VicRoads

Western Highway Project – Section 2: Beaufort to Ararat

Soils and Geology Impact Assessment Report

August 2012

This Soils and Geology Assessment Report *("Report"):*

1. *Has been prepared by GHD Pty Ltd ("GHD") for VicRoads;*
2. *May only be used for the purpose of informing the Environment Effects Statement and Planning Scheme Amendment for the Western Highway Project (and must not be used for any other purpose); and*
3. *May be provided to the Department of Planning and Community Development for the purpose of public exhibition as part of the Environment Effects Statement and Planning Scheme Amendment for the Western Highway Project.*

The services undertaken by GHD in connection with preparing this Report were limited to those specifically detailed in Section '4. Methodology' of this Report.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing the Report ("Assumptions"), as specified in Section '4. Methodology' and throughout this Report.

GHD excludes liability for errors in, or omissions from, this Report arising from or in connection with any of the assumptions being incorrect.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation. GHD has not, and accepts no responsibility or obligation to update this Report to account for events or changes occurring subsequent to the date that the Report was signed.

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Executive Summary

VicRoads is progressively upgrading the Western Highway as a four-lane divided highway between Ballarat and Stawell (Western Highway Project). The Western Highway Project consists of three sections, to be constructed in stages. Section 2 (Beaufort to Ararat) of the Western Highway Project (the Project) is the subject of this report.

On 27 October 2010, the Victorian Minister for Planning advised that an Environment Effects Statement (EES) would be required to identify the anticipated environmental effects of the Project. GHD has been commissioned by VicRoads to undertake a soils and geology impact assessment for Section 2 of the Project as part of the EES.

Following a multi-criteria assessment of numerous potential alignment options, VicRoads selected an alignment for the Project which was subjected to the risk and impact assessment presented in this report. The Alignment Options (identified as Option 1, Option 2 and Option 3) were subject to the risk and impact assessment presented in this report. The Alignment Options are outlined in Section 6.1 of this report.

This report, together with other technical reports prepared by GHD and other consultants as part of the EES, will inform VicRoads' selection of the preferred and alternate alignment for the Project from the three Alignment Options. VicRoads' preferred and alternate alignment for the Project will be documented in the EES.

The EES Scoping Requirements for the soils and geology impacts assessment of the Project are detailed in Section 2 of this report. In summary, the relevant evaluation objectives from the EES Scoping Requirements are:

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

The impact assessment undertaken by GHD involved:

- A review of historical aerial photographs (one per decade from 1947) of the study area, to assist in establishing the physical patterns of development over time;
- A review of publicly available literature and geotechnical information relevant to the study area;
- Sourcing and collating relevant available borehole, test pit and other geotechnical data;
- Interpretation of the available information;
- Development of a preliminary geological and geotechnical model of the study area;
- A preliminary acid sulfate soil (ASS) hazard assessment;
- A site visit;
- Identification of the soils and geology cause and effect pathways associated with the construction and operation of the Project;
- Identification of the key potential benefits or opportunities to soils and geology that the Project could provide; and
- Provision of standard environmental protection measures and additional Project specific controls recommended to be incorporated into the Environmental Management Framework for the Project.

In summary, the assessment identified the following potential impacts and risks:

- Based on the existing conditions review, historic and current land uses and soil conditions identified in the project area may give rise to shallow dispersed contamination during the construction phase of the project. Such contamination may be associated with agricultural uses, isolated point source contamination associated with sheep dips, land filling, railway lines, uncontrolled historic mine tailings and waste disposal.

  Preliminary intrusive investigation for the purpose of early identification and confirmation of contaminated soils is recommended along project areas where excavation is proposed. This will assist with the implementation of site specific management and mitigation measures prior to construction works. Intrusive investigation works would involve an assessment in accordance with the State Environment Protection Policy (Prevention and Management of Contamination of Land), the National Environment Protection (Assessment of Site Contamination) Measure and Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soils (CASS) and Australian Standard AS4481.1 2005.

  Therefore, the overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to contaminated soils resulting from historic uses along the alignment, including a service station, sheep shearing sheds and associated infrastructure such as sheep dips, railway corridors, areas of disturbed soils and uncontrolled historic mining works is considered to be moderate.

  The overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to ASS is considered to be insignificant.

- The risk from chemical spills along the alignment during construction is considered to be low as the construction works would be governed by a Construction Environmental Management Plan (CEMP). This results in the overall impact from chemical spills during construction of the Project to be considered insignificant.

- There is considered to be an increased risk of transportation of contaminants offsite during operation in locations where the alignment does not follow the existing highway. As the proposed duplication would be constructed and operated in accordance with the VicRoads Integrated Water Management Guidelines (2011), the VicRoads Water Sensitive Road Design Guidelines (2007) and the Best Practice Environmental Management Guidelines (CSIRO, 1999),both the risk and overall impact of this risk is considered to be insignificant.

- Geological conditions along the alignment are expected to be quite variable, with an assemblage of Quaternary and Devonian Age volcanic rock overlaying and intruding the Cambro-Ordovician age sediments. The development of drainage lines across the undulating topography has resulted in the deposition of surficial Quaternary sediments in well-defined corridors. The propensity for soil erosion and local instability exists along sections of the alignments associated with soft compressible materials and those displaying dispersive tendencies.

- Available specific geotechnical information was limited to a small number of historic bores conducted near the Buangor township and on the approach to Ararat. Detailed site investigations prior to detailed design, together with appropriate design of final slope batters and adoption of appropriate control measures, should effectively control and reduce the impact of soil erosion and wasting during the Project construction and operation.

All of the identified risks are considered to be negligible or low provided that the identified mitigation measures (specified in section 7 of this report) are implemented. Of the three Alignment Options, Alignment Option 1 is considered to be the preferred alignment option in terms of the anticipated geological conditions and potential impacts posed by construction.

1. Introduction

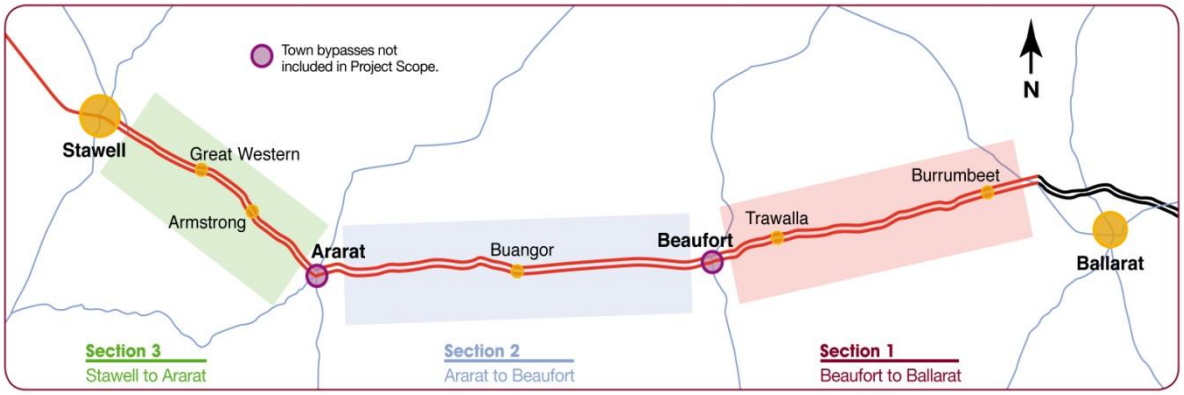
1.1 Background

The Western Highway (A8) is being progressively upgraded as a four-lane divided highway for approximately 110 km between Ballarat and Stawell. As the principal road link between Melbourne and Adelaide, the Western Highway serves interstate trade between Victoria and South Australia and is the key corridor through Victoria's west, supporting farming, grain production, tourism and a range of manufacturing and service activities. Currently, more than 5 500 vehicles travel on the highway west of Ballarat each day, including 1 500 trucks.

The Western Highway Project (here within described as 'the Project') consists of three stages, as illustrated in Figure 1:

- Section 1: Ballarat to Beaufort
- Section 2: Beaufort to Ararat
- Section 3: Ararat to Stawell

Figure 1: The Western Highway Project



Source: VicRoads

Works on an initial 8 km section between Ballarat and Burrumbeet (Section 1A) commenced in April 2010 and will be completed in 2012. Construction for Section 1B (Burrumbeet to Beaufort) commenced in 2012 and is expected to be completed by 2014. Section 1C began in 2011 and will finish in 2012 (this is the 3 km section east of Beaufort). Separate Environment Effects Statements (EESs) and Planning Scheme Amendments (PSAs) must be prepared for both Sections 2 and 3. It is expected that Sections 2 and 3 would be completed and opened in stages through to 2016, subject to future funding.

Section 2 of the Project commences immediately west of the railway crossing (near Old Shirley Road) west of the Beaufort township and extends for a distance of approximately 38 km to Heath Street, Ararat.

Section 3 of the Project commences at Pollards Lane, Ararat and extends for approximately 24 km to Gilchrist Road, Stawell.

The EES will focus on assessment of the proposed ultimate upgrade of the Western Highway between Beaufort and Stawell to a duplicated highway standard complying with the road category 1 (freeway) of

VicRoads Access Management Policy (AMP1). The project includes a duplicated road to allow for two lanes in each direction separated by a central median.

The EES has also considered a proposed interim upgrade of the Western Highway to a highway standard complying with the VicRoads Access Management Policy AMP3. When required, the final stage of the project is proposed to be an upgrade to freeway standard complying with AMP1.

The proposed interim stage of the Project (AMP3) would provide upgraded dual carriageways with wide median treatments at key intersections. Ultimately the Western Highway is proposed to be a freeway (AMP1) where key intersections would be grade separated, service roads constructed and there would be no direct access to the highway.To date $505 million has been committed for the Western Highway Project by the Victorian Government and the Australian Government as part of the Nation Building Program.

Highway improvements for the three sections between Ballarat and Stawell will involve:

- Constructing two new traffic lanes adjacent to the existing highway, separated by a central median.
- Constructing sections of new four-lane divided highway on a new alignment.

In addition to separating the traffic lanes, highway safety would be improved with sealed road shoulders, safety barriers, protected turning lanes, intersection improvements, and service lanes for local access at some locations.

Town bypasses of Beaufort and Ararat are not included in the current proposals. Beyond Stawell to the Victorian border, ongoing Western Highway improvements would continue with shoulder sealing works, new passing lanes and road surface improvements.

The aims/objectives of this Project are to:

- Provide safer conditions for all road users by:
  - Reducing the incidence of head-on and run-off-road crashes;
  - Improving safety at intersections; and
  - Improving safety of access to adjoining properties.
- Improve efficiency of freight by designing for High Productivity Freight Vehicles.
- Provide adequate and improved rest areas.
- Locate alignment to allow for possible future bypasses of Beaufort and Ararat.

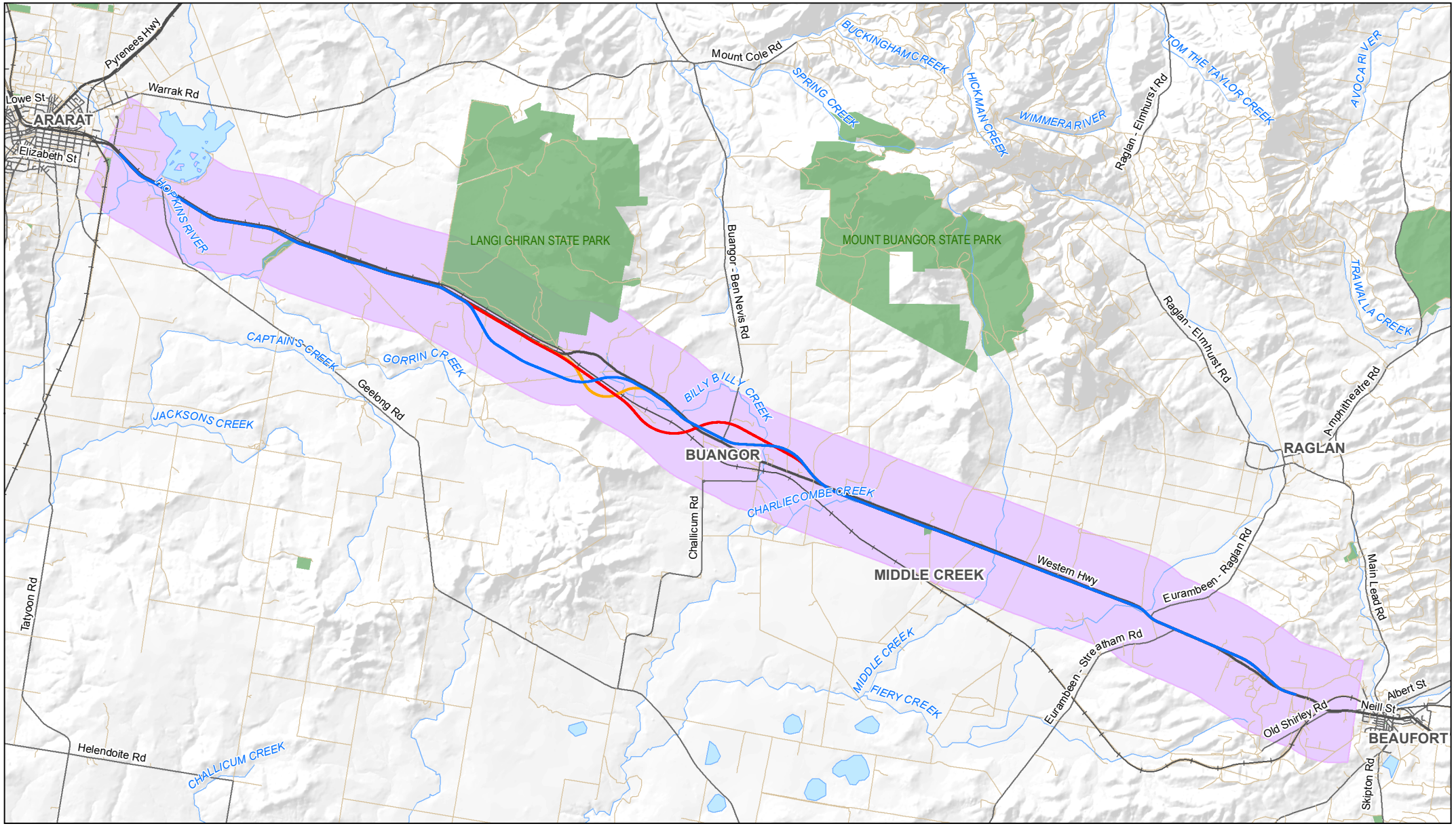
1.2 Project and Study Areas

1.2.1 Project Area

The project area was defined for the purposes of characterising the existing conditions for the Project, and to consider alignment alternatives. The project area encompasses a corridor extending up to 1 500 m either side (north and south) of the edge of the road reserve (encompassing the extent of new alignment possibilities), and is illustrated in Figure 2.

1.2.2 Study Area

The study area for this soils and geology assessment is the same as the project area described above.



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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LEGEND

- Option 1
- Option 2
- Option 3
- Highway
- Sealed road (arterial & local)
- Unsealed road
- Study Area

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Job Number 31-27558
Revision B
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Beaufort to Ararat Study Area

Figure 2

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180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: DSE, VicMap, 2012; VicRoads, 2012; GHD, Design 2012. Created by:splaird

1.2.3 Proposed Alignment

A multi-criteria assessment of alignment options was conducted based on information from the existing conditions assessments. The outcome was the selection of three proposed alignments to take forward to the risk and impact assessment presented in this report. These three alignments are described in Section 6. This report informs the selection of a preferred and alternate alignment from these three alignments for the EES for Section 2. The assessment and selection of the proposed alignments is documented in Chapter 5 of the EES for Section 2, and in the Options Assessment Paper (Technical Appendix to the EES).

2. EES Scoping Requirements

2.1 EES Objectives

For the soils and geology aspects of the Western Highway Project, the relevant draft evaluation objective outlined in the EES Scoping Requirements are:

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

2.2 EES Scoping Requirements

The EES Scoping Requirements for soils and geology aspects are as follows:

- *Identify and assess 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);*
- *Identify proposed measures to avoid, mitigate and manage any potential adverse effects, including any relevant design features of the road or techniques for construction; and*
- *Identify residual effects of road construction and operation activities on soils in the project area, including any implications for future land use activities.*

Where relevant, investigations should take into account the requirements of the State Environment Protection Policy (Prevention and Management of Contaminated Land). If contaminated soils are identified, an assessment should be prepared outlining what is known about the contamination and the further steps to be implemented.

3. Legislation, Policy and Guidelines

3.1 Commonwealth

There are no Commonwealth legislation or policies that are relevant to this soils and geology investigation.

3.2 State

State legislation and policies that are relevant to soils and geology are presented in Table 1.

Table 1 Key Legislation and Policies

Legislation / Policy Title	Purpose
Environment Protection Act 1970 (EP Act)	The EP Act (1970) 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.
State Environmental Protection Policy (SEPP), Prevention and Management of Contamination of Land	The SEPP sets out policies of the Government to control, reduce environmental pollution and provide acceptable environmental quality standards and conditions for discharging wastes and identification of beneficial uses of the environment. The SEPP (Prevention and Management of Contamination of Land) establishes a range of general uses of land in Victoria and is the main guidance document for the management of contaminated land in Victoria. The SEPP outlines the process for establishing land contamination and management and remediation of impacted sites.
Catchment and Land Protection Act 1994 (CALP Act)	The *Catchment and Land Protection Act* (1994) 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. All construction activities must comply with the general performance measures outlined in the legislation.
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)	Outlines a management framework and specific requirements for the management of acid sulfate soils in an environmentally responsible manner.
Best Practise Environmental Guidelines (BPEG), Environmental Guidelines for Major Construction Sites	The BPEG provides a framework within which due diligence obligations can be met and environmental damage can be avoided during the commissioning or construction of freeways, major roads or major developments.

4. Methods

4.1 Existing Conditions

4.1.1 General

A desktop review was undertaken to assess the existing soil and geological conditions within the study area. The whole of the Project Area was assessed, including a long list of alignment options, and this existing condition assessment informed the most appropriate selection of the "Alignment Options". The Alignment Options were then subject to the risk and impact assessment outlined in Section 6 of the Report.

The scope of work for the assessment of the existing conditions in relation to soils and geology included a review of available information required to address the scoping requirements. This comprised the following tasks:

- A review of historical aerial photographs (one per decade from 1947) of the study area, to assist in establishing the physical patterns of development over time;
- A review of publicly available literature and geotechnical information relevant to the study area;
- Sourcing and collating relevant available borehole, test pit and other geotechnical data;
- Interpretation of the available information;
- Development of a preliminary geological and geotechnical model of the study area;
- A preliminary acid sulfate soil (ASS) hazard assessment; and
- A site visit including: documentation and photographing of site features; confirmation of features documented in the desktop review; inspection for potential sources of contamination; and to confirm regional geology and identify anomalies or extraneous conditions along or near the proposed alignment options.

A review of historic title deeds was planned, however due to the lack of potential areas of concern identified in the historical aerial photograph review, this was not necessary.

4.1.2 Assumptions and Limitations

Assumptions and limitations regarding the investigation of the soil and geological conditions within the project area include:

- GHD relied on information supplied by others, which may not have been independently verified. Intrusive investigation for the purpose of soil sampling, analytical testing and geological logging were not undertaken during the compilation of this report. It should be noted that evidence of soil contamination is not always obvious by visual inspection;
- Image resolution issues that may have led to uncertainties in interpretation are stated in the historical aerial photograph review presented in Appendix B;
- Geological understanding is based on previously completed geological mapping, and is assumed to be reasonably accurate;

- Geotechnical information is generally a site specific parameter and may only be understood through extensive intrusive investigations; and
- Previously completed boreholes, bore locations and associated logs and interpretations are assumed to be correct.

4.1.3 Information Sources

Sources of available geological and geotechnical information used as the basis for the assessment of the soils and geological environment included the following:

- Birch (eds.) (2003) Geology of Victoria, Geological Society of Australia;
- Cayley, R.A., 1995. Beaufort 1:100,000 Geological Map. Geological Survey of Victoria;
- Cayley, R.A. & Taylor, D.H., 2000. Ararat 1:50,000 Geological Map. Geological Survey of Victoria;
- CSIRO Atlas of Australian Soils, 1960;
- CSIRO Australian Soil Resource Information (ASRIS);
- Department of Primary Industries (DPI) Map 1, Far South West Coast;
- Department of Primary Industries (DPI), Minerals and Petroleum Division, Explore Victoria Online – GeoVic web mapping application;
- Department of Sustainability and Environment (DSE), Aerial Photography Register;
- Douglas, Ferguson (eds.) (1988) Geology of Victoria, Geological Society of Australia;
- Geological Exploration & Development Information System (GEDIS) database;
- Geological Survey of Victoria; Geological Map Series Ballarat, 1:250 000;
- King (1986) Ballarat 1:250 000 Geological Map Explanatory Notes; and
- Williams, B. & Bibby, L.M., 2003. Ararat 1:100,000 regolith-landform map. Geological Survey of Victoria.

4.2 Impact and Risk Assessment

4.2.1 Risk Assessment Methodology

The following risk assessment methodology was used to determine the soils and geology impact pathways and risk ratings for the Project:

1. Determine the impact pathway (how the Project impacts on a given soils and geology value or issue).
2. Describe the consequences of the impact pathway.
3. Determine the maximum credible 'consequence level' associated with the impact. Table 2 provides guidance criteria for assigning the level of consequence. The method for defining these criteria is described in Section 4.2.2.
4. Determine the likelihood of the consequence occurring to the level assigned in step 3. Likelihood descriptors are provided in Table 3 below; and
5. Using the Consequence Level and Likelihood Level in the Risk Matrix in Table 4 to determine the risk rating.

Table 2 Soils and Geology Impacts Consequence Table

Aspect	Insignificant	Minor	Moderate	Major	Catastrophic
Erosion / sediment generation potential	Negligible potential	Potential for erosion and sediment mobilisation in small isolated locations along the alignment	Potential for erosion and sediment mobilisation in multiple locations along the alignment	Potential for erosion and sediment mobilisation along the majority of the alignment	Potential significant erosion, sediment generation or land instability along the majority of the alignment
Land Contamination (historic, construction or operation)	Insignificant risk of encountering historic land contamination during construction, or contaminating land through construction or operation	Potential for minor land contamination, but minimal risk to sensitive receivers	Potential for moderate land contamination, some risk to sensitive receivers	Potential for gross land contamination, confined to a localised area. Significant risk to sensitive receivers, health	Potential for gross and widespread land contamination. Significant risk to sensitive receivers, health
Soil settlement due to poor (compressible) ground conditions	No potential	Potential for significant soil settlement in small isolated locations along the alignment	Potential for significant soil settlement in multiple locations along the alignment	Potential for significant soil settlement along many sections of the alignment	Potential significant soil settlement along the majority of the alignment

Table 3 Likelihood Guide

Descriptor	Explanation
Almost Certain	The event is expected to occur in most circumstances
Likely	The event will probably occur in most circumstances
Possible	The event could occur
Unlikely	The event could occur but not expected
Rare	The event may occur only in exceptional circumstances

Table 4 Risk Matrix

Likelihood	Consequence Level				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Low	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Possible	Negligible	Low	Medium	High	High
Unlikely	Negligible	Low	Medium	Medium	High
Rare	Negligible	Negligible	Low	Medium	Medium

4.2.2 Consequence Criteria

Consequence criteria (Table 2) range on a scale of magnitude from “insignificant” to “catastrophic”. Magnitude is considered a function of the size of the impact; the spatial area affected and expected recovery time of the environmental system. Consequence criteria descriptions indicating a minimal impact over a local area, and with a recovery time potential within the range of normal variability were considered to be at the insignificant end of the scale. Conversely, catastrophic consequence criteria describe scenarios involving a very high magnitude event, affecting a State-wide area, or requiring over a decade to reach functional recovery.

