REPORT No. : 1150077-2 Issue 2

CLIENT : PG & BK Ruby
3340 Bass Highway
ANDERSON VIC 3995

PROJECT LOCATION : Lot 1 / 3340 Bass Highway
KILCUNDA

COMMISSION: : The commission was to carry out a desktop geotechnical assessment of mining subsidence potential for the proposed site which is located in an area of underlying coal mine workings in the KILCUNDA Township. Investigation for site classification (Australian Standard 2870-2011 Residential Slabs and Footings), recommend foundation treatment where appropriate.

PROPOSAL : It is proposed to re-subdivide the site into two lots and construct a new dwelling on proposed Lot 1.

1. INTRODUCTION:

The proposed development site is located within the area of the Kilcunda coal mine workings which were generally carried out from 1910 to 1953. Coal was extracted from a single seam at Kilcunda during this period of time. Two mines in operation were the Kilcunda mine and the Victorian mine. The total area undermined was about 60 hectares.

Some minor extraction had taken place in the area through various small tunnels and shafts prior to 1910. In fact, coal mining was started by the Westernport Coal Mining Company as early as 1875.

Based on the mining history of this area, the local council advised that a geotechnical engineering study of the site be carried out giving due consideration to potential mining subsidence occurring at this site. In this connection, Civiltest Pty Ltd was engaged to carry out the geotechnical assessment and make recommendations on the possible effects of mining subsidence, which may occur. The location plan of the site in attached to this report as Appendix A.
2. SITE GEOLOGY:

Geologically, the Bass Shire comprises Cretaceous sandstones, mudstones and minor black coal seams. These sediments comprise the elevated central spine of the area and underlay the Tertiary and Quaternary sediments of the surrounding plane. Pronounced north easterly faulting showed a marked effect on the topography (Cooney, 1983).

Geological maps of the area suggest that the site is in an area of KLS - Cretaceous Sediment - CLAYS. The site investigation confirmed this.

3. SITE TOPOGRAPHY:

The site has a gentle to moderate slope down to the west. The ground cover comprises of natural grasses.

4. INVESTIGATION:

Three boreholes were drilled by mechanical auger at the approximate locations shown on the attached plan.

The logs of each bore are attached showing the soil descriptions and depths along with any cohesive strength measured and observed densities on non-cohesive soils.

5. FINDINGS:

The boreholes revealed that the natural soil profile consisted of silty SAND overlying silty CLAY with sand followed by extremely weathered MUDSTONE in borehole 1, silty SAND overlying extremely weathered MUDSTONE in borehole 2 and clayey SILT overlying silty CLAY followed by extremely weathered MUDSTONE in borehole 3.

The extremely weathered MUDSTONE was encountered at a minimum depth of 0.6 metres in the boreholes.
6. **MINING SUBSIDENCE:**

Where mining is carried out in shallow workings, there is a great risk of caving in of the overlying rock and soil layers leading to craters or sinkholes in the ground surface. Coal workings, which are deep down from the ground surface do not experience such occurrences of craters or sinkholes. As a guide to determining whether a coal mine has shallow workings, Golder Associates’ (1988, ref. 2.1) statement that a 1.0 - 1.5 metres thick seam mined at 40 metres depth will not likely cause severe subsidence is taken as a reference yardstick.

In contrast to craters and sinkholes, a less severe effect may involve ground settlement developing when caving of the underground excavation occurs. This caving gradually continues upward through the solid strata, with the downward migration of rock and soil materials in filling the void until there are no more voids remaining. Bulking associated with broken rock materials created via the progressive caving can prevent the caving from progressing to the surface as the void is filled completely by material from above. Consequently, the overlying stratum warps down to reflect the movement in the rock below. This feature is termed ‘subsidence’, and the down-warping at the surface, called the ‘subsidence profile’, is the feature which can cause damage to structures constructed at the ground surface.

Giedl (1984/97) stated that the severity of subsidence and its effects at the surface are related to factors such as the mining depth, extraction thickness and mining method used in the extraction. A major portion of the maximum anticipated mining subsidence generally occurs within one to two years of cessation of mining works. However, Giedl explained further that the period over which subsidence continues is dependent on the thickness of cover rocks and their competence but in general the time period was less than 20 years. There are also cases where subsidence was observed well over 50 years after mining works had stopped. The effect of time is very difficult to assess, and to determine whether subsidence has fully occurred and reached an equilibrium state is almost impossible.

