

10. Soils and Geology

The Soils and Geology Assessment examined the potential for the Project to encounter adverse geological conditions, affect soil stability, cause soil erosion and expose contaminated and acid sulfate soils (ASS).

Based on a review of previous and current land use, the potential for localised contamination in the study area is considered to be moderate. Several features were identified that indicate potential for land contamination. These include; farm /shearing sheds (often associated with sheep dips), an existing service station (potential hydrocarbon contamination), railway lines (historic land management practices), areas of disturbed soils (potential sites of buried waste) and historic mining works (mine tailings).

ASS have not been identified within the study area, though no analysis for potential ASS has been undertaken. Therefore, targeted sampling would be required prior to construction, particularly in locations where infrastructure such as bridge supports would be installed at depth.

Exposure to contaminated soils and ASS represent a potential risk to human health and the environment. Construction activities also present a risk of contamination through fuel and chemical spills. These risks would be adequately managed, firstly through the identification of contaminated soils, ASS soils and spill risks and then by proper management via the Project Construction Environmental Management Plan (CEMP).

There is limited information on the soil properties and characteristics of the study area at this stage of project development and so specific areas which may be more susceptible to soil erosion cannot be accurately identified. However, there is a moderate risk of encountering unstable geological units which may contribute to soil erosion, associated with softer alluvial sediments, historical mine workings and in the vicinity of Box's Cutting and the Langi Ghiran Railway cutting.

Standard construction management approaches have been recommended in this EES and site specific soil erosion management plans would be developed as part of the Project CEMP.

Detailed geotechnical site investigations, complemented with appropriate design of temporary and final batter slopes would

largely eliminate issues of gross ground instability and minimise the potential for soil erosion.

Preliminary earthwork estimates suggest a large quantity of imported fill material would be required. Fill material would be sourced from surplus materials from site and additional sources including local quarries, borrow pits under arrangement between Contractor(s) and local land owners. Where soils are to be imported to the site, all soils would need to comply with relevant legislative requirements to prevent the importation of contaminated materials. Based on the preliminary earthworks volume estimates, Option 2 is favoured over Option 1 because it would require approximately 1.2 million cubic metres less imported fill material.

Of the two alignment options, when taking into consideration the potential for exposure of sensitive receivers (human health and ecological), it is considered that Option 1 is the preferred alignment as it has less intersection with and sections in close proximity to the railway line (and potential associated contaminants). However, the environmental impact of both options would be low with implementation of the nominated management measures.

Option 1 is also preferred with regard to geological and geotechnical considerations on the basis of unfavourable geotechnical conditions in Option 2 in the vicinity of Langi Ghiran railway cutting. Langi Ghiran railway cutting being the zone of transition between granite and sandstone geology. However, the environmental impact for both options would be low with the implementation of the nominated management measures.

10.1 EES Objectives

The EES objectives relevant to geology and soils are:

- *To protect catchment values, surface water and groundwater quality, stream flows and floodway capacity, as well as to avoid impacts on protected beneficial uses.*

This chapter discusses the geology and soils of the project area, the potential impacts from the Project on these natural features and vice versa, and the management measures to be implemented to minimise these impacts. More specifically, this chapter:

- Identifies and assesses the potential effects of road construction and operation activities on soil stability, erosion and the exposure and disposal of any waste or hazardous soils (e.g., highly saline or contaminated soils). The effects these

issues have on road construction and operation are also assessed.

- Identifies measures to avoid, mitigate and manage any potential effects, including any relevant design features of the road or techniques for construction.
- Identifies residual effects of road construction and operation activities on soils in the project area, including any limitations to future land use activities.

This chapter is based on the Soils and Geology Impact Assessment report completed by GHD Pty Ltd (2012c), and is included in Technical Appendix E.

10.2 Study Area

The Soils and Geology Assessment study area is the same as the project area, which encompasses a corridor extending up to 1500 metres (m) north and south of the edge of the existing Western Highway, encompassing the extent of new alignment possibilities.

10.3 Methodology

A desktop review was undertaken to assess the existing soil and geological conditions within the study area. This comprised the following tasks:

- A review of historical aerial photographs of the study area, where available, to assist in establishing historic land use and potential contamination sources;
- A review of publicly available geological mapping, literature and geotechnical information relevant to the study area;
- Sourcing and collating relevant available borehole, test pit and other geotechnical data;
- Development of a preliminary geological and geotechnical model of the study area;
- A preliminary coastal acid sulfate soil (CASS) hazard assessment; and
- Interpretation of the available information.

10.4 Legislation and Policy

The relevant legislation and government policies for soils and geology are shown in Table 10-1.