The soils and geology consequence criteria were derived taking into account various magnitudes of potential impacts of sediment generation and land instability, risks of the potential for exposure to contaminants in soil to sensitive receivers and the environment, and the risk of ground settlement due to soft or compressible soils.

5. Existing Conditions

5.1 Regional Geology

The Geological Survey of Victoria, Ballarat map sheet (1:250 000 scale) is situated in central west Victoria and depicts the surface geology of the study area. The west and south of the mapped area is characterised by volcanic plains and gently dissected Lower Palaeozoic sediments, which give rise to the flat to gently undulating topography. This dramatically contrasts the rugged Pyrenees north of Beaufort to the north and east of the study area. The difference in terrain is attributed to the presence of granitoid bodies (large granite or granite-like masses) in the north and east that were emplaced during the Devonian period and have provided greater resistance to erosion.

An extract of the geological map is presented as Figure 3 for reference.

The western sub province of Victoria is comprised of three structural zones, namely the Stawell, Bendigo and Melbourne Zones. The study area lies completely within the Stawell Zone and this zone is therefore of relevance to this study. The Stawell Zone encompasses the rocks extending from the Moyston Fault eastward to the Avoca Fault. It is comprised of Cambrian volcanics overlain by extensive Cambro-Ordovician quartz-rich turbidites, characterised by folding and north-west trending faults. Sediments of the Murray Basin cover the northern area of the Stawell Zone, while Neogene volcanics and Quaternary deposits cover expanses of the southern and western parts.

The geological history of the Ballarat map sheet area (map sheet SJ 54-8, 1:250 000 scale) is marked by periods of volcanic activity and sedimentation. During the Cambrian era volcanism and minor sedimentation was taking part in the western part of the map area, followed by the deposition of a thick sequence of Cambrian age turbidites. Widespread granitic intrusion was experienced during the Devonian period. Advancing through the Permian, the end of the early Pliocene saw the seas retreat completely from the map sheet area. Streams rejuvenated, incising new valleys and depositing sediments. Vulcanicity followed, associated with mild earth movements and an inundation of fluid lavas across much of the map area.

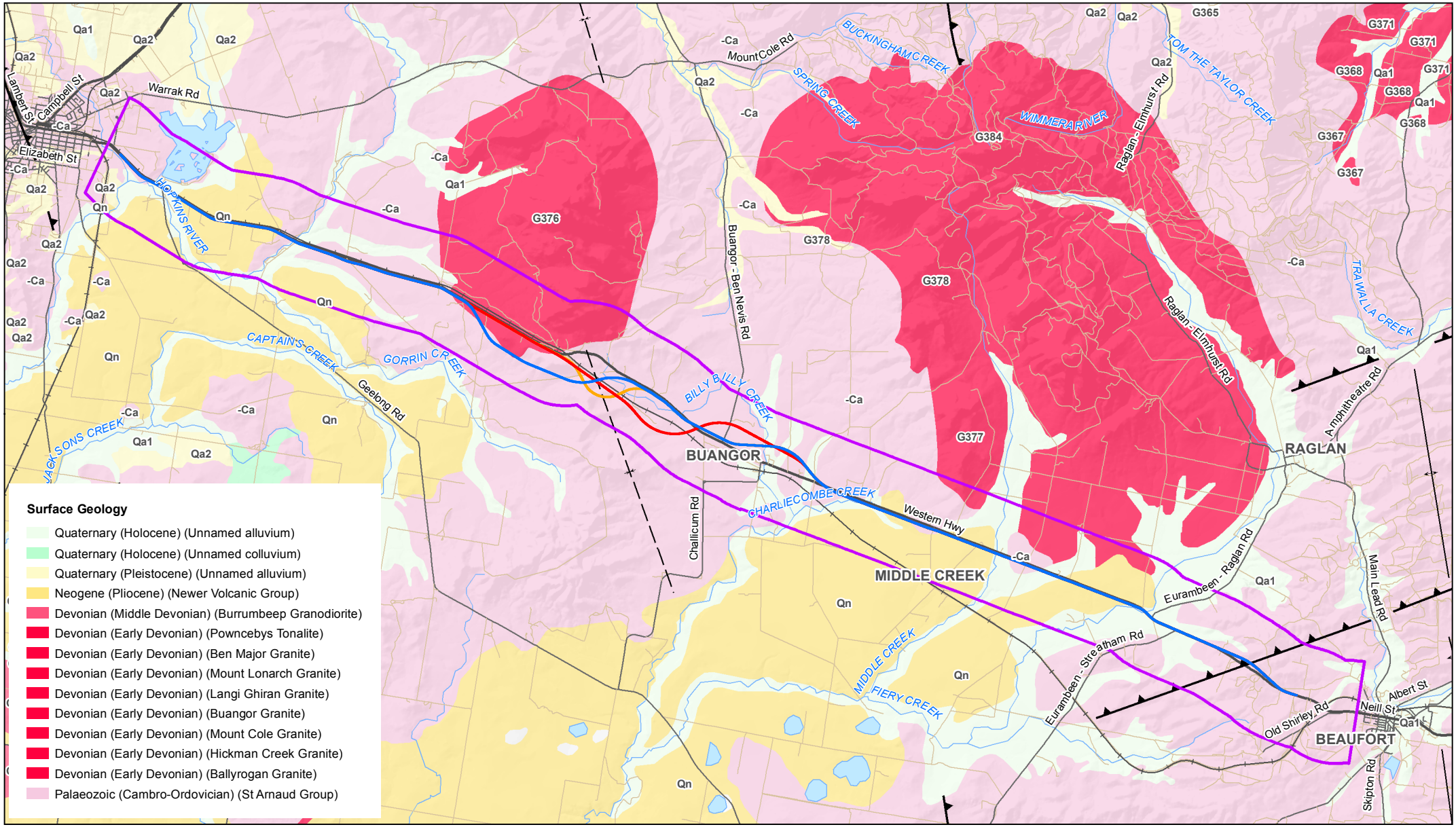
The Western Highway between Beaufort and Ararat falls predominantly within the Midlands Geomorphic subdivision. Parts of the Midlands, especially around the fringes, have quite subdued topography and are often deeply weathered.

5.2 Geological Characteristics of Study Area

It is generally anticipated that the majority of the road construction activities for the Project would intersect Cambro-Ordovician sedimentary rock and Quaternary Age Volcanics of the Newer Volcanics Province.

Unconsolidated Quaternary sediments (alluvial) are developed on eroded Quaternary volcanics and Palaeozoic (Devonian, Siluro-Ordovician and Cambro-Ordovician) surfaces within the study area.

The geological formations likely to be encountered within the study area, from youngest to oldest, are summarised in Table 5 and described in more detail in subsequent sections of this report.



Paper Size A4

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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LEGEND

Option 1
Option 2
Option 3
Study Area

Geology structure

Anticline fine
Fault
Syncline fine

Highway
Sealed road (arterial & local)
Unsealed road

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Job Number 31-27558
Revision D
Date 22 Aug 2012

Beaufort to Ararat Regional Geology

Figure 3

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180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: DSE, VicMap, 2011; GSV, Surface Geology 250k 2011 ; VicRoads, 2011; GHD, Design 2012. Created by:splaird

Table 5 Simplified Regional Stratigraphy

Period	Formation	Lithological Description	Comment
Quaternary	Undifferentiated alluvials, colluvials (Qa1, Qa2, Qc)	Fluvial, alluvium, gravel sand silt	Generally restricted to existing creeks, drainage lines and outwash fans.
Tertiary	Newer Volcanics (Qn)	Olivine and iddingsite basalt, limburgite, scoria, minor tuff	Flows mapped around Middle Creek (southeast of Buangor) and Dobie. Distribution heavily associated with ancestral valleys, Alignment intersects in limited sections.
	Calivil Formation ('Deep Leads')	Unconsolidated sands, gravels and clays	
Unconformity			
Devonian	Mount Cole Granite, Langi Ghiran Granite (Mount Cole Suite) (G376 through G378)	Granite, biotite granite, associated aplite, pegmatite	Large intrusions into basement rock. Generally northeast and northwest of Buangor.
Unconformity			
Cambro-Ordovician	St Arnaud Group (Ca)	Indurated marine sandstones, siltstones and shales	Geological basement, outcropping across majority of alignment

5.2.1 Quaternary Sediments (Qa1, Qa2, Qc)

Alluvial deposits are expected within limited sections of the study area, spanning existing tributaries and previous depositional channels.

Alluvial deposition has continued from the Neogene through to present. The Ballarat map sheet identifies an infrequent occurrence of quaternary age fluvial deposits along the valleys and floodplains of ancestral or current watercourses. Younger alluvial deposits are often associated with the indistinct drainage system that has re-established itself on the basalts. In the lower Palaeozoic areas, most streams contain recent alluvial deposits of varying thickness, often overlying, but incised into, the older alluvial sediments.

Quaternary age colluvial (gravity) deposits are shown on more detailed mapping of the area but not shown on the 1:250,000 scale mapping. The colluvial deposits are generally as the result of outwash fans from drainage lines in the steeper areas of topography. The colluvial deposits are described on the map sheets to consist of gravel, sand and silt. They are frequently associated with the granitic masses in the study area.

The thickness and composition of the Quaternary deposits is not known, with the map sheet suggesting the alluvial material comprises silt, sand and gravel.

5.2.2 Quaternary Newer Volcanics (Qn)

Quaternary age basalt flows originating from the south cease within the study area. This gives rise to small, localised areas of volcanics beneath the study area. The volcanic geology represents about a fifth

of the geology within the study area and is situated in distinct areas within 10 km of each of the townships of Beaufort and Ararat.

The Newer Volcanics Province is dominated by an extrusive igneous rock comprising tholeiitic to minor alkaline basalts and pyroclastic (scoria) products, which covers a large area of south western Victoria - extending from Melbourne to the South Australian border. The Newer Volcanics Province was formed by a series of short-lived eruptions from relatively small vents.

The basalts are usually dark bluish grey to black when fresh, and display a variable degree of vesicularity. The development of joints, including infilled joints, extremely weathered and crushed seams and zones have been identified throughout the rock structure. Joints are primarily developed during the cooling of the lava flows; with an orientation dominantly sub-vertical and sub-horizontal.

The Newer Volcanics weather in a variety of different ways, with all the minerals eventually converting to clay and iron oxides. Since there is no quartz in the original rock fabric, the final weathering product is often a base rich, grey to grey-brown, heavy soil of high plasticity. 'Floaters' or corestones of basalt occasionally occur in the weathered clay. Calcareous nodules may occur within the weathered profile.

The basalts are expected to have high strengths which may require additional effort to excavate in the form of ripping, hydraulic breaking or the use of explosives. This should be addressed during the detailed design stage as a comprehensive intrusive geotechnical investigation will be undertaken to establish appropriate excavation methods. Any adverse impacts caused by additional excavation efforts (if required) are expected to be accounted for during detailed design and mitigated by following industry guidelines and EPA regulations during construction.

The Newer Volcanics are normally less than 60 m thick, with local maxima of 120 m to 150 metres. Individual flows rarely exceed a 30 m thickness.

The basaltic Newer Volcanics in some locations overlie Neogene deposits and in other instances the older Cambro-Ordovician bedrock. Numerous eruption points are located in the areas around the study area.

5.2.3 Devonian Granite (G376 through G378)

Numerous granite or granite-like masses of varying sizes intrude the Cambro-Ordovician aged sedimentary rock within the vicinity of the project area. Erosion of the surrounding Cambro-Ordovician sedimentary rocks since emplacement has caused the granitic rocks to outcrop at the surface. A significant exposure of granitic rock is encountered immediately adjacent and at times intersected by the study area, to the east and west of Buangor. Isolated hills punctuating the flat plains of the Cambro-Ordovician landscape remain due to the high weathering resistance of the granitic material.

The Geological Survey of Victoria has documented the presence of a regionally significant granite intrusion (significant geological feature, BL18) at the Langi Ghiran railway cutting, near the existing Western Highway. The railway cutting has exposed the contact between the Devonian granite intruding the Cambro-Ordovician sediments, and presents the best exposure and example in the Ballarat region.

The granites are expected to be of locally high strength which may require additional effort to excavate in the form of ripping, hydraulic breaking or the use of explosives. This should be addressed during the detailed design stage as a comprehensive intrusive geotechnical investigation would be undertaken to establish appropriate excavation methods. Any adverse impacts caused by additional excavation efforts

(if required) are expected to be accounted for during detailed design and mitigated by following industry guidelines and EPA regulations during construction.

5.2.4 Cambro-Ordovician Saint Arnaud Group (Ca)

Surface exposures of the Saint Arnaud Group are likely over much of the central portion of the study area, with localised exposures in the environs of Beaufort and Ararat.

The Saint Arnaud Group comprises a sequence of largely unfossiliferous, marine quartz-mica turbidites (muddy sandstones) and occasional black shales of the previously defined Stawell Zone. This formation largely forms the bedrock of the entire Zone. In some locations, some of the rocks that make up the Saint Arnaud Group are expected to be pyritic. The only location where the base of the Saint Arnaud Group is observed to outcrop is in the vicinity of Stawell (outside the immediate study area), where quartz-rich turbidites appear to lie on the Magdala Volcanics.

Tectonic activity has subjected the Cambro-Ordovician sedimentary rock (Saint Arnaud Group) to extensive regional deformation. The deformation has left behind a folded sequence disrupted by variably persistent faulting along two dominant axes. The alignment options intersect a north-east trending fault to the west of Beaufort (refer to Figure 3). The surface characteristics of the fault are unknown at this point in time, and could not be identified in the drive through assessment.

The sedimentary rocks have also been thermally metamorphosed adjacent to the Devonian granite intrusions. Where the sedimentary rock has been metamorphosed it is expected to have become crystalline with a corresponding increase in strength which may require additional effort to excavate in the form of ripping, hydraulic breaking or the use of explosives. Any adverse impacts caused by additional excavation efforts (if required) are expected to be accounted for during detailed design and mitigated by following industry guidelines and EPA regulations during construction.

Excavation and re-use of un-oxidised pyrite bearing sedimentary rock may cause oxidation of the pyrite and the resultant production of acid. This would be addressed during the detailed design stage as a comprehensive intrusive geotechnical investigation would be undertaken to confirm the characteristics of each of the geotechnical units.

5.3 Geological Structures and Faults

A review of the Department of Primary Industries (DPI) database has identified a number of synclines, anticlines and fault lines within the study area, although only one fault is presented in Figure 3 at the current scale of 1:250,000. These are predominantly orientated along two axes orientated along a WSW-ENE, and NNW-SSE axis. A WSW-ENE tending fault line has been identified to intersect the proposed alignment some 4 to 5 km outside Beaufort heading towards Buangor. Areas directly impacted by faulted zones may be highly variable and present conditions which are difficult to predict. Poor rock mass conditions and advanced weathering in faulted areas are prone to instability and rapid deterioration.

Tectonic activity in the form of a NNW-SSE orientated syncline with steeply dipping bedding planes and alteration has been identified within Cambro-Ordovician geology in the general vicinity of Langi Ghiran railway cutting. In the vicinity of fold axes, the rock is more likely to be fractured and weathered and therefore more susceptible to erosion.

The preliminary drive through assessment did not identify any significant remnant features of the mapped faults (one of which is shown on Figure 3) intersecting the proposed alignment options. It is expected that

further investigation would be undertaken to understand the significance of the geological structures identified in the regional geological information.

5.4 Historic Mining Works

A review of geological maps and information held by the DPI has indicated that the area around Ararat and Beaufort was mined for gold. These mine workings take the form of deep shafts and drives along the "deep-leads" and also open-cut mining of shallow alluvial deposits. The DPI database on previous mining activity shows the majority of the past mining activity centres on the Beaufort and Ararat town centres. A scattering of shallow and deep workings exist adjacent the alignments in the outer surrounding areas of Beaufort and Ararat (generally covering a radius of some 5 km), generally confined within alluvial deposits surrounding the aforementioned townships.

Whilst the nature and extent of these workings is not able to be defined with certainty, there remains a slight possibility of encountering abandoned mineshafts used to access deep-leads during construction. The probability of encountering abandoned backfilled shallow workings is considered to be greater. These abandoned shallow mine workings may be filled with uncompacted, soft and compressible soils and possibly rubbish and dumped items of machinery, timbers or equipment. The backfill may also be contaminated with chemicals associated with the mining process.

5.5 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 have the potential to develop during earthwork operations, particularly along the banks of the existing creeks and steeply inclined areas where geological contacts may necessitate a weak failure surface.

During the drive through survey (site inspection) it was noted that the Cambro-Ordovician aged geology appeared prone to erosion. The Cambro-Ordovician intruding (contacting) granitic geology also appeared reasonably susceptible to erosion within its weathered profile. These locations have been identified in the risk assessment matrix as presented in Section 6.5.

5.6 Review of Previous Reports

No soils or geology reports were available specifically within the defined study area.

5.7 CSIRO Atlas of Australian Soils

The Atlas of Australian Soils was compiled by CSIRO in the 1960s to provide a consistent national description of Australia's soils. It comprises a series of ten maps and associated explanatory notes, compiled by K.H. Northcote and others. The Atlas of Australian Soils provides the only consistent source of spatial soil information for the entire continent.

Mapped units in the Atlas are soil landscapes, usually comprising of a number of soil types. The explanatory notes accompanying the soil atlas include descriptions of soils landscapes and soil components.

The Quaternary and Cambro-Ordovician surface geology units identified within the study area closely correspond, geographically, to mapping units of the soil atlas.

Areas within the study area identified as the Newer Volcanics have been described in the CSIRO Atlas explanatory notes as gilgai plains of hard, alkaline and neutral, yellow mottled soils in association with small areas of cracking grey clays with occasional stony rises.

Geographically, the Cambro-Ordovician sediments correspond closely to the CSIRO description of hills and valley plains (Tb1). The descriptors specify the hills and hill slopes of these regions to comprise hard acidic yellow mottled soils in association with hard neutral red soils, shallow grey-brown sandy soils and rock outcrops.

North of the study area, the soil atlas identifies an amorphous shaped region of hilly to mountain soils described as “hard acidic yellow soils in association with hard acidic red soils with rock outcrops and shallow grey-brown sandy soils”. This zone roughly corresponds to prominent hills associated with the highly weather resistant granitic masses.

5.8 Historic Boreholes (GEDIS)

The interrogation of available historic bores within the study area will assist in developing a preliminary understanding of the geotechnical and geological conditions along the proposed alignment in the absence of site specific geotechnical investigations.

A search of the Geological Exploration & Development Information System (GEDIS) database identified numerous historic boreholes within and adjacent to the study area. It was determined that only a limited number (seven) within the study area contained lithological information. Four of the boreholes were established to be in the vicinity of the Buangor township, approximately 20 km west of Beaufort. The remaining bores neighbour the Western Highway on the approach to Ararat.

The GEDIS historic borehole logs are presented in Appendix A.

The description on the logs is generally brief and lacking details of material characteristics, however the logs are generally sufficient to gain a preliminary understanding of the subsurface conditions.

The historic bores extend to a maximum depth of approximately 52 m below ground surface and were generally drilled for the purpose of groundwater investigation.

The bores adjacent to Buangor intersect a sequence of clays and sands overlying basalt and bedrock (sandstone). Where encountered, the basalt was indicated to commence at a depth of approximately 10 m. Exploratory boreholes toward Ararat suggest a similar profile with basalt rock encountered to considerable depths.

5.9 Review of Historic Aerial Photographs

The examination of current and historic aerial photography can assist in developing and understanding previous land use and the social and environmental dynamics along the alignment. Previous land instabilities and potential contamination issues may be identifiable from the review of historical aerial photography.

A review of available aerial photography across the study area was undertaken of photos obtained for the period 1947 to 2009. This photography was sourced from the Victorian Department of Sustainability and Environment (DSE). The historical aerial photograph review is presented in Appendix B.

The aerial photography shows a steady increase in residential and rural development within the study area, particularly around the towns of Buangor and Ararat.

The existing Western Highway and Melbourne to Adelaide rail corridor were identified in the study area from 1947. Rail corridors have the potential to lead to dispersed contamination (surface application of herbicides and other related rail uses).

A substantial number of relatively small farm dams were identified as being created or altered within the study area during the period 1947 to current, including a large earthworks operation reinstatement situated along the Western Highway approximately 4 km west of the Hillside Road / Western Highway intersection (eastern intersection). The disturbance is possibly associated with quarrying or land clearing activities. This process may have substantial impacts on the geotechnical performance of the area. The observed small dams that were either created or altered were often in line with, or in reasonable proximity to the alignment options. The frequency of dams appears to be less prevalent in more recent records, either as a result of in-filling or not containing water at the time the photographs were taken. The potential of encountering local soft or saturated zones associated with present or past dam storage areas should therefore not be discounted.

Localised areas of increased vegetation were observed within the study area, with large plots of land west of Beaufort, and in close proximity to Buangor, showing a marked increase in vegetation. The addition or removal of vegetation would impact the mobility of the soils.

The review of aerial photography did not identify obvious evidence of ground instability or movement. The broad scale of the aerial photography means that small-scale localised instabilities or ground movement can be difficult to confirm. Historic landslips may be disguised by subsequent revegetating and human activities. The determination of scarp features or hummocky ground may be achieved through a dedicated, thorough field reconnaissance undertaking.

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 sheep, namely arsenic) were observed in the study area, although the frequency of pasture and grazing farming properties within the corridor of the study area indicates the potential for their presence and the potential for dispersed contamination sources. No suspected landfills were observed in the study area.

Buildings were observed in the location of the Red Kangaroo Roadhouse (United Petroleum Service Station) approximately 2 km west of Beaufort in 1966. Due to the small scale of the aerial photographs it is not known when the location was first used as a service station site. The presence of a service station at this location poses the potential for petroleum hydrocarbon contamination of soil associated with refuelling activities and spills.

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 within the study area.

5.10 Preliminary Acid Sulfate Soils Hazard Assessment

5.10.1 Acid Sulfate Soils (ASS)

ASS (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. ASS 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 ASS may occur directly through lowering of surface or groundwater pH, or mobilisation of metals to waterways impacting 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 ASS can be problematic for construction projects where PASS or AASS is disturbed. Ideally disturbance of ASS should be avoided, however in instances where this is not possible, ASS must be carefully managed in order to prevent potential impacts to the environment.

5.10.2 ASS Guidelines

The *Victorian Coastal Acid Sulfate Soils Strategy 2009* (CASS Strategy) was developed with the intent of protecting the environment, humans and infrastructure from impacts associated with disturbance of Coastal Acid Sulphate Soils (CASS). To implement the actions and objectives of the CASS Strategy, in October 2010 the Department of Sustainability and Environment (DSE) released the CASS Best Practice Guidelines (CASS BPG), which outline a risk-based approach to identifying, assessing and managing Acid Sulfate Soils (ASS). The CASS BPG outlines four stages to the risk identification process:

- Stage A: Preliminary CASS hazard assessment – desktop assessment and site inspection to determine whether the proposed project involves a high risk activity (e.g. excavation of soil >1 000 m^3), and is within a CASS risk area;
- Stage B: Detailed site soil sampling program and assessment – involves characterising the extent and concentrations of CASS above specific action levels so that potential impacts associated with disturbance can be evaluated, and management strategies developed;
- Stage C: Surface/groundwater sampling program and assessment – if CASS is detected in Stage B, a detailed assessment of groundwater and surface water receptors that may be impacted by disturbance of CASS is required; and
- Stage D: CASS hazard assessment – if Stage B identifies CASS above the action levels, Stage D assessment is used to determine the level of hazard (low, medium or high) associated with CASS disturbance. The hazard rating is then used to determine the planning and management strategies to be implemented during disturbance (e.g. construction) to prevent adverse effects to the environment, human health and/or infrastructure.

