Pulver Cooper & Blackley Pty Ltd

Proposed Residential Subdivision Rayford Street and Daydawn Avenue, Warners Bay

Slope Stability Assessment

Report No. RGS01426.1-AE 30 May 2017





30 May 2017

Pulver Cooper Blackley Pty Ltd 98 Lawes Street EAST MAITLAND NSW 2323

Attention: Mr Mark Daniels

Dear Mark

RE: Proposed Residential Subdivision at 40 Rayford St & 19 Daydawn Ave, Warners Bay

Geotechnical Assessment

Regional Geotechnical Solutions (RGS) has undertaken a slope stability assessment to assess the feasibility of undertaking residential subdivision development on the above adjoining sites, which are situated in an area with a history of slope instability.

The assessment was undertaken in accordance with the Australian Geomechanics Society 2007 Practice Note Guidelines for Landslide Risk Management. Based on the findings of the assessment, it has been concluded that residential development on the lower slopes would be feasible from a geotechnical perspective.

An area of recently active landslide was identified on the upper to mid slopes of the northern end of the site, with a lobe of resultant debris having travelled onto the lower, footslope area. Development should be avoided on the active part of the landslide on the upper slopes. This area is identified and delineated in the report.

A second area of historic landslide activity was identified on the lower slopes of the section of the property at 19 Daydawn Avenue. It is recommended that residential development be avoided in this part of the site, however, it is considered appropriate for incorporation into a road easement provided some remedial works are undertaken, primarily involving installation of measures to drain the subsurface profile.

Development of the remainder of the site is considered feasible from a landslide risk perspective. Some remedial works will be required to allow development in the area directly downslope of the active landslide at the northern end of the site, and some drainage measures should be undertaken if development is to encroach on the moderate to steep colluvial slopes near the centre of the site. For both areas, further geotechnical investigation is required to gather the information required to design the slope remediation and drainage works.



The report presents the findings of the assessment, delineates the geotechnical terrain of the area, identifies potential landslide hazards, and provides general recommendations regarding the geotechnical constraints and measures that would be required to allow residential subdivision development of the site.

If you have any questions regarding this development, please contact the undersigned.

For and on behalf of

Regional Geotechnical Solutions Pty Ltd

CO

Steven Morton Principal



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1 INTRODUCTION

At the request of Mr Mark Daniels of Pulver Cooper & Blackley (PCB) Pty Ltd, Regional Geotechnical Solutions Pty Ltd (RGS) has undertaken a geotechnical slope stability assessment on two adjoining properties located at

- No. 40 Rayford Street, Warners Bay; and
- No 19 Daydawn Ave, Warners Bay.

There is currently a proposal to establish residential development on the two lots. This report addresses both lots in conjunction and the combined lots are herein referred to as "the site".

The site is situated on the southeast facing slopes of Munibung Hill and is roughly rectangular, occupying an area of 355m by 442m. Surface elevations range from approximately RL25m AHD at the eastern boundary, to approximately 110m AHD at the western boundary.



Subject property comprising No 40 Rayford Stree outlined in red, and No 19 Daydawn Avenue outlined in yellow

The site is bounded to the east by residential subdivision development, however, it falls within the East Munibung Hill Area Plan delineated under Section 4.20 of the Lake Macquarie City Council Development Control Plan 1 (DCP1). The plan designates the foothills of Munibung Hill as an area that will remain largely undeveloped with no further subdivision due to scenic quality, environmental and geotechnical constraints. The geotechnical constraints pertain to the site being located in a region of known previous slope instability.

Taking into account the planning constraints and slope stability concerns, the purpose of the work presented herein was to assess the site with regard to the geotechnical feasibility of developing all or some of the site for the purposes of a residential subdivision. The assessment has been undertaken in accordance with the AGS 2007 Practice Note Guidelines for Landslide Risk Management (Ref.1).

