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Beaufort Bypass Geotechnical Desk Study

BECA

May 2011





Planning, design and management services for infrastructure development

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Beaufort Bypass Geotechnical Desktop Study

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01	Beaufort Bypass Geotechnical Desktop Study DRAFT	09.05.11	J. Harendran	A. Doe	P. Styles
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1 INTRODUCTION

Halcrow has been commissioned by Beca Pty Ltd (Beca) to conduct a geotechnical desktop study regarding the proposed Beaufort Bypass. This study supports the CORRIDORS STUDY – BEAUFORT BYPASS, WESTERN HIGHWAY conducted by Beca for VicRoads.

The purpose of this study is to collate available geotechnical and geological data relevant to the proposed bypass options and report on the following key points:

- Where geological features are likely to impose significant additional costs;
- Where geological features are likely to impose significant restrictions to the time of construction;
- Anticipated geology beneath the study area.

2 AVAILABLE DATA

Relevant data was sourced from various sources including the following:

- The Department of Primary Industries Victoria,
- VicRoads, online and special contacts sourced by Phil Styles
- General news and community sources.

A detailed list of references is provided at the end of this report.

3 ANTICIPATED GROUND CONDITIONS

3.1 Geological History

The following summary of the geological history of Beaufort is extracted and modified from Cayley (1995).

1. Cambrian and Late Devonian

- Submarine volcanism (not exposed in Beaufort) in the Cambrian to Late Devonian, followed by;
- Deposition of marine sediments in the Ordovician to Middle Devonian, this includes the siltstones and sandstones of the St Arnaud Group that were formed by turbidite flows, which underlie most of the area of interest for the Beaufort bypass, followed by;
- Episodes of regional metamorphism, folding, faulting, intrusion of granite masses, contact metamorphism and mineralisation

2. Late Devonian to Mid-Mesozoic

- A period of tectonic stability and erosion
- Erosion resulting in a landscape of low to gentle relief by the middle of the Mesozoic

3. Mid Mesozoic to present

- The break up of the Gondwana super-continent, followed by;
- Opening of the Tasman Sea and subsidence of the Otway basin to below or just above sea level, which lies South of Beaufort, followed by;
- Uplift of the area inland of the Otway basin, including Beaufort, followed by
- Episodes of erosion separated by periods where changing sea levels caused widespread non-marine deposition in the Tertiary, followed by;

- An episode of non-marine basaltic volcanism in the later tertiary to Pliocene. This includes the volcanic deposits that lie to the east of Beaufort. These lava flows temporarily or permanently blocked streams in the Beaufort area resulting in significant changes in depositional patterns of sediments.

3.2 Expected Subsurface Conditions

Figure 1 includes an extract from the local 1:100,000 scale geological map (Cayley and McDonald 1995), which has been geo-referenced and overlain by the initial alignment options provided by Beca.

The area of interest for the Beaufort bypass has been categorised based on the expected underlying geology and surface geomorphology. These zones titled "Geological Domains" are listed and described in Table 3-1 below, and graphically defined in Figure 2.