Table 10-1 Relevant soils and geology legislation and government policies

Legislation/Policy	Description
State	
<i>Planning and Environment Act 1987</i>	Section 12 of the Act includes provisions to ensure that potentially contaminated land is suitable for the use allowed within the relevant planning scheme.
<i>Environment Protection Act 1970</i>	Enables EPA Victoria to implement the State Environmental Protection Policy (SEPP) in regard to contaminated land, and the Industrial Waste Management Policy for waste acid sulfate soils. All construction activities must comply with the general performance measures outlined in the legislation.
<i>Catchment and Land Protection Act 1994</i>	Provides a framework for the integrated and co-ordinated management of catchments in regards to long-term land productivity and maintenance of the quality of the State's land and water resources.
State Environmental Protection Policy (SEPP), Prevention and Management of Contamination of Land 2002 (Land SEPP)	The Land SEPP establishes a range of general uses of land in Victoria, and is the principle regulation for the management of contaminated land in Victoria. The Land SEPP outlines the process for establishing land contamination and management and remediation of impacted sites.
Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soils (CASS BPG)	The CASS BPG outlines a tiered, risk-based approach to identifying, assessing and managing acid sulfate soils.
Industrial Waste Management Policy (Waste Acid Sulfate Soils) 1999	This policy outlines a management framework and specific requirements for the management of acid sulfate soils in an environmentally responsible manner.
Best Practice Environmental Management (BPEM): Siting, Design, Operation and Rehabilitation of Landfills	Guidelines for existing and future landfill operations. Provides planning authorities and regulatory bodies with considerations for works approvals or licensing of existing and new landfill sites.

10.5 Existing Conditions

10.5.1 Geology

The regional geology is relatively simple with only a limited number of formations occurring within the study area. A description of the geological formations or layers found in the region is mapped in Figure 10-1.

The oldest rocks in the region are the Cambro-Ordovician age indurated (or hardened) sandstones, shales, slates and siltstones, which are of marine origin. These basement rocks are likely to outcrop (exist at the surface) along the majority of the alignment. This includes the study area 5 kilometre (km) immediately west of Beaufort, and much of the study area west of Buangor. Following their formation, these rocks experienced geological folding and faulting, injection with quartz veins, intrusion with granites, and were subjected to extensive erosion.

The granite intrusives are likely to outcrop within the construction corridor between Buangor and Dobie, and also form the elevated areas north of the alignment at Mount Cole, Mount Langi Ghiran, Bayindeen and Mount Buangor. These rocks were uplifted and then deeply eroded with valleys and drainage systems.

Deposited within these old valleys and drainage lines are the Calivil Formation or "Deep Leads". Although this layer does not outcrop at the surface, it was the target of historical gold mining activities within the study area, and therefore has relevance for potential ground subsidence and potential contamination.

The youngest geological formation within the construction corridor consists of unconsolidated gravels, sands and silt alluvium. These are associated with existing and previous depositional stream channels and floodplains.