Detailed below are the findings of a Stage A Preliminary CASS hazard assessment.

5.10.3 Review of ASS Mapping

A review of published maps indicating the potential occurrence of ASS was undertaken, including:

- CSIRO Australian Soil Resource Information (ASRIS); and
- Department of Primary Industries (DPI) Map 1, Far South West Coast.

These maps were produced using a geomorphic approach, which identifies areas of higher sea level during the mid-Holocene period. The higher sea levels often resulted in the deposition of sediments containing significant concentrations of iron sulphide. The scale of the maps is of low resolution, and is intended as a guide only. It should be noted that the study area is not covered by the DPI Coastal Acid Sulfate Soil Hazard maps; therefore they were not considered relevant to this assessment. The mapping information indicates the following:

- The CSIRO ASRIS indicates the site is within an area of “low probability of occurrence” of acid sulfate soils; and
- Map 1 – Central Coast indicates the site is not within an area of “prospective land” containing potential coastal acid sulfate soils.

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

5.10.4 Conclusions from Preliminary CASS Hazard Assessment

Due to the low probability of ASS occurring within the region it is concluded that the study area for Section 2 of the Project is not within a CASS risk area. It should be noted that although the published maps indicate that there is a low risk of ASS occurring along the alignment, there is uncertainty in regards to the accuracy of the published maps due to their age and resolution, and that it is considered prudent to assess and confirm the soils are not ASS.

5.11 Site Inspection

A site inspection of the proposed alignments summarised in Section 6.1 was conducted by a GHD environmental engineer and geotechnical engineer on 20 December 2011.

The inspection noted that the Project area was predominately used for agricultural purposes (pasture and grazing). No evidence of contamination was observed along the proposed alignments. Potential sources of contamination observed included two service stations, farm / shearing sheds and associated infrastructure, and the Ballarat to Ararat rail corridor. The inspection confirmed the findings of the desktop study.

As part of the site inspection and drive through survey, an assessment of cut exposures and local land features was made to verify the regional geological setting and identify any extraneous conditions along or near the proposed alignment options. Instances of steeply dipping strata and discontinuities within the vast, regional Cambro-Ordovician units were exposed in a number of road and railway cuttings during the site inspection. Progressive rill erosion was noted across numerous cuttings along the alignment which attest to the erodible nature of sediments likely to be encountered during construction. The exercise assisted in corroborating the conceptual geological model developed during the existing conditions assessment.

6. Impact Assessment

The detailed impact assessment documented in this report addresses the potential impacts of the construction and operation of the proposed alignments of Section 2 of the Project. The alignments assessed are a culmination of progressive refinement of the design and consideration of potential impacts.

The Existing Conditions section of this report covers an area encompassing the long list of alignment options considered for the Project. Potential impacts of each option in the long list of alignments were considered in Phase 1 of the options assessment process, and were used to reduce the initial long list to a short list of alignment options.

The potential impacts of each option in the short list of alignment options were considered in more detail in Phase 2 of the option assessment process. Three proposed alignments were selected for further detailed assessment in the EES. The impacts of the proposed alignments, together with potential mitigation measures, were considered in detail through the environmental risk assessment process. The outcomes of the risk assessment process were used to finalise the proposed alignments assessed in the EES.

The proposed alignments assessed in this report are the outcome of progressive refinement through each phase of the options assessment process. The proposed alignments were also refined following the initial consideration of the environmental risk assessment.

The alignment options assessment process is described in the 'Western Highway Project Section 2 Options Assessment Report' (February 2012). The environmental risk assessment methodology and complete risk register for all specialist disciplines is presented in 'Western Highway Project Section 2 EES Environmental Risk Assessment' (February 2012) report.

Extracts form the environmental risk register are provided in this report and the identified impacts of the preferred proposed alignments are considered in detail in the following sections.

6.1 Project Description

The Project provides two lanes in each direction and associated intersection upgrades to improve road safety, and facilitate the efficient movement of traffic. It commences at the railway overpass west of Old Shirley Road, Beaufort and extends for approximately 38 km to Heath Street, Ararat. The upgrade assessed in this impact assessment is a combination of freeway standard (AMP1) and highway standard (AMP3). For the first length from the railway crossing to approximately Ch. 800, near McKinnon Lane, there are no works proposed. Then from Ch. 800 to Warrayatkin Road on the outskirts of Ararat the proposed upgrade would be to freeway standard (AMP1). For the final length from Warrayatkin Road to Heath Street the proposed upgrade would be to highway standard (AMP3). Grade separated interchanges are proposed at Eurambeen-Streatham Road, Peacocks Road, Hillside Road (south-eastern end), and Langi Ghiran Picnic Ground Road. An at grade intersection with a wide median treatment is proposed for Warrayatkin Road.

There are three proposed alignment options that are being assessed. These share a common alignment from Beaufort to near the Anderson Road intersection, east of Buangor (Ch. 16800), retaining the existing single carriageway footprint, and providing a duplicate carriageway located between

approximately 15 to 100 m to the north. Thereafter the options differ in their geometry, and whether a duplication or an entirely new dual carriageway is constructed. The alignment options are summarised in Table 6.

All alignment options bypass the small township of Buangor, which is currently accessed via local roads from the Western Highway. The Project proposes access to Buangor via grade separated interchange facilities.

There are steep grades from Beaufort through to Fiery Creek, before the highway levels for 18 km. To the west of Buangor the topography undulates as the highway crosses the Ballarat to Ararat railway line, and passes to the south of Langi Ghiran State Park. The highway then levels once again from the west side of Langi Ghiran State Park through to Ararat. Apart from the State Park and small areas of remnant forest, the surrounding land use is predominately agricultural (grazing and cropping).

Other than the Ballarat to Ararat railway, which carries local passengers, no State significant infrastructure such as major pipelines or power transmission lines is located within the study area. The alignment options all involve a crossing of the railway, six major waterways and 21 minor waterways (tributaries, drainage lines and irrigation channels).

Table 6 Alignment Option Descriptions

Option	Location and Chainage (m) East to West	Description
Common to all options	Box's Cutting to Warrayatkin Road (Ch. 840 to 34400)	**Duplication to AMP1 standard**
	Warrayatkin Road to Heath Street (Ch. 34400 to 39600)	**Duplication to AMP3 standard**
	Beaufort to the base of Box's Cutting (Ch. 840 - 3400)	**New dual carriageway** north of the existing highway (the existing highway would be used as a service lane) No duplication works undertaken between Ch. 0-840.
	Box's Cutting to Waldrons Road (Ch. 3400 – 12000)	**Duplication** of existing highway on the northern side then transferring to the southern side at Fiery Creek (Ch. 5900), with a median treatment from approximately 15 m to 30 m depending on the extent of constraints. Includes a new interchange at Eurambeen-Streatham Road / Eurambeen-Raglan Road
	Waldrons Road to east of Anderson Road (Ch. 12000 – 15700)	**Duplication** of the existing highway on the southern side, maintaining a median from approximately 15 m in the east to 40 m in the west.
Option 1	Anderson Road to Pope Road (Ch. 16500 – 22400)	**New dual carriageway** to the north of Buangor, and meeting the existing highway west of Buangor-Ben Nevis Road. Alignment common to Option 3
	Pope Road to the eastern end of Hillside Road (Ch. 22400 – 24800)	**New dual carriageway**, extending southwest from the existing highway and crossing the rail line.

Option	Location and Chainage (m) East to West	Description
	Eastern end of Hillside Road to Heath Street, Ararat. (Ch. 24800 – 39600)	**New dual carriageway** located approximately 700 m south of the existing highway until Ch. 28400 where it converges over a 1.5 km distance. A **duplication** of the existing carriageway occurs from Ch. 28400 with the new carriageway to the south. The median width varies from 30 m in the east to a narrow 6 m treatment in the west.
Option 2	Anderson Road to Pope Road (Ch. 16600 – 24600)	**New dual carriageway** that bypasses Buangor to the north, then extends south over the existing highway and rail line.
	Pope Road to the eastern end of Hillside Road (Ch. 22600 – 24200)	**New dual carriageway**, extending along the southern side of the railway line, meeting the existing highway.
	Eastern end of Hillside Road to Heath Street, Ararat. (Ch. 24200 – 39400)	**Duplication** of the existing highway on the southern side. Alignment common to Option 3.
Option 3	Anderson Road to Pope Road (Ch. 16500 – 22400)	Common alignment with Option 1 **New dual carriageway** to the north of Buangor, and meeting the existing highway alignment west of Buangor-Ben Nevis Road.
	Pope Road to the eastern end of Hillside Road (Ch. 22400 – 24800)	**New dual carriageway**, extending southwest across the rail line further than Option 2, then meeting the existing highway alignment in a similar location to Option 2.
	Eastern end of Hillside Road to Heath Street, Ararat. (Ch. 24800 – 39600)	Alignment common to Option 2. **Duplication** of the existing highway on the southern side.

6.2 Key Issues

The risk assessment for the Project area was divided into five key aspects in regards to geology and soils, including:

- 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 proposed road design is likely to have a positive outcome on the protection of the environment where the proposed alignment follows the existing alignment as it may effectively manage issues relating to containment of uncontrolled spills by incorporating improved drainage.

6.3 Impact Pathways

This section identifies and describes soils and geology cause and effect pathways associated with the construction and operation of the Project. The risk assessment is presented in Table 7.

6.3.1 Contaminated Soils

Excavation of soils would be required during the construction of the highway duplication. 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.

Aside from these general exposure pathways, contaminated soil on a construction project poses a number of additional risks to the environment mainly in the form of sediment generation. Therefore, knowledge of these types of issues is important in planning and implementing an effective environmental management system during construction and potentially in the post-completion or operational phase.

6.3.2 Unstable & Compressible Geological Units

Although brief and spatially limited, the historic boreholes available indicate the presence of variable ground conditions with the propensity of hard rock conditions at shallow depths. The site inspection conducted observed the presence of shallow rock in a number of cuttings along the existing highway. The deformed, steep dipping sedimentary rock (Cambro-Ordovician) may be liable to ground movement depending on the unfavourable orientation of discontinuity relative to local site geometry.

The Project area spans multiple creek and river systems including a number of current and ancestral watercourses defined by the presence of Quaternary sediments. The alluvium deposits are primarily established on the basaltic plains and may comprise unconsolidated, low-strength soils. Ground instabilities may develop during the earthwork operations, particularly along the banks of existing creeks and tributaries, where construction equipment and embankment construction may result in additional soil driving forces.

Earthworks operations may also destabilise marginal slopes where cut operations remove toe support at the base of longer / large slopes or where otherwise stable slopes are surcharged by the placement of fill. Potential weaker planes within variably weathered soil and rock units may be activated by improperly designed or conceived earthworks structures.

Areas of geological contact may present unstable ground conditions. The Langi Ghiran granite-bedrock contact is an example of a zone which has been significantly altered and deformed by the intrusive nature of the contact. The site walkover and drive through survey noted the formation of unfavourable planes across the granite intrusion exposure (Langi Ghiran Railway cutting). It is likely that the stability of cut excavations would be dominated by pre-existing planes of weakness and would need to be confirmed by intrusive investigations and adequately accounted for in the design of final slope batters.

As detailed in Section 6.4, taking into account the mitigation measures proposed, the overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being affected by unstable and compressive units is considered to be minor.

6.3.3 Soil Erosion

Construction of the Project would result in the removal of some vegetation. Observations undertaken during a preliminary site walkover and drive through exercise indicates the presence of soils which exhibit dispersive characteristics. The exposed earthen batters of numerous road and rail cuttings are progressively undergoing soil wasting processes, including slumping movement and rill erosion. The soil wasting and erosion is occurring across a number of geological units. Materials with dispersive characteristics are likely to be more prone to soil erosion.

The rate of erosion depends on factors, such as surface incline, climatic factors and the amount of and type of ground cover. Failure to reinstate exposed areas properly after construction may exacerbate soil erosion and loss of material from disturbed areas.

6.3.4 Cut & Fill Material

There is a potential for large quantities of fill material being required during the construction of the Project. A risk exists that in order to meet the demands for fill material, deeper cut excavations may be required, exposing a greater surface area to the processes of erosion and degradation. Depending on haul distances and location of suitable local or commercial quarries to areas requiring fill, temporary stockpiles of material may be required to keep pace with construction schedules.

The location and geometry of any stockpiles would need to be carefully considered during detailed design, as local instabilities and excessive erosion may affect nearby environment features, including waterways. Stockpiles have a propensity to suffer erosion as they are typically of high batter angles and generally exposed soil surfaces.

Deeper cuts have the tendency to become more difficult to excavate with depth due to an increase in material strength, generally resulting in greater overbreak of material. Blasting may also be required that may result in production of oversized material. Oversized material may be unsuitable for use unless crushed and may result in unplanned disposal off-site and higher demand for alternate sources of fill material. It is expected that less weathered granite intrusions, basalt layers or stronger sedimentary rock would be more difficult to excavate and may require blasting or splitting in order to achieve the required minimum width earthworks profile. The implications of the blasting may include dust production, vibration and noise. These risks are expected to be accounted for during design and mitigated by following industry guidelines and EPA regulations during construction.

Larger fill embankments impose a broader footprint and stress influence zone on founding soils. The build-up in pore pressure of moderate to high fills constructed across wet or marshy areas may take some time to dissipate (years to tens of years). Consolidation of founding soils and settlement of fill embankments may therefore continue sometime after construction.

As detailed in Section 6.4, the overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being affected by imbalance of cut and fill material is considered to be minor.

6.3.5 Geological Faults

Areas directly impacted by faulted zones may be highly variable and present conditions which are difficult to predict. Poor rock mass conditions and advanced weathering in faulted areas are prone to instability and rapid deterioration.

Whilst no discernible remnant surface features were identified during the drive through survey exercise, it is expected that further investigation would be required in areas identified to be subjected to faulting to quantify the risk posed by past tectonic activity. Future activity along existing faults may occur, and the impacts of such movements may need to be considered in the design of batter slopes and significant structures. Potential impacts to the project include higher rates of erosion and the requirement for shallower batter angles.

The indicative location of the fault line at 1:250,000 scale as prepared by the Geological Society of Victoria is shown on Figure 3.

6.3.6 Historic Mine Workings

A review of previous mine workings indicates that limited sections of each of the shortlisted alignment options may interact with historic shallow or deep lead workings (Section 5.4). The nature and extent of the historic mining works is relatively unclear at this point in time and would need to be further explored during progressive phases of the Project (detailed design).

Shallow mine workings may have been reinstated to a substandard specification. Poor or uncontrolled backfilling may give rise to unpredictable and inadequate ground conditions (soft spots). The spatial distribution of shallow workings may be difficult to identify from surficial inspections as years of vegetation growth may have destroyed the remnants of disturbance.

Deep lead works, including mine shafts, may instigate ground subsidence once subjected to a different stress regime (i.e. increased loading). Progressive or sudden collapse of mine works may result during or after the Project construction activities. The reinstatement works of the mines may be poorly documented.

The control measures for mine shafts and deep lead mining will depend on numerous factors such as the depths and reinstatement methods adopted after the completion of the mining works.

The mitigation measures to reduce the impact of ground subsidence or collapse associated with historic mine workings through ground replacement or reinforcement would present an overall low risk to the project. These measures would be identified as part of the detailed design and investigation stages for the project.

6.3.7 Transport of Road Contaminants

There is a potential for the transportation of road contaminants such as petroleum products (fuel and lubricants) from vehicles offsite during normal road operation after construction. In locations where the proposed duplication follows the existing highway, it is proposed that the existing carriageway would be utilised with the existing bi-directional road converted to a single direction, and a new parallel carriageway constructed to serve traffic in the opposite direction. Where this configuration is applied, the existing waterway crossings would typically be matched for the proposed duplication. The proposed duplication would be constructed and operated in accordance with the VicRoads Integrated Water Management Guidelines (2011), the VicRoads Water Sensitive Road Design Guidelines (2007) and the

Best Practice Environmental Management Guidelines (CSIRO, 1999). Therefore, it is considered that the upgrade of the existing highway through the construction of the proposed duplication would have a positive outcome on the protection of the environment from offsite contaminant transport during operation.

In locations where the proposed alignment does not follow the existing highway, the duplication would involve the construction of two new carriageways in a corridor typically between 80-110 m wide. As such, there is an increased risk of exposure of sensitive receptors to potential transportation of road contaminates offsite during operation, in particular at waterway crossings. Although there is considered to be an increased risk of transportation of contaminants offsite during operation in locations where the alignment does not follow the existing highway, the overall impact of this risk is considered to be insignificant.

6.4 Risk Assessment

VicRoads has a standard set of environmental protection measures which are typically incorporated into its construction contracts for road works and bridge works. These are described in VicRoads Contract Shell DC1: Design & Construct, April 2012, hereafter referred to as the "VicRoads standard environmental protection measures". These measures have been used as the starting point for the impact assessment. Those that are relevant to soils and geology are included in the "planned controls" column of the risk assessment (Table 7) and outlined in more detail in Section 7.

As a result of the initial risk assessment, in some cases additional Project specific controls have been proposed to reduce risks. These are outlined in the "additional controls" column of the risk assessment in Table 7, and are described in more detail in Section 7.

Both VicRoads standard environmental protection measures and the additional Project specific controls have been included in the Environmental Management Framework for the Project.

Key observations from the risk assessment of each of the shortlisted alignment options and associated construction corridors are:

- The risk of encountering contaminated soils is considered to be low;
- The risk of an imbalance in the volume of suitable fill and the volume of excavated material is considered to be low; and
- The risk of encountering erosion prone areas, compressible soils and historic mine workings is considered to be low.

The potential for adverse impacts of contaminated soils (including ASS), chemical spills, unstable geological units, historic mine workings and cut and fill material was assessed through the risk assessment process described in Section 4.2 with further mitigation proposed to manage impacts.

The risks associated with the various alignment options are discussed in more detail below.

6.4.1 Exposure to Potentially Contaminated Soils

Based on land-use activities, the potential for contaminants to be identified within the Project area is moderate as there have been several different historic uses along the alignment that would give rise to gross contamination, including a service station, sheep shearing sheds and associated infrastructure such as sheep dips, railway corridors, areas of disturbed soils and uncontrolled historic mining works.

The main risk that would need to be considered is exposure of construction workers to contaminated materials, dust, fuels and chemicals used during the construction phase.

Once contaminated soil and/or waste material is exposed during excavation works, appropriate mitigation procedures should be implemented to manage potential risks to the environment, particularly with regards to sediment and leachate generation.

In terms of the type of land uses identified along the alignment, the main human health and environmental risks are considered below:

Agriculture – Pasture and Grazing

The potential risks to human health and the environment associated with this land use would be relatively low across most of the Project area, as contaminant concentrations due to the application of fertilizers and other pastoral improvement substances, where present, are unlikely to be high (orders of magnitude greater than the National Environment Protection (Assessment of Site Contamination) Measure, NEPC 1999 criteria). The general contamination associated with this land use type is likely to have dispersed source characteristics, and would benefit from in-situ intrusive investigation along the alignment as part of future works. The exception to this generalisation would be farm/shearing sheds with associated infrastructure such as sheep dip/shower sites, which would represent localised high contaminant concentrations as they tend to be infrastructure confined to a discrete location. Farm/shearing sheds of potential concern occur along the alignment at the following chainages:

- **Options 1, 2 and 3**
  - Ch. 10 600 to 10 800
  - Ch. 14 500
- **Option 1 and 3**
  - Ch. 19 600
  - Ch. 24 000
- **Option 2 and 3**
  - Ch. 24 400

Given the magnitude and localised effects of farming associated activities, it would be appropriate that potential contamination be managed through a Construction Environmental Management Plan (CEMP). It would be beneficial to conduct intrusive investigations at the locations listed above prior to development of the CEMP to ensure that the risk to construction contractors is limited and that any potential remedial works can be performed in a timely manner.

Waste Disposal

These types of areas, such as the infilling of dams, quarries or borrow pits with contaminated soils or other wastes, and 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 Project area other than the locations of disturbed soils located at the following chainages:

- **Options 1, 2 and 3**
  - Ch. 6 000
- **Option 1**
  - Ch. 28 200

Given the potential localised effects of infilled dams, quarries or borrow pits, areas of disturbed soil and mine tailings, it would be appropriate that they be managed through a CEMP. It would be beneficial to conduct intrusive investigations at the locations listed prior to development of the CEMP to ensure that the risk to construction contractors is limited and that any potential remedial works can be performed in a timely manner.

Commercial and Industrial Activity

There were no significant commercial and industrial activities within the Project area. Two (2) service station sites, an airport and rail infrastructure were observed within the study area. As one (1) of the services stations (the Red Kangaroo Roadhouse) and the airport are not located within close proximity to the proposed alignment options, they are considered unlikely to pose a potential contamination exposure risk to the project and have therefore not been included in the risk assessment. A potential for contamination exists at the service station site located within close proximity to the alignment and where the highway alignment crosses or is parallel to the railway lines. The areas of concern are located at the following chainages:

- **Options 1, 2 and 3: Service Station**
  - Ch. 36 800
- **Options 1, 2 and 3: Rail Corridor (Intersection with Alignment)**
  - Ch. 29 400
  - Ch. 32 200
  - Ch. 34 300
  - Ch. 38 000
- **Option 1: Rail Corridor (Intersection with Alignment)**
  - Ch. 23 400
- **Option 2: Rail Corridor (Intersection with Alignment)**
  - Ch. 20 800
- **Option 3: Rail Corridor (Intersection with Alignment)**
  - Ch. 23 000
- **Options 1, 2 and 3: Rail Corridor (Close Proximity to Alignment)**
  - Ch. 29 000 to 39 600
- **Option 2: Rail Corridor (Close Proximity to Alignment)**
  - Ch. 22 600 to 25 000
- **Option 3: Rail Corridor (Close Proximity to Alignment)**
  - Ch. 24 800 to 25 200

Thus, a preliminary intrusive assessment would be appropriate prior to construction works, if excavation works are proposed within these locations and where the alignment crosses or is in close proximity to the rail infrastructure.

The overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to contaminated soils resulting from historic uses along the alignment, including a service station, sheep shearing sheds and associated infrastructure such as

sheep dips, railway corridors, areas of disturbed soils and uncontrolled historic mining works is considered to be moderate.

Acid Sulfate Soils

There is a potential for ASS to be present in the waterways within the project area. Discussions with the Glenelg Hopkins Catchment Management Authority indicate that no ASS has been identified within the Project area, although they have not conducted any analysis of the soils for PASS. It is considered that there would be some benefit in undertaking limited selected sampling along the alignment as part of future works. This should occur in particular where infrastructure such as bridge supports will be installed at depth.

It is also considered that a CEMP would provide guidance for the appropriate method of stockpiling uncharacterised soil and provide appropriate sampling guidance to assess re-use or disposal options.

The overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to ASS is considered to be insignificant.

6.4.2 Chemical Spills

The risk of impact from chemical spills along the alignment during construction is considered to be low as the construction works would be governed by a CEMP. It is considered that a CEMP would include specific procedures to minimise leakage or spillage of any fuels or chemicals; and to 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.