Table 3-1: Summary of Expected Geology and Geomorphology

Geological Domain	Underlying Geology and Geomorphology	Geotechnical Risks & Construction Related Considerations	Additional Comments / Land Use
GD01	The White Hills Gravel, fluvial gravel, course quartz gravel to cobble sized in a matrix of sand, silt and clay, occasional boulders of quartz. The lower slopes of hills are flanked by colluvium, deposits from erosion of the slope comprising poorly consolidated gravel, sand and silt.	• Cuttings through unconsolidated gravels will require appropriate slope design.	Greenfields land comprising mainly farms and forests. The White Hills Gravel is a significant source of gravel that has been used for road base course material. However clay content can have a high plasticity index, possibility rendering the gravels unsuitable for use a road base.
GD02	Red basaltic soil underlain by basalt (volcanic lava deposit) at depth. The basalt tends to have a deep weathering profile.	• Basaltic soils tend to have a high shrink-swell potential and high plasticity index. • Layers of stronger basalt may be present at any depth due to variability of lava flows/weathering	Greenfields land comprising mainly farms and forests.
GD03	Flood plains and very low hills comprised of colluvium and alluvium. Existing stream deposits of unconsolidated gravel, sand and clay. Older stream deposits of well graded sandy clay, occasional sand lenses and gravel beds. Gullies and the boundaries of hills covered in slope wash and fans of eroded material comprising well graded, unconsolidated gravel, sand and silt. The underlying bedrock is marine turbiditic sandstone, mudstone and siltstone of the Pyrenees Formation and the Beaufort Formation.	• Potential for lenses and larger deposits of soft soils in river channels and flood plains. • Existing creeks and low points will require bridges or appropriate culverts. • There is increased risk of flooding where roads are constructed in low lying areas.	Greenfields land comprising mainly farms and forests.
GD04	Low lying hills comprised of marine turbiditic sandstone, mudstone and siltstone of the Pyrenees Formation and the Beaufort Formation (the St Arnaud Group of Ordovician to Cambrian age). Creeks and gullys at the base of these hills are filled with either recent alluvium or colluvium comprised of unconsolidated well graded sand, clay and sand. Some hills, particularly those within 4Km of the Beaufort town centre, contain elevated terraces of unconsolidated older alluvial sediments of well graded sand, gravel and clay.	• Excavations and cuttings through hills may intersect elevated terraces of unconsolidated sediments. • There are several minor creeks that may require bridges or culverts. • The southernmost initial alignment option traverses through several farm dams and houses. • Small scale slips may affect stability of cuttings and embankments	Greenfields land comprising mainly farms and forests.
GD05	Basalt bedrock at depth and basaltic soil flanking areas of swamps and lacustrine swamp deposits. Swamp deposits are comprised of dark brown mud and clay, minor fine grained sand; rich in organic matter, minor peat deposits.	• Basaltic soils tend to have a high shrink-swell potential and high plasticity index. • Swamp related sedimentary deposits may be highly compressible and problematic. Road construction in this area may require significant ground improvement.	Greenfields land comprising mainly farms and forests.

3.3 Bridges

Some historical design drawings have been provided by VicRoads regarding two bridges in the Beaufort area, on the Western Highway (VicRoads 1962 & VicRoads 1966). The following key points are derived from these drawings, however they must be considered in the context of the VicRoads "Conditions for the Provision of Geotechnical Data", which states that the documents are provided for information purposes only, and that no guarantee is granted regarding the accuracy or completeness of the data. The lithological terminology and logging used in these historical documents may not be accurate. The points are as follows:

Bridge over the railway line on the Western Highway, 2Km West of Beaufort Township:

- The bridge is comprised of two abutments and two central piers.
- The road level sits on approximately 6m depth of fill.
- The abutments are founded in "soft mudstone".
- The natural geology of the site is comprised of approximately 0.6m of clay, underlain by "soft mudstone".

Bridge over Fiery Creek on the Western Highway, Central-Eastern Beaufort Township:

- The bridge is comprised of two abutments and two central piers, all founded on piles that extend to approximately 12m depth from the road surface.
- The road level sits on approximately 2.4m depth of fill.
- The piles terminate in or just above "Basalt" at a depth of approximately 8m below the natural surface. The soils above the "basalt" are reported to be silt, silty clay, sandy clay and clay.
- Note that according to the geological map (Cayley R.A. 1995), the geology of this area is comprised of alluvium and colluvium (GD03). This data suggests that basalt underlies these sediments in this area.

These bridges may have been upgraded or changed since the time of this design drawing.

3.4 Problematic Soils

The available information for the Beaufort area does not provide specific data regarding the thickness of compressible clays, silts and swamp deposits. However deposits in GD03 have potential to contain lenses or significantly thicker layers of compressible soils. GD04 includes swamp deposits underlain by basalt. Issues related to construction on soft soil can be mitigated by avoiding swampy areas where possible as well as drilling and site investigation in order to detect problematic soils early in the design.

