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PO Box 7960
Baulkham Hills NSW 2153

Project 75853.02
11 December 2019
R.001.Rev0
TDM

Attention: Kevin Rigg

Email: Kevin.rigg@robsoncivilprojects.com.au

Dear Sirs

Slope Stability Assessment
Proposed Rezoning
39 Dell Road, West Gosford

1. Introduction

This revised report presents the results of a slope stability assessment undertaken for proposed rezoning at 39 Dell Road, West Gosford. The report details the results of an initial assessment undertaken in September 2018 and has been updated to provide the results of a supplementary assessment undertaken in November 2019. The investigation was initially commissioned in an email dated 31 August 2018 by Kevin Rigg of Robson Civil Projects Pty Ltd, with the supplementary assessment was commissioned in an email dated 29 November 2019. The work was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal CCT180310 dated 31 August 2018. The investigation was also carried out in consultation with Wales & Associates Pty Ltd.

It is understood that the client is planning to rezone a section in the north-eastern part of the site to 'IN1' (General Industrial) with the remainder of the site to be zoned 'E2' (Environmental Conservation).

Council has conditioned the rezoning indicating that *"all stability issues on the land are to be identified and resolved by an experienced geotechnical company and any measures necessary to eliminate the risk of future rock fall or instability on future downslope development are to be undertaken on that part of the land to be retained in private ownership are to be installed and managed at no cost to Council"*.

Given the above condition, an assessment was undertaken to identify the geotechnical hazards at the site and to provide comment on appropriate stabilisation measures, if required. The assessment comprised a walkover by an experienced geotechnical engineer.

Subsequent to the initial assessment, it was advised by Council that the report is to be amended to *"include the area of the site that abuts the former quarry site. Concerns regarding stability issues are not limited to the rock escarpment to the rear of the site but includes the mounded areas that appear to have been disturbed at some stage"*.

Further assessment of the site was undertaken to address the matters outlined by Council.

Given that the details of the proposed development are not known, a slope stability assessment strictly in accordance with the Australian Geomechanics Society (AGS) Landslide Taskforce “*Practice Note Guidelines for Landslide Risk Management*” March 2007 was beyond the scope of the current investigation. Reference has, however, been made to the above guidelines to provide assess the general stability risks at the site.

2. Site Description and Regional Geology

The site has a street address of 39 Dell Road, West Gosford and is identified as Lot 6 in Deposited Plan 3944. Figure 1 shows the extent of the site and also indicates the proposed rezoning boundaries.