2 SITE INVESTIGATIONS

The assessment of the site involved the following:



- Review of a previous "Site Stability Design Report" undertaken for the 19 Daydawn Avenue section of the site which contained the results of subsurface geotechnical investigations include borehole logs, sections, and piezometric information;
- Review of other available reports and published information regarding slope stability and landslide issues in the area;
- Walkover site assessment to observe surface conditions that may be relevant to slope stability evidence of past landsliding, unusual ground formations, drainage conditions, the presence of disturbed or hummocky ground etc.
- Excavation, logging, and sampling of test pits within selected areas of the 40 Rayford Street part of the site. The logging involved assessment of profile conditions, evidence of disturbed ground, water inflows, presence of potential shear planes on which failure could occur. Due to the information available in the previous report for the 19 Daydawn Avenue, no further subsurface investigations were deemed necessary for this preliminary or feasibility stage of investigations.
- Identification, on the basis of the above information, of areas having the potential for residential development.

The test pit locations are shown on Figure 1. Test pit logs are included as Appendix A.

3 BACKGROUND AND GEOTECHNICAL SETTING

3.1 Regional Geology

The site is situated within an area underlain by the Moon Island Beach sub-group of the Newcastle Coal Measures. The elevated ridges and steep slopes nearing the crest of Munibung Hill to the west of the site are formed by the weathering resistant thick conglomerate and sandstone beds of the Teralba Conglomerate member. This is directly underlain by the Booragul Tuff and the Great Northern seam that sub-crop on the lower slopes, directly below the steeply sloping scarps that delineate the edge of the Teralba Conglomerate sub-crop. These units generally comprise tuffaceous claystones of low shear strength. Water which infiltrates through widely spaced joints in the overlying conglomerate concentrates at the interface of the conglomerate and these underlying claystone units. The water tends to flow laterally through these layers and daylights as seepage on the slopes below.

The lower slopes are typically underlain by the fine grained tuffaceous sandstones, siltstones and claystones of the Awaba Tuff. This directly overlies the Fassifern coal seam, which sub-crops at or about the level of Fairfax Road, to the east of the subject site.

A previous study by RGS at the northern end of Fairfax Road, approximately 450m north of the subject site, encountered Teralba Conglomerate overlying the Great Northern Seam, with the seam encountered at approximately RL55m AHD. The Bashi report, as well as other studies undertaken at Daydawn Avenue encountered the Great Northern Seam at approximately RL 40m AHD. This correlates well with the known overall regional dip of the strata towards the west and southwest, with dip angles varying between 2 and 5 degrees. Based on interpolation between these two locations, the Great Northern Seam would be expected to subcrop at approximately RL 40 to 45m at the northern end of the current site, and approximately 40m at the southern end.



3.2 History of Slope Instability in the Area

The site is situated in an area where large scale landslides are known to have occurred periodically through the 1920's, 1950's and into the 1970's. In the 1950's a large scale landslide above Chelston Street, to the west of Fairfax Road, resulted in a debris flow extending some 250m, with the debris crossing Fairfax Road and extending to the east.

Numerous studies and reports have been prepared in relation to the landsliding in the area. These previous works have indicated that the landslides typically occur due to the sliding of thickly bedded, joint-bound conglomerate and sandstone blocks over underlying, near horizontal tuffaceous claystone beds associated with the Great Northern coal seam, due to a combination of concentrated water flows and low shear strengths on the weathered claystone horizons.

Groundwater levels in the area have been shown to be a major contributor to triggering of the landslides with a study by Fell et al (Ref.3) indicating that landslides occurred on these slopes when groundwater levels rose to at, or near, the ground surface and that, based on available records at the time, this was likely to occur on an average return interval of approximately 25 to 30 years. The Fell paper included broad scale mapping of landslide-related zones within the study area. This mapping is overlain on the current subject site in Figures 3 and 4.

