regional roads victoria

16 Soils, geology and contaminated land

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1 Treasury Place, Melbourne

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Tables

Figures

16.1 Overview

This chapter provides an assessment of the soils, geology and contaminated land impacts associated with the project. It describes the existing conditions of the project study area in relation to geology and soils, including potentially contaminated land. The potential impacts as a result of construction and operation of the project have been identified and assessed in relation to land contamination and geological conditions. This chapter has been informed by EES Appendix K*: Soils and geology impact assessment*.

The soils and geology assessment considered the following factors:

- erosion and sedimentation, including the condition and stability of the soil on which the project will be constructed and the potential for soil movement
- the potential for fill to compress soil, causing ground settlement
- ground instability and the presence of existing land slips and the level of impact associated with areas of cut
- the suitability of excavated soils to be re-used on-site as fill, treated fill, landscaping, noise mounds or, as a last option, to be removed off site.

The assessment also investigated known contaminated land and potential sources of contaminants in the study area, as well as the likely presence of acid sulfate soils, a potentially harmful soil type which can have serious environmental, agricultural, engineering and human health impacts.

CONTAMINATED LAND

Land that contains a hazardous substance that may harm the environment or human health. Land contamination can occur due to the incorrect storage, use or disposal of hazardous substances, and can reduce land productivity and value, and corrode building structures.

There is an extensive framework in place for the management of soils, sediment and contaminated land to which the project will need to comply. These governing documents are detailed in Table 16.3 and include, but are not limited to:

- National Environment Protection (Assessment of Site Contamination) Measure 1999 Amendment 2013
- General Environmental Duty
- Environmental Reference Standards
- State Environment Protection Policy – Prevention and Management of Contaminated Land
- State Environment Protection Policy (Waters)
- Industrial Waste Resource Guidelines (2009)
- VicRoads Contract Specifications
- *Occupational Health and Safety Act 2004*
- *Catchment and Land Protection Act 1994.*

16.2 EES objectives

The evaluation objective set in the scoping requirements relevant to the soils, geology and contaminated land impact assessment is:

> ***Catchment values and hydrology:*** *To protect catchment values, surface water and groundwater quality, stream flows and floodway capacity, and avoid impacts on protected beneficial uses.*

The key issues identified in the scoping requirements relevant to the soils, geology and contaminated land assessment are outlined in Table 16.1 below.

Table 16.1 EES key issues – Soils, geology and contaminated land

Key issues
Potential for unsuitable soil conditions to support the proposed bypass, including the potential for unearthing acid sulphate and contaminated soils.

Specific aspects to be addressed were also detailed in the scoping requirements. These are detailed in Table 16.2 below.

Table 16.2 EES requirements – soils, geology and contaminated land

EES requirements
Priorities for characterising the existing environment
Undertake a geotechnical assessment to identify soil types and structures in the study area and to identify the potential for unsuitable soil conditions to support the bypass, and potential location of acid sulphate, contaminated soils and fill.
Design and mitigation measures
Identify the potential risks at waterway crossings, and the potential for soil erosion, soil stability, aquifers, acid sulphate, cut and fill and storage of top soil in flood plains.
Identify potential and proposed design alternatives and mitigation measures which have the least environmental, social and economic impact.
Assessment of likely effects
Assess the potential for effects associated with the exposure and disposal of any waste including acid sulphate and contaminated soils.
Confirm which alignment alternatives have the greatest risk from a geotechnical perspective and the relative cost implications of each alignment alternative.
Approach to manage performance
Identify proposed principles or approach for managing surface run-off, preventing sedimentation of waterways, flood risks and risks associated with excavation spoil, areas of contaminated land and other waste management.
Identify an approach to manage risk and impacts associated with construction and operation.
Include identified measures in the Environmental Management Framework (EMF).

Some overlap between contamination and hydrology values exists with regard to the specific aspects described in Table 16.2. The key issues and requirements relating to surface water and groundwater are addressed in EES Chapter 11: *Catchment values and hydrology* and where relevant, cross reference between the two chapters has been included.

16.3 Legislation and policy

The relevant legislation and government policies related to soils, geology and contaminated land are outlined in Table 16.3.

Table 16.3 Relevant legislation and government policies

Legislation/ policy	Description		Relevance to Project
Commonwealth			
National Environment Protection Council Act 1994	National Environment Protection (Assessment of Site Contamination) Measure 1999 Amendment 2013	The National Environment Protection Council provides guidance to establish a nationally consistent approach to the assessment of site contamination to ensure sound environmental management practices by the community, which includes regulators, site assessors, environmental auditors, landowners, developers and industry. The *National Environment Protection (Assessment of Site Contamination) Measure 1999 Amendment 2013* aims to provide adequate protection of human health and the environment where site contamination has occurred through the development of an efficient and effective national approach to the assessment of the site contamination. The *National Environment Protection (Assessment of Site Contamination) Measure 1999 Amendment 2013* is made under the *National Environment Protection Council Act 1994* and is given effect by individual legislation and guidelines in each state and territory. The *National Environment Protection (Assessment of Site Contamination) Measure 1999 Amendment 2013* provides site assessment criteria for soil, groundwater and vapour for various beneficial uses of the land and groundwater.	The project will need to comply to the criteria prescribed in the *National Environment Protection (Assessment of Site Contamination) Measure 1999 Amendment 2013* guidelines for physical soil, water and vapour testing completed during construction.

Legislation/ policy	Description		Relevance to Project
State			
Environment Protection Act 2017	The *Environment Protection Act 2017* focuses on preventing waste and pollution impacts rather than managing those impacts after they have occurred. Central to the *Environment Protection Act 2017* is the general environmental duty. Under the general environmental duty, businesses must understand the risk from their activities and how to address them. The extent of measures undertaken to address impacts depends on how much risk the activities pose to human health and the environment. The *Environment Protection Act 2017* establishes the powers, duties and functions of the EPA. These include the administration of the *Environment Protection Act 2017* and any regulations and orders made pursuant to it, recommending Environmental Reference Standards, State Environment Protection Policy, issuing works approvals, licences, permits, pollution abatement notices and implementing National Environment Protection Measures.		The *Environment Protection Act 2017* is the overarching legislation for environment protection and is applicable to all projects.
	State Environment Protection Policy – Prevention and Management of Contaminated Land (superseded by Environmental Reference Standards)	Environmental Reference Standards which are informed by the superseded State Environment Protection Policy (Prevention and Management of Contamination of Land) sets out the regulatory framework for the prevention and management of contaminated land within the State of Victoria. The framework has been developed around the concept of protecting beneficial uses of land and groundwater. The State Environment Protection Policy requires soil excavated during the construction work of the project to be assessed (for site re-use, protection of human health and environment) against the open space and recreation guidelines specified in National Environment Protection (Assessment of Site Contamination) Measure 1999 Amendment 2013.	The Environmental Reference Standards which are informed by the superseded State Environment Protection Policy gives limited land-use designations. Given the proposed use of the study area as a road, the most appropriate land use designation under the State Environment Protection Policy (Prevention and Management of Contamination of Land) is 'Recreational/Open Space', consisting of general open spaces and public access areas.