3.5 Slope Stability & Embankment Stability

The geological map of Beaufort (Cayley and McDonald 1995) has provision to include landslide deposits (denoted by Qx). However Cayley (1995) has noted that relief of Beaufort is too gentle for large scale landslides. He goes on to state, "*Many small rotational slips occur on the steep slopes in the Pyrenees Range, especially those which have been cleared, resulting in destabilisation of the soil and rocks. These slips are too small to be denoted on the map (1:10000), but they do form a significant land use problem. Many of these slips are active only in the winter months when the soil is saturated.*"

The small slips mentioned by Cayley (1995) may also occur on the proposed initial alignment options in the area denoted by GD04 in Figure 2. The hills in this area are relatively low lying but are likely to require cuttings in order to achieve a practical design grade for the proposed bypass.

Figure 3-1 Photograph of a railway cutting near Beaufort (Bonzle 2011)

3.6 Surface Water

The township of Beaufort and surrounding land was significantly affected by the floods of January 2011. News reports indicate that parts of the town and the railway line were inundated. The township is itself built in a low lying area flanked by streams to the north-east. A significant low lying area is to the west of the town, denoted by Geological Domain 03 (GD03) in Figure 2, this area is underlain by alluvial sediments and has surface water in streams and mudflats. It is anticipated that GD03 and GD04 will be susceptible to flooding during significant flood events.

3.7 Mines – Existing and Historic

A search of the online databases of selected government departments was conducted. Beaufort is in an area that was mined extensively during the period of the Victorian gold rush. Most of these workings were surface alluvial excavations but there remains the potential for small underground excavations.

According to the Department of Primary Industries (DPI) register of current exploration licenses (DPI 2011a), exploration license EL4935 covers the area of

interest for the Beaufort Bypass. EL4935 is owned by Oroya Mining Ltd, Suite 3, 72 Canning Hwy, Perth WA 6100. Oroya Mining are particularly interested in the Fiery Creek lead, which is situated to the north east of Beaufort township (DME-Vic 1984).

According to the DPI GeoVic database (DPI 2011b), there have been several mineral exploration licenses that are now expired, that cover the area of interest for the Beaufort Bypass. Figure 3 is an extract from the GeoVic database (DPI 2011b) which shows historical mines and mineral occurrences in the vicinity of Beaufort township.

It should be noted that mapping of historical mines and mineral occurrences may not be exhaustive.

4 REFERENCES

Cayley R.A. & McDonald P.A. (1995) Beaufort 1:100 000 Map Geological Report, Geological Survey of Victoria Report 104

Cayley R.A. (1995) Beaufort 1: 100 000 Geological Map, Geological Survey of Victoria

Australian Mining Atlas (2011) http://www.australianminesatlas.gov.au/ , cited 29/4/2011

Department of Primary Industries (2011a) http://new.dpi.vic.gov.au/earth-resources/industries/minerals/current-licences--and--permits, cited 29/4/2011

Department of Primary Industries (2011b) http://new.dpi.vic.gov.au/earth-resources/products-services/online/geovic, cited 29/4/2011

Google (2011) Google Earth Professional software, satellite images cited April 2011.