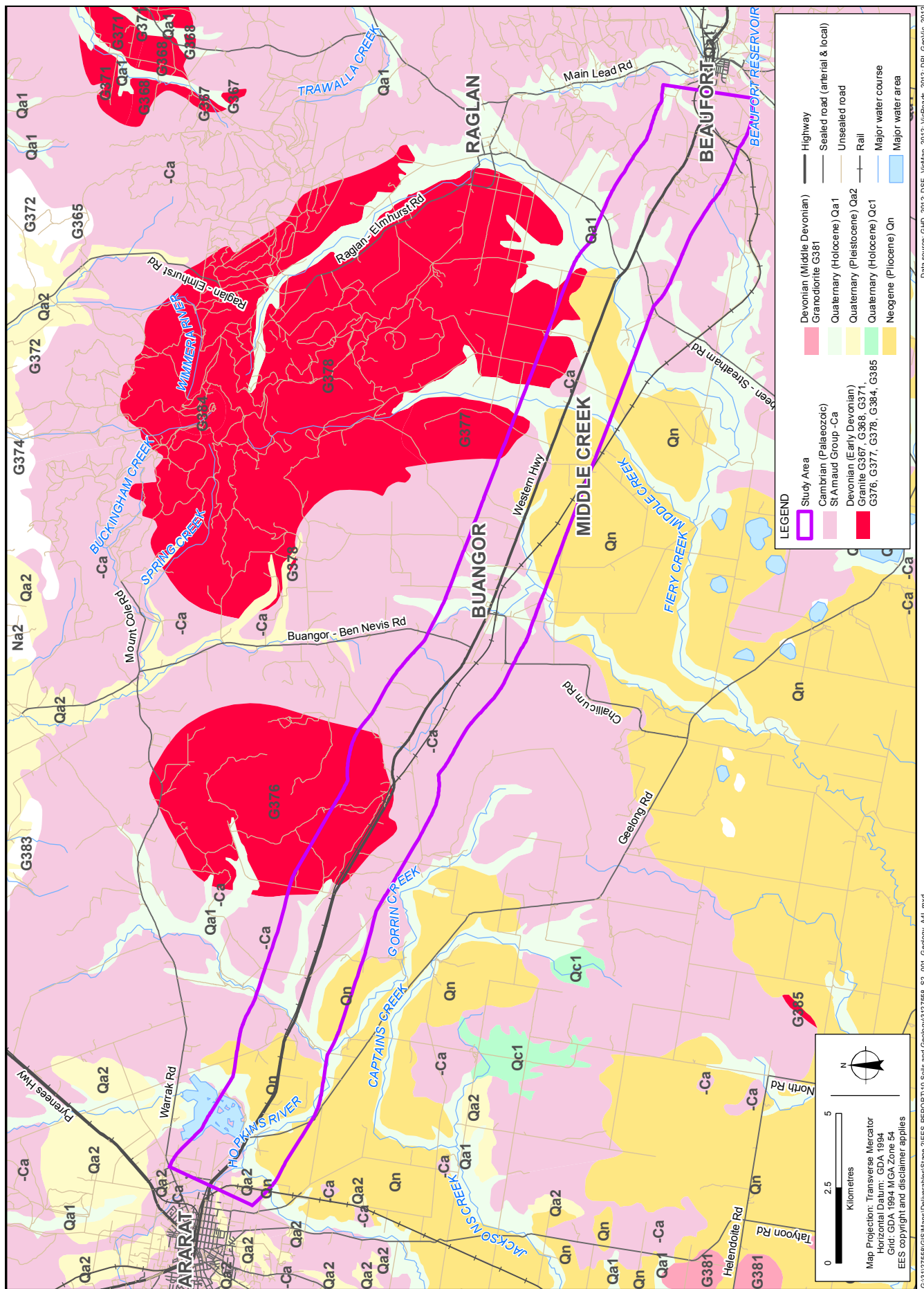


Figure 10-1 Geology of the study area

10.5.2 Historic Mining Works

The areas around Ararat and Beaufort were mined for gold. These workings take the form of deep shafts and drives along the “deep leads”, and also open cut mining of shallow alluvial deposits. A search of the DPI GeoVic database on past mining activities shows no recorded workings within at least 1km from Option 1 or Option 2, except in the area north-west of Old Geelong Road, Ararat, where recorded workings are several hundred metres away. There is therefore only a remote possibility of encountering abandoned mineshafts during construction. The potential for encountering abandoned backfilled shallow workings is greater.

10.5.3 Erosion

Erosion is the process of weathering and transport of sediments. The rate of erosion depends on many factors, including climatic factors and the amount of and type of ground cover. Sediment with high silt and sand content and areas with steep slopes erode more easily. Ground instabilities may develop during the earthwork operations, particularly along the banks of the existing creeks and steeply inclined areas where geological contacts may necessitate a weak failure surface.

10.5.4 Potential for Contaminated Land

Aerial photography over a period of time can be analysed in order to identify potentially contaminating land use activities for a particular region. Aerial photography, conducted sporadically during the period 1947 to 2009, was obtained for the study area. A number of features along the alignment have changed significantly during the time period covered by the aerial photography, including the density and sprawl of residential and rural allotments, particularly adjacent to town centres. A number of small farm dams have been created or altered during the period examined.

Based on the review of aerial photography, no obvious or apparent evidence of present or past ground instability or movement was distinguished. However, small scale localised instabilities or ground movement may exist throughout the study area. Historic landslips may be well disguised by subsequent revegetation and human activities.

The aerial photographs show that the majority of the land in the study area between Beaufort and Ararat has been used for farming (typically grazing and agriculture). Farming activities such as land clearing/cropping and surface earth works were prevalent along the alignment. The most notable land activity along the corridor alignment was a large earthworks operation reinstatement situated along the Western Highway approximately 4km west of the eastern Hillside Road/Western Highway intersection (Ch. 24000), which was consistently visible from 1947 (earliest photo available) to present day. This disturbance is possibly associated with quarrying or land clearing activities. This

process may have substantial impacts on the geotechnical performance of these areas.

Potential land contamination activities that were observed in the study area included two service stations, the railway line, localised earthworks, agricultural practices and the Ararat Aerodrome. Agricultural land use for pasture and grazing has the potential to lead to both point source (sheep dips) and dispersed contamination (surface application of fertilizers, herbicides and pesticides). No sheep dips (which can be a concern due to the chemicals used to dip the sheep, namely arsenic) were observed in the study area, although the frequency of pasture and grazing properties along the corridor alignment indicates the potential for their presence and the potential for dispersed contamination sources (associated with fertilisers, herbicides and pesticides). No suspected landfills were observed in the study area.

An aeroplane runway was observed in 1947 and associated structures were observed in the south-west of the study area from 1966 to 2009. The historical presence of aircraft in the area poses the potential for petroleum hydrocarbon contamination of soil associated with refuelling activities and spills.

10.5.5 Coastal Acid Sulfate Soils (CASS)

CASS (including actual acid sulfate soil (AASS) and potential acid sulfate soils (PASS)) generally occur where soils contain high levels of metal sulphides (predominantly iron sulphide), and can occur naturally in coastal and inland settings. CASS has been found to occur in a range of soil types in Victoria, ranging from loamy sands to clays and silts.

Under natural conditions, PASS is usually located below the water table. Left undisturbed, PASS is unlikely to cause any harm to the environment, however when exposed to oxygen through excavation or lowering of the water table, the metal sulphides have the potential to oxidise and form sulphuric acid and AASS. Under acidic conditions, metals such as aluminium and iron as well as trace metal toxicants may be mobilised from the soil through infiltrating water.