As shown on Figures 3 and 4, the previous mapping identified an inferred "old" landslide on the lower slopes of the property at 19 Daydawn Avenue.

In 1988 Lake Macquarie City Council undertook major works to install deep (up to 10m) subsoil drains within the landslide area to the west of Chelston Street, which is located to the north of the current site, but at a similar position within the slope profile and geological profile. The drains extended down to zones of water flow at the top of the claystone beds above the Great Northern Seam. The purpose of these deep drains was to discharge water from the potential slide planes and inhibit the buildup of groundwater levels and piezometric pressures in response to rainfall. It is understood there have been no significant landslides in the Chelston Street area since the installation of these drains.

4 SITE CONDITIONS

4.1 Surface Conditions

The site is located to the west and north of the western end of the existing Rayford Street and Daydawn Avenue, and extends through to the current termination of Winterlake Street at the northern boundary. An existing residence and some associated sheds and outbuildings occupy a small area off the end of Rayford Street. Otherwise the site is vacant. Much of the land was previously cleared for orcharding and grazing of livestock. Parts of the site, predominantly between Rayford Street and Winterlake Street, and areas upslope of those streets, are currently used for agistment of horses. No 19 Daydawn Avenue is vacant, has been cleared, and is now vegetated by mown grass.

Topographically, the western boundary of the site is delineated the toe of a steep escarpment that slopes from RL 110m AHD, to about 80mAHD at the boundary. Below this, the site can generally be divided into three areas:

<u>An upper bench</u> that occupies the western third of the site. This area has a gentle overall slope to the southeast, and ranges in elevation from RL 80m down to RL 70m at the northern boundary, and 60m at the southern boundary. This area is generally cleared, shows evidence (confirmed by old



aerial photographs) of having previously been occupies by orchards, and contains unusual drainage features including cross slope drainage features near the rear, or western boundary of the zone.

<u>Steeply sloping Central zone</u> – this zone occupies the central third (roughly) of the site and slopes steeply to the east and southeast at angles of between 20 and 30 degrees. Much of this zone is thickly vegetated by regrowth vegetation following past clearing for agricultural uses, other than on the Daydawn Avenue end of the site where it has been cleared and slashed.

Within this central zone, at the northern end of the site and off the end of Daydawn Avenue, there is some visible evidence of past landslide activity. At the northern end of the site near Winterlake Street there is evidence of possible recent re-activation. Such evidence includes irregular, hummocky ground, visible lobes of debris, scarps at the rear of the slide area, and erosion of soils disturbed and re-deposited by former landslides.

<u>Eastern, lower slopes and footslopes</u> – generally below approximately RL40mAHD, the lower slopes vary, but slope generally to the east. There are some areas of irregular ground that may be due to the deposition of landslide debris in the past. The lower slopes grade onto a gentle footslope area that appears to be poorly drained, but contained no significant seepage or water inflow into the test pits during the fieldwork.

The footslope area contains a small dam that was holding water at the time of the investigations, with no significant seepage observed.

The ground surface was trafficable at the time of the fieldwork.

4.2 Subsurface Conditions

The subsurface materials encountered in the test pits varied across the site, however, the findings correlate well with the known regional geology. Based on the profiles encountered in the test pits and the regional geological setting discussed in Section 3.1 above, a geotechnical model for the site is presented in Figures 5 and 6.

The following points are noted from Figures 5 and 6 and the subsurface conditions encountered by this and previous investigations:

- In most locations, the ground surface was underlain by a soil profile comprising colluvial clay soils. These varied in depth. On the lower slopes they were underlain by residual clays of high plasticity in some locations.
- In TP1 at the rear of the site the profile comprised deep gravelly colluvium with some organics. This was deemed to represent the 'tension zone' referred to by Fell (Ref. 3) which is part of the natural slope formation processes identified on Munibung Hill. This tension zone can be a zone of water ingress to the slope.
- The rock profile was weathered and rock types comprised conglomerate on the upper slopes, and interbedded extremely to highly weathered tuffaceous claystone, siltstone, and fine grained sandstone that was readily excavated by a small excavator on the lower slopes.
- Disturbed coal was observed in TP11 at the northern end of the site within the zone of recent landslide activity.
- No water inflows were encountered in the test pits.