According to Cooney (1983), coal in Kilcunda was extracted from one single seam. Cooney pointed out that based on a few available drilling logs, the seam was found to be part of a sequence of sandstone, mudstone, shale and other very thin coal seams, and frequently both the roof and the floor of the main seam were shale. The approximate seam thickness was up to about 0.7 – 1.0m and the approximate depths of the coal workings varied significantly between 10 – 100m below ground surface.

The seam had a slope of 1 in 7.5 (7.6°) towards the northeast. This northerly dip coupled with increasing elevation of the land surface topography northwards meant that there was an overall increase of overburden cover towards the north (towards the Bass Highway). The site in question is located close to the Bass Highway, overburden thickness in this area is assumed to increase proportionately as the land rises in elevation.

The extent of subsidence if any over this area cannot be confirmed as no detailed survey of the ground surface had been done before and after the mining.
7. RECOMMENDATIONS ON MINING SUBSIDENCE:

With the currently available information and literature, the following deductions can be made about mining subsidence at the given site:-

(1) Site Location: The site is located in an area of intermediate potential for subsidence as indicated by Cooney (1985).

(2) Subsidence Hazard Zoning according to Cooney (1985) indicates that the site is in Zone 2.
   Where:
   Zone 1 = Areas for which there is a likelihood that subsidence troughs and/or sinkholes may occur;
   Zone 2 = Areas for which there is a likelihood that subsidence troughs but not sinkholes may occur;
   Zone 3 = Areas not underlain by old workings or their transition zones.

(3) Overburden Thickness: The site is located in an area of fairly immediate to deep coal workings. The area of the site is thought to have approximately 40 metres overburden coverage according to Cooney (1985/68, fig.9), which is 20 times the presumed cavity height of 2.0 m.

(4) The year in which mining ceased: Mining works ended in 1953. A time period of about 61 years has lapsed and it is expected that a major portion of the subsidence would have taken place by now. However, it cannot be certain since pre- and post-mining topographical survey data is not available to confirm this.

(5) Other existing structures: Many houses and other structures are presently located over the Kilcunda coal workings but thus far, there is no clear evidence to prove that subsidence is still continuing.

(6) Site observation: The site appeared to have no evidence of troughs or humocky ground that might signify the effect of subsidence occurring on the site.

Based on the above, it is prudent to take into account the possibility of some movement occurring. Since cavities were made beneath the area and these may to some extent remain open, the possibility of their eventual and further collapse with repercussions cannot be dismissed. Based on the above points however, the risk of subsidence affecting a structure built on this site appears to be intermediate. As a safeguard it is recommended that the building design be limited to 20.0 metres in length to limit to very slight. If the proposed building length is more than 20.0 metres then an engineered slab as recommended in section 9 should be adopted. The most advisable structure would be of timber or similar flexible construction, but if a masonry dwelling is selected it should be fully articulated, so that any differential movement which may occur will cause minimum distress to the structure.
8. SITE CLASSIFICATION:

After considering the area geology, the soil profile encountered in the bores, the proposed superstructure and mining subsidence potential, this site has been classified as CLASS P with respect to foundation construction (Australian Standard 2870-2011 Residential Slabs and Footings).

It is anticipated that the seasonal surface movement at this site will not exceed 40mm.

It must be emphasised that the recommendations referred to in this report are based on the soil profile (See AS2870 – 2011, Clause 2.3) and other information, without taking into account any abnormal moisture conditions as defined in AS2870 – 2011, Clause 1.3.3.

9. FOOTINGS SYSTEM IN A SUBSIDING AREA:

Mine subsidence can subject footing systems and the dwellings they support to ground movement including lateral strain, settlement, slope and curvature. In order to reduce the effect of the ground movement, the footing system should be designed to accommodate the differential movement that may occur between footing sections. Therefore it is recommended that an adjustable stump footing system be adopted to support the proposed dwelling. The adjustable stump footings should be designed to allow adjustment of the stump height when subsidence void migration occurs at the ground surface. Sufficient crawl space below the dwelling to allow for re-levelling would also be acceptable in this instance.

It is also recommended that the stump size be designed up to 30% larger than those for the normal condition to accommodate possible lateral strain and any occurring load eccentricity from the upper structure.

Articulation of both the upper structures and footing system should also be considered where applicable.
10. ALLOWABLE BEARING GUIDE FOR STUMPS:

This site has been classified as CLASS P (AS2870-2011), therefore if stumps are required in the proposed building for this site then these will need to be designed by a qualified engineer (as defined in AS2870) using engineering principles following AS2870-2011.