The proposed Western Highway Project is likely to have a lower environmental risk of uncontrolled spills during its operation, relative to the existing highway. The design improves road safety thus reducing the risk of spills occurring as a result of a traffic accident, and the containment of uncontrolled spills is improved by incorporating improved drainage.

Fuel and chemical spills that occur during operation are not generally VicRoads' responsibility. VicRoads' maintenance contractors are required to have emergency preparedness and response procedures, and these detail how the emergency is managed including contacting emergency services (the CFA and police are the lead agencies), and EPA. VicRoads provides support for traffic management. For these reasons, the overall impact of the Project from chemical spills is considered to be insignificant.

6.4.3 Unstable Ground

Review of historic aerial photography, spanning approximately 62 years, demonstrated no discernible 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 Project 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, thereby heightening the potential of localised ground instabilities. Creek and river banks may become unstable under the changing stress conditions associated with construction activity.

The removal of toe support, surcharging of slope crests or the interception of planes of weakness may result in significant slope instabilities. Erodible soils present an additional risk to soil stability, as the movement of soils from the slope toe may initiate a destabilising effect.

Fissures within the clayey weathering profile of the Newer Volcanics may cause instability during construction due to the increased potential of blocks of clay collapsing into the excavation. Excavations in weathered granitic rock may encounter instability attributed to higher sand content within the weathered rock mass. Where weathering has not had a significant effect on the strength of a rock mass, stability is likely to be governed by structural weaknesses, such as joints, faults, bedding and shear zones. An understanding of the orientation and type of discontinuities is an important aspect in assessing the stability of rock slopes and cuttings.

Geological contacts, such as the Langi Ghiran granite-bedrock exposure, may be characterised by unfavourable conditions. Rock masses deformed by metamorphism and regional activity are liable to poor quality and persistent planes of weakness. The tendency for ground instability would need to be further explored during intrusive geotechnical works. It is expected that the nature of the soil and rock and presence of contacts or low strength material would be established during the intrusive works. Areas of steep cuts (proposed and existing) or natural slopes should be the focus of the site stability assessment.

Detailed geotechnical site investigations complemented with appropriate design of temporary and final batter slopes would largely eliminate or overcome gross soil or rock instability. The overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being affected by unstable ground is considered to be minor which translates to a low risk to the Project.

6.4.4 Soil Erosion

Despite efforts to avoid existing farm dams and water crossings along the alignment which may be more prone to soil erosion, the exposure of subsoils can only be minimised and not eliminated regardless of the alignment option selected. A preliminary geological conceptual model has been developed for the Project area on the basis of regional geological mapping, and limited historic investigative works. This conceptual model has been corroborated with the outcome of the preliminary walk-over and drive through survey to characterise the susceptibility of the various encountered geological units to the processes of soil erosion.

Soil erosion is an ongoing geomorphological process and has the potential to occur to varying degrees anywhere and anytime along the Project area and not just during construction. The exposure of subsoils during construction activities would give rise to favourable sheet and rill erosion conditions.

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

Exposed subsoils, consequent of vegetation and topsoil removal, would inevitability be subjected to a degree of erosion upon contact with flowing water. The control and restriction of the eroded soil, through the implementation of erosion and sediment control measures, is paramount to avoiding detrimental effects to nearby creeks and water bodies. The programming and management of the Project to avoid works during or preceding wet weather and those near watercourses would assist in isolating and containing erosion breaches.

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 in the control of soil erosion, however, site specific soil erosion management plans should be developed as part of the CEMP. The provision of a site specific soil erosion management plan is common for most large scale Projects.

Similar to the mitigation measures proposed for encountering unstable geological units by the adoption of appropriate batter slopes and surface drainage measures as described in Table 7, the overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being affected by soil erosion is considered to be minor.

6.4.5 Ground Settlement (Compressible Soil)

Ground settlement typically occurs due to increased soil loadings, and is exaggerated in weak subsoil conditions. The proposed construction of earthen fill platforms and embankments is expected to initiate a degree of settlement commensurate with the magnitude of loading and subsoil characteristics. The proposed bridge approach embankments may result in surface loadings conducive to significant settlements where poor ground conditions dominate. Geotechnical information is limited along the alignment, and details regarding the thickness and spread of soft compressible soils are unknown and would require further geotechnical investigation to quantify.

Load induced ground settlements are unavoidable during the construction of embankments and fill platforms; however it may be possible to manage these effects. A staged construction approach should be considered to manage the likelihood of significant settlements. This would involve the embankment being constructed with multiple smaller load increments allowing sufficient time for the strengthening of weak underlying subsoils under a sustained load condition. This proposed methodology would result in mitigation of large settlement deformations and local instabilities, and should be based on the acquisition of sufficient suitable geotechnical data of prevailing ground conditions.

Soft and compressible ground can be expected in less elevated portions of site (valley bottoms) and within the flood plains of current and historic water courses. Alluvial sediments have the propensity to be of variable strength and performance and as such would need to be accounted for in the design of fill embankments constructed across such areas. The more significant areas which may require further attention against the risk of ground settlement are listed in Table 7.

Based on the implementation of the recommended environmental controls and appropriate level of geotechnical investigations to inform design the risks associated with ground settlement have been assessed as a medium initial risk. With the additional measures as detailed in Table 7, the residual risk rating may be reduced to low.

The overall impact during construction of the Project from the risk to sensitive receptors (human or ecological) potentially being affected by ground settlement is considered to be minor which translates to a low residual risk to the project. Residual risks to the project may include increased frequency of maintenance interventions.

6.4.6 Cut & Fill

Preliminary earthwork estimates suggest a large quantity of imported fill material may be required. Detailed analysis during the detailed design would assist in effective, proper planning of sourcing and disposal requirements.

Considering the likely significant short-fall of suitable fill materials, sources of materials would need to be located, preferably from local quarries. Depending on the volumes of fill required by the project this could exhaust the resources of small or local quarries thereby requiring additional sources or alternatively longer haul distances.

Preliminary estimates for cut and fill volumes:

Alignment Option 1	Cut 1.75 million cubic metres; Fill 3.44 million cubic metres; Fill deficit 1.69 million cubic metres
Alignment Option 2	Cut 2.82 million cubic metres; Fill 3.32 million cubic metres; Fill deficit 0.5 million cubic metres
Alignment Option 3	Earthworks volumes not updated on the basis of being the least preferred alignment option under the remainder of the assessment criteria.

Alignment options with a closer cut/fill balance would be preferred in consideration of the overall environment; therefore Option 2 is preferred in this regard.

Notwithstanding, by careful management of earthworks quantities and early identification of fill volume requirements, the impact posed by the project by an imbalance of Cut and Fill volumes is considered to be a minor consequence with an overall low residual risk to the project.

6.4.7 Ground Subsidence or Collapse (Anthropogenic)

The presence of historic mining works may give rise to the existence of finite areas where the ground conditions may be unstable and liable to subsidence or collapse once disturbed or altered.

Ground subsidence can be induced by increased ground loadings and may be exaggerated in areas of large voids or cavities, such as previous mine workings. Information regarding the extent and nature of the mining works including information from the DPI is limited and would require further review and assessment, including the undertaking of a geotechnical investigation. Areas identified as being problematic due to previous mine workings may be rendered suitable following the implementation of ground improvement techniques.

The overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being affected by anthropogenic ground subsidence is considered to be low provided adequate geotechnical investigations and information reviews are undertaken prior to construction.

6.4.8 Geological Faults

Several geological faults are expected to traverse the project area with one such feature shown on the 1:250,000 scale geological map sheet (Figure 3). Based on locations shown on referenced map-sheets no visible surface trace could be identified during the drive through survey, however, these features may be evident in cutting excavations within the project area.

Geological hazards arising from the presence of faults include a reduction of rock mass strength caused by more pervasive fracturing in the vicinity of the fault which in turn can lead to deeper weathering of the fault zone. These fractured, weaker and more deeply weathered zones may require treatment to stabilise them in cuttings to prevent erosion and spalling into the excavation. Large scale wedge failures of rock affecting the footprint of the cutting may also occur into the excavation along a persistent defect such as

a fault. Faults and fault zones may also act as conduits for groundwater flow out of an excavation because of the increased fracturing. Conversely, the increased weathering along a fault and subsequent clay deposits in the fault may reduce the overall permeability and cause a difference in groundwater levels on either side of the fault.

In the absence of intrusive ground investigation in the area of geological faults and on the basis that no discernible remnant surface features could be identified from drive through survey, the overall impact of such features on the project is considered to be minor. Considering the influence of geological faults can be assessed under the category of encountering unstable geological unit or erosion prone areas (Risk No. 4), the overall risk to the project is low. This residual risk rating is based on the adoption of appropriate batter slopes and surface drainage measures as part of detailed design, which in turn would be supported by ground investigations to characterise potential areas affected by geological faults, to effectively reduce the initial risk from medium to overall low residual risk to the project.

6.5 Key Impacts

Key impacts resulting from the risk assessment of the proposed alignment(s) and associated construction corridor on the basis of the adopted assessment criteria are:

- The overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to contaminated soils resulting from historic uses along the alignment, including a service station, sheep shearing sheds and associated infrastructure such as sheep dips, railway corridors, areas of disturbed soils and uncontrolled historic mining works is considered to be moderate;
- Although there is considered to be an increased risk of transportation of contaminants (in rainfall runoff) offsite during operation in locations where the alignment does not follow the existing highway, the overall impact of this risk is considered to be insignificant;
- The impact of encountering unstable or erosion prone geological units during construction is considered to be minor;
- The impact of soft and compressible soils being encountered in the construction of fill embankments or drawdown of groundwater inducing ground settlement is considered to be minor;
- The impact of imbalance in earthworks cut and fill volumes during construction is assessed as being minor;
- The overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to ASS is considered to be insignificant; and
- The impact of historical gold mining works being encountered during construction is considered to be minor.

The distinction between alignment options can be assessed under the following impact pathway criteria:

Potentially contaminated soils:

Of the three alignment options proposed, 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 intersections and sections in close proximity to the railway line (and potential associated contaminants) than alignment Options 2 and 3.

Soil erosion:

As the various alignment options encounter the same prevailing regional geological conditions across the project area, there is no distinction between the alignment options on the basis of soil erosion. Alignment options with shorter slope lengths may be more advantageous in terms of soil erosion. Option 1 is anticipated to have significantly less cut volume than Option 2, and as such a reduced area exposed to erosion mechanisms. Option 1 is therefore preferred on the basis of the risk of soil erosion.

Ground settlement:

In the absence of site specific geotechnical investigation it is not possible to distinguish between the various alignment options as all proposed alignment options encounter areas of low elevation (valley bottoms), flood plains and alluvial dominated sediments which may be prone to ground settlement on loading. As such, a preferred alignment cannot be identified on the basis of risk against ground settlement.

Unstable ground:

In the absence of specific ground investigation data there is generally no significant distinction between the various alignment options in terms of the risk of encountering unstable ground. Noting that the various alignment options are likely to transect fault line in the vicinity of Box's Cutting it is expected that further investigations would be required to specifically characterise this location.

Cut and fill balance:

Based on the estimated earthworks volumes produced under preliminary design assumptions in terms of horizontal and vertical alignment and proposed batter slopes, Option 2 holds an advantage over Option 1 in terms of cut/fill balance.

Historical Mine workings:

As the portion of road duplication potentially impacted by historical mine workings is generally limited to the environs of Beaufort and Ararat (radius of 5 to 5.5 km), there is no distinction between the various alignment options on the basis of impact to ground subsidence or collapse attributed to historical mining works. As such, preferred alignment is determined on the basis of other criteria.

Comparison of Alignment Options:

Considering the potential for exposure of sensitive receivers (human health and ecological) to potentially contaminated soils it is considered that Option 1 is the preferred alignment as it has the least intersections and sections in close proximity to the railway line (and potential associated contaminants) of the three proposed alignment options.

Under the identified risks associated with geological and geotechnical considerations, Option 1 is preferred, primarily on the basis of unfavourable geological conditions common to Options 2 and 3 in the vicinity of Langi Ghiran Railway cutting.

Considering the alignment options encounter common geological units across the study area, the only significant distinction between the three alignment options in terms of geology is found in the vicinity of the Langi Ghiran Railway cutting, in which the contact between Devonian granite intrusion and the Cambro-Ordovician sedimentary sequence is exposed. This complex granite-bedrock contact (exposure) has been documented as a site of geological significance by the Geological Survey of Victoria (King, 1986). A zone of folding and metamorphic alteration is evident close to this contact which dominates over a length of some 300 m, characterised by variable ground conditions and distinctly orientated planes of

weakness. Construction activities within 300 m of the point of contact would present physical construction difficulties (unfavourable bedding and discontinuities) and on-going maintenance issues. As such, the proposed Project alignment options 2 and 3 would be less preferred in terms of the prevailing geological setting than Option 1.

Alignment option 1 is anticipated to have significantly less cut volume than alignment option 2, and as such, a reduced area exposed to erosion mechanisms. Soil erosion is a key criterion in which to assess the impact of the various alignment options on sensitive receptors. By virtue of significantly lower cut volumes, Option 1 is preferred on the basis of the risk to soil erosion.

Table 7 Soils and Geology Risk Assessment

Risk No.	Impact Pathway	Description of Consequences	Planned Controls to Manage Risk (as per Project Description, and VicRoads Standard Specification (April 2012)).	Initial Risks			Additional Controls Recommended to Reduce Risk	Residual Risks		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
G1	Presence of contaminated soil along alignment.	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: **OPTIONS 1, 2 and 3** - 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) **OPTION 1** - Disturbed Soil (Ch. 28200) - Intersection with Rail Corridor (Ch. 23400) **OPTION 1 and 3** - Farm Sheds (Ch. 19600 and 24000) **OPTION 2** - Intersection with Rail Corridor (Ch. 20800) - Close proximity with Rail corridor (Ch. 22600 to 25000) **OPTION 2 and 3** - Farm Sheds (Ch. 24400) **OPTION 3** - Farm Shed (Ch. 24400) - Intersection with Rail Corridor (Ch. 23000) - Close proximity with Rail corridor (Ch. 24800 to 25200) Generation of surplus soils during construction may require treatment and appropriate handling or disposal.	1) The discovery of contaminated material on the site during construction works shall be managed in accordance with VicRoads and EPA Guidelines. 2) Where putrescible waste material is encountered, the Superintendent and EPA shall be notified. Construction works along the affected area shall stop until a mitigation plan is established and agreed between the relevant project stakeholders. 3) The Contractor shall undertake a visual assessment of the Site for contaminated soils and uncontrolled waste during construction works.	Moderate	Possible	Medium	The Construction Environmental Management Plan (CEMP) is to provide details on appropriate methods for managing contaminated soils. An in-situ investigation in accordance 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 results of the investigation would assist to provide appropriate soil management advice including disposal recommendations.	Moderate	Rare	Low

Risk No.	Impact Pathway	Description of Consequences	Planned Controls to Manage Risk (as per Project Description, and VicRoads Standard Specification (April 2012)).	Initial Risks			Additional Controls Recommended to Reduce Risk	Residual Risks		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
G2	Uncontained spill or leak of chemicals during construction.	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: - 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) - Greenhills Creek (Ch. 38300)	Contaminated Soils and Waste Materials 1) The discovery of contaminated soils along the alignment during construction works shall be managed in accordance with VicRoads and EPA Guidelines. 2) Where putrescible waste material is encountered the Superintendent and EPA shall be notified and a management strategy established to mitigate any potential risks to immediate. 3) The Contractor shall undertake a visual assessment of the construction areas for contaminated soils and waste materials. Fuels and Chemicals 1) CEMP to include specific procedures to minimise spillage of any fuels or chemicals and mitigate the effect in the event that leakages and spillages occur. 2) Fuel, chemical and equipment storage areas shall be visually monitored at intervals of not more than 7 days to mitigate contamination in a timely manner.	Moderate	Rare	Low	Additional measures may be required depending on the CEMP which would include: - Appropriate procedures for containing spills and leaks should be contained - Appropriate methods for cleaning up spills and leaks where safe to do so. If an uncontained spill or leak occurs during construction resulting in soil contamination, refer to management controls detailed in G1.	Insignificant	Rare	Negligible

Risk No.	Impact Pathway	Description of Consequences	Planned Controls to Manage Risk (as per Project Description, and VicRoads Standard Specification (April 2012)).	Initial Risks			Additional Controls Recommended to Reduce Risk	Residual Risks		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
G3	Runoff transports road contaminants offsite during operation.	Contamination of waterways with hydrocarbons or heavy metals. Impacts on water resources, flora, fauna, and human health, including: - Maintenance workers - General Public - Local Flora and Fauna The following potential areas may be affected: - 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) - Greenhills Creek (Ch. 38300)	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).	Insignificant	Possible	Negligible		Insignificant	Possible	Negligible

Risk No.	Impact Pathway	Description of Consequences	Planned Controls to Manage Risk (as per Project Description, and VicRoads Standard Specification (April 2012)).	Initial Risks			Additional Controls Recommended to Reduce Risk	Residual Risks		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
G4	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: - Ch. 800 to 4000 - Ch. 12400 to 34200 - Ch. 38300 to 39600	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. 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.	Geotechnical investigations would be conducted prior to construction to assess nature of soils encountered along the alignment. Implement Erosion and Sediment Control Measures through an EMP, 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.	Moderate	Possible	Medium	Detailed design of cuts and final batter slopes to appropriately reflect the local geological and geotechnical conditions. Improved surface drainage measures in the management of Erosion and Sediment Control. This may include the installation of appropriately design surface or sub-surface drainage systems such as swales, pipes or lined channels.	Minor	Possible	Low

Risk No.	Impact Pathway	Description of Consequences	Planned Controls to Manage Risk (as per Project Description, and VicRoads Standard Specification (April 2012)).	Initial Risks			Additional Controls Recommended to Reduce Risk	Residual Risks		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
G5	Soft or compressible soils are present along proposed alignment. The following locations predominantly associated with alluvial sediments are highlighted: - 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	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: - 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) - Greenhills Creek (Ch. 38300)	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.	Moderate	Possible	Medium	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. 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.	Minor	Possible	Low

Risk No.	Impact Pathway	Description of Consequences	Planned Controls to Manage Risk (as per Project Description, and VicRoads Standard Specification (April 2012)).	Initial Risks			Additional Controls Recommended to Reduce Risk	Residual Risks		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
G6	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: - 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)	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.	Earthworks are expected to be dominated by the need for fill above the natural surface to achieve drainage and greater 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 or disposed of in the following order of priority: 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, waste disposal facility or borrow pit excavated during the construction phase to source additional fill material and licenced to receive waste materials.	Minor	Possible	Low	Assess likely earthworks volumes during design to optimise design solution (balance cut and fill where possible). Surplus material that cannot be used on site would be re-used or disposed of in the following order of priority: 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, waste disposal facility or an approved borrow pit.	Minor	Possible	Low

Risk No.	Impact Pathway	Description of Consequences	Planned Controls to Manage Risk (as per Project Description, and VicRoads Standard Specification (April 2012)).	Initial Risks			Additional Controls Recommended to Reduce Risk	Residual Risks		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
G7	Construction intersects Acid Sulfate Soil/Rock, potential disturbance and exposure to air	The Project alignment options are not considered to be in a Potential Acid Sulfate Soil risk area. 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).		Moderate	Rare	Low	Soils suspected of being acid sulfate soils (ASS) are to be sampled and analysed to assess the ASS potential. In the event ASS are discovered an ASS Management Plan would be prepared.	Insignificant	Rare	Negligible
G8	Construction intersects historic gold mining works, including deep lead and shallow workings.	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.	Geotechnical investigations would be conducted prior to design and construction to identify the extent and nature of the historic mine workings.	Minor	Possible	Low	Project to implement a ground improvement programme for areas identified as having shallow workings. Such measures may include ground replacement, or reinforcement with geosynthetic materials. The control measures for mine shafts and deep lead mining will depend on numerous factors such as the depths and reinstatement methods adopted after the completion of the mining works.	Minor	Unlikely	Low

6.6 Benefits and Opportunities

This section identifies key potential benefits or opportunities to soils and geology that the Project could provide, rates the significance of these, and outlines measures to enhance and capture these benefits.

Benefit ratings are described in Table 8.

Table 8 Benefit Ratings

Rating	Potential Project benefits
Very well	Significant benefit to the State Superior benefit to the region Policy consistency with superior positive impact
Well	Moderate benefit to the State Significant benefit to the region Superior benefit to the locality Policy consistency with significant positive impact
Moderately well	Moderate benefits to the region Significant benefit to the locality Policy consistency with moderate positive impact
Partial	Minor benefits as a local level or significant benefits for a small number of individuals
Negligible	Minimal benefit at any level

A potential benefit from the construction of the proposed duplication would be:

- A positive outcome on the protection of the environment where the proposed alignment follows the existing alignment as it may effectively manage issues relating to containment of uncontrolled spills by incorporating improved drainage, particularly at waterway crossings.

It is proposed that the waterway crossing treatments for the existing highway would typically be matched for the duplication. It is also proposed that the duplication be designed to meet the objectives for water quality described in the *Best Practice Environmental Management Guidelines (CSIRO) and* would be constructed and operated in accordance with the *VicRoads Integrated Water Management Guidelines (2011)* and *VicRoads Water Sensitive Road Design Guidelines (2007).* As such, the Project would likely lead to an improvement in the management of surface water runoff, in particular at waterway treatments, which would be considered both a 'Superior Benefit to the locality' and a 'Significant benefit to the region' from the protection of waterway from potential environmental degradation with a benefit rating of 'Well'.

Where the alignment deviates from the existing highway and comprises fill embankment constructed across generally less elevated terrain, such construction may offer the potential benefit of flood water control. The benefit of such construction is found in retarding flood waters, building up against fill embankments, and via outlet control (culverts designed for a particular storm event) offsetting the time of concentration that may be realised had the embankment not been in place. The benefit offered is in reducing overland flow energies downstream of the fill embankment and confining downstream floodwaters to pre-existing drainage lines.

7. Mitigation Measures

7.1 Construction

VicRoads would require the construction contractor to develop and implement a Construction Environmental Management Plan (CEMP) for the Project. VicRoads standard environmental protection measures and some additional Project specific controls identified below have been incorporated into the Environmental Management Framework for the Project. VicRoads would require the construction contractor to incorporate all of these measures into the CEMP.

VicRoads standard environmental protection measures for soils and geology that would be adopted for this Project include:

1200.08 EROSION AND SEDIMENT CONTROL

(a) General

All exposed surfaces shall be free of erosion.

Soil conservation measures shall include but are not limited to:

- *minimising the amount of exposed erodible surfaces during construction - this may include staging of works;*
- *installation and maintenance of erosion and sedimentation controls, established in accordance with EPA best practice guidelines for the treatment of sediment laden run-off resulting from construction activities;*
- *prompt temporary and/or permanent progressive revegetation of the Site as work proceeds;*
- *installation and maintenance of catch drains to divert and segregate water runoff from catchments outside the construction site from water exposed to the construction site and to adequately control and route runoff within the construction site to the appropriate sedimentation control installation;*
- *treatment of open drains to prevent erosion before adjacent ground is disturbed and excavation is commenced;*
- *prompt covering of exposed surfaces (including batters and stockpiles) that would otherwise remain bare for more than 28 days - cover may include mulch, erosion control mat or seeding with sterile grass;*
- *minimising the timing between clearing and stripping of the Site and covering of erodible surfaces; and*
- *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.*

(b) Work in/near Waters

Works shall be programmed and managed so as to avoid work in waters. Where work in waters is unavoidable, procedures shall be developed and implemented to satisfy the requirements of this Clause 1200 and as required by any permits from the responsible authority(s).