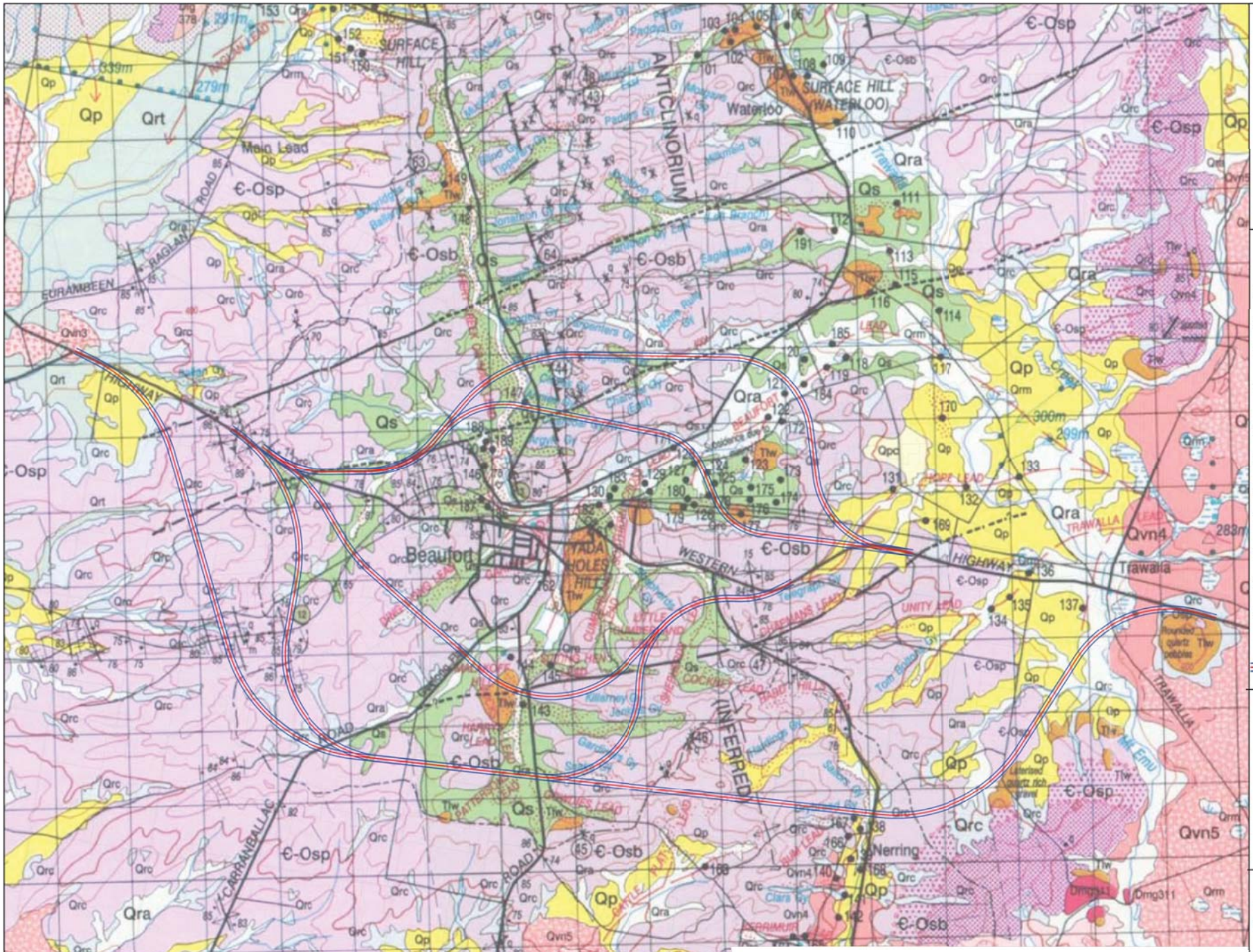
Bonzle.com (2011) http://maps.bonzle.com/c/a?a=pic&fn=5bfbgvsp&s=4, Image of railway cutting near Beaufort, cited 29/4/2011

DME-Vic (1984) Deep Lead Gold Deposits in Victoria Map No. 3 Beaufort, Bulletin No. 62, Department of Minerals and Energy Victoria

VicRoads (1962) Design Drawing for the Bridge over Fiery Creek – Central Beaufort Township, Country Roads Board, Project 6369m Contract No. 528 N2 280, Drawing 40759

VicRoads (1964) Design Drawing for the Bridge over Railway Line (Approx 2Km West of Beaufort), Country Roads Board, Project 6837, Contract 522 LC2 565, Drawing 41752, Sheets 1 & 2 of 9

Figures



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SIMPLIFIED LEGEND EXCERPTED FROM CAYLEY (1995), REFER ATTACHMENT 1 FOR FURTHER DETAILS

Qra	Alluvium: deposits of existing streams.
Qrm	Lacustrine deposits in swamps and lakes.
Qx	Landslide deposits
Qpc	Dissected colluvium: deposits formed at the toe of slopes by rockfalls, weathering and erosion.
Qrt	Alluvial terraces
Qp	Older alluvial terraces: deposits of valley backfilling following the eruption of Qvn laval flows
Qs	Basalt deposits from lava flows
Qvn	White Hills Gravel: dissected fluvial braid gravel
Tlw	Marine turbiditic sandstone and minor mudstone
€ -Csp	Marine turbiditic interbedded siltstone, mudstone and minor sandstone
€ -Csb	Initial alignment options provided by BECA