The following allowable bearing pressures may be used as a guide:

<table>
<thead>
<tr>
<th>Depth into Founding Material (mm)</th>
<th>Allowable Bearing Capacity in Native CLAY Soil (kPa)</th>
<th>Allowable Bearing Capacity in Extremely Weathered ROCK (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>500</td>
<td>180</td>
<td>240</td>
</tr>
<tr>
<td>800</td>
<td>220</td>
<td>300</td>
</tr>
</tbody>
</table>

In accordance with Appendix D of AS2870-2011, the soil profile and site conditions should be inspected at footing excavation stage by CIVILTEST PTY LTD to confirm the soil profile and site classification.

11. RECOMMENDATIONS FOR SLAB:

As an alternative to using adjustable stumps, an engineer designed stiffened raft slab could be used to span a loss of support of up to 1.5 metres in diameter under the slab and/or stiffening beams including any corner of the slab. This slab can be founded into any of the naturally occurring soils as described in the engineering logs, however the founding depth below the finished surface level surrounding the slab must be at least 200mm.

The slab must be designed for an allowable bearing pressure of not more than 80kPa under the edge and stiffening beams founded not less than 100mm into the naturally occurring soils.

Consideration in the design should be given to the likelihood of differential movement of the slab and ground surrounding the slab. This is particularly important where service conduits enter and leave the building.

In accordance with Appendix D of AS2870–2011, the soil profile and site conditions should be inspected at footing excavation stage by CIVILTEST PTY LTD to confirm the soil profile and site classification.
12. CONDITIONS OF THE RECOMMENDATIONS:

12.1 Foundations Adjacent to Easements:
It is recommended that where any footings are to be constructed next to existing underground services (sewers, etc.) and / or excavations, then these footings or edge beams should be founded at a depth below the invert of the service at an angle of repose of 45° for CLAYS and extremely weathered ROCK and 30° for SANDS, unless special consideration has been given to the founding material.

12.2 Review of the recommendations:
The recommendations made in this report may need to be reviewed by Civiltest Pty Ltd should any of the following occur:

12.2.1 Where any site works disturb any soil 300mm below the founding depth of any footing system as defined in AS2870 Clause 1.8.25.
12.2.2 Where any individual foundation depth exceeds the investigation depth.
12.2.3 Where any earthworks lower the building area by 0.5 metres or more.

12.3 Founding soils and depths:
Since the soil horizons and layers can vary in depth and thickness over the site, the depths and bearing pressures given in this report are given as a guide only. If the footings are founded at the minimum depth as stated and are in the soil as described in the logs of boring for this site, then the requirements of this report have been met.

12.4 Soil descriptions:
The descriptions of the soils found in the boreholes closely follow those outlined in AS1726 -1993 (Geotechnical Site Investigations). Colour descriptions can vary with soil moisture content. It should be noted therefore, colour and shade descriptions mentioned in this report are made when the soil is in a moist condition.

12.5 Amendment of the report:
This report has been compiled and recommendations made based on information supplied in the brief to Civiltest Pty Ltd and from the field investigations and observations made including the extent of, if any, site filling. Every care has been taken within the terms of the brief to ensure that the field investigation is representative of the site. Therefore, if it is found that for any reason information received by Civiltest Pty Ltd is incorrect, or conditions on site vary considerably during construction to those described in this report, then the comments and recommendations made in this report may need to be amended by Civiltest Pty Ltd.
12.6 Long term maintenance and performance:
To ensure acceptable long term performance of the footing systems recommended in this report, care should be taken that the fundamental building, landscaping and long term maintenance procedures are adhered to as set out in the CSIRO Building Technology File 18-2011 http://www.publish.csiro.au/pid/7076.htm, "Foundation Maintenance and Footing Performance: A homeowners guide”. This information sheet forms an integral part of this report.

12.7 Abnormal moisture conditions:
The recommendations made in this report are based on current findings and investigations. Civiltest Pty Ltd cannot be held responsible for any financial loss and / or hardship in relation to the construction of the structure and future performance of the footing system if relevant historical information has not been supplied in writing by the client to Civiltest Pty Ltd. (For example, the recent removal of trees or buildings or any other activity that is likely to have created abnormal moisture conditions as defined in AS2870 prior to Civiltest being commissioned for the investigation reported herein.)

12.8 Building cost estimation:
The limitations of this report should be closely observed when carrying out detailed costings of the proposed structure.

12.9 The information and any recommendations given in this report are limited to the client named herein.

12.10 Whilst CIVILTEST PTY LTD has accepted the commission for the work reported herein, the ownership of the report and any liabilities associated with it, remain with CIVILTEST PTY LTD until all relevant accounts have been paid.