Where construction activities are undertaken in, near or over waters, Environmental Management Plan(s) shall be prepared to protect beneficial uses in accordance with any permit, the State Environment Protection Policy (Waters of Victoria), its schedules and best practice guidelines.

(c) Sedimentation Basins

Where sedimentation basins are proposed as control measures, basins shall be designed to contain flows from a rainfall event having an Average Recurrence Interval of not less than 2 years and 6 hours duration when allowing for a 30% reduction in capacity as a result of sediment accumulation.

Sedimentation basins shall be modelled and sized to manage rainfall intensities and soil characteristics specific to the region shall be used. The sizing and modelling of sedimentation basin(s) shall consider the expected works and associated area of disturbance within catchment areas(s) within the site.

The sizing and modelling of temporary sedimentation basins shall be undertaken utilising recognised 'best practice' modelling techniques or by utilising 'VicRoads Temporary Sedimentation Basin Design Tool'.

Spillways or bypass systems (installations that divert all clean surface flows around a works site) shall be designed for an event having an Average Recurrence Interval of 5 years.

An independent hydraulic consultant who has demonstrated competence and suitable experience in the design of temporary sedimentation basins, shall complete and sign a declaration in accordance with the proforma included in Appendix E2 of this specification. The declaration shall accompany submission of the sedimentation basin designs to the Superintendent.

HP[1] ***The Contractor shall submit to the Superintendent the temporary sedimentation designs and the associated independent verification declarations not less than 2 weeks prior to the commencement of construction of the temporary sedimentation basin.***

Sedimentation basins shall be cleaned out whenever the accumulated sediment has reduced the capacity of the basin by 30 percent or more, or whenever the sediment has built up to a point where it is less than 500 mm below the spillway crest, whichever occurs earlier.

The Contractor shall maintain the capacity of the sedimentation basin and shall ensure compliance with Clause 1200.04(b)(ii) if dewatering to a waterway.

(d) Stockpiles

Where soil is stockpiled on Site, such stockpiles shall be located, where possible, to provide a clearance of not less than 10 metres from waters. Where it is not possible to provide a clearance of 10 metres, the stockpile shall be above the normal high water level of the waters and additional protection shall be provided to prevent the stockpiled material entering the waters.

(e) Monitoring

The Contractor shall monitor the whole Site for instances of soil erosion or scour and the effectiveness of erosion and sedimentation controls in accordance with the following:

- *at intervals not more than 7 days;*
- *within one hour of the commencement of any runoff resulting from rain events during working hours;*
- *every 4 hours during periods of continuous rain during working hours; and*
- *within 12 hours of a rain event outside working hours.*

[1] Hold Point

Any defects and/or deficiencies in control measures identified by monitoring undertaken shall be rectified immediately and these control measures shall be cleaned, repaired and augmented as required to ensure effective control thereafter.

Additional, Project specific controls are also proposed to reduce risks to soils and geology includes:

- If soils are to be reused on site, liaise with EPA to determine soil reuse options in accordance with the "State Environment Protection Policy (Prevention and Management of Contamination of Land) No. S95", (4-June-2002).
- Where contaminated soils are identified, or occur as a result of chemical spills on site, an assessment is to be undertaken in accordance with the "State Environment Protection Policy (Prevention and Management of Contamination of Land) No. S95", (4-June-2002), the "National Environment Protection (Assessment of Site Contamination) Measure", (NEPC 1999) and the Australian Standard AS4482.1 – 2005, "Guide to the sampling and investigation of potentially contaminated soil" and the nominated beneficial uses of land as defined by the SEPP.
- Where concentrations of contaminants impact the beneficial uses identified in the SEPP as a result of contamination caused by construction or operation activities, soil remediation and groundwater contamination investigations may be required. Where remediation works are required, remediation of soil and groundwater (if required), should be completed to the extent practicable.
- Where soils exhibit indicators of AASS or PASS, a "Stage B: Detailed site soil sampling program and assessment" should be undertaken in accordance with the CASS Best Practice Guidelines (CASS BPG) (October 2010).
- Soils to be stockpiled onsite are to be placed on plastic and covered to prevent spread of the material via transport vectors such as wind and rain. Prior to re-use or off-site disposal, stockpiled soil is to be classified in accordance with EPA Industrial Waste Resource Guideline (IWRG) 621 "Soil Hazard Categorisation and Management" with frequency of sampling to be performed in accordance with EPA IWRG 702 "Soil Sampling".
- Where soils are to be imported to the site (for example, for the purpose of site levelling and/or temporary construction requirements), all soils shall 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; and
  - Shall meet the requirements of the State Environment Protection Policy (Prevention and Management of Contamination of Land) No. S95, 4-June-2002 (Land SEPP).
- Where soils exhibit susceptibility to erosion, measures required during the construction to manage short and long term soil erosion to include, but not limited to:
  - EPA Publication 480 Best Practice Environmental Management: Environmental Guidelines for Major Construction Sites; and
  - EPA Publication 275 Construction Techniques for Sediment Pollution Control.
- The design and construction should limit or prevent surface water channelization.

- Earthworks are expected to be dominated by the need for fill above the natural surface to achieve drainage and greater flood control. Fill material would be sourced from surplus materials from site, and additional sources including local quarries, and possible borrow pits under arrangement between Contractors and local land owners and with required approvals.
- Road pavement materials would be sourced from appropriately licenced facilities to meet quality requirements as per VicRoads specifications.
- Surplus material that cannot be used on site would be re-used or disposed of in the following order of priority:
  - Transfer to nearby VicRoads projects for immediate use or to an approved VicRoads stockpile site for future use;
  - Transfer to an alternative VicRoads approved site for re-use on concurrent private/local government project; or
  - Disposal at an accredited materials recycling, waste disposal facility or approved borrow pit.

7.2 Operation

Project specific controls proposed that would reduce risks to geology and soils during operation include:

- Where contaminated soils occur as a result of chemical spills on site, an assessment is to be undertaken in accordance with the Land SEPP, the National Environment Protection (Assessment of Site Contamination) Measure, NEPC 1999, and the Australian Standard, Guide to the sampling and investigation of potentially contaminated soil AS4482.1 – 2005 and the nominated beneficial uses of land as defined by the SEPP.
- Where concentrations of contaminants exceed the beneficial uses identified in the SEPP as a result of contamination caused by construction or operation activities, soil remediation and groundwater contamination investigations may be required. Where remediation works are required, remediation of soil and groundwater (if required), should be completed to the extent practicable.
- Suspected or known contaminated soils including topsoils should be stockpiled on plastic and covered to prevent spread of the material via transport vectors such as wind and rain. Prior to re-use or off-site disposal, stockpiled soil is to be classified in accordance with EPA Industrial Waste Resource Guideline (IWRG) 621 “Soil Hazard Categorisation and Management” with frequency of sampling to be performed in accordance with EPA IWRG 702 “Soil Sampling”.
- Where soils are to be imported to the site (for example, for the purpose of site levelling and/or temporary construction requirements), all soils shall 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;
  - Have contaminant concentrations that will not be detrimental to the receiving environment and human health; and
  - Shall meet the requirements of the Land SEPP.
- All VicRoads maintenance contractors are required to develop an Environmental Management Plan (EMP) that includes specific procedures to mitigate the effect on the environment from fuels and

chemicals including herbicides and pesticides. In the event of a fuel or chemical spill during operation of the Project the procedures in this CEMP will be implemented. These procedures include, but are not limited to:

- Providing readily accessible and maintained hydrocarbon spill kits to the purpose of cleaning up oil and fuel spillages on the site; and
- Ensuring that personnel trained in the efficient deployment of the spill kits are readily available in the event of spillages.

7.3 Summary

Table 9 presents a summary of the mitigation measures that have been identified to avoid, reduce or minimise impact risk. The measures comprise both relevant requirements of the VicRoads standard environmental protection measures as well as the additional measures identified by this impact assessment. The aim to achieve the relevant EES Objectives described in Section 2.1.

Table 9 Environmental Management Measures

Risk No.	Risk Description	Management Measures	Responsibility
G1	There is a potential that contaminated soils could be encountered during construction of the duplication resulting in exposure of construction works to contaminated soils.	The discovery of contaminated material on the site during construction works shall be managed in accordance with VicRoads and EPA Guidelines. Where putrescible waste material is encountered, the Superintendent and EPA shall be notified. Construction works along the affected area shall stop until a mitigation plan is established and agreed between the relevant project stakeholders. The Contractor shall undertake a visual assessment of the Site for contaminated soil and uncontrolled waste during construction works. A Construction Environmental Management Plan (CEMP) developed to provide details on appropriate methods for managing contaminated soils. 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.	VicRoads
G2	An uncontained spill or leak of chemicals occurs during construction of the duplication.	Refer to management details detailed in G1 for soils that are contaminated by an uncontrolled spill or leak. 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 shall be visually monitored at intervals of not more than 7 day to mitigate contamination in a timely manner. Additional management measures may be required depending on the CEMP which would include: - Appropriate procedures for containing spills and	VicRoads

Risk No.	Risk Description	Management Measures	Responsibility
		leaks should be contained. - Appropriate methods for cleaning up spills and leaks where safe to do so.	
G3	Potentially contaminated runoff reaching sensitive water ways during and after construction	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) Road construction should include design features to mitigate runoff of spills into waterways.	VicRoads
G4	Excavation encounters unstable geological units or erosion prone areas. Geological units of Cambro-Ordovician origin may be more prone to erosional processes on exposure.	Geotechnical investigations would be conducted prior to construction to assess nature of soils encountered along the alignment. 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. Detailed design cuts and final batter slopes to appropriately reflect the local geological and geotechnical conditions. Improved surface drainage measures in the management of erosion and sediment control.	VicRoads
G5	Soft or compressible soils are present along the alignment.	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. 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. 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.	VicRoads
G6	Imbalance in the volume of suitable fill and the volume of excavated material.	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:	VicRoads

Risk No.	Risk Description	Management Measures	Responsibility
		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 Assess likely earthworks volumes during design to optimise solution (balance cut and fill where possible).	
G7	Construction intersects Acid Sulfate Soils, potential disturbance and exposure to air	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.	VicRoads
G8	Construction intersects historic mining works, including deep lead and shallow workings.	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.	VicRoads

8. Conclusion

The draft EES evaluation objective relevant to the soils and geology assessment outlined in the Scoping Requirements was as follows:

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

The assessment was undertaken in accordance with the EES Scoping Requirements.

Based on the soils and geology existing conditions review and identified impacts, the potential for significant widespread contamination was considered moderate, with some localised contamination potentially existing as a result of general farming and other activities.

Existing Conditions

In accordance with the land SEPP, the quality of the land environment must be maintained to maximise to the extent practicable the beneficial uses of the land environment. Therefore, the effective identification of potential sources of impact is considered important to protect human health and the environment. The potential for contamination in the Project area is generally associated with farming practices such as:

- Sheep dip sites used to treat livestock for pests,
- Application of fertilisers or other pastoral improvement substances across individual fields sub regions; and
- Filling of dams, quarries or borrow pits with contaminated soils or other wastes.
- Further to the above, the following potential land uses may give rise to soil contamination;
- Services Stations;
- Railway lines; and
- Uncontrolled mine tailings.

Aerial photography shows that the majority of the project area between Beaufort and Ararat has been used for farming (typically grazing and agriculture).

No evidence of contamination was observed during an inspection of the project area although potential sources of contamination were identified including a services station, farm / shearing sheds and associated infrastructure and the Ballarat to Ararat rail corridor. Progressive rill erosion was noted across the numerous cuttings along the existing highway alignment.

In terms of a geological setting:

- A review of published maps providing information about the potential occurrence of ASS indicated that the project area is not within an ASS risk area;
- Published geological and soil indicate the geology of the study area consists of Cambro-Ordovician marine sedimentary rocks, Devonian intrusive volcanics, Quaternary extrusive volcanics and unconsolidated Quaternary sediments;
- The areas around Ararat and Beaufort were historically mined for gold and as such, there is a potential for encountering old mine workings in the project area; and

- Cambro-Ordovician and contacting intrusive volcanics were noted during site inspection to appear prone to erosion, with exposures exhibiting rill erosion.

Positive Impacts

The positive impacts of the Project during construction as they relate to soils and geology are the protection of the environment where the proposed alignment follows the existing alignment as it may effectively manage issues relating to containment of uncontrolled spills by incorporating improved drainage, particularly at waterway crossings.

Negative Impacts

The negative impacts of the Project during construction as they relate to soils and geology are:

- Taking into account land use type and the location of these in relation to the proposed construction, it is considered that there may be potential risks to human health and the environment at locations where the proposed duplication alignment encounters potential sources of contamination, such as sheep dips, in-filled dams, quarries and borrow pits, uncontrolled mine tailings and at locations in close proximity or intersection with the railway lines.
- Considering the alignment options encounter common geological units across the study area the only significant distinction between the three alignment options in terms of geology is found in the vicinity of the Langi Ghiran Railway cutting, in which the contact between Devonian granite intrusion and the Cambro-Ordovician sedimentary sequence is exposed. This complex granite-bedrock contact (exposure) has been documented as a site of geological significance by the Geological Survey of Victoria (King, 1986). A zone of folding and metamorphic alteration is evident close to this contact which dominates over a length of some 300 m, characterised by variable ground conditions and distinctly orientated planes of weakness. Construction activities within 300 m of the point of contact would present physical construction difficulties (unfavourable bedding and discontinuities) and on-going maintenance issues. As such, the proposed Project alignment options 2 and 3 would be less preferred in terms of the prevailing geological setting than Option 1.

Notwithstanding, all of the adverse impacts identified in the course of this assessment can be efficiently managed and mitigated through the implementing of the measures outlined in Section 7 of this report.

Preferred Alignment Option

Overall, from a soil and geology perspective, Alignment Option 1 is preferred on the balance of impacts under the key categories to assess the risk to sensitive receptors (human or ecological). This assertion is based on assessment under the criterion of encountering contaminated soil; contaminated runoff entering sensitive waterways; encountering unstable geological units, erosion prone areas, or soft and compressible materials; and imbalance of cut and fill volumes.

9. References

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Appendix A

Historic Boreholes

GEDIS

GEDIS Borehole System

Borehole Details

Borehole Summary Information

Site ID:	46183
Parish Name:	ARARAT 10002
Purpose:	Groundwater
Sub Purpose:	
Method:	Percussion (cable)
Usage:	
Status:	Abandoned
Other Names:	Rural Water Comm Borehole Name: 046183

Location:

Datum	MGAEm	MGANm	MGA Zone	Latitude	Longitude	+/-	Method
GDA94	673418	5871842	54	37.28387	142.95622	300.0 m	Digitised metric

Location Check:	
Elevation:	-999.0 m Kelly Bush: Unknown Elevation Acc: Unknown
Maps	Ararat(7423.2.1) 1:25000
Orientation/Depth:	Measured Depth: 28.95 m Collar Inclination: Unknown Collar Azimuth: Unknown
Authority:	Dept. Manufacturing & Industry
Regulation:	Department of Health (Act unknown)
Operator:	Department of Health
Contractor:	Unknown (or Not Specified)
Completed On:	26/05/1975
Child Borehole Details:	None Recorded

Contact :

Selected core is available for inspection at Werribee, Contact
A. Olshina
GeoScience Victoria
GPO Box 4440 Melbourne Victoria 3001
Email: avi.olshina@dpi.vic.gov.au
Ph: (03) 9658 4533
Fax: (03) 9658 4555

Available Data

Attributes		Links		External Data	
Core Samples:	0	Tenements:		Aquifer:	0
Lithology Log:	1	References:		Construction:	0
Qualitative Log:	0	Surveys:		Water Chem:	0
Quantitative Log:	0	Projects:	2	Water Level:	0
Strat Log:	0	Notes:		Pump Test:	0
Biostratigraphy:	0	Petroleum Well:	0		
Geophys Logs:	0	Petroleum Casing:	0		
Temp Samples:	0				
Collar Data:	0				
Downhole Survey:	0				

Borehole Project Details

Project Code	Project Description
LITHO	Lithological Logs
TEMP	Temporary marker

No Borehole Notes Recorded

No Borehole References Recorded

No Borehole Core Samples Recorded

Lithological Logs

Drillers Log created by UNKNOWN on May 26, 1975

From	To	Comments
0.0	13.54	SANDY CLAY
13.54	27.43	BASALT
27.43	28.95	GREY PIPE CLAY

No Borehole Quantitative Logs Recorded

No Borehole Qualitative Logs Recorded

No Borehole Stratigraphic logs Recorded

No Borehole Biostratigraphy Recorded

No Borehole Geophysical Header Logs Recorded

No Borehole Geophysical Data Logs Recorded

No Geothermal Information Recorded

No Down Hole Survey Information Recorded

No Collar Information Recorded

GEDIS Borehole System

Borehole Details

Borehole Summary Information

Site ID:	46184
Parish Name:	ARARAT 10003
Purpose:	Groundwater
Sub Purpose:	
Method:	Percussion (cable)
Usage:	
Status:	Abandoned
Other Names:	Rural Water Comm Borehole Name: 046184

Location:	Datum	MGAEm	MGANm	MGA Zone	Latitude	Longitude	+/-	Method
	GDA94	673418	5871854	54	37.28376	142.95622	300.0 m	Digitised metric

Location Check:	
Elevation:	-999.0 m Kelly Bush: Unknown Elevation Acc: Unknown
Maps	Ararat(7423.2.1) 1:25000
Orientation/Depth:	Measured Depth: 30.48 m Collar Inclination: Unknown Collar Azimuth: Unknown
Authority:	Dept. Manufacturing & Industry
Regulation:	Department of Health (Act unknown)
Operator:	Department of Health
Contractor:	Unknown (or Not Specified)
Completed On:	16/05/1975
Child Borehole Details:	None Recorded

Contact : Selected core is available for inspection at Werribee, Contact

A. Olshina
GeoScience Victoria
GPO Box 4440 Melbourne Victoria 3001
Email: avi.olshina@dpi.vic.gov.au
Ph: (03) 9658 4533
Fax: (03) 9658 4555

Available Data

Attributes		Links		External Data	
Core Samples:	0	Tenements:		Aquifer:	1975
Lithology Log:	1	References:		Construction:	0
Qualitative Log:	0	Surveys:		Water Chem:	0
Quantitative Log:	0	Projects:	2	Water Level:	0
Strat Log:	0	Notes:		Pump Test:	0
Biostratigraphy:	0	Petroleum Well:	0		
Geophys Logs:	0	Petroleum Casing:	0		
Temp Samples:	0				
Collar Data:	0				
Downhole Survey:	0				

Borehole Project Details

Project Code	Project Description
LITHO	Lithological Logs
TEMP	Temporary marker

No Borehole Notes Recorded

No Borehole References Recorded

No Borehole Core Samples Recorded

Lithological Logs

Drillers Log created by UNKNOWN on May 16, 1975

From	To	Comments
0.0	4.87	EARTH & CLAY
4.87	6.4	GREY CLAY
6.4	21.34	PUG CLAY
21.34	22.86	SCORIA
22.86	24.38	BASALT
24.38	30.48	BASALT

No Borehole Quantitative Logs Recorded

No Borehole Qualitative Logs Recorded

No Borehole Stratigraphic logs Recorded

No Borehole Biostratigraphy Recorded

No Borehole Geophysical Header Logs Recorded

No Borehole Geophysical Data Logs Recorded

No Geothermal Information Recorded

No Down Hole Survey Information Recorded

No Collar Information Recorded

GEDIS Borehole System

Borehole Details

Borehole Summary Information

Site ID:	52333							
Parish Name:	BUANGOR 1							
Purpose:	Groundwater							
Sub Purpose:								
Method:								
Usage:	Groundwater Investigation							
Status:								
Other Names:	Rural Water Comm Borehole Name: 052333							
Location:	Datum	MGAEm	MGANm	MGA Zone	Latitude	Longitude	+/-	Method
	GDA94	692743	5862212	54	37.36681	143.17657	300.0 m	Digitised metric
Location Check:								
Elevation:	339.54 m Kelly Bush: Unknown Elevation Acc: Unknown							
Maps	Warrak(7523.3.1) 1:25000							
Orientation/Depth:	Measured Depth: 44.501 m Collar Inclination: Unknown Collar Azimuth: Unknown							
Authority:	Dept. Manufacturing & Industry							
Regulation:	Regulation Unknown							
Operator:	Department of Manufacturing & Industry Development, Victoria							
Contractor:	Unknown (or Not Specified)							
Completed On:	31/12/1959							
Child Borehole Details:	None Recorded							

Contact :

Selected core is available for inspection at Werribee, Contact
A. Olshina
GeoScience Victoria
GPO Box 4440 Melbourne Victoria 3001
Email: avi.olshina@dpi.vic.gov.au
Ph: (03) 9658 4533
Fax: (03) 9658 4555

Available Data

Attributes		Links		External Data	
Core Samples:	1	Tenements:		Aquifer:	1959
Lithology Log:	1	References:		Construction:	0
Qualitative Log:	0	Surveys:		Water Chem:	0
Quantitative Log:	0	Projects:	3	Water Level:	0
Strat Log:	0	Notes:		Pump Test:	0
Biostratigraphy:	0	Petroleum Well:	0		
Geophys Logs:	0	Petroleum Casing:	0		
Temp Samples:	0				
Collar Data:	0				
Downhole Survey:	0				

Borehole Project Details

Project Code	Project Description
CORE	Core record
LITHO	Lithological Logs
TEMP	Temporary marker

No Borehole Notes Recorded

No Borehole References Recorded

Core Samples

From	To	Orig	Type	Recovery	Location	Trays	Bay	From Row	To Row
0.305 m	44.501 m	F	Cuttings	Unknown	CORE	1	012	Q	Q

Lithological Logs

Geologists Log created by UNKNOWN on December 31, 1959

From	To	Comments
0.0	0.31	SURFACE SOIL
0.31	0.91	GREY SILTY CLAY
0.91	2.13	GREY MOTTLED CLAY & GRAVEL
2.13	4.88	RED MOTTLED CLAY
4.88	11.28	YELLOW SANDY CLAY
11.28	20.73	VESICULAR BASALT
20.73	34.75	BLUE CLAY & SOFT BASALT
34.75	35.36	BASALT SOFT
35.36	37.8	DARK GREY CLAY
37.8	44.5	BEDROCK

No Borehole Quantitative Logs Recorded

No Borehole Qualitative Logs Recorded

No Borehole Stratigraphic logs Recorded

No Borehole Biostratigraphy Recorded

No Borehole Geophysical Header Logs Recorded

No Borehole Geophysical Data Logs Recorded

No Geothermal Information Recorded

No Down Hole Survey Information Recorded

No Collar Information Recorded

GEDIS Borehole System

Borehole Details

Borehole Summary Information

Site ID:	52334
Parish Name:	BUANGOR 2
Purpose:	Groundwater
Sub Purpose:	
Method:	Percussion (cable)
Usage:	Drought | Groundwater Observation
Status:	
Other Names:	Location of bore: BUANGOR T/SHIP Drilling Rig Borehole Name: 07/78/004 Rural Water Comm Borehole Name: 052334

Location:	Datum	MGAEm	MGANm	MGA Zone	Latitude	Longitude	+/-	Method
	GDA94	691921	5862177	54	37.36729	143.16731	100.0 m	Approximation from map