Legislation/ policy	Description		Relevance to Project
	State Environment Protection Policy (Waters) (superseded by Environmental Reference Standards)	Environmental Reference Standards which are informed by the superseded State Environment Protection Policy (Waters) aims to maintain and, where necessary, improve groundwater quality to a standard that protects existing and potential beneficial uses of groundwater. It sets a consistent approach to, and provides quality objectives for, groundwater protection throughout Victoria. This policy overrides all existing groundwater protection provisions in other State Environment Protection Policies.	The project must meet the objectives of the Environmental Reference Standards which are informed by the superseded State Environment Protection Policy for urban stormwater runoff, which includes the protection of beneficial uses and the demonstration of best practice. Clause 56 of the State Environment Protection Policy requires construction works be managed to minimise land disturbance, soil erosion and the discharge of sediment and other pollutants to surface waters.
	Industrial Waste Resource Guidelines (2009)	Under the Environment Protection Act 2017, the Environment Protection Authority Victoria provides a regulatory framework for the handling, management and disposal of prescribed industrial waste due to the potential risks that soils pose to human health and environment. The Environment Protection Authority Victoria publication 621 Soil Hazard Characterisation and Management provides analytical criteria to categorise the soil into Category A, B, C or fill material to determine disposal or management options for that material.	The project is likely to require excavation of soil. Soil testing and classification to identify potential acid sulfate soils is required for spoil management and constructability purposes during construction.
	Acid Sulfate Soil and Rock Publication 655.1 (July 2009)	The *Acid Sulfate Soil and Rock Publication 655.1* provides guidance to landowners, developers, consultants and other people involved in the disturbance of soil, sediment, rock and/or groundwater about identifying, classifying and managing acid sulfate soils and rock.	The project is likely to require excavation of soil. Soil testing and classification to identify potential acid sulfate soils is required for spoil management and constructability purposes during construction.
	Industrial Waste Management Policy (Waste Acid Sulfate Soils) 1999 (17 August 1999)	The *Industrial Waste Management Policy (Waste Acid Sulfate Soils) 1999* provides guidelines for the management of waste acid sulfate soils and rock.	The project is likely to require excavation of soil. Soil testing and classification to identify potential acid sulfate soils is required for spoil management and constructability purposes during construction.

Legislation/ policy	Description		Relevance to Project
	Landfill Management Guidelines	The Environment Protection Authority Victoria (2015) Publication 788.3 *Best Practice Environmental Management – Siting, design, operation and rehabilitation of landfills* provides existing and future operators of landfills, planning authorities and regulating bodies with: • information on potential impacts of landfills on the environment and how these are to be mitigated • a clear statement of environmental performance objectives for each segment of the environment • information on how to avoid or minimise environmental impacts, including suggested measures to meet the objectives.	Potential former or existing landfills could impact on the constructability and on-going management requirements associated with the project.
	Environmental Reference Standards	A subordinate instrument to the Environment Protection Act 2017, Environmental Reference Standards articulate community expectations about the state of the environment, providing a basis for assessing and reporting on environmental conditions. Over time the Environmental Reference Standards will replace the existing suite of State Environment Protection Policy publications as they are reviewed and updated.	The detailed design and construction of the project will need to consider and comply the Environmental Reference Standards that are current during the future stages.

16.4 Methodology

Soils, geology and contaminated land were assessed through a desktop review and field investigations, as outlined below.

16.4.1 Existing conditions

Desktop review – soils, geology and contaminated land

A desktop assessment of available information was undertaken to understand the geological profile of the study area and to identify any existing potentially contaminated land. This assessment included a review of background information and data, including:

- published geology maps
- aerial photographs to identify pre-existing landslides
- historical borehole and groundwater data
- heritage geology database
- Environment Protection Authority Victoria environmental audit database and Priority Sites Register
- areas of potential contamination
- acid sulfate soils maps on the CSIRO Australian Soil Resource Information System.

The project has assessed potential impacts from salinity through EES Appendix D: *Groundwater impact assessment*, with the key findings presented in EES Chapter 11: *Catchment values and hydrology*.

Geotechnical investigation

A preliminary geotechnical investigation was conducted in January 2018 and involved the drilling of 16 boreholes to observe the subsurface soil conditions across the project study area to inform the options assessment process. The installation of three standpipe piezometers (a device to monitor groundwater by measuring the water pressure in rock and soil), as described in EES Chapter 11: *Catchment values and hydrology*, was also conducted during this investigation to allow longer term monitoring of groundwater levels at selected locations.

Laboratory tests were completed on soil samples collected during geotechnical investigations to provide information on:

- subsurface conditions along the proposed alignment at targeted locations based on areas of significant cut or fill, including depth to and condition of rock (if encountered) and thickness of alluvial deposits
- dispersion potential of encountered materials
- settlement potential beneath fill embankments
- suitability of excavated material for re-use as engineered fill
- subgrade suitability
- permanent batter slopes angles for areas of cut.

A plan showing the location of the boreholes is provided in Figure 16.1.