Impacts to the environment resulting from disturbance of CASS may occur directly through lowering of surface or groundwater pH, or mobilisation of metals to waterways, which impact on marine or freshwater ecosystems. Acidic conditions can also be corrosive to concrete and steel structures (pipes, bridge abutments, underground services and other infrastructure).

The presence of CASS can be problematic for construction projects where PASS or AASS is disturbed. Ideally, disturbance of CASS should be avoided, however in instances where this is not possible, CASS must be carefully managed in order to prevent potential impacts to the environment.

A review of the available mapping information indicated the following:

- The CSIRO Australian Soil Resource Information System indicated the site is within an area of “low probability of occurrence” of acid sulfate soils.
- The Department of Primary Industries (DPI) Map 1, Far South West Coast (DPI, 2006) indicated the site is not within an area of “prospective land” containing PASS.

Both sources indicated that the study area does not lie within an area of PASS, therefore, it is considered there is a low probability that ASS exist in the study area.

Due to the low probability of ASS occurring within the region, it is concluded that the study area is not within a CASS risk area.

10.6 Impact Assessment

10.6.1 Key Issues

- Exposure to contaminated soils (including ASS) encountered during construction;
- Encountering unstable geological units including erosion prone areas or compressible soils during construction;
- Intersecting historic mine workings which may be characterised by soft, unstable or collapsible ground;
- An imbalance in the volume of suitable cut and fill material during construction, resulting in either unplanned offsite disposal of material, or the need to source additional suitable uncontaminated material; and
- Transport of road contaminants offsite during operation.

The duplicated highway would incorporate improved drainage design, providing an environmental benefit in the event of an accidental uncontrolled spill.

10.6.2 Impact Pathways

10.6.2.1 Exposure to Contaminated Soils

Exposure to contaminated soils (including ASS) is known to be associated with a potential risk to human health and the environment. These risks are realised when the receptor (human or ecological) is exposed to the contaminants by one of the following pathways;

- Dermal contact with skin causing the contaminants to be absorbed into the underlying tissue and blood stream,
- Ingestion of a contaminated soil and water due to adhesion to skin and transfer onto food; and
- Inhalation of components and contaminated dust carried by air into the lungs and respiratory systems of the organism.

The main exposure risk is to construction workers via dust, fuels and chemicals used during the construction phase.

Based on land-use activities, the potential for contaminants to be identified within the study area is moderate as there have been several different historic uses along the alignment that could give rise to gross contamination, including service stations, sheep dips and shearing sheds, railway corridors, areas of disturbed soils and uncontrolled historic mining works. These are discussed in the following sub-sections.

10.6.2.2 Agriculture – Pasture and Grazing

The potential risks to human health and the environment associated with contamination to soil and groundwater along the alignment from agriculture would be relatively low across most of the study area. This is because contaminant concentrations due to the application of fertilisers and other pastoral improvement substances, where present, are likely to be low. The exception to this generalisation would be farm or shearing sheds with associated sheep dip sites. Though no sheep dips were found in a review of the aerial photographs of the study area, the following chainages identify farms/shearing sheds of potential concern due to the potential for localised high contaminant concentrations:

Option 1

- Ch. 10600 to 10800 ■ Ch. 14500
- Ch. 19600 ■ Ch. 24000

Option 2

- Ch. 10600 to 10800 ■ Ch. 14500
- Ch. 24400

In-situ intrusive investigation along the alignment would be undertaken in these agricultural areas of concern prior to construction. Given the small size and localised effects of dip sites, it would be appropriate that potential contamination be managed through a CEMP.

10.6.2.3 Waste Disposal

Areas of potential waste disposal, such as the infilling of dams, quarries or borrow pits with contaminated soils or other wastes such as uncontrolled tailings from former mining works, could represent a moderate risk due to the potential for elevated contaminant concentrations to occur. However, there is no evidence to suggest extensive waste disposal in the study area, other than the areas of disturbed soils located at Ch. 6000 (Options 1 and 2), and Ch. 28200 (Option 1 only).

10.6.2.4 Commercial and Industrial Activity

There are no significant commercial or industrial areas within the study area. Potential for contamination exists at the service station site and where the option alignments cross or are parallel to

the railway, which occurs for both Option 1 and 2. This is due to the potential for hydrocarbon contamination, and historic land management measures by the rail authority, such as the use of pesticides.

10.6.2.5 Acid Sulfate Soils

Discussions with the Glenelg Hopkins Catchment Management Authority indicate that no ASS has been identified within the study area, although they have not conducted any analysis of the soils for PASS. Therefore, targeted sampling prior to construction should occur, particularly where infrastructure such as bridge supports would be installed at depth.

It is also considered that a CEMP should provide guidance for the appropriate method of stockpiling uncharacterised soil (e.g. on plastic and covered), and provide appropriate sampling guidance to assess re-use or disposal options.