N
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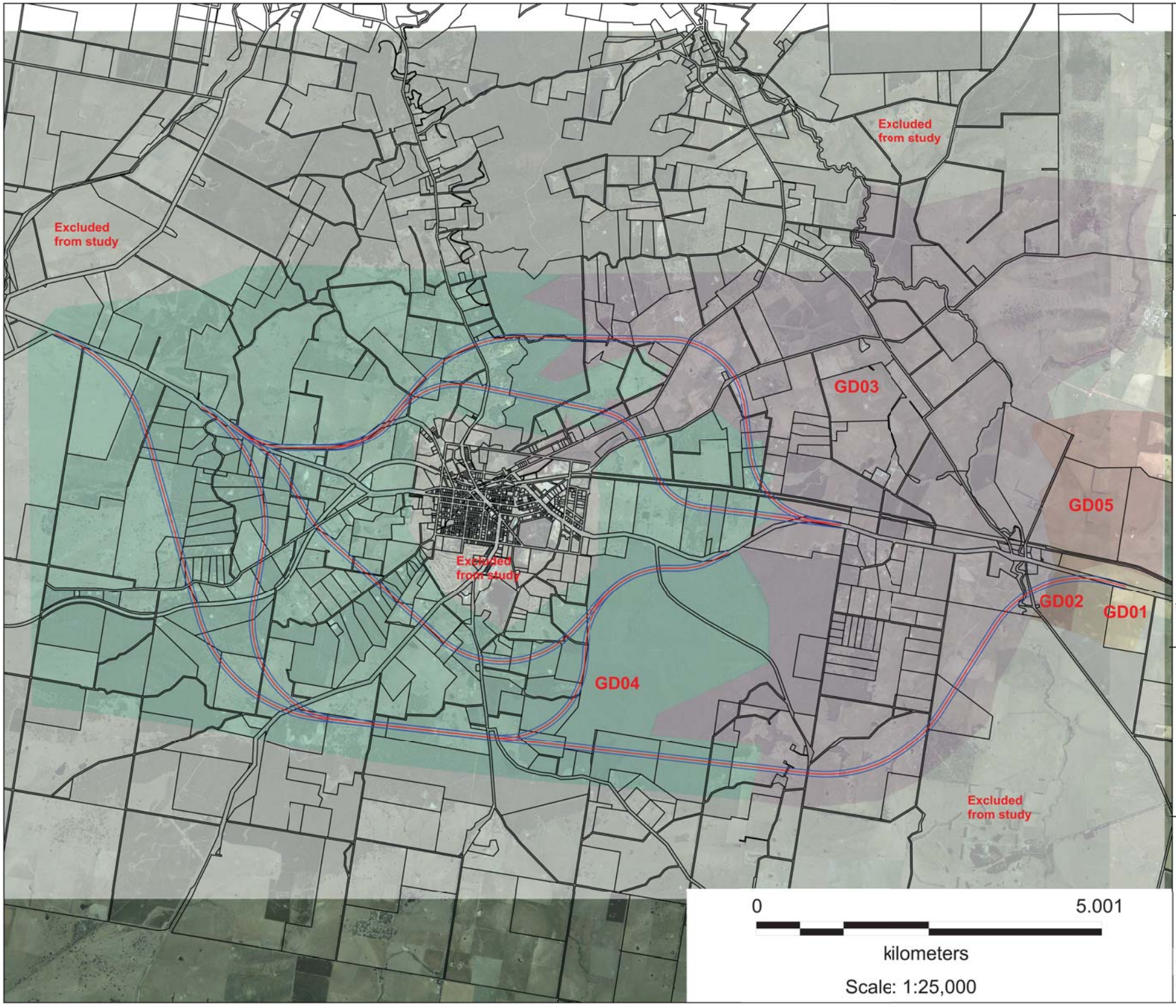
DATUM: MGA94
PROJECTION: Zone 54