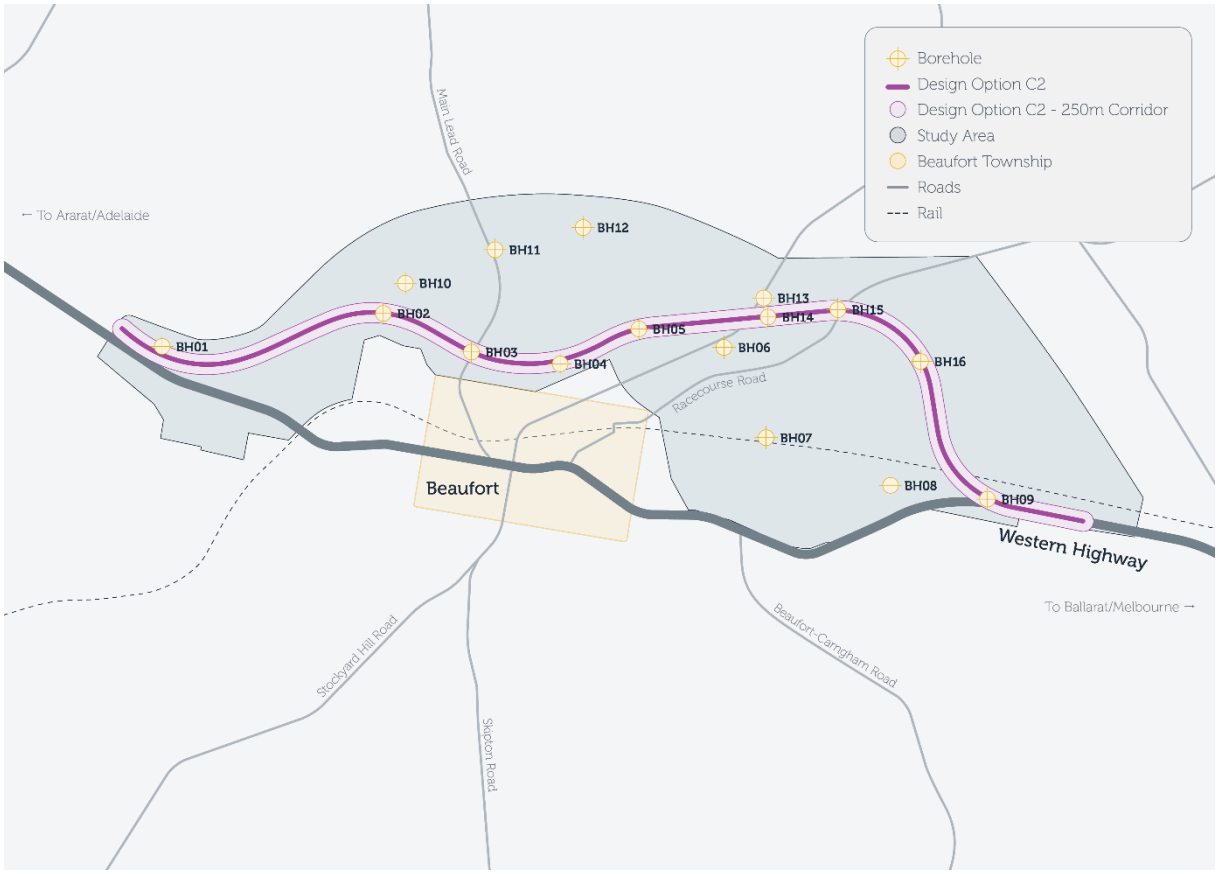

Figure 16.1 Geotechnical investigation borehole locations

16.4.2 Impact assessment

The soils, geology and contaminated land impact assessment was informed by an environmental risk assessment, which was undertaken to identify key issue areas requiring further investigation. The impact of the project on soils, geology and contaminated land during the construction and operation of the project was evaluated based on the extent, magnitude and duration of the potential impact.

16.4.3 Mitigation

Specific design, construction and operational mitigation measures were developed in consultation with RRV to manage the potential soils, geology and contaminated land impacts of the project. All identified mitigations have been informed by technical specialist experience, with proven feasible control measures for major civil infrastructure projects, industry best practice measures and regulatory measures defined by State, Commonwealth and International Government agencies.

16.5 Study area

The study area for the project includes approximately 1,800 ha of land north of the Beaufort township. This study area contains the four bypass options assessed as part of the EES process to determine potential environmental impacts and constraints associated with the alignment options. Figure 16.2 below shows the project study area and the preferred bypass alignment corridor, C2. This area was assessed in the soils, geology and contaminated land assessment.

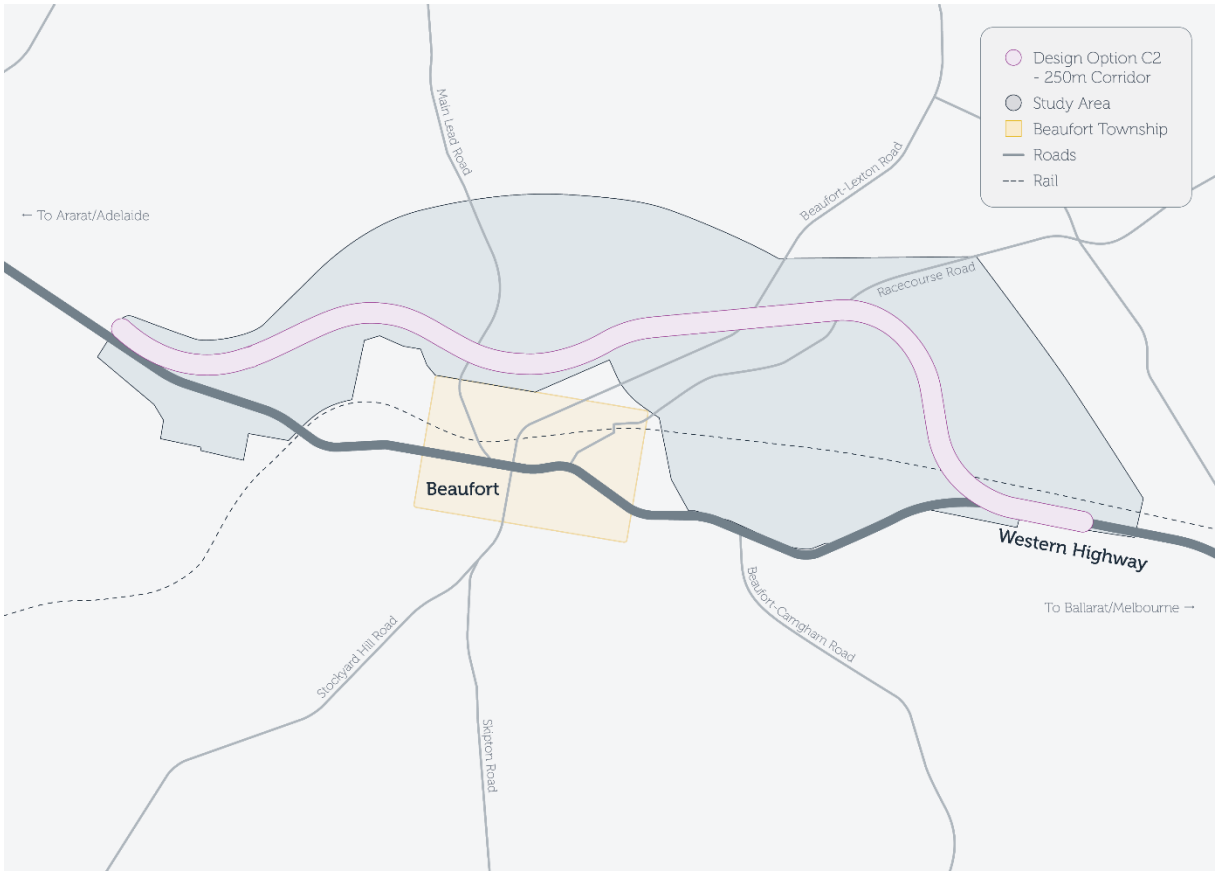

Figure 16.2 Soils, geology and contaminated land study area

16.6 Existing conditions

16.6.1 Topography

The general topography of the study area is undulating, with gently sloping hills to the east and west of Beaufort, and more steeper sections in the centre through the Camp Hill area, crossing the flat low-lying floodplain of Yam Holes Creek on either side of Camp Hill (Figure 16.3).