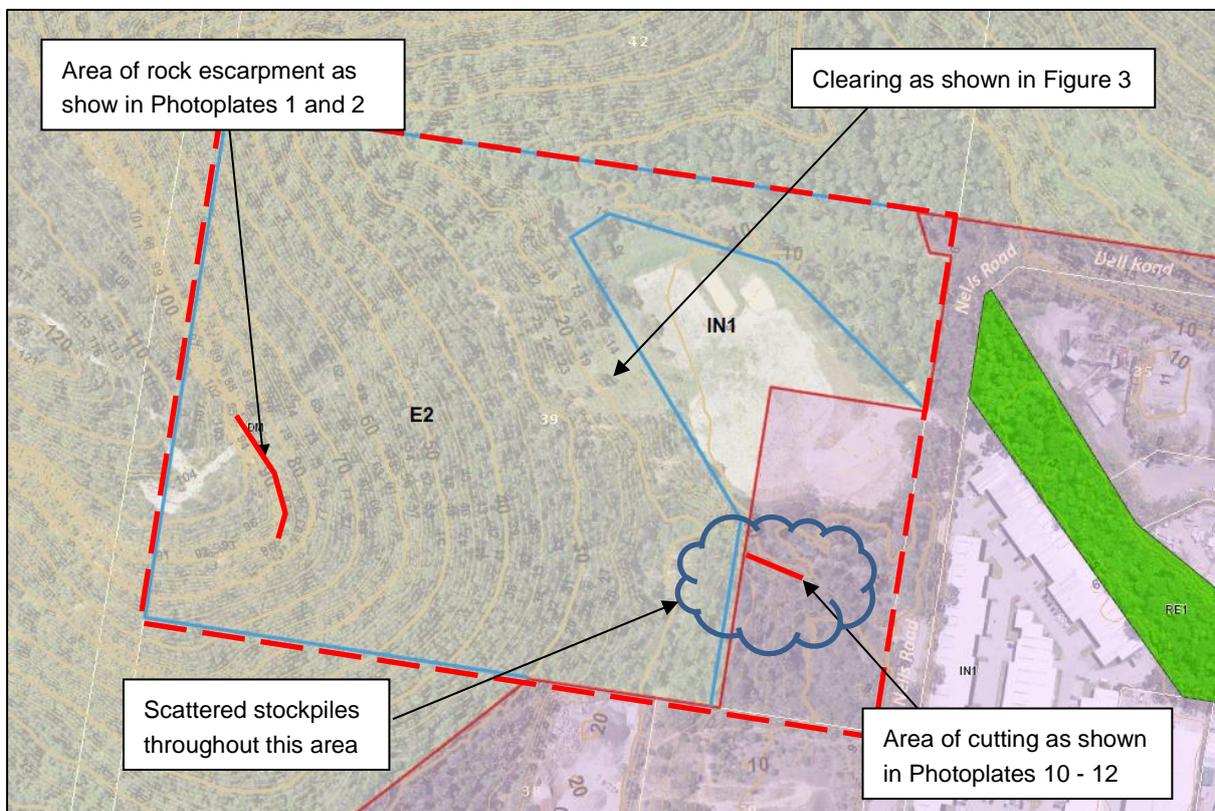


Figure 1 – Extent of site and rezoning boundaries (as provided by Wales & Associates Pty Ltd)

The south-east corner of the site (shaded red) is already zoned ‘IN1’.

At the time of the inspection, the northern area of the site to be rezoned ‘IN1’ had been filled, to create a level building platform (refer Figure 2). Surface levels in this area are in the order of about RL 10 m to 14 m AHD.



Figure 2 – Photograph of filled area to be zoned ‘IN1’, looking west

The area to the west and south is generally heavily vegetated with immature and mature trees, with the exception of small cleared area (refer Figures 1 and 3).



Figure 3 – View of cleared area at toe of slope and vegetated area beyond, looking west

Based on review of the available survey information, surface levels to the west of the area to be zoned ‘IN1’ rise to approximately 105 m AHD, at the crest of a rock escarpment. The surface levels in the area to the south, including the area already zoned ‘IN1’, range from about RL 9 m to 20 m AHD.

An intermittent tributary of Narara Creek is located adjacent to the northern boundary of the site. An electrical easement is also located crossing through the north-western corner of the site and then following the northern boundary to the east.

Reference to the local geological mapping indicates that the majority of the site is underlain by the Terrigal Formation, which typically comprises fine-grained, lithic-quartz sandstone and siltstone with shale interbeds. The weathering products of sandstone and shale are usually clay soils, overlying highly and extremely weathered sandstone bedrock. An area mapped as Quaternary alluvium, which typically comprises sand, gravel, silt and clay, also borders the eastern boundary of the site.

Further comment regarding pertinent site features, with respect to slope stability are provided below.

3. Field Observations

Observations made during the initial and supplementary walkover assessment were recorded and are summarised below:

- Upslope of the area to be rezoned 'IN1', the natural slopes typically range from about 15° to 20° with some localised steeper areas up to about 30°;
- Some basal bending and leaning of trees (although not consistent) were observed in the trees, suggesting possible previous shallow soil movement;
- Boulders are present upslope of the area to be rezoned 'IN1' and appear to have detached from the rock escarpment above. The closest boulders are relatively small (i.e. <3 m across) and approximately 80 m upslope of the proposed zone boundary. Larger boulders, up to about 8 m to 10 m across, were also observed approximately 50 m from the escarpment (i.e. about 150 m from the proposed zone boundary);
- No boulders were observed in or adjacent to the area to be rezoned 'IN1';
- The rock escarpment is approximately 8 m high. Some undercutting was observed near the base of the escarpment, however, no signs were observed to suggest that large boulders were becoming detached from the escarpment. Some smaller boulders (<2 m across), however, appeared to have detached and caught up within the escarpment;
- No signs of gross instability were observed during the inspection;
- An area of exposed sandstone was observed near the toe of the slope and at the southern end of the proposed zone boundary;
- Residual clay soils are exposed to the south of the cleared area, near the toe of the slope;
- A bund / catch drain has been constructed approximately 45 m upslope of proposed zone boundary, diverting upslope run-on to the intermittent drainage alignment to the north;
- Catch drains have also been constructed at the toe of slope, just west of the fill pad within the area to be rezoned 'IN1';
- Some fill (soil) mounds are present to the south-east area of the site, adjacent to and within the area to be rezoned 'IN1' or already zoned 'IN1'. These fill mounds were typically no higher than about 2 m and at some locations were covered with felled trees, branches and other vegetation;