DATA SOURCE: Geological Base Map Extracted from Cayley, (1995), Provided as Attachment 1

Client:	BECA
Project:	BECA ARARAT - BEAUFORT STUDY
Title:	Beaufort Bypass - Expected Geology
Plot size:	A1
Job Number:	JEXBEC
Figure:	1

Rev	Date	By	Approved
A	06-05-2011	HO	AD

Report: JEXBEC-R002



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LEGEND

GD01 Fluvial gravel and colluvium may require adoption of shallower cutting angles

GD02 Basaltic soils over basalt, variable weathering profile and potential for harder basalt layers at depth requiring ripping or blasting, soils have high shrink-swell potential

GD03 Low lying flood plain deposits, potential lenses of soft soil, bridges and culverts required for low points and creeks, susceptible to flooding

GD04 Sandstone mudstone and siltstone with colluvium and terraces of alluvial sediments. Cuttings may intersect elevated terrace of unconsolidated sediments. Several minor creeks requiring bridges of culverts. The southernmost alignment options traverse through several farm dams and houses. Potential for small scale landslips to affect cutting and embankment stability.

GD05 Mixed domain of basaltic soils and swamp/lacustrine deposites. Basaltic soils have high shrink-swell potential. Swamp/lacustrine deposits may be highly compressible requiring significant ground improvement.

Initial alignment options provided by BECA

For more detail on domains see Beaufort Bypass Geotechnical Desktop Study

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DATUM: MGA94
PROJECTION: Zone 54

DATA SOURCE: Google Earth Professional
Geological base map extracted from geological survey of Victoria