Location Check:	
Elevation:	-999.0 m Kelly Bush: Unknown Elevation Acc: Unknown
Maps	Warrak(7523.3.1) 1:25000
Orientation/Depth:	Measured Depth: 86.38 m Collar Inclination: Unknown Collar Azimuth: Unknown
Authority:	Dept. Manufacturing & Industry
Regulation:	Regulation Unknown
Operator:	Department of Manufacturing & Industry Development, Victoria
Contractor:	Unknown (or Not Specified)
Completed On:	22/08/1978
Child Borehole Details:	None Recorded

Contact :	Selected core is available for inspection at Werribee, Contact A. Olshina GeoScience Victoria GPO Box 4440 Melbourne Victoria 3001 Email: avi.olshina@dpi.vic.gov.au Ph: (03) 9658 4533 Fax: (03) 9658 4555

Available Data

Attributes		Links		External Data	
Core Samples:	2	Tenements:		Aquifer:	1967
Lithology Log:	2	References:		Construction:	1967
Qualitative Log:	0	Surveys:		Water Chem:	0
Quantitative Log:	0	Projects:	4	Water Level:	0
Strat Log:	0	Notes:		Pump Test:	0
Biostratigraphy:	0	Petroleum Well:	0		
Geophys Logs:	0	Petroleum Casing:	0		
Temp Samples:	0				
Collar Data:	0				

Attributes	Links	External Data
Downhole Survey: 0		

Borehole Project Details

Project Code	Project Description
CORE	Core record
GWATE	Ground Water Projects
LITHO	Lithological Logs
TEMP	Temporary marker

No Borehole Notes Recorded

No Borehole References Recorded

Core Samples

From	To	Orig	Type	Recovery	Location	Trays	Bay	From Row	To Row
20.5 m	21.5 m	M	Drill Core	Unknown	CORE	1	088	N	N
81.0 m	86.34 m	M	Drill Core	Unknown	CORE	1	088	N	N

Lithological Logs

Drillers Log created by UNKNOWN on September 1, 1978

From	To	Comments
0.0	9.7	CLAY
9.7	79.5	CLAY BASALT
79.5	86.38	SANDSTONE - DEEPENED FROM 1968 BORE OP EN HOLE

Geologists Log created by UNKNOWN on December 31, 1967

From	To	Comments
0.0	0.31	SURFACE GRAVEL
0.31	1.22	DARK BROWN CLAY
1.22	2.13	LIGHT BROWN CLAY
2.13	4.88	LIGHT BROWN CLAY AND STONE
4.88	7.32	LIGHT BROWN CLAY
7.32	9.75	GREY CLAY
9.75	14.02	HARD BLACK BASALT
14.02	18.9	HARD GREY BASALT

No Borehole Quantitative Logs Recorded

No Borehole Qualitative Logs Recorded

No Borehole Stratigraphic logs Recorded

No Borehole Biostratigraphy Recorded

No Borehole Geophysical Header Logs Recorded

No Borehole Geophysical Data Logs Recorded

No Geothermal Information Recorded

No Down Hole Survey Information Recorded

No Collar Information Recorded

GEDIS Borehole System

Borehole Details

Borehole Summary Information

Site ID:	52335
Parish Name:	BUANGOR 3
Purpose:	Groundwater
Sub Purpose:	
Method:	Percussion (cable)
Usage:	
Status:	
Other Names:	Drilling Rig Borehole Name: 07/78/003
	Rural Water Comm Borehole Name: 052335

Location:	Datum	MGAEm	MGANm	MGA Zone	Latitude	Longitude	+/-	Method
	GDA94	692617	5862187	54	37.36706	143.17516	300.0 m	Digitised metric

Location Check:	
Elevation:	337.18 m Kelly Bush: Unknown Elevation Acc: Unknown
Maps	Warrak(7523.3.1) 1:25000
Orientation/Depth:	Measured Depth: 18.0 m Collar Inclination: Unknown Collar Azimuth: Unknown
Authority:	Dept. Manufacturing & Industry
Regulation:	Regulation Unknown
Operator:	Department of Manufacturing & Industry Development, Victoria
Contractor:	Unknown (or Not Specified)
Completed On:	15/12/1978
Child Borehole Details:	None Recorded

Contact : Selected core is available for inspection at Werribee, Contact

A. Olshina
GeoScience Victoria
GPO Box 4440 Melbourne Victoria 3001
Email: avi.olshina@dpi.vic.gov.au
Ph: (03) 9658 4533
Fax: (03) 9658 4555

Available Data

Attributes		Links		External Data	
Core Samples:	0	Tenements:		Aquifer:	0
Lithology Log:	0	References:		Construction:	0
Qualitative Log:	0	Surveys:		Water Chem:	0
Quantitative Log:	0	Projects:	1	Water Level:	0
Strat Log:	0	Notes:	1	Pump Test:	0
Biostratigraphy:	0	Petroleum Well:	0		
Geophys Logs:	0	Petroleum Casing:	0		
Temp Samples:	0				
Collar Data:	0				

Attributes	Links	External Data
Downhole Survey: 0		

Borehole Project Details

Project Code	Project Description
TEMP	Temporary marker

Borehole Notes

Note Subject	Note Text
2243/00003-00003 CANCELLED-NOW STRANGWAYS 5	

No Borehole References Recorded

No Borehole Core Samples Recorded

No Lithology Logs Recorded

No Borehole Quantitative Logs Recorded

No Borehole Qualitative Logs Recorded

No Borehole Stratigraphic logs Recorded

No Borehole Biostratigraphy Recorded

No Borehole Geophysical Header Logs Recorded

No Borehole Geophysical Data Logs Recorded

No Geothermal Information Recorded

No Down Hole Survey Information Recorded

No Collar Information Recorded

GEDIS Borehole System

Borehole Details

Borehole Summary Information

Site ID:	52338
Parish Name:	BUANGOR 10001
Purpose:	Groundwater
Sub Purpose:	
Method:	
Usage:	Domestic & Stock water supply
Status:	
Other Names:	Rural Water Comm Borehole Name: 052338

Location:	Datum	MGAEm	MGANm	MGA Zone	Latitude	Longitude	+/-	Method
	GDA94	692629	5861984	54	37.36889	143.17535	300.0 m	Digitised metric

Location Check:	
Elevation:	-999.0 m Kelly Bush: Unknown Elevation Acc: Unknown
Maps	Warrak(7523.3.1) 1:25000
Orientation/Depth:	Measured Depth: 12.95 m Collar Inclination: Unknown Collar Azimuth: Unknown
Authority:	Rural Water Commission
Regulation:	Groundwater Act
Operator:	Private Individual/Corporation
Contractor:	Unknown (or Not Specified)
Completed On:	24/01/1973
Child Borehole Details:	None Recorded

Contact :

Selected core is available for inspection at Werribee, Contact
A. Olshina
GeoScience Victoria
GPO Box 4440 Melbourne Victoria 3001
Email: avi.olshina@dpi.vic.gov.au
Ph: (03) 9658 4533
Fax: (03) 9658 4555

Available Data

Attributes		Links		External Data	
Core Samples:	0	Tenements:		Aquifer:	1973
Lithology Log:	1	References:		Construction:	0
Qualitative Log:	0	Surveys:		Water Chem:	0
Quantitative Log:	0	Projects:	2	Water Level:	0
Strat Log:	0	Notes:		Pump Test:	0
Biostratigraphy:	0	Petroleum Well:	0		
Geophys Logs:	0	Petroleum Casing:	0		
Temp Samples:	0				
Collar Data:	0				
Downhole Survey:	0				

Borehole Project Details

Project Code	Project Description
LITHO	Lithological Logs
TEMP	Temporary marker

No Borehole Notes Recorded

No Borehole References Recorded

No Borehole Core Samples Recorded

Lithological Logs

Drillers Log created by UNKNOWN on January 22, 1973

From	To	Comments
0.0	0.3	NO DETAILS AVAILABLE
0.3	0.91	TOPSOIL
0.91	10.97	CLAY
10.97	12.95	SAND

No Borehole Quantitative Logs Recorded

No Borehole Qualitative Logs Recorded

No Borehole Stratigraphic logs Recorded

No Borehole Biostratigraphy Recorded

No Borehole Geophysical Header Logs Recorded

No Borehole Geophysical Data Logs Recorded

No Geothermal Information Recorded

No Down Hole Survey Information Recorded

No Collar Information Recorded

GEDIS Borehole System

Borehole Details

Borehole Summary Information

Site ID:	52339
Parish Name:	BUANGOR 10002
Purpose:	Groundwater
Sub Purpose:	
Method:	Percussion (cable)
Usage:	Domestic & Stock water supply
Status:	
Other Names:	Bore Construction Permit No: C/4308
	Rural Water Comm Borehole Name: 052339

Location:	Datum	MGAEm	MGANm	MGA Zone	Latitude	Longitude	+/-	Method
	GDA94	692198	5862148	54	37.3675	143.17046	300.0 m	Digitised metric

Location Check:	
Elevation:	-999.0 m Kelly Bush: Unknown Elevation Acc: Unknown
Maps	Warrak(7523.3.1) 1:25000
Orientation/Depth:	Measured Depth: 30.48 m Collar Inclination: Unknown Collar Azimuth: Unknown
Authority:	Rural Water Commission
Regulation:	Groundwater Act
Operator:	Private Individual/Corporation
Contractor:	Unknown (or Not Specified)
Completed On:	04/12/1973
Child Borehole Details:	None Recorded

Contact :

Selected core is available for inspection at Werribee, Contact
A. Olshina
GeoScience Victoria
GPO Box 4440 Melbourne Victoria 3001
Email: avi.olshina@dpi.vic.gov.au
Ph: (03) 9658 4533
Fax: (03) 9658 4555

Available Data

Attributes		Links		External Data	
Core Samples:	1	Tenements:		Aquifer:	0
Lithology Log:	1	References:		Construction:	0
Qualitative Log:	0	Surveys:		Water Chem:	0
Quantitative Log:	0	Projects:	3	Water Level:	0
Strat Log:	0	Notes:		Pump Test:	0
Biostratigraphy:	0	Petroleum Well:	0		
Geophys Logs:	0	Petroleum Casing:	0		
Temp Samples:	0				
Collar Data:	0				

Attributes	Links	External Data
Downhole Survey: 0		

Borehole Project Details

Project Code	Project Description
CORE	Core record
LITHO	Lithological Logs
TEMP	Temporary marker

No Borehole Notes Recorded

No Borehole References Recorded

Core Samples

From	To	Orig	Type	Recovery	Location	Trays	Bay	From Row	To Row
11.887 m	30.48 m	F	Cuttings	Unknown	CORE	1	098	R	R

Lithological Logs

Drillers Log created by UNKNOWN on December 4, 1973

From	To	Comments
0.0	2.44	SURFACE CLAY
2.44	6.1	MIXED CLAY
6.1	9.15	YELLOW CLAY
9.15	11.89	YELLOW & WHITE CLAY
11.89	14.63	YELLOW & BROWN CLAY & QUARTZ
14.63	17.68	YELLOW & BROWN CLAY & QUARTZ
17.68	21.34	YELLOW & BROWN CLAY & QUARTZ
21.34	22.86	YELLOW & BROWN CLAY & QUARTZ
22.86	24.99	YELLOW & BROWN CLAY & QUARTZ
24.99	27.43	BROWN & YELLOW CLAY & SHALE & QUARTZ
27.43	30.48	BROWN & YELLOW CLAY SHALE & QUARTZ

No Borehole Quantitative Logs Recorded

No Borehole Qualitative Logs Recorded

No Borehole Stratigraphic logs Recorded

No Borehole Biostratigraphy Recorded

No Borehole Geophysical Header Logs Recorded

No Borehole Geophysical Data Logs Recorded

No Geothermal Information Recorded

No Down Hole Survey Information Recorded

No Collar Information Recorded

GEDIS Borehole System

Borehole Details

Borehole Summary Information

Site ID:	74235
Parish Name:	LANGI-GHIRAN 10001
Purpose:	Groundwater
Sub Purpose:	
Method:	
Usage:	Stock/Poultry water supply
Status:	
Other Names:	Rural Water Comm Borehole Name: 074235

Location:	Datum	MGAEm	MGANm	MGA Zone	Latitude	Longitude	+/-	Method
	GDA94	678248	5868792	54	37.31043	143.01141	300.0 m	Digitised metric

Location Check:	
Elevation:	-999.0 m Kelly Bush: Unknown Elevation Acc: Unknown
Maps	Dobie(7523.3.4) 1:25000
Orientation/Depth:	Measured Depth: 51.85 m Collar Inclination: Unknown Collar Azimuth: Unknown
Authority:	Rural Water Commission
Regulation:	Groundwater Act
Operator:	Private Individual/Corporation
Contractor:	Unknown (or Not Specified)
Completed On:	24/01/1973
Child Borehole Details:	None Recorded

Contact :

Selected core is available for inspection at Werribee, Contact
A. Olshina
GeoScience Victoria
GPO Box 4440 Melbourne Victoria 3001
Email: avi.olshina@dpi.vic.gov.au
Ph: (03) 9658 4533
Fax: (03) 9658 4555

Available Data

Attributes		Links		External Data	
Core Samples:	0	Tenements:		Aquifer:	1973
Lithology Log:	1	References:		Construction:	0
Qualitative Log:	0	Surveys:		Water Chem:	0
Quantitative Log:	0	Projects:	2	Water Level:	0
Strat Log:	0	Notes:		Pump Test:	0
Biostratigraphy:	0	Petroleum Well:	0		
Geophys Logs:	0	Petroleum Casing:	0		
Temp Samples:	0				
Collar Data:	0				
Downhole Survey:	0				

Borehole Project Details

Project Code	Project Description
LITHO	Lithological Logs
TEMP	Temporary marker

No Borehole Notes Recorded

No Borehole References Recorded

No Borehole Core Samples Recorded

Lithological Logs

Drillers Log created by UNKNOWN on January 24, 1973

From	To	Comments
0.0	30.5	FINE DECOMPOSED REEF & FINE CLAY VERY LITTLE GRAVEL & SOME SOLID DECOMPOSED REEF
30.5	51.85	THIN BAND OF GRAVEL DECOMPOSED REEF FINE CLAY OF PINKISH COLOUR CHANGING TO LIGHT YELLOW

No Borehole Quantitative Logs Recorded

No Borehole Qualitative Logs Recorded

No Borehole Stratigraphic logs Recorded

No Borehole Biostratigraphy Recorded

No Borehole Geophysical Header Logs Recorded

No Borehole Geophysical Data Logs Recorded

No Geothermal Information Recorded

No Down Hole Survey Information Recorded

No Collar Information Recorded

Appendix B

Historic Aerial Photographs

Review

Western Highway Project - Section 2 Zone 1

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arcmap GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description / Justification*
1947	P: 906/6 F: 603 R: 09 Ph:40	4750	Other	Gap in vegetation along existing highway adjacent to alignment 1B - may be part of creek bed adjacent to northeast (polygonID52)	Rural residential and farming properties were observed around the study area. Isolated area of high density vegetation were also noted. The study area follows the alignment of the Melbourne to Adelaide rail corridor.	Rail corridor
	P: 906/6 F: 603 R: 09 Ph:40	4752	Other	Creek bed- possibly dry- intersects Alignments 1A 1B		
	P: 906/6 F: 603 R: 09 Ph:42	4747	Dam	Adjacent to existing highway ~ 50 m north of alignment 1AB		
	P: 906/6 F: 603 R: 09 Ph:42	4749	Disturbed earth	Lack of vegetation and grass- possible paddock entry point- in path of alignment 1AB		
	P: 909/6 F: 603 R: 9 Ph: 40	4756	Other	Creek bed- possibly dry- intersects Alignments 1A 1B (Also ID: 4755)		
	P: 906/6 F: 602 R: 7 Ph: 78	4721	Rural Residential	Outside buffer		
	P: 906/6 F: 602 R:8 Ph: 125	4708	Low density vegetation			
	P: 906/6 F: 602 R: 7 Ph: 76	22	Low density vegetation			
	P: 906/6 F: 602 R: 7 Ph: 78	21	Rural Residential			
	P: 906/6 F: 603 R: 09 Ph:40	4751	Other	Creek bed- possibly dry adjacent to southwest side of existing highway		
	P: 906/6 F: 603 R:9 P: 40	75	High density vegetation	Outside buffer		
	P: 909/6 F: 603 R: 9 Ph: 40	4753	Other	Clearing in vegetation- possible service road Adjacent to existing highway southwest of alignments 1A and 2B		
	P: 906/6 F: 603 R:9 Ph: 42	4	Dam	North of existing highway and alignment 1AB		
	P: 906/6 F: 603 R:9 Ph: 42	1	Dam	Within buffer to the north of existing highway		
1958	No photo's for zone 1 in 1950's					
1966	P: 550 F: 1913 R: 33 Ph: 65	6601	Dam	Dam present in 1947 (ID4) has increased in size at time of 1966 photo- less than 1/4 full	No major changes observed. Additional dams observed on properties surrounding the study area.	Rail Corridor
	P: 550 F: 1913 R: 33 Ph: 67	6602	Dam	Within road reserve of existing highway adjacent to alignment option 1A		
	P: 550 F: 1913 R: 34 Ph: 58	6604	Dam	Dam on alignment option 1A		
	Proj: 550 Film: 1913 Run: 33 Photo: 67	3	Earthworks	Possible quarry or landfill within study area not on alignment		
	P: 550 F: 1913 R: 35 Ph: 44	6618	Rural Residential	At buffer perimeter		
	Proj: 550 Film: 1913 Run: 33 Photo: 65 & 67	2	Industrial property	Possibly industrial (may be general farming) observed adjacent to existing highway- not on alignment		
	P: 550 F: 1913 R: 34 Ph: 56	11	Dam	Outside buffer		
	P: 550 F: 1913 R: 34 Ph: 58	9	Dam	Outside buffer		

Western Highway Project - Section 2 Zone 1

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arcmap GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description / Justification*
1966 continued	P: 550 F: 1913 R: 34 Ph: 58	7	Building	Outside buffer	No major changes observed. Additional dams observed on properties surrounding the study area.	Rail Corridor
	P: 550 F: 1913 R: 34 Ph: 56	10	Dam	In path of alignment 1AB		
	P: 337 F: 1054 R: 09 Ph: 125	20	Building	Within 1947 polygon (ID11) Buildings identified in 1947 (point ID 14 & 15) but image quality did not allow accurate structure count. At time of 1966 photo 6 large structures can be seen 4 smaller structures (likely sheds) are also apparent		
	P: 550 F: 1913 R: 33 Ph: 67	4	Dam	Outside buffer		
	Proj: 550 Run: 33 Photo: 65	9	Dam	Within buffer 160 m northeast of alignment 1A		
	Proj: 550 Run: 33 Photo: 65 & 67	8	Building	Within industrial Property (polygon ID:4701)		
	P: 550 F: 1913 R: 33 Ph: 67	3	Dam	Outside buffer		
	Proj: 550 Run: 33 Photo: 65 & 67	7	Building	Within industrial Property (polygon ID:4701)		
	Proj: 550 Run: 33 Photo: 58	11	General farming prop	2 buildings located within the buffer by a track 153 m northeast of alignment 1A		
	Proj: 550 Run: 33 Photo: 67	1	Dam	Within buffer and part of earthworks area adjacent to rail line at the beginning of Stage 2 study area		
	P: 550 F: 1913 R: 33 Ph: 67	1	Dam	Outside buffer		
	Proj: 550 Run: 33 Photo: 65	10	Dam	Outside buffer		
	Proj: 550 Run: 33 Photo: 65 & 67	6	Building	Within industrial Property 6601		
	Proj: 550 Run: 33 Photo: 65 & 67	3	Dam	Within industrial Property 6601		
	Proj: 550 Run: 33 Photo: 65 & 67	4	Building	Within industrial Property poly: 6601		
	Proj: 550 Run: 33 Photo: 65 & 67	2	Dam	Within industrial Property poly:6601		
	P: 550 F: 1913 R: 33 Ph: 67	2	Dam	Outside buffer		
	P: 550 F: 1913 R: 33 Ph: 65	5	Dam	Small dam 33m to the south of alignment 1A		
	Proj: 550 Run: 33 Photo: 65 & 67	5	Building	Within industrial Property 6601		

Western Highway Project - Section 2 Zone 1

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arcmap GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description / Justification*
1972	P: 7523S F: 2961 R: 5 Ph: 25	7201	Building	Within earthworks area (1966 poly ID: 3)	No major changes observed	Rail Corridor
	P: 7523S F: 2961 R: 04 Ph: 55	7206	Building	Within Res. prop (poly ID 4718) - buildings present prior to this photo - but can distinguish buildings now		
	P: 7523S F: 2961 R: 04 Ph: 55	7204	Building	Within Res. prop (poly ID 4718) - buildings present prior to this photo - but can distinguish buildings now		
	P: 7523S F: 2961 R: 5 Ph: 25	7202	Dam	Adjacent to alignment 1A at the end of Zone 1		
	P: 7523S F: 2961 R: 04 Ph: 55	7210	Building	Within rural res property (poly ID 7206)		
1980	P:7523 F: 3464 R: 12 Ph: 211	8001	Dam	At buffer south perimeter ~ 170m southwest of 1B	No major changes observed	Rail Corridor
1987				No change observed	No major changes observed	Rail Corridor
2009	Arcmap Basemap -VicRoads	N/A	Rural Residential	New rural residential property south of 1AB	No major changes observed	Rail Corridor
		N/A	Dam	~60 m north of 1A ~2.1Km west of start of Zone 1		
		N/A	High Density Vegetation	Increased vegetation (plantation)north of 1A at end of Zone 1		

*Note: P = Project, F = Film, R = Run, Ph = Photo

Western Highway Project - Section 2 Zone 2

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arcmap GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1947	P: 906/6 F: 603 R: 09 Ph:40	4750	Other	Gap in vegetation along existing highway adjacent to alignment 1B - may be part of creek bed adjacent to northeast (1947 polygonID52)	Predominantly vacant fields were observed around the study area. Some farming properties and dams were noted. The study area follows the alignment of the Melbourne to Adelaide rail corridor.	Rail Corridor
	P: 906/6 F: 603 R: 09 Ph:40	4752	Other	Creek bed- possibly dry- intersects Alignments 1A 1B		
	P: 906/6 F: 603 R: 09 Ph:42	4748	Dam	Adjacent to buffer south perimeter. ~160 m south of Alignment 1AB		
	P: 906/6 F: 603 R: 09 Ph:42	4747	Dam	Adjacent to existing highway ~ 50 m north of alignment 1AB		
	P: 906/6 F: 603 R: 09 Ph:42	4749	Disturbed earth	Lack of vegetation and grass- possible paddock entry point- in path of alignment 1AB		
	P: 909/6 F: 603 R: 9 Ph: 40	4756	Other	Creek bed- possibly dry- intersects Alignments 1A 1B		
	P: 906/6 F: 603 R: 09 Ph:40	4751	Other	Creek bed- possibly dry adjacent to southwest side of exiting highway		
	P: 909/6 F: 603 R: 9 Ph: 40	4753	Other	Clearing in vegetation- possible service road. Adjacent to existing highway southwest of alignments 1A and 2B		
	P: 906/6 F: 602 R: 8 Ph: 129	10	Building	Within buffer to the south of alignment 2B		
	P: 909/6 F: 602 R: 8: Ph: 127	4751	Dam	Intersects alignment 2A- May just be disturbed earth		
	P: 909/6 F: 602 R: 8: Ph: 129	4758	Building	Within Rural Res (1947 Poly ID:12 & 13)		
	P: 906/6 F: 602 R: 8 Ph: 127	13	Dam	Within farming property (1947 polygon ID: 10)		
	P: 906/6 F: 602 R: 8 Ph: 129	4708	Dam	Adjacent to alignment 2B		
	P: 909/6 F: 602 R: 8: Ph: 129	4760	Building	Within Farming prop (Poly ID:14)		
	P:906/6 F: 602 R: 8 Ph: 129	4747	Dam	Outside buffer to the north Zone 2		
	P: 906/6 F: 602 R: 8 Ph: 129	6	Dam	Outside buffer		
	P: 909/6 F: 602 R: 8: Ph: 129	4759	Building	Within Farming prop (1947 Poly ID:14)		
	P: 909/6 F: 602 R: 8: Ph: 125	4748	Building	Within rural. res. (1947 poly ID65)		
	P: 906/6 F: 602 R: 8 Ph: 127	16	High density vegetation	Outside buffer		
	P: 906/6 F: 602 R: 8 Ph: 127	11	Dam	Outside buffer		
	P: 909/6 F: 602 R: 8: Ph: 125	4749	Building	Within rural. res. (1947 poly ID65)		
	P: 906/6 F: 602 R: 8 Ph: 129	9	Building	Adjacent to alignment 2B		
	P: 906/6 F: 602 R: 8 Ph: 127	12	Dam	Within farming property (1947 polygon 10)		
	P: 906/6 F: 603 R:9 Ph: 38	5	Dam	Adjacent to southwest buffer perimeter at beginning of Zone 2		
	P: 909/6 F: 602 R: 8: Ph: 125	4750	Building	Within rural residential property (1947 poly ID: 65)		
	P: 906/6 F: 602 R: 8 Ph: 129	4709	Building	Adjacent to alignment 2B		

