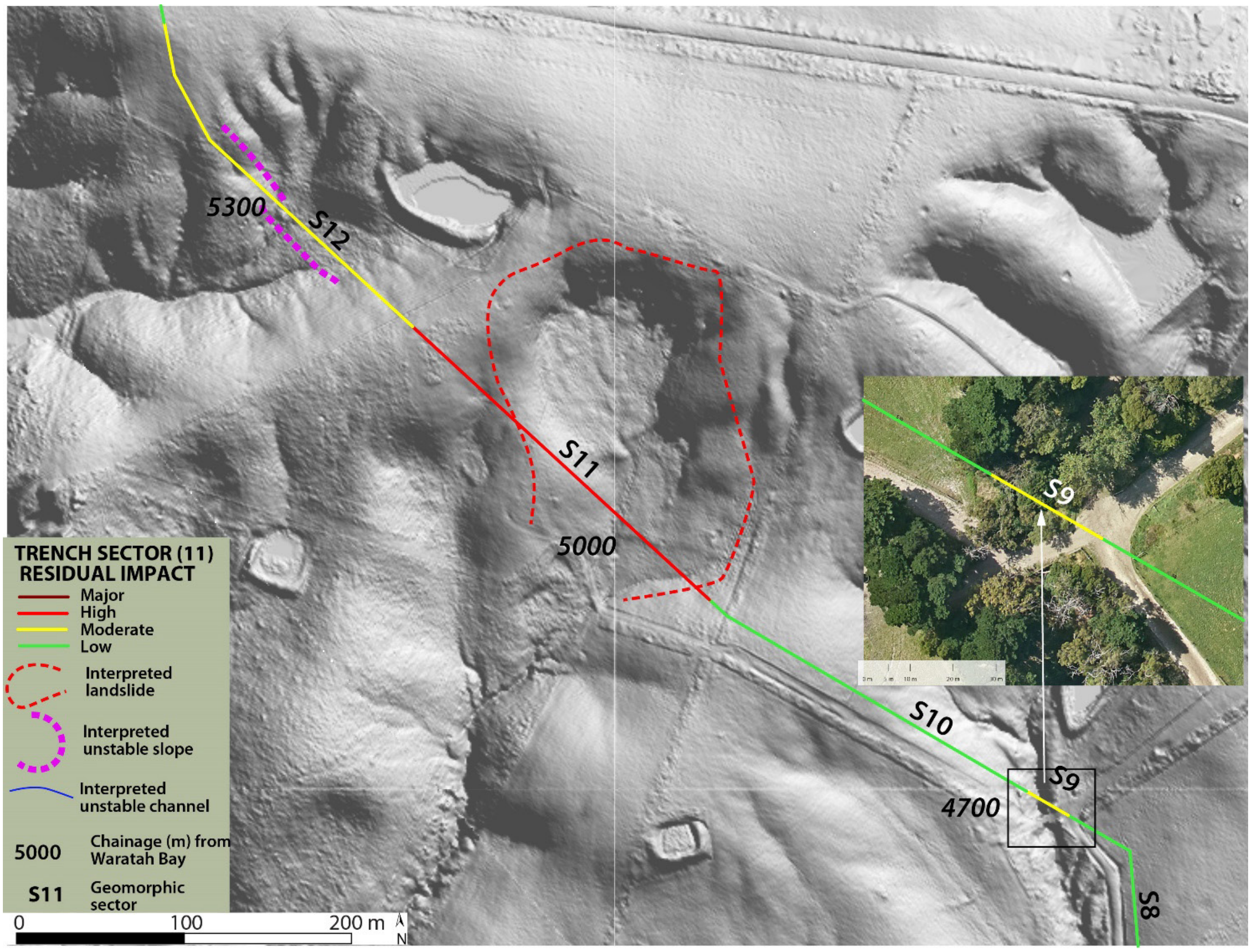
S143
72100
72000
71900
S142
71800
active springs and slope movement
71700
71600
S141
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted unstable slope
71800 Chainage (m) from Waratah Bay
S142 Geomorphic sector
0
100
200 m
N


73800
S145
73700
73600
73500
73400
S144
73300
73200
73100
73000
72900
72800
72700
72600
72500
72400
active springs and slope movement
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
73100 Chainage (m) from Waratah Bay
S144 Geomorphic sector
0
250
500 m
N