Client: BECA

Project: BECA ARARAT - BEAUFORT STUDY

Title: Beaufort Bypass - Geotechnical Risks

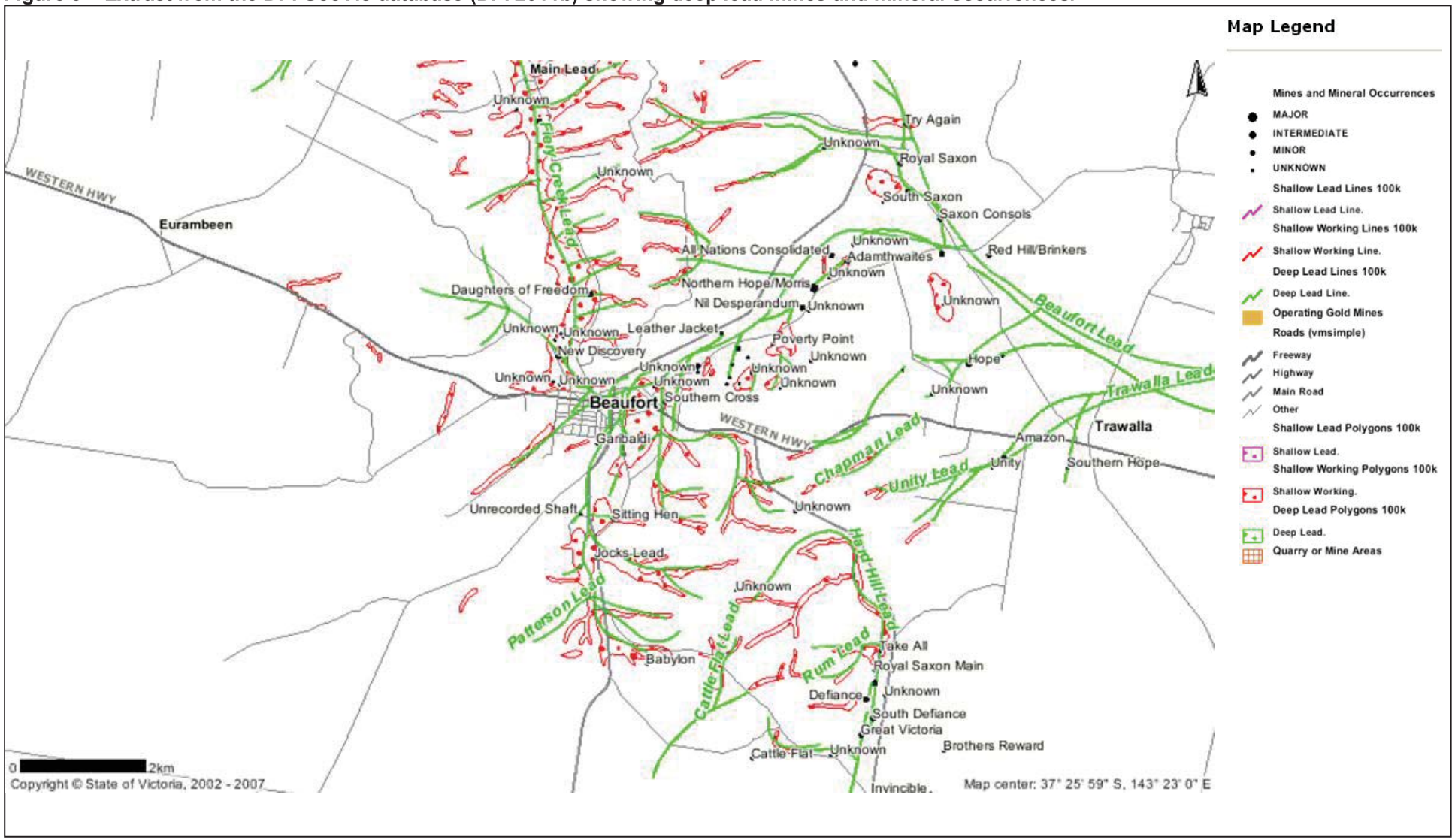
Paper Size: A1

Job Number: JEXBEC Figure: 2

Rev	Date	By	Approved
B	06-05-2011	HO	AD

Report: JEXBEC-R002

Figure 3 – Extract from the DPI GeoVic database (DPI 2011b) showing deep lead mines and mineral occurrences.



Attachments

Attachment 1: Beaufort 1:100 000 Map Geological, Geological Survey of Victoria, 1995