Western Highway Project - Section 2 Zone 2

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arcmap GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1947 Continued	P: 909/6 F: 602 R: 8: Ph: 129	4754	Dam	Outside southwest buffer zone 2	Predominantly vacant fields were observed around the study area. Some farming properties and dams were noted. The study area follows the alignment of the Melbourne to Adelaide rail corridor.	Rail Corridor
	P: 906/6 F: 602 R: 8 Ph: 127	15	Building	Within farming property (1947:polygon : 10)		
	P: 906/6 F: 602 R: 8 Ph: 129	7	Dam	Adjacent to alignment 2B		
	P: 906/6 F: 602 R: 7 Ph: 78	30	Building	Outside buffer		
	P: 906/6 F: 602 R: 7Ph: 83	45	Dam	Outside buffer		
	P: 906/6 F: 602 R: 8 Ph: 127	4716	High density vegetation	Outside buffer		
	P: 909/6 F: 602 R: 8: Ph: 129	4757	Building	Within Rural Res (1947 Poly ID:12 & 13)		
	P: 909/6 F: 602 R: 8: Ph: 129	4756	Building	Within Rural Res (1947 Poly ID:12 & 13)		
	P: 906/6 F: 602 R: 8 Ph: 127	14	Building	Within farming property (1947 polygon: 10)		
	P: 909/6 F: 602 R: 8: Ph: 129	4755	Building	Within Rural Res (1947 Poly ID: 12 & 13)		
1958	No photos available in 1950's for zone 2					
1966	P: 550 F: 1913 R: 34 Ph: 53	6612	Dam	Along road reserve in path of alignment 2B	No major changes observed	Agriculture/ crops / Rail Corridor
	P: 550 F: 1913 R: 35 Ph: 24	6627	Dam	Directly on alignment 4B at Buangor		
	P: 550 F: 1913 R: 33 Ph: 64	6603	High density vegetation	Small area increase in vegetation		
	P: 550 F: 1913 R: 35 Ph: 44	6616	Dam	Along road reserve in path of alignment 2B		
	P: 550 F: 1913 R: 34 Ph: 53	6620	Dam	Outside buffer		
	P: 550 F: 1913 R: 35 Ph: 38	6621	Dam	~ 160m southwest of alignment 2B		
	P: 550 F: 1913 R: 34 Ph: 53	6614	Rural Residential	Along existing highway. In path of alignment 2B		
	P: 550 F: 1913 R: 35 Ph: 40	6619	High density vegetation	In path of alignment 2B		
	P: 550 F: 1913 R: 35 Ph: 44	6615	Disturbed earth	Area appears to have had a dam or possibly conduit from adjacent creek- in path of alignment 2A		
	P: 550 F: 1913 R: 34 Ph: 53	6611	Dam	Within buffer 86 m southwest of alignment 2B		
	P: 550 F: 1913 R: 35 Ph: 44	6617	Disturbed earth	Probable former dam between alignment 2A and existing highway		
	P: 550 F: 1913 R: 34 Ph: 56	6609	Dam	Outside buffer		
	P: 550 F: 1913 R: 35 Ph: 42	6616	Dam	Adjacent to alignment 2A between alignment 2A and existing Hwy		
	P: 550 F: 1913 R: 34 Ph: 53	13	General farming property	Land now cleared for farming		
	P: 550 F: 1913 R: 34 Ph: 53	6613	General farming property	Land now cleared for farming		
	P: 550 F: 1913 R: 34 Ph: 56	6608	Dam	Adjacent to alignment 2A (11m northeast)		
	P: 550 F: 1913 R: 34 Ph: 56	6021	Dam	Adjacent o buffer perimeter (166m southwest of alignment 2B)		
	P: 550 F: 1913 R: 34 Ph: 44	19	Dam	In path of alignment 2A		

Western Highway Project - Section 2 Zone 2

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arcmap GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1966 continued	P: 550 F: 1913 R: 34 Ph: 53	0	Dam	Within buffer 72 m north of alignment 2A	No major changes observed	Agriculture/ crops / Rail Corridor
	P: 550 F: 1913 R: 34 Ph: 44	17	Dam	Within alignment 2A and 2B at Eurambeen-Raglan Road		
	P: 550 F: 1913 R: 34 Ph: 53	13	Dam	Outside buffer		
	P: 550 F: 1913 R: 34 Ph: 53	16	Dam	within buffer 130 m northeast of alignment 2A		
	P: 550 F: 1913 R: 34 Ph: 53	12	Dam	Outside buffer		
	P: 550 F: 1913 R: 34 Ph: 58	6	Dam	Outside buffer		
	P: 550 F: 1913 R: 34 Ph: 53	15	Dam	Outside buffer		
	P: 550 F: 1913 R: 34 Ph: 53	0	Dam	In path of alignment 2A		
	P: 550 F: 1913 R: 34 Ph: 53	14	Building	Within residential property (1966 polygon ID14)		
	P: 550 F: 1913 R: 35 Ph: 36	6632	Building	Appears to be a water tank within res farm prop. (1947 poly ID 14)		
	P: 550 F: 1913 R: 35 Ph: 36	6631	Building	Appears to be a water tank within res farm prop. (1947 poly ID 14)		
	P: 550 F: 1913 R: 34 Ph: 44	6627	Dam	Small dams NO LONGER PRESENT (1966 47 point ID 51 and 52) - On alignment 2A west of Stars Rd		
	P: 550 F: 1913 R: 35 Ph: 36	6637	Dam	~160m north of 2B		
	P: 550 F: 1913 R: 35 Ph: 36	6635	Building	Within 1947 res. farm prop. poly ID 14		
	P: 550 F: 1913 R: 35 Ph: 36	6633	Building	Within 1947 res. farm prop. poly ID 14		
	P: 550 F: 1913 R: 35 Ph: 36	6634	Building	Within 1947 res. farm prop. poly ID 14		
	P: 550 F: 1913 R: 35 Ph: 40	6629	Disturbed earth	1947- Poly ID 69- NO LONGER EVIDENT		
	P: 550 F: 1913 R: 35 Ph: 36	6636	Building	Within 1947 res. farm prop. poly ID 14		
	P: 550 F: 1913 R: 34 Ph: 44	6628	Dam	Small dams no longer visible in 1966 (47 point ID 51 and 52) - On alignment 2A west of Stars Rd		
	P: 550 F: 1913 R: 35 Ph: 36	6630	Building	Within 1947 res. farm prop. poly ID 14		
	P: 550 F: 1913 R: 34 Ph: 44	18	Dam	135m southwest of alignment 2B		
1972	P: 7523S F: 2691 R: 05 Ph: 29	7203	Dam	Possible dam to on alignment 2A at intersection of existing highway and Goulds Rd	No major changes observed	Agriculture/ crops / Rail Corridor
	P: 7523S F: 2579 R: 02 Ph: 68	7215	Crops	To northeast of alignment at end of stage 2		
	P: 7523S F: 2691 R: 05 Ph: 27	7201	Crops	Adjacent to north of existing highway and alignment 2A		
	P: 7523S F: 2691 R: 05 Ph: 29	7207	Dam	Within rural residential property polygon ID: 4712		
	P: 7523S F: 2691 R: 05 Ph: 27	7202	Grazing land	To the South of 2A and 2B at Eurambeen-Streatham Rd		
1980	P:7523 F: 3464 R: 12 Ph: 214	8002	Crops	South of alignments northwest of 2A Beaufort	No major changes observed	Agriculture/ crops / Rail Corridor
	P:7523 F: 3464 R: 12 Ph: 214	8003	Crops	To the north of Alignment 2A northwest of Beaufort		

Western Highway Project - Section 2 Zone 2

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arcmap GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1987	P:7523 F: 4069 R: 12 Ph: 167	8702	Crops	To the north of 2A at beginning of Z2		
	P:7523 F: 4069 R: 12 Ph: 169	8701	Dam	2 dams, 1 either side of alignments at beginning of Z2- northern dam on alignment 2A. south dam ~ 70m southwest of 2B	No major changes observed	Agriculture/ crops / Rail Corridor
2009	Arcmap Basemap -VicRoads		Dam	~ 100m NE of 2A ~1Km W of start of Zone 2	No major changes observed	Agriculture/ crops / Rail Corridor

*Note: P = Project, F = Film, R = Run, Ph = Photo

Western Highway Project - Section 2 Zone 3

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arcmap GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1947	P: 906/6 F: 602 R: 7 Ph: 80	4770	Dam	40 m north of alignment 3B. Between alignments 3B and 3A	Rural residential and farming properties were observed in the area. Isolated areas of high and low density vegetation were observed throughout zone 3. The study area follows the alignment of the Melbourne to Adelaide rail corridor.	Agriculture/ crops / Rail Corridor
	P: 906/6 F: 602 R: 7 Ph: 80	4718	General farming property	Likely to be residential- Difficult to be certain. Number of buildings present at time of photo unknown due to image quality.		
	P: 906/6 F: 602 R: 7 Ph: 80	4715	Low density vegetation	Old trees mentioned in alignment issues PDF document		
	P: 906/6 F: 602 R: 7 Ph: 78	4772	Other	Creek bed-Northern extent of poly ID 71- reaches adjacent to existing highway		
	P: 906/6 F: 602 R: 8 Ph: 129	12	Rural Residential	Outside buffer		
	P: 906/6 F: 602 R: 7 Ph: 80	4717	Rural Residential	Outside buffer		
	P: 906/6 F: 602 R: 7 Ph: 80	4773	Dam	~ 550 southwest of Waldrons Rd/W.Hwy intersection		
	P: 906/6 F: 602 R: 7 Ph: 78	4775	Dam	~125m northeast of alignment 3b and existing highway, ~ 250m east of Mile Post Ln		
	P: 906/6 F: 602 R: 7 Ph: 80	4774	Dam	20 m south of alignment 3B off road that intersects W.Hwy ~550m north west of Waldrons RD		
	P: 906/6 F: 602 R: 7 Ph: 80	4716	Other	Unknown - potential dam		
	P: 906/6 F: 602 R: 7 Ph: 78	29	Building	Outside buffer		
	P: 906/6 F: 602 R: 7 Ph: 78	26	Dam	Outside buffer		
	P: 906/6 F: 602 R: 7 Ph: 80	18	Dam	On alignment 3B		
	P: 906/6 F: 602 R: 7 Ph: 78	31	Building	Outside buffer		
	P: 906/6 F: 602 R: 7 Ph: 78	22	Dam	Outside buffer		
	P: 906/6 F: 602 R: 7 Ph: 78	32	Dam	Within buffer to the north of alignment 3B		
	P: 906/6 F: 602 R: 7 Ph: 80	17	Dam	Between alignment 3B and buffer to the south		
	P: 906/6 F: 602 R: 7 Ph: 78	23	Dam	Outside buffer		
	P: 906/6 F: 602 R: 7 Ph: 78	25	Dam	Between alignment 3A and buffer to the north		
	P: 906/6 F: 602 R: 7 Ph: 78	27	Dam	Outside buffer		
	P: 906/6 F: 602 R: 7 Ph: 78	28	Dam	Between alignment 3A and 3B		
	P: 906/6 F: 602 R: 7 Ph: 80	19	Building	Within Buffer north of alignment 3A within residential property		

Western Highway Project - Section 2 Zone 3

Photo Details		Site Description				Potential Areas of Concern
Year	Associated Photo*	Arcmap GHD ID:	Category	Study Area	Surrounding Area	Description/Justification
1947 continued	P: 906/6 F: 602 R: 7 Ph: 78	20	Building	Between alignment 3A and 3B. apparent building but difficult to tell- image quality		
	P: 906/6 F: 602 R: 7 Ph: 78	24	Dam	Between alignments 3A and 3B		
	P: 906/6 F: 602 R: 7 Ph: 78	21	Dam	Outside buffer		
1958	No photos available in 1950's for zone 3					
1966	P: 550 F: 1913 R: 35 Ph: 38	6022	Dam	On alignment 3B West of Woodnaggerak RD	No major changes observed	Agriculture/ crops / Rail Corridor
	P: 550 F: 1913 R: 35 Ph: 28	6625	Dam	~80 m northeast of 3A and 3B west of Mile Post Rd		
	P: 550 F: 1913 R: 35 Ph: 30	6623	Dam	Within Res farm prop (1947 Poly ID : 21)- Directly on alignment 3A		
	P: 550 F: 1913 R: 35 Ph: 30	6624	Dam	Adjacent to north side of existing highway just east of Mile Post RD ~ 130m northeast of Alignment 3A		
	P: 550 F: 1913 R: 35 Ph: 32	6643	Building	On alignment 3B ~60m west of Woodnaggerak Rd		
	P: 550 F: 1913 R: 35 Ph: 30	6647	Building	Within Residential / farming property (1947 Poly ID : 21)		
	P: 550 F: 1913 R: 35 Ph: 32	6639	Building	Additional structures on residential /farm property- (at time of 66 photo- 4 main buildings and 3 sheds) (1947point ID: 47)- in between 3a and 3B (~90m distance from each)		
	P: 550 F: 1913 R: 35 Ph: 30	6645	Building	Within Residential / farming property (1947 Poly ID : 21)		
	P: 550 F: 1913 R: 35 Ph: 32	6640	Building	Additional structures on residential /farm property- (at time of 66 photo- 4 main buildings and 3 sheds) (1947point ID: 47)- in between 3a and 3B (~90m distance from each)		
	P: 550 F: 1913 R: 35 Ph: 32	6642	Building	Additional structures on residential /farm property- (at time of 66 photo- 4 main buildings and 3 sheds) (1947point ID: 47)- in between 3a and 3B (~90m distance from each)		
	P: 550 F: 1913 R: 35 Ph: 32	6641	Building	Additional structures on residential /farm property- (at time of 66 photo- 4 main buildings and 3 sheds) (1947point ID: 47)- in between 3a and 3B (~90m distance from each)		
	P: 550 F: 1913 R: 35 Ph: 30	6644	Building	Within Residential / farming property (1947 Poly ID : 21)		
	P: 550 F: 1913 R: 35 Ph: 30	6648	Building	Within Residential / farming property (1947 Poly ID : 21)		
	P: 550 F: 1913 R: 35 Ph: 30	6646	Building	Within Residential / farming property (1947 Poly ID : 21)		
	P: 550 F: 1913 R: 35 Ph: 34	6638	Dam	Dam no longer visible --> potentially backfilled- ~20m south of alignment 3B (1947 poly ID: 74)		

Western Highway Project - Section 2 Zone 3

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arcmap GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1972	P: 7523S F: 2691 R: 04 Ph: 55	7204	Grazing land	Between existing highway and alignment southeast of Mile Post Road	No major changes observed	Agriculture/ crops / Rail Corridor
	P: 7523S F: 2691 R: 04 Ph: 55	7206	Rural Residential	North of existing highway southeast of mile Post road		
	P: 7523S F: 2691 R: 04 Ph: 55	7205	Crops	Along and to the south of 3B southeast of Mile post Rd		
	P: 7523S F: 2691 R: 04 Ph: 55	7218	Disturbed earth	Cleared grass/ tracks adjacent to rural res property poly ID 4712		
	P: 7523S F: 2691 R: 04 Ph: 55	7205	Building	Within Res. prop (poly ID 4718) - buildings present prior to this photo - but can distinguish buildings now		
	P: 7523S F: 2691 R: 04 Ph: 55	7208	Building	Within rural res property (poly ID 7206)		
	P: 7523S F: 2691 R: 04 Ph: 55	7207	Building	Within rural res property (poly ID 7206)		
	P: 7523S F: 2691 R: 04 Ph: 55	7209	Building	Within rural res property (poly ID 7206)		
	P: 7523S F: 2691 R: 04 Ph: 55	7203	Building	Within Res. prop (poly ID 4718) - buildings present prior to this photo - but can distinguish buildings now		
1980				No change observed	No major changes observed	Agriculture/ crops / Rail Corridor
1987	P:7523 F: 4069 R: 11 Ph: 121	8703	Crops	on alignment 3B northwest of woodnaggerak Rd		Agriculture/ crops / Rail Corridor
2009	Arcmap Basemap -VicRoads			No changes observed	No major changes observed	Agriculture/ crops / Rail Corridor

*Note: P = Project, F = Film, R = Run, Ph = Photo

Western Highway Project - Section 2 Zone 4

Photo Details		Site Description				Potential Areas of Concern
Year	Associated Photo*	Arcmap GHD ID:	Category	Study Area	Surrounding Area	Description/Justification
1947	P: 906/6 F: 602 R: 7 Ph: 74	4731	Building	Buangor township	Rural residential and farming properties were observed around the study area- particularly in the township of Buangor. Isolated areas of low medium and high density vegetation were observed in the area. The study area follows the alignment of the Melbourne to Adelaide rail corridor.	Agriculture/ crops / Rail Corridor
	P: 906/6 F: 1502 R: 3 Ph: 65	4797	Industrial property	To the south of Alignment 4ABCDEF		
	P: 905/6 F: 654 R: 3 Ph: 60	4792	Rural Residential	At 4A northern perimeter (township?)		
	P: 906/6 F: 602 R: 7 Ph: 74	4726	Building	Buangor township		
	P: 906/6 F: 602 R: 8 Ph: 129	13	Rural Residential			
	P: 906/6 F: 602 R: 6 Ph: 39	4784	Dam	Adjacent to the south of alignment 4B		
	P: 906/6 F: 602 R: 6 Ph: 39	4783	Dam	Adjacent to the south of alignment 4B and 6A		
	P: 906/6 F: 602 R: 6 Ph: 36	4799	Medium density vegetation	Intersects alignments 4B and 4C at Buangor		
	P: 906/6 F: 602 R: 6 Ph: 36	4781	Dam	Between alignments 5C and 4B at Buangor		
	P: 906/6 F: 602 R: 6 Ph: 35	4778	Other	Creek bed intersects alignment 4B at the beginning of the Buangor bypass		
	P: 906/6 F: 602 R: 7 Ph: 74	4723	Building	Buangor township		
	P: 906/6 F: 602 R: 6 Ph: 36	4780	Rural Residential	Adjacent to alignment 4B at Buangor		
	P: 906/6 F: 602 R: 7 Ph: 74	4724	Building	Buangor township		
	P: 906/6 F: 1502 R: 3 Ph: 65	4796	Rural Residential	To the south of Alignment 4ABCDEF		
	P: 906/6 F: 602 R: 7 Ph: 76	4777	Other	Creek bed - Intersects alignments 4A and 4C at beginning of Zone 4		
	P: 906/6 F: 602 R: 7 Ph: 74	4729	Building	Buangor township		
	P: 906/6 F: 1502 R: 3 Ph: 62	4793	Dam	~100m northeast of alignment 4ABCDEF		
	P: 906/6 F: 602 R: 7 Ph: 74	4725	Building	Buangor township		
	P: 906/6 F: 602 R: 6 Ph: 36	4779	High density vegetation	Along alignment 4C at Buangor		
	P: 906/6 F: 602 R: 7 Ph: 74	4728	Building	Buangor township		
	P: 906/6 F: 1502 R: 3 Ph: 65	4795	Rural Residential	To the south of Alignment 4ABCDEF		
	P: 906/6 F: 602 R: 7 Ph: 76	4776	Dam	On alignment 4C at beginning of Z4		
	P: 906/6 F: 602 R: 6 Ph: 39	4785	Other	Unknown- Possible Dam		
	P: 906/6 F: 602 R: 6 Ph: 36	4782	Dam	Between alignments 4C and 5C		
	P: 906/6 F: 602 R: 7 Ph: 74	4727	Building	Buangor township		
	P: 906/6 F: 602 R: 8 Ph: 129	14	General farming property	Outside study area		
	P: 906/6 F: 602 R: 7 Ph: 74	4730	Building	Buangor township		
	P: 906/6 F: 1502 R: 3 Ph: 62	4794	General farming property	To the North of Alignment 4ABCDEF		