12.13 Finally, no responsibility will be taken for this report if it is altered in any way or is not reproduced in full.

This report consists fourteen pages including one site plan.

ZHAN TANG
GEOTECHNICAL ENGINEER
CIVILTEST PTY LTD

18 November 2019

REF: MR/PB/JY/ZT/sb/th

AMENDMENT: This report was first issued on 17 February 2015, 31 May 2019 and 7 November 2019. Sections of this report were amended on 18 November 2019 and consequently this revised report now takes precedence over any previously dated report.
REFERENCES:

5) Department of Mines, Victoria, Annual Report, 1911, Plan Showing Sites of Bores on the Powlett Coal Field, Parishes of Kirrak, Wonthaggi and Woolamai at a scale of 40 chains to 1 inch (available at the library of Department of Natural Resources and Environment, Level 8, 240 Victoria Parade, East Melbourne).
6) Department of Mines, Victoria, records by J. P. L. Kenny, B.C.E., (Chief Govt. Geologist, 1944-46), with Supplementary Reports by Various Authors, 1 June 1948 (available at the library of Department of Natural Resources and Environment, Level 8, 240 Victoria Parade, East Melbourne).
12) Reports on the Victorian Coal-Fields (No. 2) by J. Stirling, SR 1893 (available at the library of Department of Natural Resources and Environment, Level 8, 240 Victoria Parade, East Melbourne).
13) State Coal Mines working plans of the Kilcunda/Woolamai Coal Fields, (microfiche nos. CM 1404/B/1&2, CM 1404/G/2, CM 1404/M/1,2,5,6&7, CM 1405/M/1&2 and CM 2275/B/1,2&3), at the library of Department of Natural Resources and Environment, Level 8, 240 Victoria Parade, East Melbourne.
LOCATION OF TEST SITES: 3340 BASS HIGHWAY KILCUNDA

NOT TO SCALE

THIS SKETCH IS NOT INTENDED TO BE AN ACCURATE DEPICTION OF THE NUMBER, SIZE OR LOCATION OF TREES AND/OR SHRUBS

Denotes Test Holes
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<th>Test Hole No 1</th>
<th>Classification</th>
<th>Shear Vane Strength kPa</th>
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<tr>
<td>0.500</td>
<td>x</td>
<td>SAND, silty</td>
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<td>. . .</td>
<td>Brown</td>
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<td></td>
<td>. . .</td>
<td>Dry to moist</td>
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<td></td>
<td>. . .</td>
<td>Dense</td>
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<tr>
<td>0.900</td>
<td>x . .</td>
<td>CLAY, silty with sand</td>
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<tr>
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<td>. .</td>
<td>Brown grey</td>
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<tr>
<td></td>
<td>. .</td>
<td>Moist</td>
</tr>
<tr>
<td></td>
<td>x . .</td>
<td>Stiff</td>
</tr>
<tr>
<td>1.500</td>
<td>0 0 0</td>
<td>Extremely weathered ROCK (MUDSTONE)</td>
</tr>
<tr>
<td></td>
<td>0 0 0</td>
<td>Pale brown</td>
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<tr>
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<td>Dry to moist</td>
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<tr>
<td></td>
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<td>Very low strength</td>
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END OF BORE (17/05/19)
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<th>Classifications</th>
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<th>Engineering Log</th>
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<tr>
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<td>SAND, silty Brown</td>
<td>Extremely weathered ROCK (MUDSTONE) Pale brown</td>
</tr>
<tr>
<td></td>
<td>x x x x x x</td>
<td>Dry to moist</td>
<td>Very low strength</td>
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<td>Very low strength</td>
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<tr>
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<td>0 0 0 0 0 0 0</td>
<td>Extremely weathered ROCK (MUDSTONE) Pale brown</td>
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</tr>
<tr>
<td></td>
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<td>Dry to moist</td>
<td>Low strength</td>
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</table>
## Engineering Log

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<th>Classification</th>
<th>Shear Vane Strength (kPa)</th>
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</thead>
<tbody>
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<td></td>
</tr>
<tr>
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<td>x x</td>
<td>SILT, clayey Brown Dry to moist Dense</td>
</tr>
<tr>
<td>0.700</td>
<td>x</td>
<td>CLAY, silty Brown grey Moist Stiff</td>
</tr>
<tr>
<td>1.500</td>
<td>0 0 0 0 0 0 0 0</td>
<td>Extremely weathered ROCK (MUDSTONE) Pale brown Dry to moist Very low strength</td>
</tr>
</tbody>
</table>

END OF BORE (17/05/19)