Photographs illustrating significant site features are presented below.



5 SLOPE STABILITY ASSESSMENT

5.1 Risk Assessment

The risk of slope instability at the subject site has been assessed using the principles and protocols of the Australian Geomechanics Society publication *Practice Note Guidelines for Landslide Risk Management, 2007*. This methodology represents the currently accepted state of practice for landslide risk assessment in Australia.



The slope risk assessment process involves identification of a potential slope failure event, or hazard, followed by an estimation of the likelihood of the event occurring, and the potential consequences should the event occur.

The terms used in the risk assessment process are defined below:

Hazard:	A condition with the potential for causing an undesirable consequence.
Likelihood:	The estimated probability that the hazardous event will occur.
Consequence:	Loss or damage resulting from a hazard event.
Risk:	A term combining the likelihood and consequence of an event in terms of adverse effects to property or the environment.

5.2 Hazard Identification

The following potential slope stability hazards were assessed in relation to the site and proposed development:

- Hazard 1: Large scale translational slide of conglomerate blocks over saturated Booragul Tuff causing debris flow (>100m³). Such a failure could cause complete destruction or large scale damage of several structures within a typical residential subdivision;
- Hazard 2: Translational or rotational slide through colluvial and residual soil profile. Should such a failure occur it could potentially cause extensive structural damage and require large scale, costly repairs, and possibly temporary evacuation of a typical residential building until repairs are complete. Maintaining good slope drainage to prevent buildup of water pressures within the profile is recommended;
- **Hazard 3**: Soil creep. Creep is an imperceptibly slow movement that takes place on sloping soil sites. It is an ongoing, natural slope process involving the progressive downslope movement of soils over the underlying rock profile. Creep will occur within the soil profile overlying weathered rock at this site, and will require management by undertaking good hillside construction practice as recommended in this report;
- **Hazard 4**: Translational slide of soil and weathered rock profile on outer edge of profile resulting from ongoing stress relief due to erosion and valley formation processes on the outer slope. The existing slides in the northern part of the site and at 19 Daydawn Avenue are examples of this type of failure. Should such a failure occur it could potentially cause extensive structural damage and require large scale, costly repairs, and possibly temporary evacuation of buildings until repairs are complete. Maintaining good slope drainage to prevent buildup of water pressures is recommended, together with remedial works to reinstate the existing failures. Planning of subdivision layouts to avoid siting residential structures over these areas is recommended, to limit potential consequences;



Hazard 5: Small scale slide (<100m³) due to failure of unsupported cuts and fills or poorly designed, constructed, or otherwise inadequate retaining walls. Such a failure could cause localised damage requiring moderate repairs to part of the structure.

Each of the identified hazards is illustrated on Figure 7.

5.3 Risk Evaluation for Existing Site Conditions

Table 1 summarises the factors affecting slope stability in relation to each of the hazards identified and assesses the risk of slope instability for each using the risk assessment matrix provided in Appendix C of the Australian Geomechanics Society (AGS) publication *Practice Note Guidelines for Landslide Risk Management, 2007*. A copy of the AGS risk matrix is presented as Appendix B.