10.6.2.6 Chemical Spills

The risk of impact from chemical spills along the alignment during construction is considered to be insignificant, as the construction works would be governed by a CEMP. It is considered appropriate that a CEMP would include specific procedures to minimise leakage and spillage of any fuels and chemicals, and mitigate the effects of a leak or spill. It would also be appropriate for the CEMP to specify regular inspections of any chemical storages and equipment fill points.

Due to proposed design improvements such as the containment of any uncontrolled spills through improved drainage, it is considered that the Project would likely have a lower environmental risk of uncontrolled spills than the existing highway.

10.6.2.7 Ground Instability

Historic aerial photography demonstrated no obvious or apparent evidence of ground instability or movement. The broad scale of the aerial photography means that small-scale localised instabilities or ground movement may be difficult to discern. Ancient landslips may be well disguised by subsequent revegetation and human activities. The topography of the study area is generally characterised by low relief, potentially limiting the areas prone to ground instabilities. It is acknowledged that construction would occur across multiple creeks and tributaries along the alignment, which may increase the potential of localised ground instabilities.

The removal of slope toe support, surcharging of slope crests, or the interception of planes of weakness may result in slope instabilities. As a result of the potentially erodible soils present on the Project, there is an additional risk to soil stability, as the movement of soils from the slope toe may initiate a destabilising effect.

The edge of the Langi Ghiran granite-bedrock exposure is a zone of contact between different rock masses, deformed by metamorphism and regional activity. These conditions may provide planes of weakness, liable to slope failure.

However, detailed geotechnical site investigations, complemented with appropriate design of temporary and final batter slopes would largely eliminate or overcome gross ground instability.

10.6.2.8 Soil Erosion

The exposure of subsoils can only be minimised and not eliminated. A preliminary geological conceptual model has been developed for the study area on the basis of regional geological mapping and limited geotechnical investigative works. The susceptibility to soil erosion would be highly dependent on the soil properties, characteristics, and local topography, which have not been accurately determined from information available at this stage of the Project.

Soil erosion is an ongoing geomorphological process and has the potential to occur anywhere and anytime within the study area, not just during construction. The exposure of subsoils during construction activities may give rise to sheet and rill erosion conditions.

Soil erosion control relies heavily on the correct installation and maintenance of erosion/sediment control mechanisms. Exposed subsoils, due to vegetation and topsoil removal, would be subjected to a degree of sheet and rill erosion upon contact with flowing water. The control and restriction of the eroded soil, through the implementation of erosion and sediment control strategies and measures, is important to avoid detrimental effects to nearby creeks and water bodies. The measures detailed in the VicRoads standard environmental requirements would reduce this risk. The programming and management of the Project to avoid works during or preceding wet weather, particularly those near water courses, would assist in isolating and containing erosion issues.

Failure of erosion and sediment control mechanisms may potentially result in significant volumes of suspended soil entering existing water bodies, including groundwater systems. To ensure a long term solution to erosion control is in place to prevent this from occurring, post-construction consideration would be required in the detailed design phase.

Soil erosion is not limited to areas of steep gradients, but is rather a process which may occur along any section of the study area. The likelihood would be reduced with the implementation of erosion control measures. The importance of erosion control and reduction is closely linked to mass wasting and soil stability. The mechanism of soil erosion may result in an increased instability of soil masses as the toe of slopes are reduced, or removed all together.

The VicRoads standard environmental requirements detail a series of control measures to aid in reducing the detrimental effects of soils erosion, including the limitation of suspended soil transfer to water bodies. The control measures are considered appropriate guidance for control of soil erosion, however, site specific soil erosion management plans should be developed as part of the CEMP.

As the two alignment options encounter the same prevailing regional geological conditions across the study area, there is no distinction between the alignment options on the basis of soil erosion.

10.6.2.9 Ground Settlement (Compressible Soil)

Ground settlements are typically due to increased soil loadings, and are exaggerated in weak subsoil conditions. Geotechnical information is limited along the alignment, and details regarding the thickness and spread of soft compressible soils are unknown at this stage. This would be confirmed following the geotechnical investigation planned for the detailed engineering design phase. In general however, soft and compressible ground is likely to occur in valley bottoms, within the alluvial floodplains of current and historic water courses.

The proposed construction of earthen fill platforms and embankments could initiate a degree of settlement, depending on the magnitude of loading and the subsoil characteristics. The proposed bridge approach embankments may result in surface loadings conducive to settlement where poor ground conditions dominate.

Load induced ground settlements occur during the development of embankments and fill platforms, however these effects can be carefully controlled by using a staged construction approach. This would be utilised where the findings of the planned geotechnical investigation suggest it as necessary.

10.6.2.10 Cut and Fill

Preliminary earthwork estimates suggest a large quantity of imported fill material may be required. Analysis during detailed design of the Project would assist in the planning of sourcing and disposing correct volumes of material, and reducing the risk associated with unplanned sourcing or disposal of materials. Fill material would be sourced from surplus materials from site, and additional sources including local quarries, borrow pits under arrangement between Contractors and local land owners.