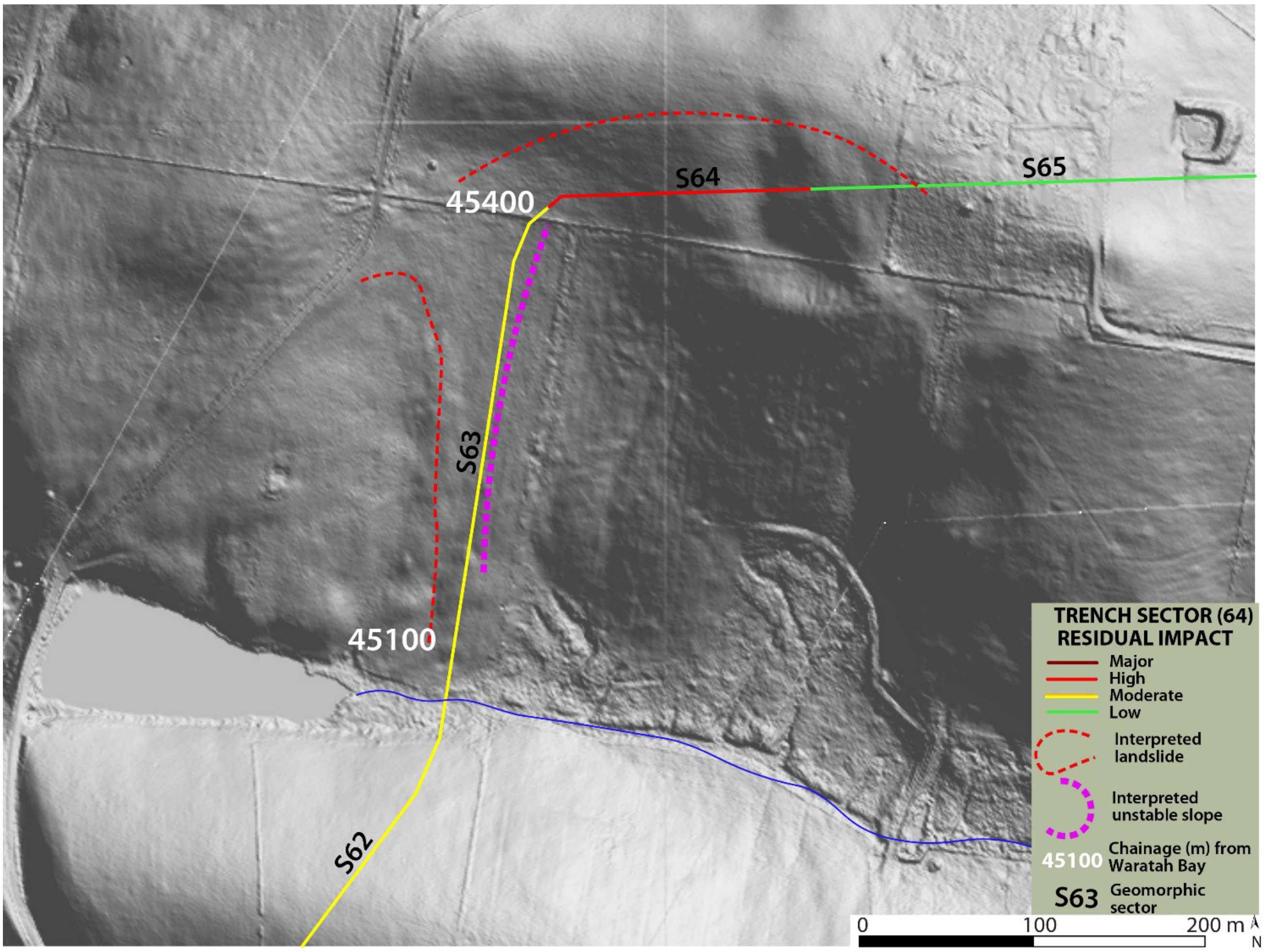

S157
77300
S158
77400
S159
77500
S160
77600
S161
S162
77700
S163
TRENCH SECTOR (S#)
UNMITIGATED IMPACT
Major
High
Moderate
Low
Interpreted unstable slope
77500 Chainage (m) from Waratah Bay
S159 Geomorphic sector
0
50
100
150 m
N