GEOLOGICAL SURVEY OF VICTORIA
1 : 100 000 Geological Map Series

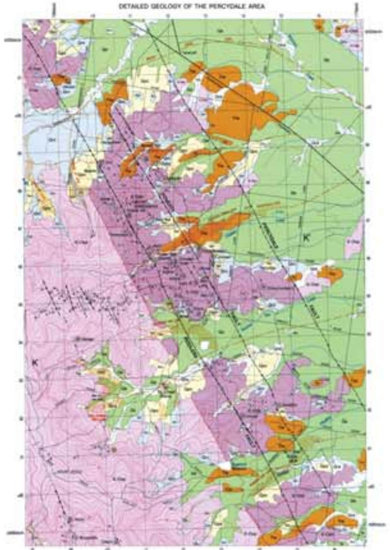
BEAUFORT

7523 ZONE 54
Edition 1

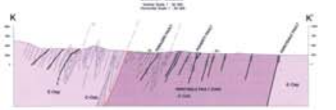
ENERGY & MINERALS VICTORIA

MINES AND MINERAL PROSPECTS

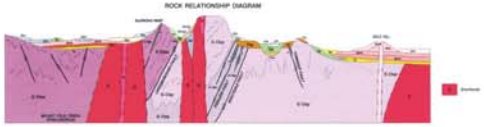
DETAILED GEOLOGY OF THE PERCYDALE AREA



Section Scales

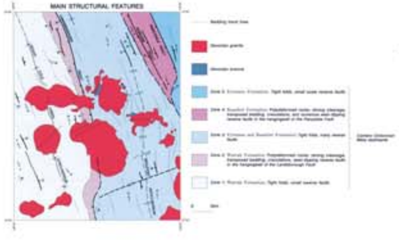


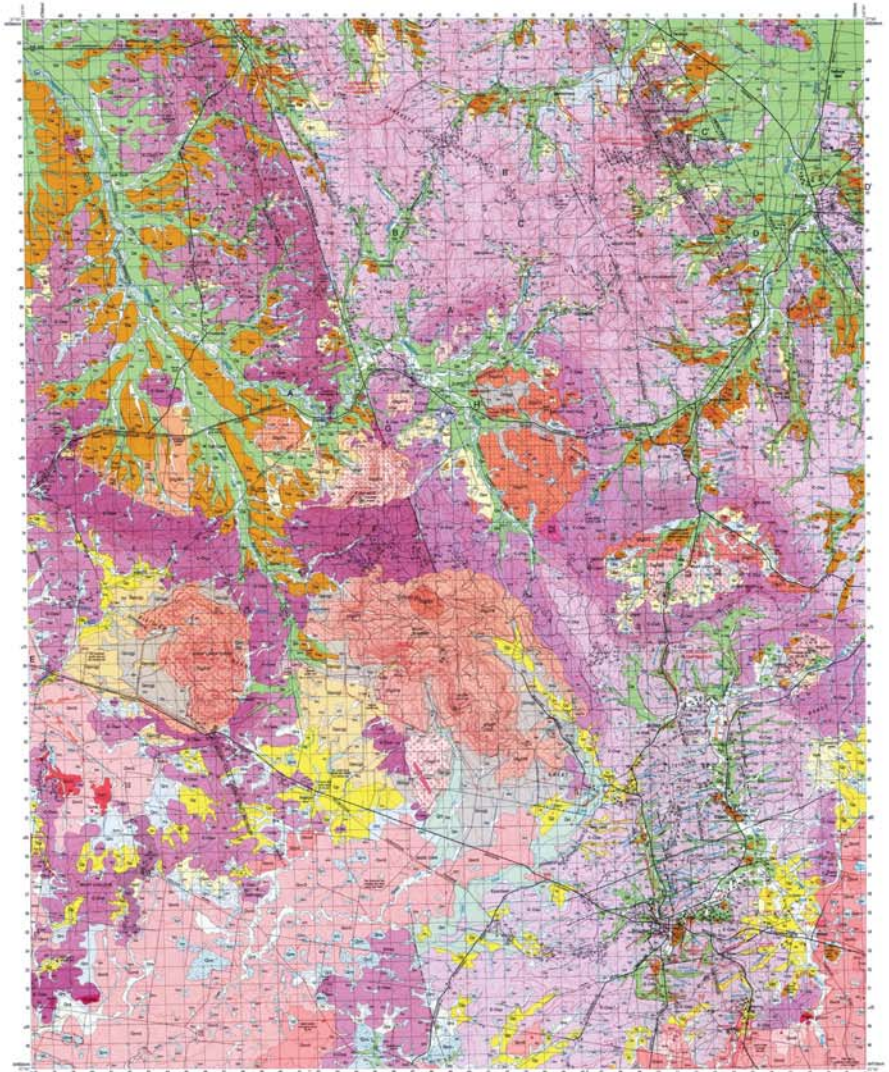
ROCK RELATIONSHIP DIAGRAM



FIELD OBSERVATION TRAVERSES

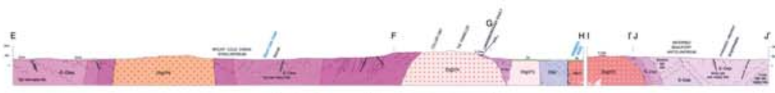
MAIN STRUCTURAL FEATURES





MAP SCALE 1 : 100 000

Section Scales



DATUM NOTES

SITES OF GEOLOGICAL INTEREST

STRATIGRAPHIC LEGEND

SEDIMENTARY | IGNEOUS

QUATERNARY — Recent, Pleistocene
TERTIARY — Pliocene, Miocene, Oligocene, Eocene, Palaeocene
DEVONIAN — Middle, Lower
ORDOVICIAN – CAMBRIAN

SYMBOL LEGEND

GEOLOGY

TOPOGRAPHY

MAP LOCATION

INDEX TO ADJOINING MAPS

RESPONSIBILITIES AND ACKNOWLEDGEMENTS

1 : 100 000 Geological Map Series

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Edition 1