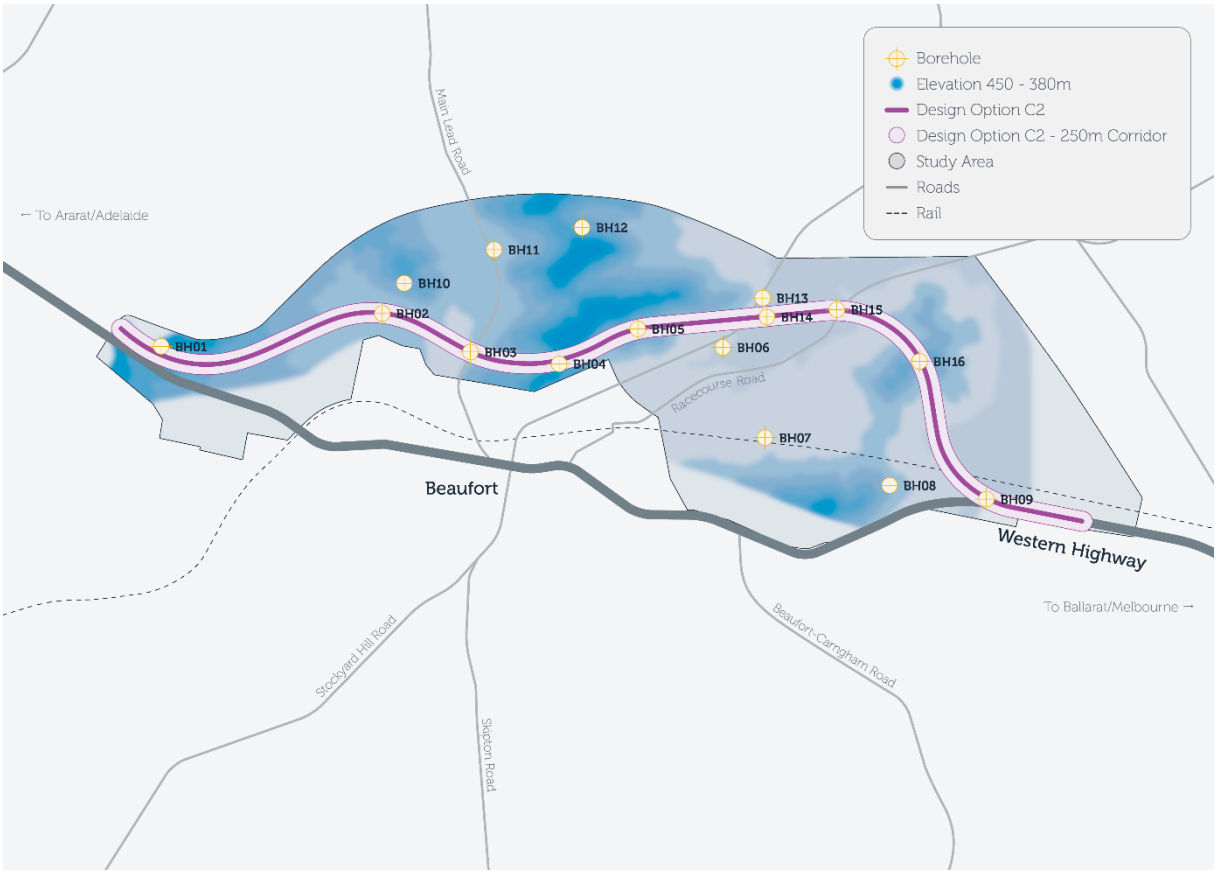

Figure 16.3 Topography of the study area

16.6.2 Soils and geology

Geology of the study area

The study area contains five primary geological units, with the Cambrian-Ordovician sandstone and mudstone considered to be basement formations that outcrop as the hills surrounding Beaufort, overlain by Tertiary gravels and Quaternary alluvial sediments along drainage lines and floodplains. These geological units are detailed in Table 16.4 and mapped in Figure 16.4 below. Additional geological information is provided in EES Appendix A: *Aboriginal cultural heritage impact assessment* and EES Appendix K: *Soils and geology impact assessment*.

Table 16.4 Geological units of the study area

Geological unit	Location in study area	Composition
Quaternary Alluvium (Qa1)	Central and western areas, deposited in valleys such as those at Yam Holes Creek between Beaufort-Lexton Road and Racecourse Road, and to the west of King Street.	Generally unconsolidated gravel, sand and silt which includes deposits of low terraces and alluvial floodplain deposits.
Quaternary Incised Alluvium (Na)	Scattered across the study area, follows the courses of Yam Holes Creek and its tributaries.	Gravel, sand, silt and iron oxides deposited along the channels and floodplains of these streams.
Tertiary White Hills Gravel (-Pxh)	South-east of the study area near Snowgums Bushland Reserve and the Melbourne-Ararat rail line.	Vein quartz conglomerate, sand, silt, clay in fluvial braid plain, outwash fan and colluvial deposits, with well-rounded pebbles and quartz.
Ordovician Pyrenees Formation (-Cap)	Western end of the study area.	Sandstone and mudstone; dominantly sand-rich turbidite facies; moderately to well-rounded quartz with minor feldspar and lithic grains in quartz silt or clay matrix; medium to thick bedded; unfossiliferous; weathered to partly kaolinised; deep marine deposits. Mostly nonmagnetic, but some parts are weakly to moderately magnetic.
Cambrian Beaufort Formation (-Cab)	Generally associated with low-lying hills at Camp Hill, between Main Lead Road and Martins Lane at the eastern end of the study area.	Sandstone, mudstone and black shale; sand-poor turbidite facies tectonically modified to phyllite, quartz-mica or graphitic schist; weathered to partly kaolinised; deep marine deposits.