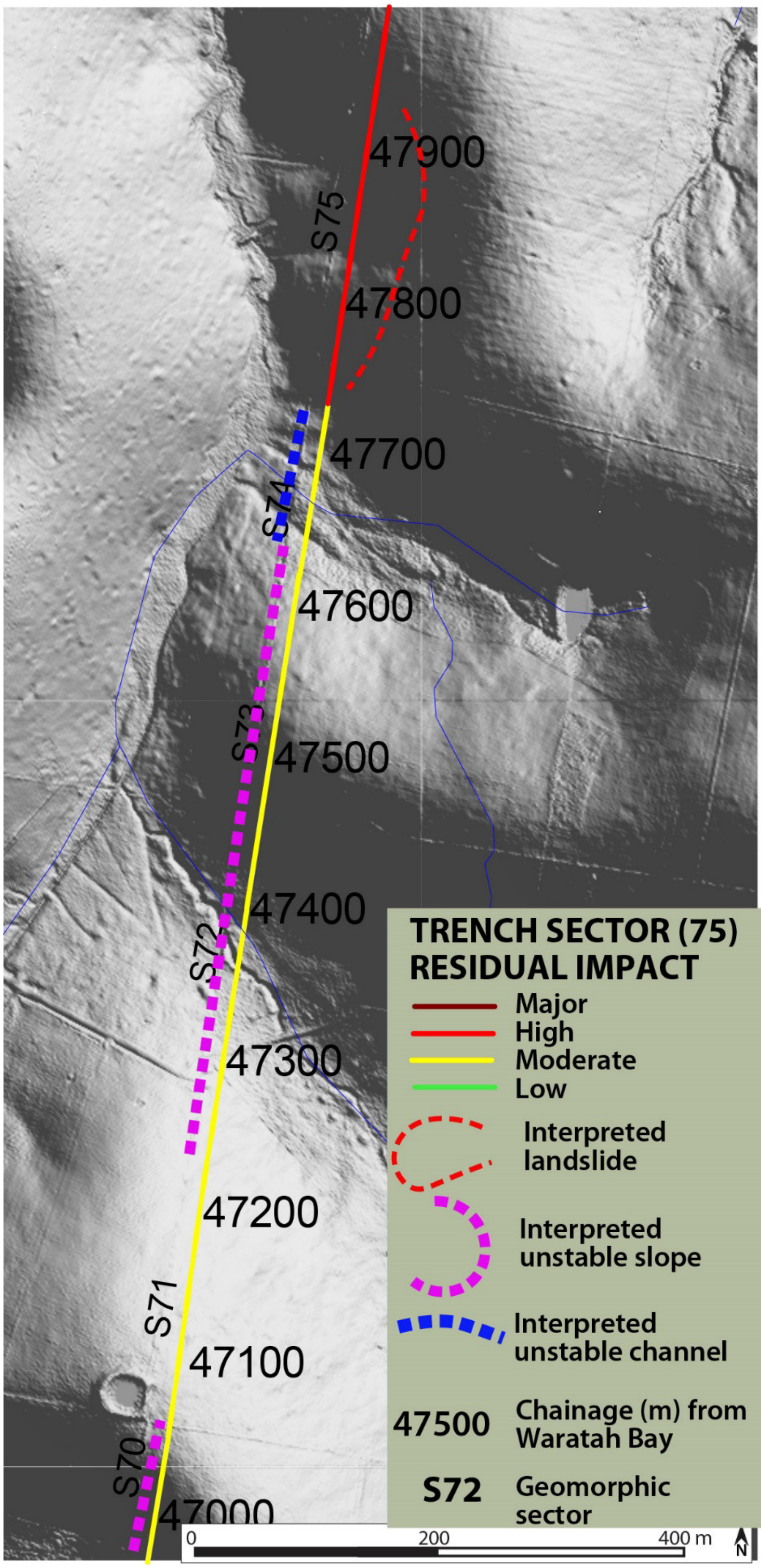
APPENDIX D: RESIDUAL HIGH SIGNIFICANCE OF IMPACT MAPS

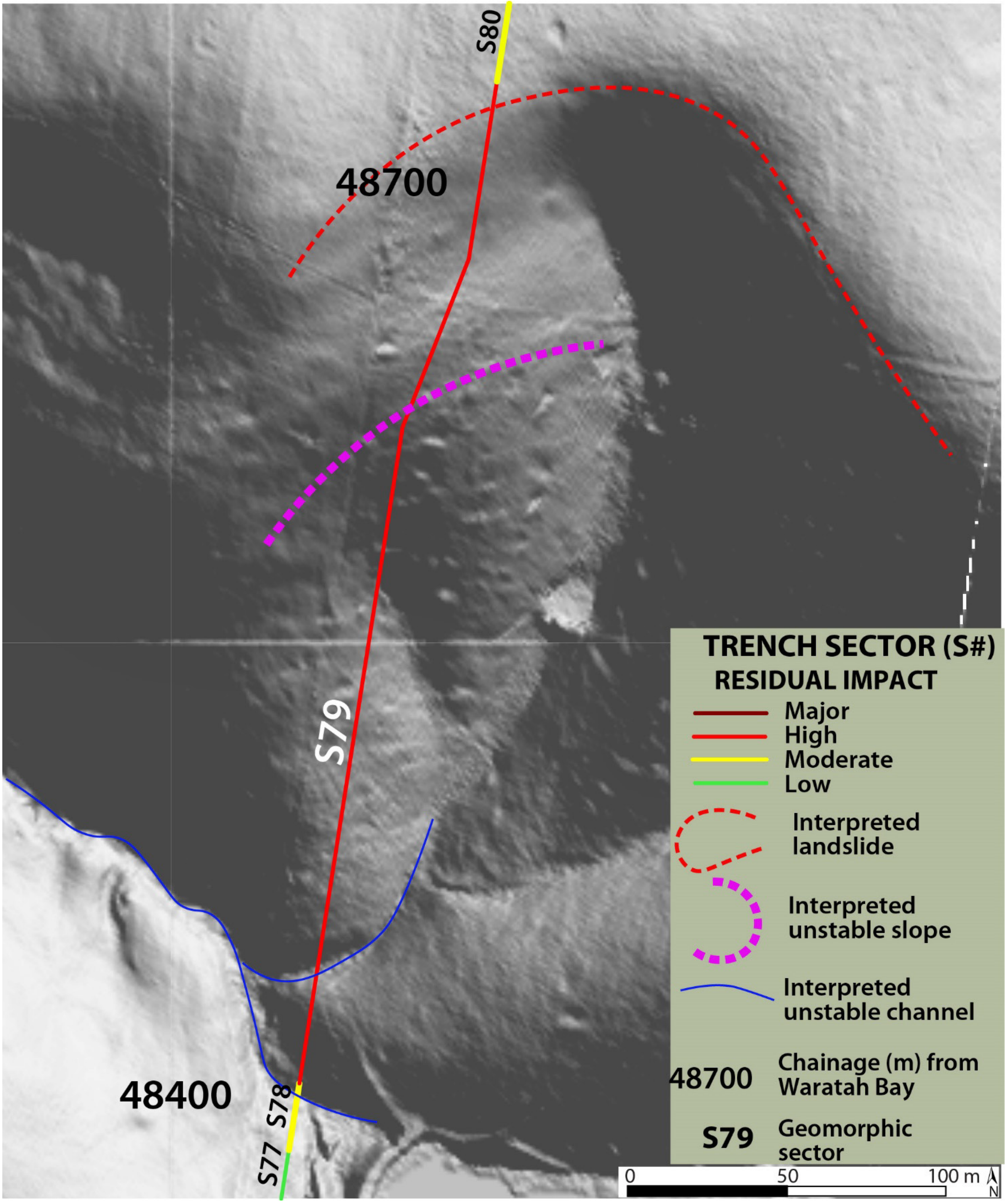

S1
0
SC3
100
200
SC2
300
400
500
600
SC1
700
800
900
1000
1100
SIGNIFICANCE OF IMPACT
RESIDUAL
SHORE CROSSING
Major
High
Moderate
Low
Very Low
SC Trench Sector
3000 Chainage
Access track
Soil_landform Units
Ag
0 m
125 m
250 m
375 m
500 m