Where soils are to be imported to the site, all soils should comply with the requirements of EPA IWRG 621 Soil Hazard Categorisation and Management (June, 2009) and meet the following minimum requirements:

- Shall be free of waste materials and be classified as fill material as defined by EPA IWRG 621.

- Have contaminant concentrations less than Table 2 of EPA IWRG 621.
- Shall meet the requirements of the Land SEPP.

Based on the preliminary earthworks volume estimates, Option 2 is more favoured than the Option 1 in terms of requiring less imported material.

10.6.2.11 Ground Subsidence or Collapse

The presence of historic mining works may give rise to localised areas of instability, which are liable to subsidence or collapse when disturbed or altered.

Information regarding the extent and nature of these works is currently limited, but could be defined prior to construction during the proposed geotechnical investigation.

Any areas identified as being problematic due to previous mine workings may be rendered suitable following the implementation of ground improvement techniques, including ground replacement (engineered fill), which may also include reinforcement with the use of geogrids.

10.7 Risk Assessment

An environmental risk assessment was undertaken on the shortlisted alignments to identify key environmental issues associated with the construction and operation of the Project. The methodology for this risk assessment has been described in Chapter 4 (EES Assessment Framework). A risk assessment report that explains the process in detail and contains the complete project risk register has also been included as Technical Appendix Q. The risk assessment was conducted on the shortlisted alignments only. Table 10-2 shows a summary for soils and geology of:

- The impact pathways identified.
- A description of the impact consequences.



Table 10-2 Soils and Geology Risks

Risk No.	Impact Pathway	Description of Consequences
G1	Presence of contaminated soil along alignment.	<p>Construction worker exposure to soil contamination via dermal contact, ingestion and inhalation. Could occur at any location along the alignment, but more likely within the vicinity of agricultural land, waste disposal sites (controlled and uncontrolled), commercial and industrial activity and rail corridors due to the use of herbicides and other related rail uses. These areas include:</p> <p>OPTIONS 1 and 2</p> <ul style="list-style-type: none"> ○ Service Station (Ch. 36800) ○ Farm Sheds (Ch. 10600 to 10800, 14 500) ○ Disturbed Soil (Ch. 6000) ○ Intersection with Rail Corridor (Ch. 29400, 32200, 34300 and 38000) ○ Close proximity with Rail corridor (Ch. 29000 to 39600) <p>OPTION 1</p> <ul style="list-style-type: none"> ○ Disturbed Soil (Ch. 28200) ○ Intersection with Rail Corridor (Ch. 23400) ○ Farm Sheds (Ch. 19600 and 24000) <p>OPTION 2</p> <ul style="list-style-type: none"> ○ Intersection with Rail Corridor (Ch. 20800) ○ Close proximity with Rail corridor (Ch. 22600 to 25000) ○ Farm Sheds (Ch. 24400) <p>Generation of surplus soils during construction may require treatment and appropriate handling or disposal.</p>
G2	Uncontained spill or leak of chemicals during construction	<p>Groundwater, soil and/or surface water contamination. Impacts on water resources, flora, fauna, and human health. This risk could occur at any location along the alignment but the more sensitive locations are within the vicinity of waterways, including:</p> <ul style="list-style-type: none"> ▪ Goodes Gully (Ch. 400) ▪ Fiery Creek (Ch. 5900) ▪ Middle Creek (Ch. 10600) ▪ Charliecombe Creek (Ch. 12600, 14400 and 14700) ▪ Billy Billy Creek (Ch. 18200 and 20800) ▪ Hopkins River (Ch. 33800) ▪ Green Hill Creek (Ch. 38300)
G3	Runoff transports road contaminants offsite during operation.	<p>Contamination of waterways with hydrocarbons or heavy metals. Impacts on water resources, flora, fauna, and human health, including:</p> <ul style="list-style-type: none"> ▪ Maintenance workers ▪ General Public ▪ Local Flora and Fauna <p>The following potential areas may be affected:</p> <ul style="list-style-type: none"> ▪ Goodes Gully (Ch. 400) ▪ Fiery Creek (Ch. 5900) ▪ Middle Creek (Ch. 10600) ▪ Charliecombe Creek (Ch. 12600, 14400 and 14700) ▪ Billy Billy Creek (Ch. 18200 and 20800) ▪ Hopkins River (Ch. 33800) ▪ Green Hill Creek (Ch. 38300)
G4	<p>Excavation encounters unstable geological units or erosion prone areas. Geological units of Cambro-Ordovician origin may be more prone to erosional processes on exposure. The following potential areas may require specific consideration associated with Cambro-Ordovician geology:</p> <ul style="list-style-type: none"> ▪ Ch. 800 to 4000 ▪ Ch. 12400 to 34200 ▪ Ch. 38300 to 39600 	<p>Instability exacerbates erosion or mass wasting impacts on safety, land and water resources. This risk may occur within areas subject to cuts, or steepening / excessive loading of existing slopes. Areas near watercourse may also be of concern.</p> <p>Materials demonstrating dispersive behaviour were observed along the alignment. Changes in prevailing topography / site geometry or exposure may result in accelerated soil loss due to loss of fines.</p>