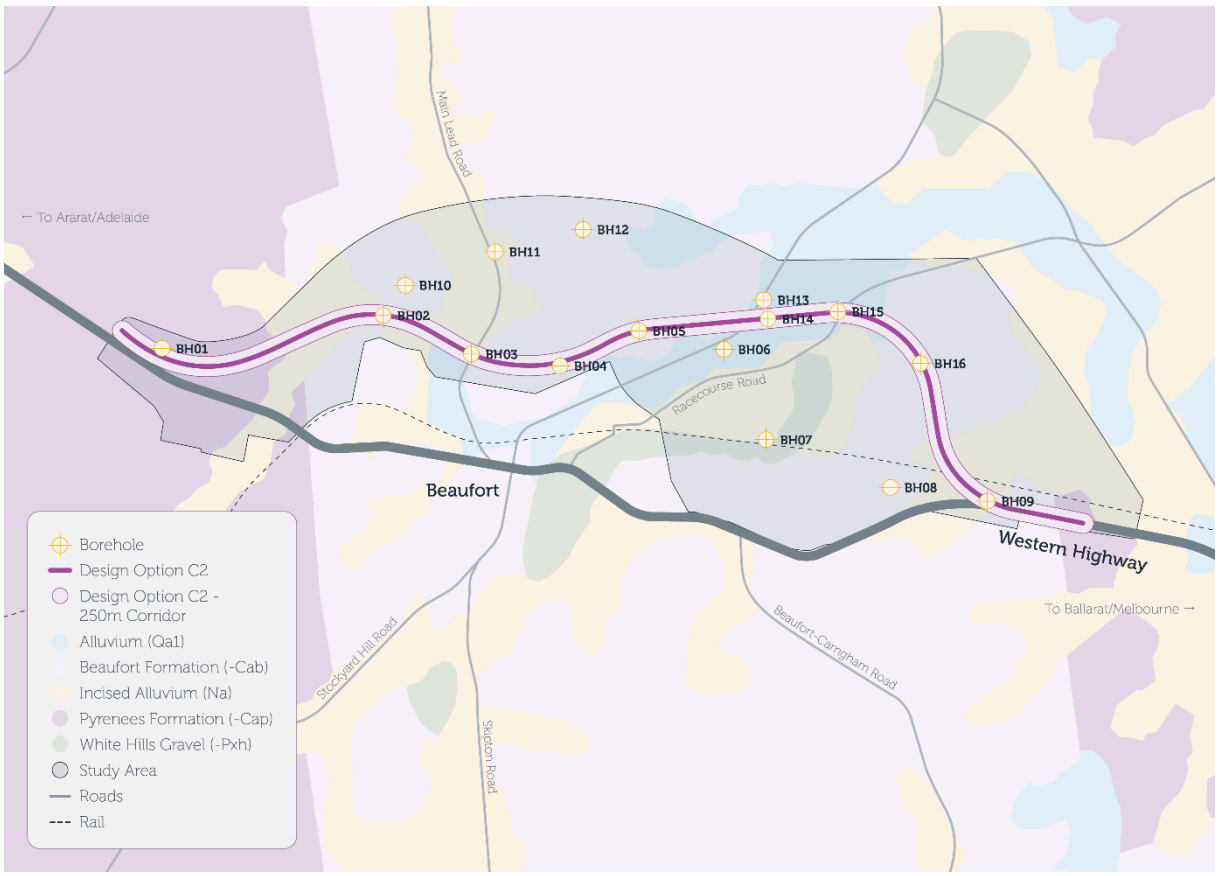

Figure 16.4 Geological units in the study area

The majority of the study area lies above the sandstones and mudstones of the Beaufort formation, and crosses the alluvial deposits and White Hill gravels contained within the valleys. The Pyrenees Formation lies beneath the project east and west tie-ins with the existing Western Highway.

A review of aerial photography identified no large-scale pre-existing landslides with the study area. The National Heritage List was also consulted, and no areas of geological significance were listed within the study area.

As part of the preliminary geotechnical investigation, soil samples recovered from the 16 borehole locations in the study area were subjected to aggressivity suite testing to assess aggressivity towards concrete and steel. The test results indicated non-aggressive to mild exposure classification for concrete piles and non-aggressive exposure classification for steel pile.

Potential acid sulfate soils

A review of the potential acid sulfate soils database was conducted on the CSIRO Australian Soil Resources Information System website, which indicated a low probability of acid sulfate soils although with very low confidence.

Soil samples collected as part of the geotechnical assessment reported pH ranging between 4.8 and 8.6 within the study area. No field indicators for the presence of acid sulfate soils were identified.

ACID SULFATE SOILS

Acid sulfate soils are those soils that contain iron sulfides or sulfidic material that, when disturbed, can oxidise and allow the release of acids to the environment, particularly where surface water transports exposed acid sulfate soil materials. Acid sulfate soils occur naturally in both coastal (tidal) and inland or upland (freshwater) settings.

They pose a considerable environmental impact when disturbed, able to adversely impact land, water and ecosystems in the following ways:

- Environmental quality — affecting soil quality, surface and groundwater quality, and aquatic habitats.
- Agricultural practices — loss of rural productivity, additional lime and fertilizer requirements, and degradation of drainage systems.
- Engineering and landscaping works — the corrosion of concrete and steel, and the design of transport structures (i.e. road or rail), buildings, embankments and drainage systems to avoid impacted areas.
- Human health — skin and eye irritation, contamination of drinking water, and occupational health and safety risks.

POTENTIAL ACID SULFATE SOILS

Potential acid sulfate soils are those soils that contain iron sulfides or sulfidic material which have not been exposed to air or oxidised. Potential acid sulfate soils pose a considerable environmental risk when disturbed, as they can become acidic when exposed to air and water to form sulfuric acid.

16.6.3 Contaminated land

No known areas of contaminated land were identified during a review of the Environment Protection Authority Victoria audit database and Priority Sites Register. However, as there is always potential for unregistered areas of contamination to present, a desktop assessment was undertaken to determine any potential sources of contaminants which may result in the presence of unknown sites within the study area. A summary of potential contamination sources is shown in Table 16.5, with their locations shown in Figure 16.5.

Table 16.5 Potential sources of contamination in soil

Source	Potential issues
Melbourne-Ararat rail line	• spills and leaks (diesel, oil) • contaminants (petroleum hydrocarbons, lead and phenols).
Former unlined landfill and council transfer station	• unlined former landfill which received municipal and commercial wastes • the contaminants of interest associated with the former landfill site are alkanes, ammonia, sulphides, heavy metals and organic acids.
Mine tailings	• former mine shafts (Nil Desperandum Mine Feature) • contaminants associated with gold mining activities (e.g. arsenic, mercury and lead) may be present in soil and groundwater. The contamination from gold mining activities is dependent on the methods used for mining • gold mining methods and activities used (puddling and shallow lead mining types) in the study area would have a low risk of land contamination.
Former council works depot	• a former Pyrenees Council works depot, located along Camp Hill Road • the depot likely stored fuels/chemicals, storage of wastes such as bitumen • the contaminants of interest associated with the former depot are total recoverable hydrocarbons, chemicals benzene, toluene, ethylbenzene and xylene, polycyclic aromatic hydrocarbons, phenols, heavy metals, and volatile organic compounds.
Beaufort Trotting Training Track	• soil contamination from the harness racing facility is expected to be minor and localised.

Source	Potential issues
Fuel service station sites	• contamination from identified existing service stations may be present, however is likely to be localised.
Farming activities	• historical farming and grazing • potential contaminants of interest include nitrates, pesticides, insecticides, fungicides and herbicides.
Environment Protection Authority Victoria licensed premise – Central Highlands Water Wastewater Treatment Plant	• the wastewater treatment plant is located outside the study area however, the irrigation areas where treated effluent is released is within the project alignment corridor • the contaminants of interest associated with operation of a wastewater treatment plant are heavy metals (aluminium, arsenic, cadmium, chromium, cobalt, lead nickel, zinc), fluoride and lime • the wastewater treatment plant is operating in compliance with all Environment Protection Authority Victoria license requirements. The irrigation areas are receiving water approved by the Environment Protection Authority Victoria and is not expected to have gross contamination.
Imported fill	• contaminants vary based on source of the imported fill – common contaminants are heavy metals, fluoride, and petroleum hydrocarbons.