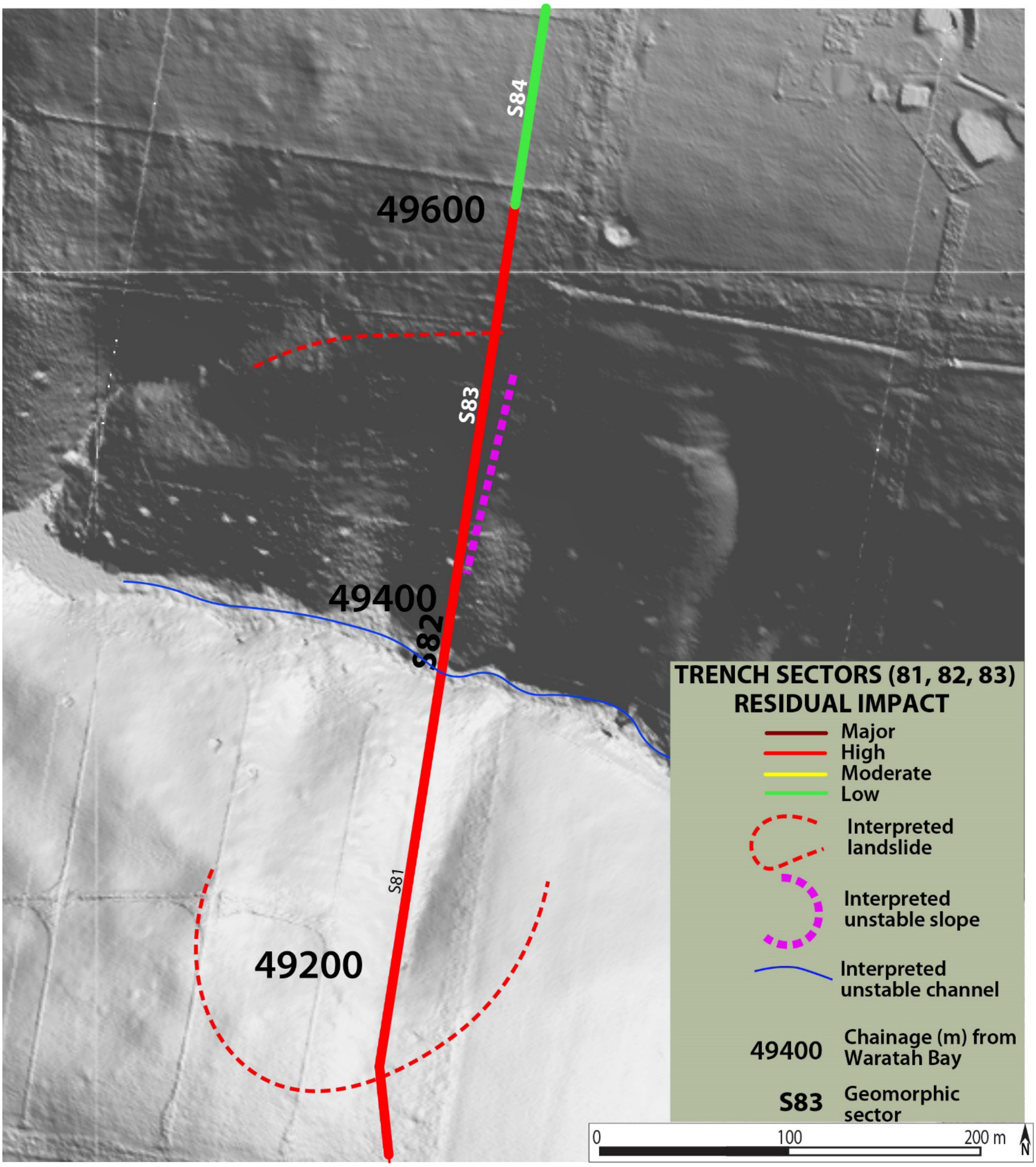


5300
S12
S11
5000
S10
S9
S9
4700
S8
TRENCH SECTOR (11)
RESIDUAL IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
Interpreted unstable channel
5000
Chainage (m) from Waratah Bay
S11
Geomorphic sector
0
100
200 m
N