- A near vertical cutting, up to approximately 4 m to 5 m high, is present approximately 50 m to the south of the main area to be rezoned 'IN1'. The cutting appears to start within the area to be rezoned and crosses into the area already zoned 'IN1'. It is noted, however, that a site survey plan showing the cutting and rezone boundaries is currently not available;
- The cut face typically appears to comprise residual clay soils, however given the vegetation cover, full inspection of the cut face was not possible. Small (less than about 0.5 m³) wedges of residual clay soils were observed to be falling away from the cut face at some locations; and
- The south-east area of the site (area already zoned 'IN1') was currently being used to stockpile soils.

Photographs taken at the time of the inspections, which relate to the notes above, are provided in the attached photoplates.

4. Comments

A detailed slope stability assessment, with reference to the AGS Landslide Taskforce "*Practice Note Guidelines for Landslide Risk Management*" March 2007, was beyond the scope of the current investigation. Notwithstanding this, based on the observations made during the inspection, it is expected that the '*risk of future rock fall or instability on future downslope development*' is very low.

Although boulders are present upslope of the future development, the nearest boulder is some 50 m away and is relatively small (<2 m across). Furthermore, given the tabular shape of the boulders and the presence of bunds / catch drains upslope of the development area, further rolling / sliding of the boulders to the development area is considered unlikely. Similarly, any new boulders that may detach from the escarpment are likely to be caught up within the densely vegetated slopes or stop prior to reaching the area of the proposed industrial development, as indicated by observations made of previous detachments at the site.

It is expected that the fill mounds, which were observed to be less than about 2 m high, are unlikely to become unstable and impact on future development. The fill mounds located within the development area are expected to be removed during construction. Further assessment of any remaining stockpiles within the rezoned area 'E2' should undertaken as part of a specific slope stability assessment at the time of development.

Given that the near vertical cutting in the south-east area of the site is showing signs of instability, it is recommended that the portion of the cutting extending into the area to be rezoned 'E2', if any, be battered to a gradient of no steeper than 2 horizontal : 1 vertical. It is noted, however, that any development within the area zoned 'IN1' will likely include bulk earthworks to provide a level building platform, thus removing the cutting and the associated risk of instability.

On this basis, provided that the recommendations given above are adopted and assuming that the proposed industrial development will comprise standard industrial buildings with tilt-up walls placed at the level of the existing building pad (or on level building pads in the area already zoned 'IN1'), the assessed general risks at the site are considered low, and therefore would usually be acceptable to the regulator. It is considered that further stabilisation measures, other than the battering of the cut face, are not required in this instance.

Notwithstanding the above, it is recommended that reassessment be carried out once the specific details of the industrial development are known to confirm that the risk remains low and whether any additional risk mitigation measures are required. This assessment should be undertaken in accordance with AGS "*Practice Note Guidelines for Landslide Risk Management*" March 2007.

5. Limitations

Douglas Partners (DP) has prepared this report for this project at West Gosford, in accordance with DP's proposal CCT180310 dated 31 August 2018 and acceptance received from Robson Civil Projects Pty Ltd also dated 31 August 2018. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Robson Civil Projects Pty Ltd and Wales & Associates Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

DP's advice is based upon the conditions observed during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the areas inspected. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction of all works (not just geotechnical components) and the controls required to mitigate risk. This report does, however, identify hazards associated with the geotechnical aspects of development and presents the results of risk assessment associated with

the management of these hazards. It is suggested that the developer's principal design company may wish to include the geotechnical hazards and risk assessment information contained in this report, in their own Safety Report. If the principal design company, in the preparation of its project Design Report, wishes to undertake such inclusion by use of specific extracts from this subject DP report, rather than by appending the complete report, then such inclusion of extracts should only be undertaken with DP's express agreement, following DP's review of how any such extracts are to be utilised in the context of the project Safety Report. Any such review shall be undertaken either as an extension to contract for the works associated with this subject DP report or under additional conditions of engagement, with either option subject to agreement between DP and the payee.