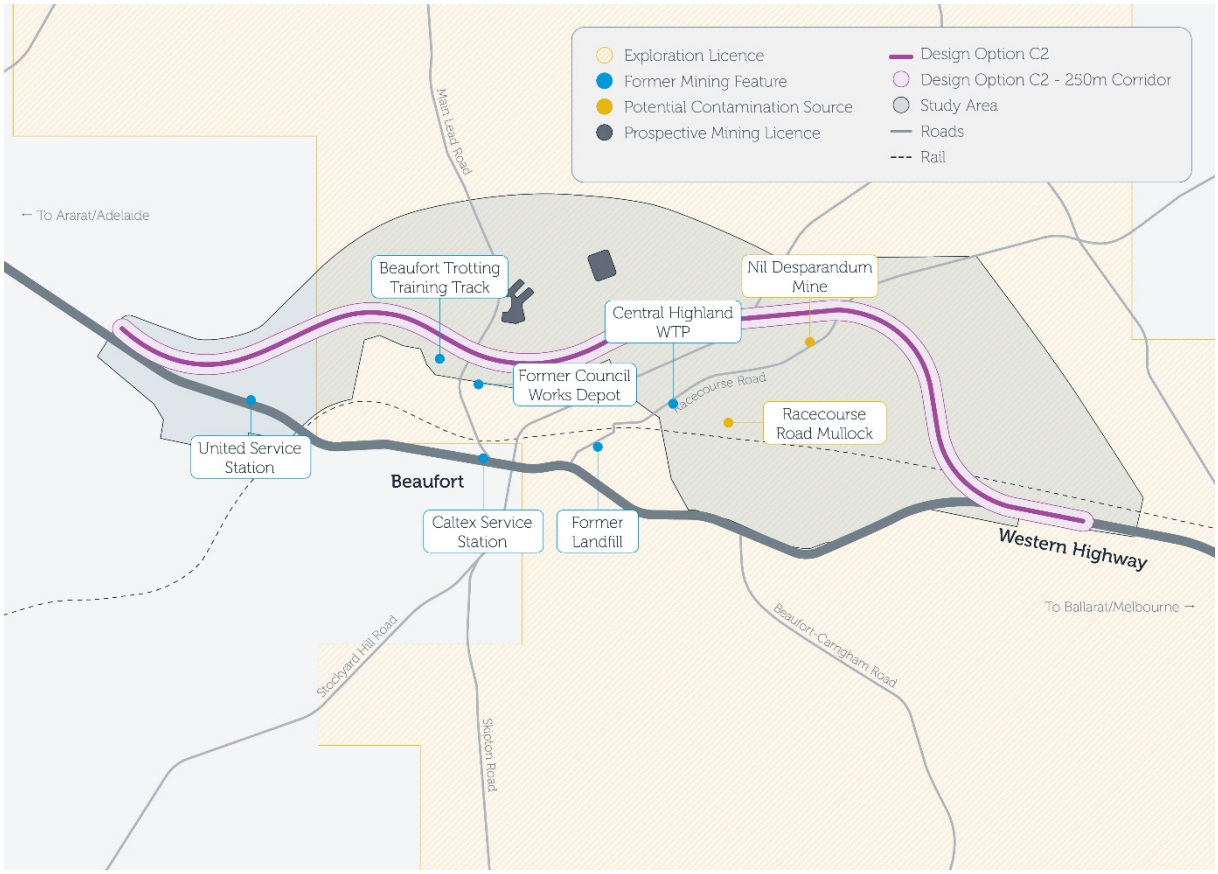

Figure 16.5 Potential sources of contamination in relation to the study area

16.7 Impact assessment

16.7.1 Construction

Soils and geology

Erosion and sedimentation

As the study area is a combination of low hills and valleys, the project will require some areas of cut and fill to achieve safe road design standards. Soil tests were conducted on samples collected during the geotechnical investigations to understand the characteristics of the soils in the study area.

One such test, the Emerson class test, was conducted on samples recovered during the preliminary investigation from proposed areas of cut. The results returned Emerson class numbers of two, which indicate that the soils are considered to be dispersive (i.e. they breakdown more easily in water).

EMERSON CLASS TEST

System of classification for dispersiveness of soils based on the instability of soil structure when immersed in water.

DISPERSIVE SOILS

Soils that are structurally unstable and disperse in water into basic particles, i.e. sand, silt and clay. Dispersible soils tend to be highly erodible and present problems for successfully managing earth works.

Cut and fill slopes formed during construction in dispersive soils have several potential impacts, including:

- surface water flow over slopes has the potential to cause slope erosion and sedimentation overland and in watercourses. These impacts are also discussed in EES Chapter 9: *Biodiversity* and EES Chapter 11: *Catchment values and hydrology*
- steeper slopes have the potential to generate higher velocity surface water runoff which would accelerate the erosion of unprotected dispersive soil slopes compared with shallow slope angles
- unprotected soil stockpiles could potentially result in erosion and cause sediments to enter watercourses and result in impacts to air quality. These impacts are also discussed in EES Chapter 9: *Biodiversity*, EES Chapter 11: *Catchment values and hydrology* and EES Chapter 14: *Amenity*.

Prior to the implementation of mitigations, the impact resulting from erosion and sedimentation during and post-construction to the adjoining and downstream environment would extend until re-colonisation of vegetation occurred and is assessed as medium.

Ground settlement

Road construction over compressible ground is likely to result in ground settlement, potentially causing damage to adjacent buildings and infrastructure. The settlement of embankments after construction also has the potential to increase the level of highway maintenance required.

Based on the soil samples recovered and tested in the preliminary geotechnical investigation, embankment settlements should be manageable through implementation of standard industry practices. The impact of ground settlement outside the footprint of the embankments would be very limited (impacts within 5 m from the toe of the embankments) and is therefore unlikely to impact any nearby buildings.

Prior to the implementation of mitigations, the potential impact resulting from ground settlement during construction and post-construction would be contained to the immediate adjoining environment and as such, is assessed as low.

Ground instability

The desktop study of aerial photography did not identify any existing landslides along the route alignment. However, excavation into the natural hillsides has the potential to re-activate any existing shallow landslips which were too small to be seen in the aerial photographs or were concealed by vegetation.

The detailed design of cuttings will consider the local geology, groundwater and existing topography to determine stable slope angles and/or requirements for reinforcement. This will minimise the potential for any steep cuttings to become unstable by ensuring they are constructed to a safe angle or supported by soil nails or retaining walls.

Mine workings present a risk of unstable ground as these areas may not have been closed off or reinstated to a safe standard. The impact assessment has only identified one previously registered mine site (Nil Desperandum Mine Feature) within the study area, however this site is not directly impacted by the functional design. As such, the assessment of impact for ground instability from encountering shallow or deep mine workings is rated as low. The spatial distribution of shallow workings may be difficult to identify as years of vegetation growth may have concealed the remnants of disturbance.

Deep lead workings or mine shafts have the potential to result in ground subsidence or collapse under increased weight of the road during or after the project construction activities.

Geophysics testing are typical inputs required to inform cut and fill batter design. As part of the detailed design of the project, geophysics testing will ensure engineering and design measures are implemented to appropriately manage potential impacts from ground instability.

Prior to the implementation of mitigations, impacts resulting from ground instability would be contained to the construction phase, limited to the extent of the project area, and are assessed as low.

Excavated unsuitable soils

The preliminary geotechnical investigation found the excavated soils are potentially of low strength, meaning they have potential to not be suitable for re-use as fill. If excavated soils are deemed too weak or susceptible to degradation under traffic loading and cannot be used to form the fill embankments, they will need to be replaced with imported soil. Preliminary investigation results suggest that it is likely that significant amounts of fill will need to be imported.

However, in an effort to minimise waste, the construction phase of project will re-use excavated soils wherever possible. Unsuitable soils can be treated to be made suitable or, where this is not practicable, the soils will be reserved for landscaping, noise mounds and/or removal off site.

Acid sulfate soil

The potential for the project alignment to contain acid sulfate soil is considered low, and it is not expected that the project will encounter any acid sulfate soil, although no analytical data is available to confirm this. The potential to expose acid sulfate soil would be limited to the construction phase of the project, contained within the project area and assessed as low.

Contaminated land

Based on the current and historical land use activities (mine workings/rail corridor/farming and grazing), the unmitigated impacts associated with the potential for contaminants to be exposed is medium. The main impact would be to human health from exposure of construction workers during the construction phase to contaminated materials, dust, vapours, fuels and chemicals, as a direct result of excavation of contaminated ground.