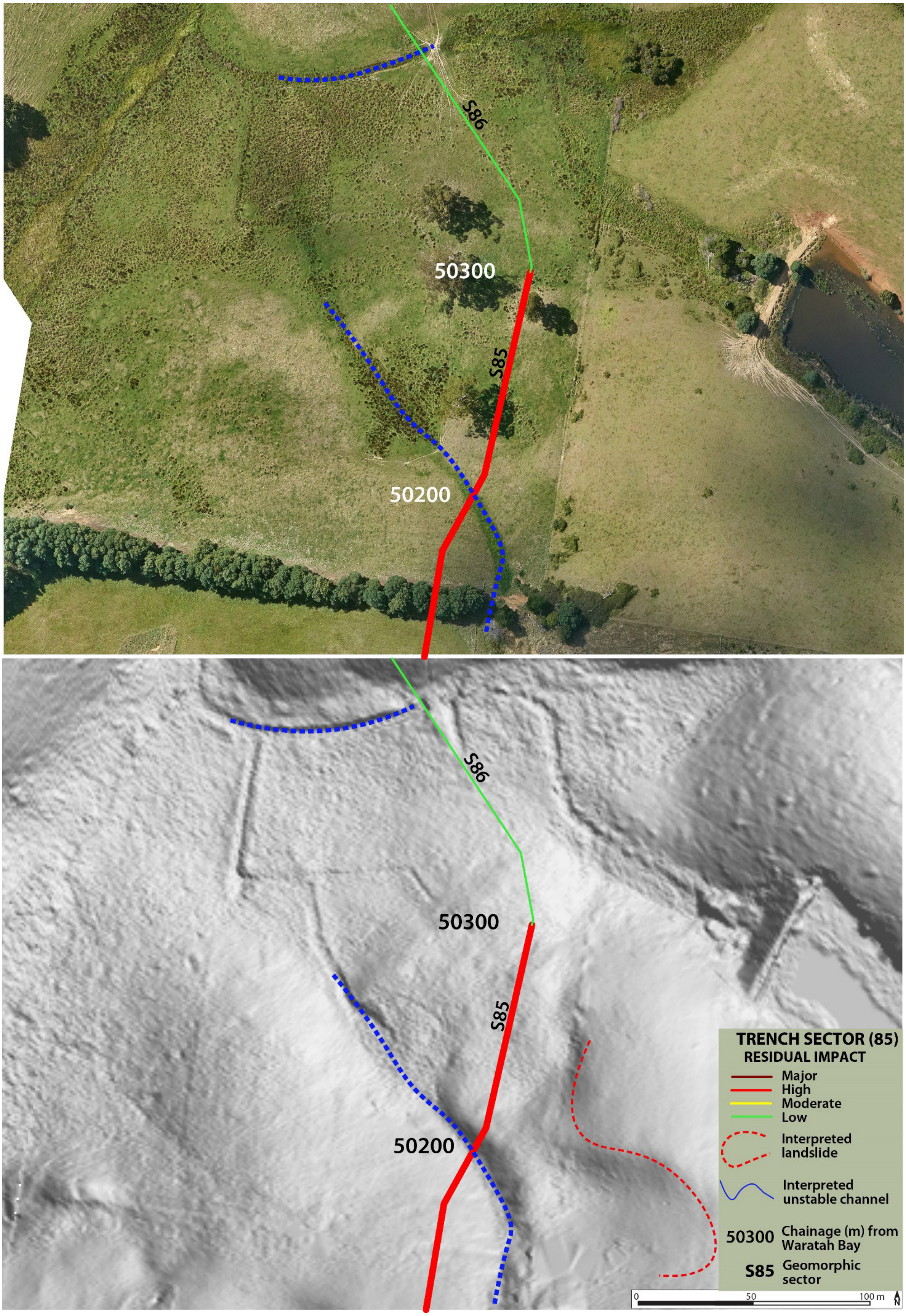

S64
S65
45400
S63
45100
S62
TRENCH SECTOR (64)
RESIDUAL IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
45100 Chainage (m) from Waratah Bay
S63 Geomorphic sector
0
100
200 m
N