We trust that the above comments are sufficient for your present requirements, if you have any questions regarding the above, please do not hesitate to contact the undersigned.

Yours faithfully

Douglas Partners Pty Ltd



Troy McClelland
Senior Associate

Reviewed by



Michael Gawn
Principal

Attachments: About this Report
 Photoplates

About this Report

Douglas Partners



Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.



Photo 1: Path from toe of escarpment, toward development area



Photo 2: Rock escarpment

	Photoplates		PROJECT:	75853.01
	Slope Stability Assessment		Plate	1
	39 Dell Road, West Gosford		REV:	A
	Client	Robson Civil Projects P/L	DATE:	11.09.2018



Photo 3: Small boulders caught up in escarpment



Photo 4: Undercutting near base of escarpment



Photoplates		PROJECT:	75853.01
Slope Stability Assessment		Plate	2
39 Dell Road, West Gosford		REV:	A
Client	Robson Civil Projects P/L	DATE:	11.09.2018



Photo 5: Large boulders detached from escarpment



Photo 6: Large boulders detached from escarpment



Photoplates		PROJECT:	75853.01
Slope Stability Assessment		Plate	3
39 Dell Road, West Gosford		REV:	A
Client	Robson Civil Projects P/L	DATE:	11.09.2018



Photo 7: Small boulders, further downslope



Photo 8: Nearest boulder (small)



Photoplates		PROJECT:	75853.01
Slope Stability Assessment		Plate	4
39 Dell Road, West Gosford		REV:	A
Client	Robson Civil Projects P/L	DATE:	11.09.2018



Photo 9: Path near toe of slope



Photo 10: Exposed sandstone batter near toe of slope



Photoplates		PROJECT:	75853.01
Slope Stability Assessment		Plate	5
39 Dell Road, West Gosford		REV:	A
Client	Robson Civil Projects P/L	DATE:	11.09.2018



Photo 11: Residual soils exposed on site



Photo 12: Catch drain / bund upslope of development area

	Photoplates		PROJECT:	75853.01
	Slope Stability Assessment		Plate	6
	39 Dell Road, West Gosford		REV:	A
	Client	Robson Civil Projects P/L	DATE:	11.09.2018



Photo 13: Catch drain at toe of slope, adjacent to development area



Photo 14: Toe of slope



Photoplates		PROJECT:	75853.01
Slope Stability Assessment		Plate	7
39 Dell Road, West Gosford		REV:	A
Client	Robson Civil Projects P/L	DATE:	11.09.2018



Photo 15: View of stockpiles of soil and vegetation, looking south



Photo 16: Exposed stockpile showing soils and vegetation



Photoplates		PROJECT:	75853.02
Slope Stability Assessment		Plate	8
39 Dell Road, West Gosford		REV:	A
Client	Robson Civil Projects P/L	DATE:	04-Dec-19



Photo 17: View of vegetation stockpiles west of cutting, looking south



Photo 18: View of stockpiles sandstone boulders



Photoplates		PROJECT:	75853.02
Slope Stability Assessment		Plate	9
39 Dell Road, West Gosford		REV:	A
Client	Robson Civil Projects P/L	DATE:	04-Dec-19



Photo 19: View of cutting looking west



Photo 20: Example of loose soil wedge



Photoplates		PROJECT:	75853.02
Slope Stability Assessment		Plate	10
39 Dell Road, West Gosford		REV:	A
Client	Robson Civil Projects P/L	DATE:	04-Dec-19



Photo 21: View of sandstone boulders at base of cutting, at western end



Photo 22: View of cutting looking east



Photoplates		PROJECT:	75853.02
Slope Stability Assessment		Plate	11
39 Dell Road, West Gosford		REV:	A
Client	Robson Civil Projects P/L	DATE:	04-Dec-19



Photo 23: View of cutting showing loose soil wedges



Photo 24: View of fill mound in south-east area of site



Photoplates		PROJECT:	75853.02
Slope Stability Assessment		Plate	12
39 Dell Road, West Gosford		REV:	A
Client	Robson Civil Projects P/L	DATE:	04-Dec-19



Photo 25: View of stockpiled soils in south-east area of site

Photoplates		PROJECT:	75853.02
Slope Stability Assessment		Plate	13
39 Dell Road, West Gosford		REV:	A
Client	Robson Civil Projects P/L	DATE:	04-Dec-19