The potential interaction of the bypass with the potential unregistered areas of contamination identified within the project area are discussed further below.

Contaminated land also has the potential to affect groundwater quality. These impacts are discussed in EES Chapter 11: *Catchment values and hydrology*.

Melbourne-Ararat rail line

The project alignment crosses the Melbourne-Ararat rail line near the eastern tie-in with the existing Western Highway. Potential local contamination from fuel and oil spills/leaks from trains is likely to be present within the project area at this location. The proposed crossings with the rail lines are expected to have concrete structures at depth (piles, foundations) and so the drilling and excavation in the rail corridor is expected to encounter soil contaminated with hydrocarbons, heavy metals, nitrates and ammonia. Impacts would be limited to the construction phase, contained within the project area, and assessed as medium.

Former unlined landfill and council transfer station

The former unlined landfill/waste transfer station is not located within the project alignment. As such, the material placed in the landfill will not be affected by the construction of the project. Groundwater and surface water impacts associated with the landfill/waste transfer station have been identified at and near the former landfill and are monitored by the Council on a biannual basis. Given the distance to the project and that the potential impact from landfill contaminant migration would be limited to the construction phase (contained within the project area), the impact is assessed as low.

Historical mine workings

EES Appendix E: *Historic heritage impact assessment* identified shallow workings and deep lead workings within the project area. The nature and extent of historic mine workings are approximate and needs to be further explored during the detailed design phase of the project. Shallow mine workings may have been reinstated to a substandard specification and have potential to give rise to unpredictable and inconsistent ground conditions. The potential contamination impact from deep or shallow mine workings would be limited to the construction phase, contained within the project area and assessed as medium.

Former Beaufort trotting training track

The former Beaufort Trotting Training Track has the potential to have minor localised contamination from site activities. However, the former Trotting Track is located on the southern edge of the project alignment within an area of proposed filling and as such, the impact of such contamination will be minimal. The potential impact from exposure of contamination by construction activity would be limited to the construction phase, contained within the project area, and assessed as low.

Fuel service stations

The two existing service stations (United and Caltex) are not within the project area. The potential hydrocarbon contamination beneath these sites will not be excavated during the construction of the project and is not considered to impact the project, with the likely impact of exposure to contamination from construction activities limited to the construction phase, contained within the project area, and assessed as low.

Agriculture and grazing

The project alignment encompasses former and current farmland where near-surface soil has the potential to be contaminated with fertilisers (nitrates), pesticides/herbicides, etc. The soil excavated during project construction has the potential to require off-site disposal if contaminant concentrations exceed human health and ecological assessment criteria. The potential impact resulting from disturbance of pesticide contamination of soil would be limited to the construction phase, contained within the project area, and assessed as medium.

Central Highlands Water wastewater treatment plant – treated water disposal fields

The Environment Protection Authority Victoria licenced wastewater treatment plant, operated by Central Highlands Water, is located within the study area but not intersected by the project area. However, the land where the treated effluent from the wastewater treatment plant is disposed for irrigation is located within the project area. As noted in the Environment Protection Authority Victoria Annual Performance Statement for the wastewater treatment plant, the wastewater treatment plant is operating within the licence limits set by the Environment Protection Authority Victoria. Assuming that the wastewater treatment plant continues to operate within the conditions of the licence limits, the potential impact resulting from contamination during construction would be limited to the construction phase, contained within the project area, and assessed as medium.

16.7.2 Operation

Erosion and sedimentation

Prior to the establishment of vegetation erosion and sediment controls, potential impacts during the operation phase include:

- surface water flow over slopes has the potential to cause slope erosion and sedimentation overland and in watercourses. These impacts are also discussed in EES Chapter 11: *Catchment values and hydrology*.
- steeper slopes have the potential to generate higher velocity surface water runoff which would accelerate the erosion of unprotected dispersive soil slopes compared with shallow slope angles
- eroded sediments have potential to collect on the slope berms and within the catch drains creating the need for long term maintenance or produce blockages to the surface drainage systems
- erosion of embankments along the edge of the road could compromise the shoulder of the road, requiring ongoing maintenance.

Prior to the implementation of mitigations, the potential impact resulting from erosion and sedimentation during operation would extend to downstream and adjoining environments until re-colonisation of vegetation occurred and is assessed as medium.

Ground settlement

Potential ground settlement impacts will be managed in the project construction phase through the implementation of standard industry practices. The impact of ground settlement outside the footprint of the embankments during operation would be contained to the immediate adjoining environment (impacts within 5 m from the toe of the embankments) and is therefore unlikely to impact any nearby buildings.

The risk of ground settlement impacts during project operation is assessed as low.

16.8 Mitigation

16.8.1 Standard environmental protection measures

RRV has a set of standard environmental protection measures, which are typically required to be complied for construction of major projects like the Beaufort Bypass project. The standard contract conditions that are applicable to soils and contaminated land are outlined in VicRoads (2016) Contract Documents *Section 177 Environmental Management (Major)*.

Table 16.6 below presents a summary of the environmental management measures proposed to manage the potential soils, geology and contaminated land impacts. The mitigations described in Table 16.6 align with the contractual requirements in the VicRoads Standard Specifications *Section 177 Environmental Management (Major)* and address relevant Commonwealth and Victorian legislation, policies and best practice.

The mitigations outlined in Table 16.6 below are also applicable to surface water, groundwater and air quality impacts discussed in EES Chapter 11: *Catchment values and hydrology* and EES Chapter 14: *Amenity*.

Table 16.6 Standard and additional mitigation measures in the management of soils, geology and contaminated land

Impacts	Mitigation measure	Mitigation number
Design/Construction		
Erosion and sedimentation	In accordance with *Section 177 Environmental Management (Major)* (VicRoads 2016), a Construction Environmental Management Plan will be prepared. The Construction Environmental Management Plan will outline the procedures, Environmental Reference Standards and best practice guidelines to manage erosion and sedimentation including: • work near waterways to manage potential water quality impacts and Glenelg Hopkins Catchment Management Authority permit requirements • installation and maintenance of erosion and sedimentation controls, established in accordance with Environment Protection Authority Victoria best practice guidelines for the treatment of sediment laden run-off, including measures to address dispersive soils (Emerson class testing to confirm dispersive nature of encountered soils/gypsum treatments) • minimising the amount of exposed erodible surfaces during construction including the staging of works • prompt temporary and/or permanent progressive revegetation of the site as work proceeds • prompt covering of exposed surfaces (including batters and stockpiles). Cover may include mulch, erosion control mat or seeding with sterile grass • installation, stabilisation and maintenance of catch and diversion drains that segregate water runoff from catchments outside of the construction site from water exposed to the construction site • adequately control and route runoff within the construction site to the appropriate sedimentation controls in accordance with Environment Protection Authority Victoria Publications 275 and 1834 • where trees are required to be removed more than two months in advance of any construction works, remove only that part of the tree that is above ground level and where possible allow the roots to remain intact beneath the ground surface to assist with erosion control • use of sedimentation basins during construction to manage sedimentation. Erosion and sediment controls will need to extend into operational phases until revegetation and landscaping of exposed surfaces is established. The Construction Environmental Management Plan is to be prepared prior to commencement of construction to manage environmental considerations and roles and responsibilities during the construction phase of the project and will be updated based on progressive investigation methods. Refer to EES Chapter 11: *Catchment values and hydrology* for mitigation measures relating to the management of water quality (sedimentation and erosion impacts) during construction and operation.	SG01
Ground settlement	Undertake early works geotechnical investigations to inform the detailed design and determine the specific engineering responses to geological conditions. Investigation to inform development of SG04.	SG02
Ground instability	Measures to address ground instability will include: • mitigations outlined in SG02.	–
Unsuitable soils	Measures to address excavation of unsuitable soils will include: • mitigations outlined in SG02.	–