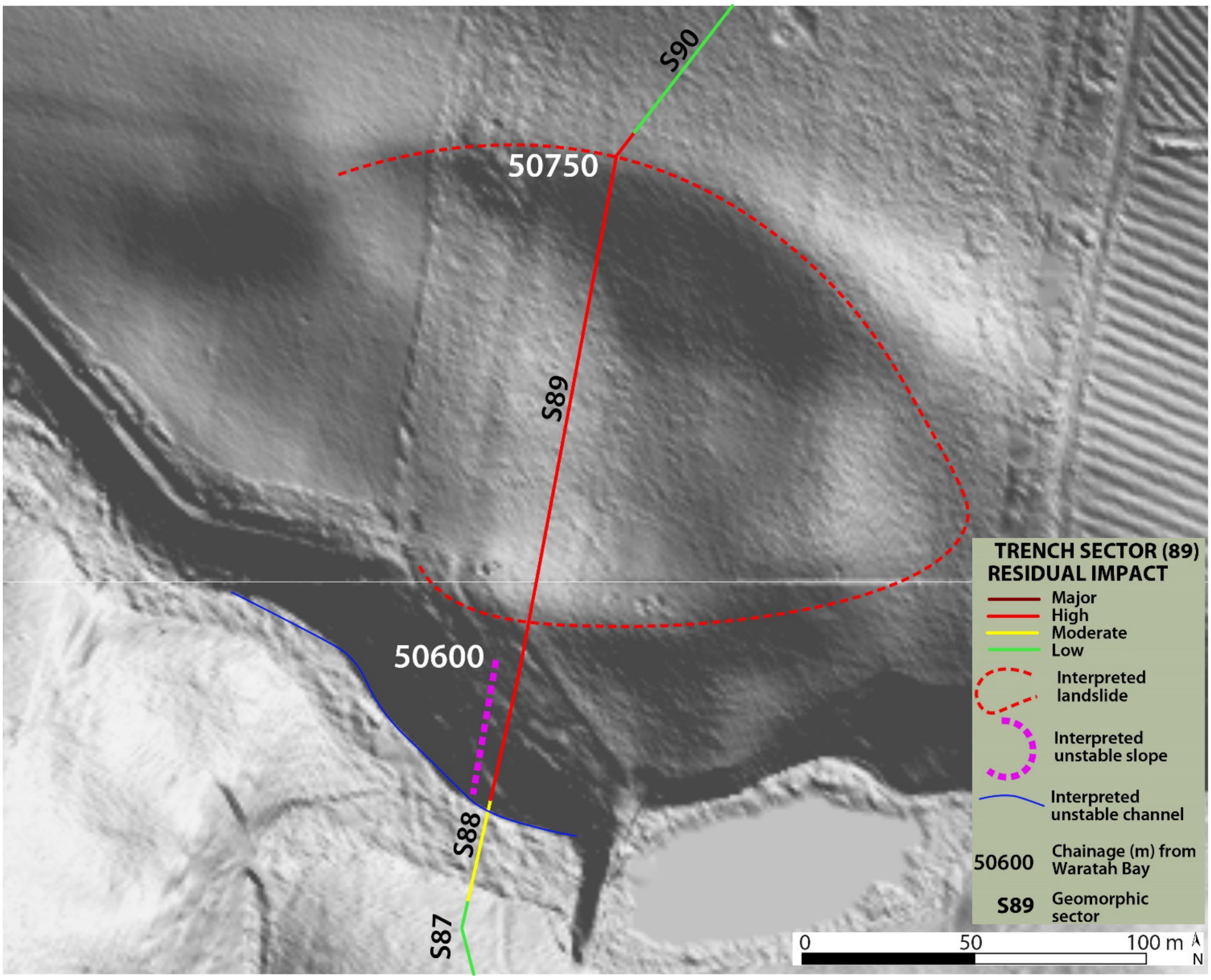

47900
S75
47800
47700
S74
47600
S73
47500
47400
S72
47300
47200
S71
47100
S70
47000
TRENCH SECTOR (75)
RESIDUAL IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
Interpreted unstable channel
47500
Chainage (m) from Waratah Bay
S72
Geomorphic sector
0
200
400 m
N


S80
48700
S79
48400
S78
S77
TRENCH SECTOR (S#)
RESIDUAL IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
Interpreted unstable channel
48700
Chainage (m) from Waratah Bay
S79
Geomorphic sector
0
50
100 m
N