Western Highway Project - Section 2 Zone 4

Photo Details		Site Description				Potential Areas of Concern
Year	Associated Photo*	Arcmap GHD ID:	Category	Study Area	Surrounding Area	Description/Justification
1947 continued	P: 905/6 F: 744 R: 4 Ph: 19, 21	4791	Other	Buildings and possibly dams located in this area- image quality prevents the individual identification of properties- likely to be rural-residential/farming	Rural residential and farming properties were observed around the study area- particularly in the township of Buangor. Isolated areas of low medium and high density vegetation were observed in the area. The study area follows the alignment of the Melbourne to Adelaide rail corridor.	Agriculture/ crops / Rail Corridor
	P: 906/6 F: 602 R: 7 Ph: 74	40	Dam	Between alignments 4A and 4B		
	P: 906/6 F: 602 R: 6 Ph: 36	4766	Building	Within Residential Property at Buangor (1947 Poly ID:80)		
	P: 906/6 F: 602 R: 6 Ph: 36	4767	Dam	Outside north buffer at end of Buangor bypass		
	P: 906/6 F: 602 R: 7 Ph: 74	41	Dam	Adjacent to existing highway and alignment 4B		
	P: 906/6 F: 602 R: 7 Ph: 72	4761	Building	Between alignments 4A and 4B at the West end of the Buangor bypass		
	P: 906/6 F: 602 R: 6 Ph: 36	4762	Dam	Within Res. Property at Buangor (1947 Poly ID 80)		
	P: 906/6 F: 602 R: 7 Ph: 74	37	Dam	Between alignments 4A and 4B		
	P: 906/6 F: 602 R: 7 Ph: 74	36	Dam	Outside buffer		
	P: 906/6 F: 602 R: 7 Ph: 74	38	Dam	Between alignments 4A and 4B		
	P: 906/6 F: 602 R: 06 Ph: 39	4768	Dam	90m north of alignment 4C		
	P: 906/6 F: 602 R: 7 Ph: 76	35	Dam	Adjacent to alignment 4C at beginning of Buangor bypass- zone 4		
	P: 906/6 F: 602 R: 7 Ph: 76	33	Dam	Adjacent to northeast buffer perimeter at beginning of Zone 4		
	P: 906/6 F: 602 R: 6 Ph: 36	4764	Building	Within Residentially at Buangor (1947 Poly ID: 80)		
	P: 906/6 F: 602 R: 6 Ph: 36	4765	Building	Within Residential Property at Buangor (1947 Poly ID: 80)		
	P: 906/6 F: 602 R: 7 Ph: 74	42	Dam	Adjacent to existing highway and alignment 4B		
	P: 906/6 F: 602 R: 7 Ph: 74	39	Dam	Between alignments 4A and 4B		
	P: 906/6 F: 602 R: 7 Ph: 76	34	Dam	75 m north of alignment 4A		
	P: 906/6 F: 602 R: 7 Ph: 74	4740	Dam	Between alignments 4A and 4B		
	P: 906/6 F: 1502 R: 3 Ph: 60	4778	Dam	Within circular study area 4A (township/growth area?) on Warrayatkin Rd north of Western Highway		
	P: 906/6 F: 602 R: 6 Ph: 36	4763	Dam	Within Residential Property at Buangor (1947Poly ID: 80)		
1958	P: 337 F: 1054 R: 09 Ph: 125	5809	Dam	Within rural residential property (poly ID 5808)	Increased number of residential properties around Buangor township	Agriculture/ crops / Rail Corridor
	P: 337 F: 1054 R: 09 Ph: 125	5804	Disturbed earth	May be low lying ground collecting water. Adjacent to south of Alignment 4A		
	P: 337 F: 1054 R: 09 Ph: 127	5812	Crops	Cleared and cropped paddocks located on alignment 5C and adjacent to 4B and 6A at Buangor		
	P: 337 F: 1054 R: 09 Ph: 125	5806	Dam	~ 45m northeast of alignment 4C		
	P: 337 F: 1054 R: 09 Ph: 125	5807	Dam	Adjacent to northern buffer perimeter- north of alignment 4C and 4B		
	P: 337 F: 1054 R: 09 Ph: 125	5811	Dam	~ 25 m southwest of alignment 4A at Buangor		
	P: 337 F: 1054 R: 09 Ph: 125	5808	Rural Residential	Residential farming property adjacent to alignment 4C		

Western Highway Project - Section 2 Zone 4

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arcmap GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1958 continued	P: 337 F: 1054 R: 09 Ph: 127	5813	Dam	On alignment 4A and 5C at Buangor	Increased number of residential properties around Buangor township	Agriculture/ crops / Rail Corridor
	P: 337 F: 1054 R: 09 Ph: 123	5802	Dam	~13m south of Alignment 4A		
	P: 337 F: 1054 R: 09 Ph: 125	5805	Dam	Between existing highway and alignment 4C Zone 5		
	P: 337 F: 1054 R: 09 Ph: 125	5802	Building	Between existing highway and alignment 4C		
	P: 337 F: 1054 R: 09 Ph: 125	5801	Building	Between existing highway and alignment 4C		
	P: 337 F: 1054 R: 09 Ph: 127	5805	Dam	Possible dam (poor image quality) - on alignments 4B and 5C		
	P: 337 F: 1054 R: 09 Ph: 127	5806	Dam	Possible dam (poor image quality) - on alignments 4B and 5C		
	P: 337 F: 1054 R: 09 Ph: 125	5804	Building	Within rural residential property (poly ID 5808)		
	P: 337 F: 1054 R: 09 Ph: 125	5803	Building	Within rural residential property (poly ID 5808)		
1966	P: 550 F: 1913 R: 35 Ph: 22	6629	Dam	~ 40m northeast of 4B at Buangor West of Buangor- Ben Nevis Rd	Increased number of properties in the area	Agriculture/ crops / Rail Corridor
	P: 550 F: 1913 R: 35 Ph: 22	6628	Dam	Immediately adjacent to alignment 4C and 5C at Buangor		
	P: 550 F: 1913 R: 35 Ph: 25	6626	Disturbed earth	Adjacent to 4A and Rail at Buangor- no grass cover- Train access area?		
	P: 337 F: 1054 R: 09 Ph: 125	19	Building	Within 1947 polygon (ID11)Buildings identified in 1947 (point ID 14 & 15) but image quality did not allow accurate structure count. At time of 1966 photo 6 large structures can be seen 4 smaller structures(likely sheds) are apparent		
	P: 337 F: 1054 R: 09 Ph: 125	16	Building	As above		
	P: 337 F: 1054 R: 09 Ph: 125	15	Building	As above		
	P: 337 F: 1054 R: 09 Ph: 125	17	Building	As above		
	P: 337 F: 1054 R: 09 Ph: 125	18	Building	As above		
	P: 550 F: 1913 R: 35 Ph: 24	6650	Building	Within Rural res prop (1947 poly ID 8)		
	P: 550 F: 1913 R: 35 Ph: 25	6649	Dam	In Buangor Township Between alignments 4A and 4B (~ 200m from each alignment option)		
	P: 550 F: 1913 R: 35 Ph: 24	6651	Building	Within Rural res prop (1947 poly ID 8)		
	P: 550 F: 1913 R: 35 Ph: 24	6652	Dam	~150 m south of 4B at Buangor		

Western Highway Project - Section 2 Zone 4

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arcmap GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1972	P: 7523S F: 2691 R: 04 Ph: 51	7208	Dam	On alignment 4A and 5C south of Buangor	No major changes observed	Agriculture/ crops / Rail Corridor
1980	P:7523 F: 3464 R: 10 Ph: 37	8005	Crops	North of 4B and 4C at end of Zone 4	No major changes observed	Agriculture/ crops / Rail Corridor\
	P: 7523 F: 3465 R: 09 Ph:48	8010	Building	Suspected residential property (Poly ID: 47101 , 6664, 6665, 6666) can no longer be seen : demolished between 1972 and January 1980		
	P:7523 F: 3464 R: 09 Ph: 48	8007	Crops	To north of alignments at edge of 4A (circle -township?)		
	P:7523 F: 3464 R: 11 Ph: 08	8004	Rural Residential	~90m north of 4C at Buangor		
1987	P:7523 F: 4069 R: 11 Ph: 125	8702	Dam	~ 250 m northeast og 4A west of Buangor	No major changes observed	Agriculture/ crops / Rail Corridor
	P:7523 F: 4069 R: 11 Ph: 123	8704	Rural Residential	on Alignment 4A at Buangor		
1986	P:7423 F: 4063 R: 10 Ph: 16	8707	Dam	On alignment 4B - northwest og Buangor - start of Z5		
	P:7423 F: 4063 R: 09 Ph: 63	8711	Crops	To the south of 6A at 4A (township)		
	P:7423 F: 4063 R: 09 Ph: 61	8712	Crops	North of 6A at 4A (township)		
	P:7423 F: 4063 R: 10 Ph: 14	8706	Disturbed earth	Cleared area along existing highway within alignment 4B		
2009	Arcmap Basemap -VicRoads	N/A		No changes observed	No major changes observed	Agriculture/ crops / Rail Corridor

*Note: P = Project, F = Film, R = Run, Ph = Photo

Western Highway Project - Section 2 Zone 5

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arcmap GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1947	P: 906/6 F: 602 R: 6 Ph: 38	47100	Medium density vegetation	Intersects alignment 5C at Buangor	Predominantly vacant fields were observed around the study area. Some farming properties and dams were noted. High density vegetation located to the north of the Study area. The study area follows the alignment of the Melbourne to Adelaide rail corridor.	Agriculture/ crops / Rail Corridor
	P: 906/6 F: 601 R: 5 Ph: 126	4786	Disturbed earth	Cleared area by road east of highway/rail crossing- possible vehical stop area at northern buffer perimeter		
	P: 906/6 F: 601 R: 5 Ph: 125	4787	Dam	Adjacent to alignment 5A- At Hillside road		
	P: 906/6 F: 602 R: 06 Ph: 38	4769	Dam	Between alignments 5C and 4A. 75 m north of rail line and alignment 4A		
	P: 906/6 F: 602 R: 06 Ph: 41	4770	Dam	150m southwest of alignment 5B		
1958	P: 337 F: 1054 R: 08 Ph: 76	5823	Dam	~ 70 m northeast of 5C and 5B. Adjacent to rail and highway crossing west of Buangor	No major change observed	Agriculture/ crops / Rail Corridor
	P: 337 F: 1054 R: 09 Ph: 127	5816	Dam	On Alignment 5B West of Buangor		
	P: 337 F: 1054 R: 08 Ph: 76	5822	Dam	On alignments 5B and 5C at Rail/highway crossing west of Buangor		
	P: 337 F: 1054 R: 08 Ph: 78	5818	Other	Creek bed- Intersects alignments 5A and 5B northwest of Buangor		
	P: 337 F: 1054 R: 09 Ph: 127	5814	Dam	~100m Southwest of alignment 5C W. Buangor - Beginning of Z5		
	P: 337 F: 1054 R: 09 Ph: 127	5815	Dam	~ 115 m southwest of alignments 5A and 5B. West of Buangor - Beginning Z5		
	P: 337 F: 1054 R: 08 Ph: 76	5821	Disturbed earth	Exposed earth along Rail line adjacent to 5C and 5A		
	P: 337 F: 1054 R: 08 Ph: 76	5819	Crops	On alignment 5C and between 5C , 5A and 5B. North west of Buangor		
	P: 337 F: 1054 R: 09 Ph: 127	5817	Dam	On Alignment 5B West of Buangor		
	P: 337 F: 1054 R: 08 Ph: 76	5808	Dam	~65 m southwest of 5A at Hillside Rd		
	P: 337 F: 1054 R: 08 Ph: 76	5807	Dam	Adjacent to 5A		
1962	P: 906/6 F:1502 R: 03 Ph: 160	6632	Crops	Cropped paddock to the southwest of alignments 5A and 5B	No major change observed	Agriculture/ crops / Rail Corridor
1966	P: 550 F: 1911 R: 36 Ph: 119	6653	Building	On 5A ~400m SE of Hillside -extension RD		
1972	P: 7523S F: 2691 R: 04 Ph: 51	7209	Rural Residential	~50m north of 5C south of Buangor	No major changes observed	Agriculture/ crops / Rail Corridor
	P: 7523S F: 2579 R: 03 Ph: 108	7212	Dam	Adjacent to 5A north of Buangor at beginning of Z5		
	P: 7523S F: 2691 R: 04 Ph: 51	7210	Dam	~ 55m north of 5C south of Buangor		
	P: 7523S F: 2579 R: 03 Ph: 108	7213	Dam	On alignment 5C adjacent to rail line southeast of Hillside Rd		
	P: 7523S F: 2691 R: 04 Ph: 51	7211	Dam	on alignment 5A and 5B north of Buangor at beginning of Z5		
	P: 7523S F: 2579 R: 03 Ph: 108	7211	Dam	Poly ID 5816 Dam no longer visible- Dry- potential for fill- On 5B west of Buangor		
1980	P:7523 F: 3464 R: 10 Ph: 37	8006	Dam	On alignment 5B northwest of Buangor	No major changes observed	Agriculture/ crops / Rail Corridor
1986	P:7423 F: 4063 R: 10 Ph: 14	8705	Crops	on 5C west northwest of Buangor	No major changes observed	Agriculture/ crops / Rail Corridor
2009	Arcmap Basemap -VicRoads		buildings	Buildings present at junction of Hillside-Extension Rd and the rail line (adjacent to 5A, 5B and 5C)		

*Note: P = Project, F = Film, R = Run, Ph = Photo

Western Highway Project - Section 2 Zone 6

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arc map GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1947	P: 905/6 F: 744 R: 4 Ph: 19	4790	Dam	~25 m southwest of alignment 6A	A racecourse is located to the south of the study area. A large lake is located to the northeast of the study area. Farming properties are still prevalent whilst an increase in residential properties is observed within close proximity to Stawell. An aeroplane runway is located to the south of the study area. The study area follows the alignment of the Melbourne to Adelaide rail corridor.	Farming /Agriculture / Rail Corridor
	P: 906/6 F: 744 R: 4 Ph: 19	47101	Other	Unknown object (poor image quality)		
	P: 906/6 F: 602 R: 6 Ph: 38	47102	High density vegetation	To north of alignments Zone 6		
	P: 906/6 F: 601 R: 5 Ph: 123	4789	Other	Cleared area of land intersecting and adjacent to alignments 6A,6B, 6C		
	P: 906/6 F: 601 R: 5 Ph: 125, 123	4798	High density vegetation	Alignments 6A, 6B, and 6C run through dense vegetation at the beginning on Zone 6		
	P: 906/6 F: 601 R: 5 Ph: 121	4773	Dam	~190 m northeast of alignment 6D		
	P: 906/6 F: 1502 R: 4 Ph: 19, 21	4775	Dam	Dams or ponds ~150 m southwest of alignments 6A & 6D		
	P: 906/6 F: 1502 R: 4 Ph: 19, 21	4777	Dam	Dams or ponds ~150 m southwest of alignments 6A & 6D		
	P: 905/6 F: 654 R: 3 Ph: 65	4781	Building	Within Industrial Property (poly ID 97)		
	P: 905/6 F: 654 R: 3 Ph: 65	4783	Building	Within Industrial Property (poly ID 97)		
	P: 905/6 F: 654 R: 3 Ph: 65	4778	Building	Within Rural Res. (Poly ID 96)		
	P: 905/6 F: 654 R: 3 Ph: 65	4785	Building	Within Industrial Property (1947 poly ID 97)- not on alignment		
	P: 906/6 F: 601 R: 05 Ph: 125	4771	Dam	Directly on alignment 6D at beginning of Z6		
	P: 905/6 F: 654 R: 3 Ph: 65	4780	Building	Within Industrial Property (1947 poly ID 97)		
	P: 905/6 F: 654 R: 3 Ph: 65	4782	Building	Within Industrial Property (1947 poly ID 97)- not on alignment		
	P: 905/6 F: 654 R: 3 Ph: 65	4775	Building	Within Rural Res. (1947 Poly ID 95)		
	P: 905/6 F: 654 R: 3 Ph: 65	4784	Building	Within Industrial Property (1947 poly ID 97)- not on alignment		
	P: 905/6 F: 654 R: 3 Ph: 65	4786	Building	Within Industrial Property (1947 polygon ID: 97)		
	P: 905/6 F: 744 R: 4 Ph: 17	4774	Dam	Between alignments 6A and 6D		
	P: 906/6 F: 1502 R: 4 Ph: 19, 21	4776	Dam	Dams or ponds ~150 m southwest of alignments 6A & 6D		
	P: 905/6 F: 654 R: 3 Ph: 65	4777	Building	Within Rural Res. (1947 Poly ID 96)		
	P: 905/6 F: 654 R: 3 Ph: 65	4779	Building	Within Rural Res. (1947 Poly ID 96)		
	P: 906/6 F: 601 R: 05 Ph: 121	4772	Dam	~200 m north of alignment 6D (most southern alignment)		
	P: 905/6 F: 654 R: 3 Ph: 65	4776	Building	Within Rural Res. (Poly ID 95)		
	P: 906/6 F: 601 R: 05 Ph:123	470201	High density vegetation	Strip of vegetation intersects alignment 6D ~ 2 km west of the beginning of Zone 6		
	P: 906/6 F: 601 R: 05 Ph:123	470202	Other	Creek bed intersects alignment 6D ~2.5 km west of the beginning of Zone 6		

Western Highway Project - Section 2 Zone 6

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arc map GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1947 continued	P: 906/6 F: 601 R: 05 Ph:121	470203	Other	exposed soil- either dry creek bed or dry dam with track leading north form Hillside road across alignment 6D	A racecourse is located to the south of the study area. A large lake is located to the northeast of the study area. Farming properties are still prevalent whilst an increase in residential properties is observed within close proximity to Stawell. An aeroplane runway is located to the south of the study area. The study area follows the alignment of the Melbourne to Adelaide rail corridor.	Farming /Agriculture / Rail Corridor
	P: 906/6 F: 601 R: 05 Ph:121	470204	Dam	Small dam located ~20 m north of alignment 6DF ~ 4.8 km west of the beginning of Zone 6		
	P: 906/6 F: 601 R: 05 Ph:121	470205	Dam	~45 m north of alignment 6D ~1.5 km west of 6DF intersection with Hillside Road		
	P: 906/6 F: 601 R: 05 Ph:121	470206	Dam	~ 110 m north of alignment 6DF, south of Western Highway and Brody Road intersection		
	P: 905/6 F: 654 R: 03 Ph: 62	470208	Other	creek bed running across alignments 6DF and 6ABCD		
1958	P: 337 F: 1054 R: 08 Ph: 73	5825	Dam	Adjacent to rail line and existing highway . ~ 100 m north of 6A. west of Langi Ghiran Picnic Ground Rd	No major change observed	Farming /Agriculture / Rail Corridor
	P: 337 F: 1054 R: 08 Ph: 76	5820	Dam	On alignments 6C and 6D		
	P: 337 F: 1054 R: 09 Ph: 125	5810	Crops	Cropped Paddock - on alignment 6A at Buangor		
	P: 337 F: 1054 R: 08 Ph: 73	5824	Dam	On alignment 6A adjacent to existing highway and rail line		
	P: 337 F: 1054 R: 08 Ph: 76	5809	Building	~ 60 m northeast of 6D - track leading to building from Hillside RD		
	P: 337 F: 1054 R: 08 Ph: 73	5810	Building	~ 60 m northeast of 6D - Off track leading from Hillside Ln		
1962	P: 906/6 F: 1502 R: 02 Ph:201	620207	Dam	on alignment 6DF ~ 1 km southeast of Dobie Road	No major changes observed	Farming /Agriculture / Rail Corridor
	P: 906/6 F: 1502 R: 02 Ph:201	620201	Dam	~160 m south of alignment 6DF adjacent to 200 m buffer edge ~5 km west of the beginning of Zone 6		
1966	P: 550 F: 1911 R: 37 Ph: 111	6633	Dam	On Alignment 6A at beginning of Zone 6		
	P: 550 F: 1911 R: 38 Ph: 91	6631	Other	Airport- To the south of alignment 4ABCDEF -previously just runway now appears to have buildings		
	P: 550 F: 1911 R: 37 Ph: 111	6630	Other	Cleared area within dense vegetation in between 6B and 6C		
	P: 550 F: 1911 R: 38 Ph: 95	6654	Dam	~ 100 m southwest of 6A		
	P: 550 F: 1911 R: 38 Ph: 87	6665	Building	Within unknown property 1947 poly ID 101- Large shed		
	P: 550 F: 1911 R: 39 Ph: 81	6656	Building	Additional building in rural res property (1947 poly ID: 96)		
	P: 550 F: 1911 R: 38 Ph: 91	6662	Building	Within Airport (1966 poly ID: 31) - SE Ararat		
	P: 550 F: 1911 R: 39 Ph: 81	6658	Building	Additional building in rural res property (1947 poly ID: 96)		
	P: 550 F: 1911 R: 39 Ph: 81	6657	Building	Additional building in rural res property (1947 poly ID: 96)		
	P: 550 F: 1911 R: 38 Ph: 91	6661	Building	Within Airport (1966 poly ID: 31) - SE Ararat		

Western Highway Project - Section 2 Zone 6

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arc map GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1966 continued	P: 550 F: 1911 R: 39 Ph: 81	6660	Building	Additional building in rural res property (1947 poly ID: 96)	No major changes observed	Farming /Agriculture / Rail Corridor
	P: 550 F: 1911 R: 38 Ph: 91	6663	Building	Within Airport (1966 poly ID: 31) - SE Ararat		
	P: 550 F: 1911 R: 38 Ph: 87	6666	Building	Within unknown property 1947 poly ID 101- Large shed		
	P: 550 F: 1911 R: 39 Ph: 81	6659	Building	Additional building in rural res property (1947 poly ID: 96)		
	P: 550 F: 1911 R: 39 Ph: 89	660202	Dam	on alignment 6DF ~300 m south of Western Highway, ~770 m west of Warrayatkin Road-small dam adjacent to 660201		
	P:550: F: 1911 R: 39 Ph: 89	660203	Building	~500 m south of western Highway ~ west of Warrayatkin Road		
	P:550: F: 1911 R: 39 Ph: 89	660204	Building	~ south of western Highway ~ west of Warrayatkin Road		
	P:550: F: 1911 R: 39 Ph: 89	660205	Building	~ south of western Highway ~ west of Warrayatkin Road		
	P:550: F: 1911 R: 39 Ph: 89	660206	Building	~ south of western Highway ~ west of Warrayatkin Road		
1972	P: 7523S F: 2579 R: 03 Ph: 110	7214	Other	Increased area of cleared vegetation on 6B (poly ID 6630)	No major changes observed	Farming /Agriculture / Rail Corridor
	P: 7523S F: 2579 R: 03 Ph: 108	7211	Dam	Poly ID 5820- Dam no longer visible- on 6C and 6D		
	P: 7623S F: 2579 R: 03 Ph: 112	720202	Dam	on alignment 6DF, ~ 780 m east of Dobie Road		
1980	P:7523 F: 3464 R: 09 Ph: 47	8009	Crops	To north of 6A at 4A(township circle)	No major changes observed	Farming /Agriculture / Rail Corridor
	P: 7523 F: 3464 R: 09 Ph: 47	800201	Disturbed earth	720204- now covered with grass/crops		
	P: 7523 F: 3464 R: 09 Ph: 47	800202	Disturbed earth	720204- now covered with grass/crops		
	P:7523 F: 3464 R: 09 Ph: 47	8008	Dam	Increase in size of poly ID 6654- now extend on to alignment 6A		
1986	P:7423 F: 4063 R: 10 Ph: 16	8708	Other	Extended area of cleared land south of 6A poly IDs: 6630, 7214	No major changes observed	Farming /Agriculture / Rail Corridor
	P:7423 F: 4063 R: 10 Ph: 18	8709	Dam	On 6A west of Langi Ghiran Picnic Ground Rd		
	P:7423 F: 4063 R: 10 Ph: 18	8710	Dam	~60 m north of 6D off Hillside Rd		
	P:7523 F: 4069 R: 10 Ph: 18	8705	Dam	~ south of 6A		
	P:7523 F: 4069 R: 10 Ph: 18	8704	Building	~ south of 6A		
	P:7523 F: 4069 R: 10 Ph: 18	8703	Building	~ 170 m south of 6A		

Western Highway Project - Section 2 Zone 6

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo**	*Arc map GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1987	P: 7423 F: 4063 R: 09 Ph: 59	8715	Rural Residential	On north side of 4ABCDEF and existing highway at southwest Ararat	No major changes observed	Farming /Agriculture / Rail Corridor
	P:7423 F: 4063 R: 09 Ph: 59	8713	Disturbed earth	Creek bed intersects 4ABCDEF southeast Ararat		
2009	Arc map Base map -Vic Roads	4771	Dam/landfill	Dam ID : 4771 is no longer visible - potential for fill	Dense vegetation (plantation to the north of 4ABCDEF)- extends dense vegetation already located to the east	Farming /Agriculture / Rail Corridor
Additional Comments		Extra alignment (6DF) not included in 1958 aerial photographs. 1962 photographs used to cover area not covered by 1966 photographs- north west portion of zone 6 (including extra alignment 6DF) not included in 1962 photographs- Note there is a small area not covered by 1962 or 1966. Arc Base map is missing ~40 m of the study area south of alignment 6DF.				

*Note: P = Project, F = Film, R = Run, Ph = Photo

GHD

180 Lonsdale Street
Melbourne, Victoria 3000
T: (03) 8687 8000 F: (03) 8687 8111 E: melmail@ghd.com.au

Document Status

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