Impacts	Mitigation measure	Mitigation number
Acid sulfate soils	Additional ground investigation will be undertaken along the alignment as part of the detailed ground investigation, targeting areas of excavation and cut, relevant to the finalised design and confirming the presence or absence of acid sulfate soils with laboratory testing. This investigation will assess the suitability of these soils for re-use as embankment fill or containment within zoned embankments to minimise the volume of imported fill required for the project. If acid sulfate soil is identified during detailed design ground investigations, the Construction Environmental Management Plan will include a specific Acid Sulfate Soil Management Plan in accordance *Industrial Waste Management Policy (Waste Acid Sulfate Soils) 1999* to manage impacts to buildings and structures, and the environment. The Acid Sulfate Soil Management Plan would, wherever possible, require the avoidance of acid sulfate soil excavation. Where this is not possible, the Acid Sulfate Management Plan would require the minimisation of disturbance by: • limiting the amount of excavation of acid sulfate soil required • locating aspects of the project on land where acid sulfate soils are buried deepest, so the amount of acid sulfate soil removed is reduced • using construction methods and site management procedures that do not leave acid sulfate soils exposed to air without treatment • treatment of acid sulfate soil if disturbed.	SG03
Contaminated land	Spoil Management Plan, a sub-plan of the Construction Environmental Management Plan, is to be prepared prior to commencement of construction based on the soil re-use requirements of the project. In accordance with *Section 177 Environmental Management (Major)* (VicRoads 2016): • all excavated soil not suitable for re-use due to contamination is to be appropriately stored prior to disposal off-site to an appropriately licenced facility in accordance with relevant Environment Protection Authority Victoria regulations • soils stockpiles on-site are placed on plastic and covered to prevent spread of materials via wind and rain. The geometry and location of the stockpile is to be designed to avoid soil erosion and contamination of nearby ecosystems. Prior to re-use or off-site disposal, stockpiles soils or importation of fill are to be assessed in applicable guidelines • if soils are to be re-used on site (either structurally or for landscaping), liaise with Environment Protection Authority Victoria to determine soil re-use options in accordance with Environmental Reference Standards and State Environment Protection Policy (Prevention and Management of Contaminated Land). The Spoil Management Plan to include plans for fill requirements for the project including source locations, type of fill and stockpile management. Refer to EES Chapter 11: *Catchment values and hydrology* for mitigation measures relating to the management of water quality (relating to sedimentation and erosion impacts) during construction and operation.	SG04
	Prior to the commencement of construction, an area specific or task specific Occupational Health and Environment Safety Plan is to be prepared so that impacts from specific contaminants can be appropriately managed.	SG05

16.9 Residual impacts

Following incorporation of mitigations outlined in Section 16.8, the following residual impacts will apply for the project.

Table 16.7 Residual impacts for soils, geology and contaminated land

Impacts	Residual impacts	Residual rating
Erosion and sedimentation	The potential for excavation works causing sediments to enter waterways is considered to have medium impact prior to mitigation. Through detailed design, construction methodology and incorporation of the mitigation measures described in SG01 into the Construction Environmental Management Plan, the impacts to the surrounding environment and waterways can be mitigated during and after construction. Regular monitoring of Construction Environmental Management Plan control measures, as prescribed in the Environmental Management Framework, will result in a low residual impact from erosion and sedimentation during and after construction.	Low
Ground settlement	The potential for ground settlement is considered to have a low residual impact. Ground settlement impacts can be further reduced and mitigated during the detailed design phase and through the implementation of standard industry practices.	Low
Ground instability	Impacts associated with ground instability from the project were assessed as low, which could be further reduced and mitigated during detailed design and through the implementation of standard industry practices. The residual impact is also assessed as low for ground instability.	Low
Unsuitable soils	There is a high likelihood of encountering unsuitable soils within the project area, such as weak and/or erosion/sedimentation prone soils. However, the project will require a greater volume of fill material to form embankments than available from excavation of the proposed cuttings. If excavated soils cannot be used to form the fill embankments, greater quantities of imported fill materials will be required. These unsuitable soil impacts can be reduced through further geotechnical investigation, laboratory testing, soil treatment and design solutions to utilise the soils from cuttings and excavation on site. Use of imported fill will also reduce these impacts. The residual impact is therefore considered low with further investigation and design solutions.	Low
Acid sulfate soils	Based on limited data of the existing ground conditions and the proposed mitigation measures, the potential for acid sulfate soils to impact the construction and operation of the project is considered low. Any potential impacts can be further understood through an acid sulfate soils investigation including laboratory testing and appropriate mitigation and/or management measures adopted as part of the Construction Environmental Management Plan. The residual impact is therefore also considered low.	Low
Contaminated land	The potential for existing contamination to impact the project and the surrounding environment was initially considered medium. Potential impacts would be quantified through a soil contamination investigation including laboratory testing and appropriate mitigation and/or management measures adopted as part of the Construction Environmental Management Plan. During the detailed design phase, soil sampling and analysis will be conducted to further quantify the contamination impacts, and to provide guidance on specific management requirements to further reduce residual impacts. With the implementation of the proposed soil sampling, and application of standard controls, the residual impact will be low.	Low

16.10 Conclusion

The scoping requirement evaluation objectives relevant to soils, geology and contaminated land were assessed based on a desktop study of existing conditions and the findings of a preliminary field investigations. The following conclusions were formulated through the development of the soils, geology and contaminated land impact assessment:

- the potential for a medium impact to the environment from contamination due to the construction of the project, without mitigation. With implementation of proposed standard mitigation measures the residual impact is considered low
- the potential for acid sulfate soils from the construction and operation of the project is considered low. Any potential impacts will be further understood through an acid sulfate soils investigation and laboratory testing, with appropriate mitigation and/or management measures adopted as part of the Construction Environmental Management Plan
- construction impacts on the soil and geology within the project alignment are likely to have only low residual impacts on the protected beneficial uses of the surrounding land
- there is a high potential of encountering unsuitable soils. This risk can be reduced to low through further geotechnical investigation, laboratory testing and engineering solutions, as well by using imported fill
- there is a medium impact related to excavation works causing sediments to enter watercourses, which can be mitigated and result in low residual impacts through design and with appropriate mitigation and/or management measures adopted as part of the Construction Environmental Management Plan
- there is a low impact in terms of ground instability and settlement. The implementation of standard measures during the detailed design phase will further reduce and mitigate these potential impacts. As such, the residual impacts to the environment from potential ground instability and settlement resulting from the construction of the project is considered minimal.