Risk No.	Impact Pathway	Description of Consequences
G5	<p>Soft or compressible soils are present along proposed alignment. The following locations predominantly associated with alluvial sediments are highlighted:</p> <ul style="list-style-type: none"> ▪ Ch. 4200 to 6400 ▪ Ch. 8600 to 9200 ▪ Ch. 10300 to 10800 ▪ Ch. 14300 to 14800 ▪ Ch. 16400 to 16800 ▪ Ch. 17400 to 18400 (high fill / grade separation) ▪ Ch. 33200 to 33900 ▪ Ch. 37600 to 38200 	<p>Construction of fill embankments or drawdown of groundwater induces ground settlement. This risk could occur at locations along the alignment characterised by soft fluvial sediments, being areas dominated by Quaternary age sediments. The more sensitive locations are within the vicinity of waterways, including the following significant watercourses:</p> <ul style="list-style-type: none"> ▪ Fiery Creek (Ch. 5900) ▪ Middle Creek (Ch. 10600) ▪ Charliecombe Creek (Ch. 12600, 14400 and 14700) ▪ Billy Billy Creek (Ch. 18200 and 20800/21200) ▪ Hopkins River (Ch. 33800) ▪ Green Hill Creek (Ch. 38300)
G6	<p>Imbalance in the volume of suitable fill and the volume of excavated material. Areas requiring more significant volumes of cut and fill are identified in the following locations:</p> <ul style="list-style-type: none"> ▪ Ch. 1400 to 3000 (high cut volumes) ▪ Ch. 4200 to 5200 (high fill / grade separation) ▪ Ch. 17400 to 17800 (high fill / grade separation) ▪ Ch. 23000 to 23600 (Option 1) (high fill volumes) ▪ Ch. 24400 to 25200 (Option 2) (high cut volumes) ▪ Ch. 25000 to 25800 (Option 1) (high cut volumes) ▪ Ch. 33600 to 34000 (high cut volumes) 	<p>Imbalance of suitable cut-to-fill material during construction results in unplanned disposal of cut material off site, or sourcing of suitable additional material. Greater requirement for site won fill material results deeper cuts, larger exposed areas, and / or longer slope lengths</p>
G7	<p>Construction intersects ASS, potential disturbance and exposure to air.</p>	<p>The Project alignment options are not considered to be in a PASS risk area.</p> <p>Sulphuric acid, iron, aluminium and heavy metal contamination. Potential impacts to ecology, human health, crops, infrastructure and property (through corrosion, iron precipitates, and/or subsidence).</p>
G8	<p>Construction intersects historic gold mining works, including deep lead and shallow workings.</p>	<p>Construction on areas of shallow working may result in soil instability and ground subsidence. Construction near historic deep lead workings and shafts may result in ground subsidence or instability.</p>

In assessing the impacts, the majority of risks associated with the Project have been assigned as medium to low. There is potential for impacts from localised contamination potentially as the result of activities associated with farming, rail operation and the existing service station. There is also some medium potential risk of encountering unstable

geological units, associated with softer alluvial sediments, any historical mine workings and in the vicinity if the Langi Ghiran railway cutting. This latter feature provides the only distinction between the two options, slightly favouring Option 1 over Option 2.



10.8 Environmental Management Measures

VicRoads has a standard set of environmental management measures which are typically incorporated into their construction contracts for road works and bridge works. These measures have been used as the starting point for the assessment of construction related risks, and are described in

detail in Chapter 21 (Environmental Management Framework). In some instances, additional Project specific environmental management measures have been recommended to reduce risks.

Management measures specific to each identified impact pathway, and the residual risk rating after environmental management measures have been applied, are outlined in Table 10-3.