Table 1:Slope Risk Assessment Based on AG\$2007 method

Hazard	H1 – Large scale translational landslide and debris flow	H2 – Translational failure of colluvial soils over weathered rock profile	H3 - Soil Creep	H4 - Translational failure through weathered rock profile (existing failures)	H5 - Localised failure of poorly retained cuts
Slope height	50m	10 - 20m	50m	20 – 30m	Up to 3m
Cause or trigger	Slope deterioration and weathering, exceptionally prolonged and intense rainfall	Slope deterioration (10 - 100yr) followed by extreme weather (1in 1,000yr event)	Ongoing process of imperceptibly slow soil movement	Ongoing erosion, stress release, adverse wet weather event (1 in 20 - 30 yr event)	Cut steeper than angle of repose, unsupported,1 in 10yr rain event
Estimated probability	10 ⁻⁶ yr (inconceivable except under extreme exceptional circumstances)	10 ⁻⁵ yr	10 ⁻¹ yr	10 ⁻² yr	10 ⁻³ yr
Assessed Risk With	out Mitigation				
Likelihood	Rare	Unlikely	Almost Certain	Likely	Possible
Consequence	Extensive damage to numerous structures within downslope area	Damage to one or possibly more structures requiring extensive repair	Ongoing, slow movement of foundation, displacement of services, possible minor distortion of pathways etc. Generally manageable within life of structure	Extensive damage to structure if within active zone (upper slope) ¹ . Moderate to minor damage to structure(s) if within debris zone on footslope ¹	Localised minor damage to some of structure requiring minor repairs
	Catastrophic	Major	Insignificant	Major (Upper) Medium (Lower)	Minor

Moderate

Moderate

Risk

Low

Very High (Upper)

High (Lower)

Moderate



	H1 – Large scale translational landslide and debris flow	H2 – Translational failure of colluvial soils over weathered rock profile	H3 - Soil Creep	H4 - Translational failure through weathered rock profile (existing failure)	H5 - Localised failure of poorly retained cuts
Proposed Mitigation, Management, Development Restrictions	Undertake drainage measures and subdivision works in accordance with good hillside practice.	Install subsoil drains. Found all structures in weathered rock where slopes exceed 10 degrees.	Found all structures in rock, where slopes exceed 10 degrees. Use good hillside construction/ drainage measures.	Avoid residential development on active slide area. Install drainage/ remedial measures to enable development within potential debris zone of northern slide area, or to allow use of former slide areas as road easements ³ .	Avoid or retain cuts >1m on sloping areas of the site

Assessed Risk with Mitigation, Management, Development Restrictions

Likelihood	Barely Credible	Rare	Almost Certain	Unlikely	Rare
Consequence	Catastrophic	Major	Insignificant	Minor ^{2, 3}	Minor
Risk	Low	Low	Low	Low	Very Low

Notes 1 Refer to Fig 5 for approximate delineation of upper and lower zone within existing northern slide area.

2 Post development damage on upper slope considered minor, as proposed management measures will avoid development in the upper slope zone

3 Includes proposed development on 19 Daydawn Ave, assuming former slide area to be remediated and then incorporated as road easement only.



5.4 Evaluation of Risk Level

The assessment indicates the risk of slope instability to be **High to Very High** in the areas affected by previous landslide activity at the northern end of the site and off the end of Daydawn Avenue. The **Very High** rating applies to the active landslide zone on the upper slopes of the northern failure. It is recommended that development be avoided in this area. Remedial measures are proposed that would reduce the likelihood of further re-activation of the landslide, but the remedial works proposed would not reduce the risk of instability to a level whereby development of the active slide area itself would be feasible.

The proposed remedial works will, however, reduce both the likelihood of failure and the potential downslope movement of debris from the landslide identified at the northern end of the site to the extent that, post remediation, the risk of developments on the footslope area below the slide being affected by the instability above could be reduced to **Low**.

On the Daydawn Avenue end of the site, the likelihood of reactivation of the existing landslide or further activation of landslides in the surrounding area can be reduced by installation of remedial measures predominantly in the form of subsurface drainage measures. This will require further, specific investigation and design work, however, on completion of the work and installation of the improved drainage measures, the risk of instability affecting the land surrounding the previous landslide would be considered **Low**. The risk of instability affecting the former landslide area itself would be **Moderate**. Development in that part of the site should be restricted to roads or public space.