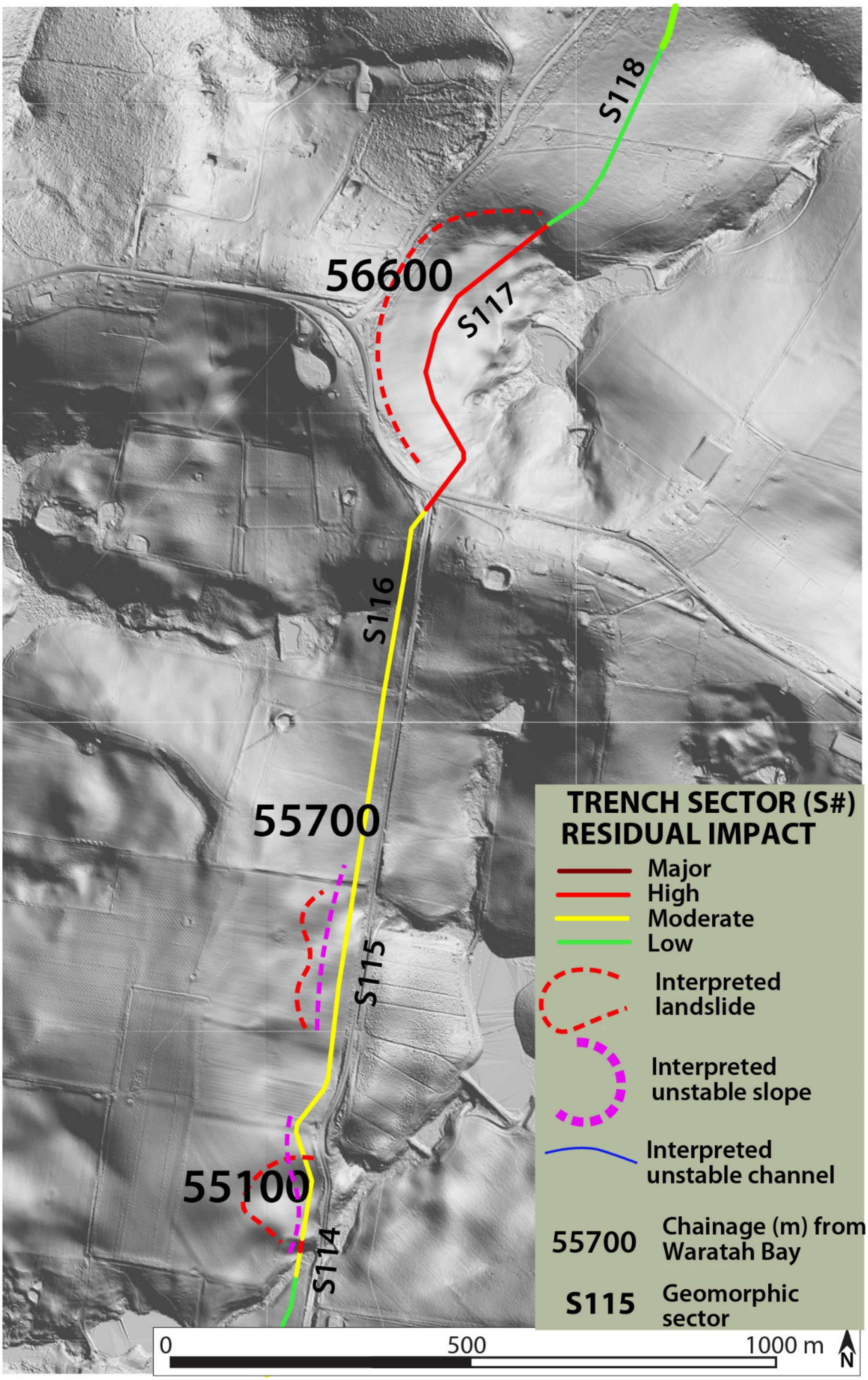


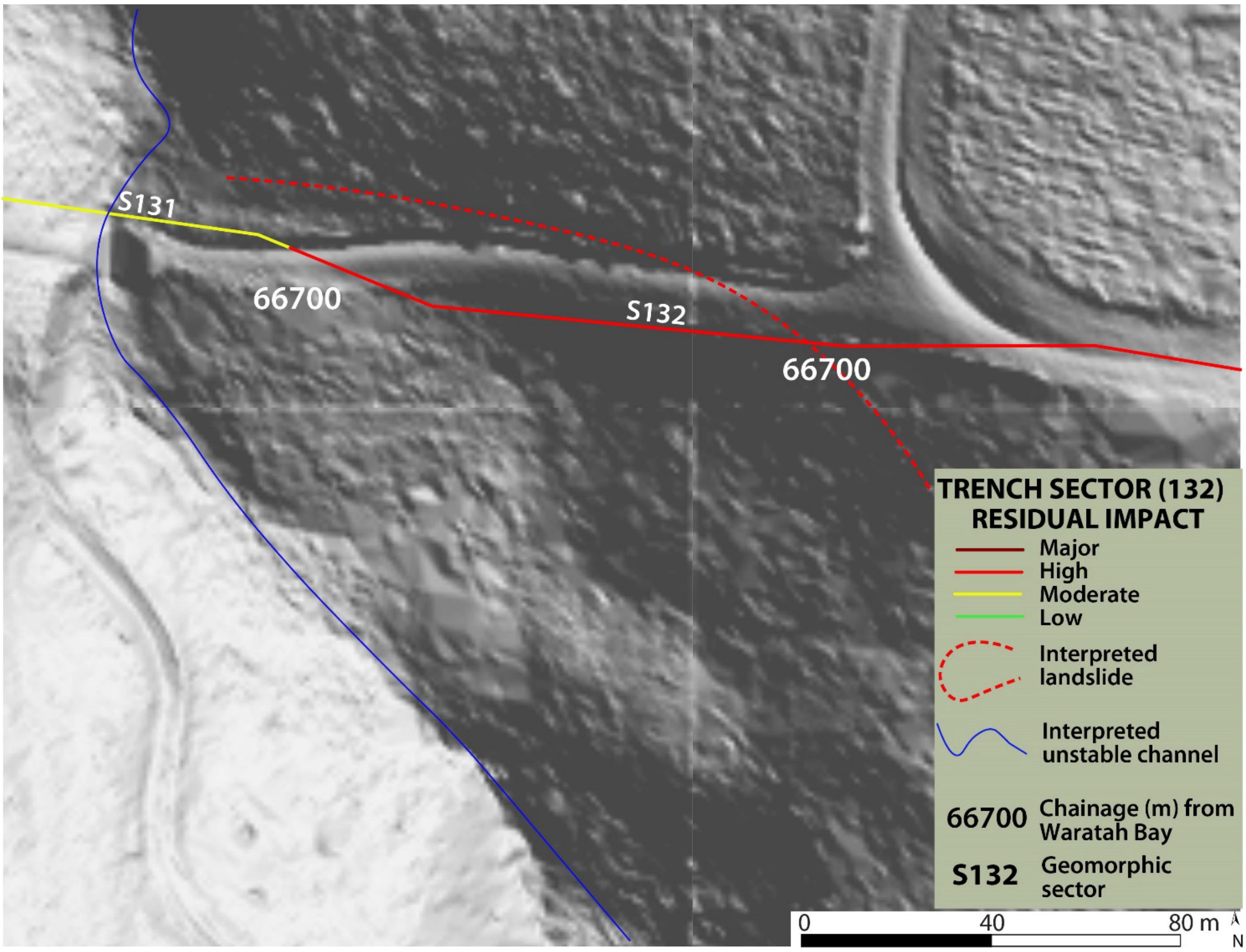
S84
49600
S83
49400
S82
S81
49200
TRENCH SECTORS (81, 82, 83)
RESIDUAL IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
Interpreted unstable channel
49400
Chainage (m) from Waratah Bay
S83
Geomorphic sector
0
100
200 m
N


S86
50300
S85
50200
S86
50300
S85
50200
TRENCH SECTOR (85)
RESIDUAL IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable channel
50300 Chainage (m) from Waratah Bay
S85 Geomorphic sector
0
50
100 m
N


S90
50750
S89
50600
S88
S87
TRENCH SECTOR (89)
RESIDUAL IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
Interpreted unstable channel
50600
Chainage (m) from Waratah Bay
S89
Geomorphic sector
0
50
100 m
N


S115
S114
very steep slope
55500
S113
S112
S115
S114
very steep slope
55500
S113
S112
TRENCH SECTOR (114)
RESIDUAL IMPACT
Major
High
Moderate
Low
Chainage (m) from Waratah Bay
Geomorphic sector
0
15
30 m
N


S118
56600
S117
S116
55700
S115
55100
S114
TRENCH SECTOR (S#)
RESIDUAL IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable slope
Interpreted unstable channel
55700
Chainage (m) from Waratah Bay
S115
Geomorphic sector
0
500
1000 m
N


S131
66700
S132
66700
TRENCH SECTOR (132) RESIDUAL IMPACT
Major
High
Moderate
Low
Interpreted landslide
Interpreted unstable channel
66700 Chainage (m) from Waratah Bay
S132 Geomorphic sector
0
40
80 m
N

APPENDIX E: MARINUS SITES OF SIGNIFICANCE REPORT

Desktop review for Environmental GeoSurveys P.L.