Table 10-3 Soils and Geology Environmental Management Measures and Residual Risk

Risk No.	Environmental Management Measures	Residual Risk Rating
G1	<p>The discovery of contaminated material on the site during construction works would be managed in accordance with VicRoads and EPA Guidelines.</p> <p>Where putrescible waste material is encountered, the Superintendent and EPA would be notified. Construction works along the affected area would stop until a mitigation plan is established and agreed between the relevant project stakeholders.</p> <p>The Contractor would undertake a visual assessment of the Site for contaminated soil and uncontrolled waste during construction works.</p> <p>A Construction Environmental Management Plan (CEMP) developed to provide details on appropriate methods for managing contaminated soils.</p> <p>An in-situ investigation in with EPA Industrial Waste Resource Guideline (IWRG) 702 would be completed along the proposed alignment to establish if contaminated soils are present. If contaminated soils are present, the result of the investigation would assist to provide appropriate soil management advice including disposal recommendations.</p>	Low
G2	<p>Refer to management details detailed in G1 for soils that are contaminated by an uncontrolled spill or leak.</p> <p>For Fuel and Chemicals stored onsite, the CEMP would include specific procedures to minimise spillage of any fuels or chemicals and mitigate the effect in the event that leakages and spillages occur. Fuel, chemical and equipment storage areas would be visually monitored at intervals of not more than 7 day to mitigate contamination in a timely manner.</p> <p>Additional management measures may be required depending on the CEMP which would include:</p> <ul style="list-style-type: none"> ▪ Appropriate procedures for containing spills and leaks. ▪ Appropriate methods for cleaning up spills and leaks where safe to do so 	Negligible
G3	<p>Water Sensitive Road Design measures would be evaluated for inclusion in the detailed design phase, as described in VicRoads Integrated Water Management Guidelines (August 2011)</p> <p>Road construction would include design features to mitigate runoff of spills into waterways.</p>	Negligible
G4	<p>Geotechnical investigations would be conducted prior to construction to assess nature of soils encountered along the alignment.</p> <p>Implementation of erosion and sediment Control Measures though CEMP, including but not limited to: minimising the amount of exposed erodible surfaces, installation of erosion and sedimentation control, prompt covering of exposed surfaces, progressive revegetation of the site, management of stockpiles and co-ordination to avoid works near watercourses.</p> <p>Detailed design cuts and final batter slopes to appropriately reflect the local geological and geotechnical conditions.</p> <p>Improved surface drainage measures in the management of erosion and sediment control.</p>	Low
G5	<p>Geotechnical investigations would be conducted prior to construction to identify and assess the nature of soft or compressible soils, together with recommendations for construction. Such recommendations may include adopting a staged construction approach (allowing for dissipation of pore pressure and / or temporary surcharge loading) or treatment of existing subgrade soils.</p> <p>Project to implement a staged construction approach in the construction of fill embankments, allowing for dissipation of excess pore water pressures where soft soils are expected or known to exist. Subgrade treatment or improvement may be required in instances to control settlement of fills.</p> <p>Consider the identification of soft or compressible soils by using the proof roll of prepared subgrades to receive fill, together with in-situ density and bearing capacity tests, at an appropriate interval for the section of road being constructed.</p>	Low

Risk No.	Environmental Management Measures	Residual Risk Rating
G6	<p>Earthworks are expected to be dominated by the need for fill above the natural surface to achieve drainage and great flood control or grade separation. Fill material would be sourced from surplus materials from site, and additional sources including local quarries, borrow pits under arrangement between Contractors and local land owners. Road pavement materials would be sourced from appropriately licenced facilities. Surplus material that cannot be used on site would be re-used disposed of in the following order of priority:</p> <ol style="list-style-type: none"> 1) Transfer to nearby VicRoads projects for immediate use or to an approved VicRoads stockpile site for future use; 2) Transfer to an alternative VicRoads approved site for re-use on concurrent private / local government project; or 3) Disposal at an accredited materials recycling or waste facility. 4) Disposal at an approved borrow pits for fill material <p>Assess likely earthworks volumes during design to optimise solution (balance cut and fill where possible).</p>	Low
G7	Soils suspected of being Acid Sulfate Soils are to be sampled and analysed to assess the Acid Sulfate Soil potential. In the event that Acid Sulfate Soils are discovered an Acid Sulfate Soil Management Plan would be prepared.	Negligible
G8	Desktop assessment complimented with Geotechnical investigations would be conducted prior to design and construction to identify and assess the nature and extent of the shallow and deep mine workings. Construction may include ground improvement techniques to bridge identified poorly reinstated or susceptible historical mining areas.	Low

10.8.1 Residual Risks

Following implementation of the proposed mitigation measures there are not expected to be any significant impacts. The overall risk to soils and geology is low.

10.9 Conclusion

Several features were identified that indicate potential for land contamination. These include; farming/shearing sheds (often associated with sheep dips), one existing service station (potential hydrocarbon contamination), railway lines (historic land management practices), areas of disturbed soils (potential sites of buried waste) and historic mining works (mine tailings). Exposure to contaminated soils represents a potential risk to human health and the environment. However, based on the review of previous and current land use, the potential for localised contamination in the study area is considered moderate.

The potential for encountering unstable geological units including erosion prone areas or compressible soils during construction is also considered to be moderate.

Appropriate management responses have been outlined to protect catchment values and avoid impacts associated with potential adverse geological conditions, contaminated soils, acid sulfate soils, soil erosion and instability risk. Following implementation of the recommended mitigation measures, all identified impacts are considered to be negligible to low.

Of the alignment options, when taking into consideration the potential for exposure of sensitive receivers (human health and ecological), it is considered that Option 1 is the preferred alignment

as it has less intersection with, or sections in close proximity to, the railway line (and potential associated contaminants). However, the environmental impact of both options would be low with implementation of the nominated management measures.

Option 1 is also preferred with regard to geological and geotechnical considerations on the basis of unfavourable geotechnical conditions in Option 2 in the vicinity of Langi Ghiran railway cutting. Langi Ghiran railway cutting being the zone of transition between granite and sandstone geology. However, the environmental impact for both options would be low with the implementation of the nominated management measures.