GSA(V) database of sites of geological & geomorphological significance

Marinus Link Project Victoria

This report is a desktop report provided by Dr Susan White, (BA, BSc, Dip Ed, MSc (Melb), PhD (La Trobe). She is an experienced earth scientist with expertise in geological and geomorphological heritage assessment and manages the site database for GSA(V).

The Geological Society of Australia (Victoria) database of Sites of Geological & Geomorphological Significance for the onshore area of Victoria affected by the construction of the Marinus electricity link was interrogated for potential sites of significance.

The area is on the Warragul 1:250 map sheet and are in the Local Government Areas of Baw Baw and South Gippsland Shire Councils and La Trobe City Council. The easement corridor is narrow.

Only two sites are listed in this corridor; Waratah Bay- Cape Liptrap (WL 001) and the La Trobe Valley Brown Coal Deposits (WL 008). Both of these are large sites.

Both these sites do have subsites that are of high significance, but the actual easement does not affect these specific subsites. As a result, the details of these subsites are not provided.

The general details of the 2 sites are:

WL 001 Waratah Bay - Cape Liptrap
Large site; Public and private land
Description
The coastal exposure reveals part of the complex section across the Waratah Bay axis. At the cave (WL 001.1) is Cambrian greenstone which is flanked on the west by L. Devonian Waratah Limestone faulted against Lower Devonian Liptrap Formation. To the east, the Cambrian rock abut Lower Ordovician Digger Island Limestone which is the only calcareous facies in the Ordovician sequence and contains small karst caves (WL 001.2), Further east is Lower Devonian Bell Point Limestone which unconformably overlies Waratah Limestone. The Digger Island Limestone contains well-preserved trilobites and Waratah Limestone a variety of corals. Spectacular examples of tightly folded Liptrap Formation outcrop in cliffs and shore platforms (WL 001.3). The diversity of lithologies and structures arc reflected in variable coastal geomorphology. Sea caves are also present. Includes Bird Rock, Bell Point Trilobite localities, formations. Complex and recent faulting is exposed in the cliff on the eastern side of Cape Liptrap where an uplifted shore platform is exposed (WL 001.4). The top surface of the Cape has well dated Pleistocene carbonate and siliceous dunes. Old lime kilns present.
Significance
State/National
This is a large site which exposes the complex sedimentary, tectonic and landscape history of the area from Cambrian through to Pleistocene. Of particular significance is the group of chevron folds in Pleistocene Bridgewater Formation and the uplifted shore platform indicating that faulting and uplift has continued to occur recently. Spectacular exposures of tectonic activity occur in the cliffs and shore platforms. Excellent teaching and research site. The sequences of dated dunes on the uplifted surface of Cape Liptrap are important for the understanding of the current landscape evolution.

WL 008 La Trobe Valley Brown Coal Deposits
Large site: crown/public
Description

The Morwell Formation, a complex late Oligocene to early Miocene unit of thick brown coal seams with subordinate interseam sediments, is widespread in the La Trobe Valley Depression, the Haunted Hill Block and the Moe Swamp Basin. It is 150 metres to 180m thick at Morwell, increasing to 210m near Gormandale and has at least 4 seams the upper one being exposed in the Morwell Open Cut. Overlying the Morwell Formation in the La Trobe Valley Depression is the youngest unit of the coal measures sequence, the Yallourn Group of middle to late Miocene age. The lower part of the Yallourn Group comprises ~120m of clay, sand and local thin coal seams (Morwell IO Seam). The overlying Yallourn Seam is up to 97 metres thick, and near the La Trobe River is overlain by another unnamed seam up to 16 metres thick. Post-Yallourn Seam gravel, sand and clay sediments (Haunted Hill Gravel Formation) up to 100m thick, occur in the deeper synclinal areas. The age of the formation is considered to be largely late Pliocene to early Pleistocene. Three subsites have been identified: WL 008.1 (Fish and plant fossil site); WL 008.2 (Western Batters Haunted Hills gravels); WL 008.3 (North western batters exposure of upper part of sequence).

Significance

International

The Morwell open cut includes the type section of the Morwell Formation Coal Measures and the associated overburden sediments. The Yallourn open cut contains the type section of the Yallourn Formation. Significant fossils, especially pollen occur and some deposits show the transition between terrestrial and coastal conditions. The deposits are one of the largest known sequences of Olig-Miocene brown coal deposits in the world.

Conclusion

I do not see any serious issues with sites of significance with the development of the project. The limited width of the easement and the route taken avoids most of the known sites. The 2 sites that are relevant are large and construction damage should be able to be avoided.

Susan White

Dr Susan White OAM

Wakelin Associated Pty Ltd