As shown in Table 1, by adopting the recommendations of this report, the risks can be reduced to **Low** for a large proportion of the site. Based on the assessment presented in Table 1 and the proposed remedial measures, the risk of slope instability and potential development areas available at the site are presented on Figure 8.

6 GEOTECHNICAL CONSIDERATIONS FOR DESIGN AND CONSTRUCTION

6.1 Potential Development Area

Figure 8 delineates the identified landslide areas on which residential development should be avoided.

Development of the footslope area downslope of the active landslide in the northern part of the site, and the areas surrounding the former landslide off Daydawn Avenue is considered feasible provided some remedial works are undertaken.

If development in the colluvial slope area adjacent to the current active landslide is proposed (See Figure 8), preventative or remedial measures such as implementation of subsoil drains should be undertaken prior to construction.

The remainder of the subject site is considered appropriate for residential construction provided it is undertaken in accordance with good hillside construction practice as outlined in Appendix B herein, as well as with the specific recommendations of this report.



General recommendations to assist in the design and construction of a residential subdivision development on the site are provided in the following sections of this report. Stabilisation of the identified active and former landslides, and implementation of drainage measures for the colluvial midslope area, will require additional investigations to obtain the specific information required for design.

6.2 Type of structure

There are no specific constraints regarding the type of structure considered suitable for the slope, provided design and construction is undertaken in accordance with the recommendations of this report.

6.3 Foundations

As a general guide, for development on the sloping areas upslope of the Great Northern Seam subcrop line as shown on Figure 8, it is recommended that further site investigations be undertaken to determine suitable founding strata and appropriate foundation design parameters.

For the footslope areas downslope of the Great Northern Seam, structures may be supported on the natural profile provided they are designed and constructed in accordance with the guidance provided in AS2870-2011 *Residential Slabs and Footings*. This will require a site classification in accordance with AS2870-2011 for each of the proposed lots once final lot layouts are known.

6.4 Support of Excavations and Filling

Cuts or fills exceeding 1m in height should be avoided where practicable. Cuts and fills of up to 1m can be battered at 1V:2H or flatter. Deeper cuts and fills should be supported by engineer designed and properly constructed retaining walls.

All retaining walls should be provided with complete drainage at the back of the wall that drains to an ag drain, weep-hole or similar that allows free discharge of water from behind the wall.

Retaining walls must be designed to accommodate surcharge loading from all slopes, structures, or foreseeable traffic above the wall.

Further recommendations and design advice for retaining walls can be provided once the layout and configuration of the proposed development are known.

6.5 Access and driveway

The construction of driveways and site access must comply with the recommendations provided herein regarding limitations to, and support of, cuts and fills. Where cuts of more



than 1m are required for access construction, they must be supported by engineer-designed retaining walls. Driveways must be designed and configured so as to not impede the drainage of the slope.

6.6 Control of Stormwater

All stormwater should be collected from surface and roof runoff and should be discharged well beyond the building areas in a controlled manner that limits erosion. Once the final building location is selected, it is recommended that a berm be constructed around the upslope side to divert all upslope runoff around the building area.

6.7 Subsoil Drains

Should development be proposed in the colluvial midslopes near the centre of the site (delineated in yellow on Figure 8), it is important that measures be taken to prevent water travelling through the weathered rock profile from becoming trapped beneath the low permeability colluvial clay soils that cover the slope. To assist in preventing buildup of water pressures beneath the slope profile, it is recommended that a series of subsoil drains be installed within the proposed building area.

Prior to undertaking these works, additional geotechnical investigations should be undertaken to further define the slope conditions and allow the layout and configuration of the drains to be designed appropriately.

7 REMEDIAL MEASURES

7.1 Northern Landslide Area

Prior to development of the footslopes below the identified landslide zone on Figure 8, it is recommended that remedial measures be implemented within the identified active landslide zone above. Such measures are likely to involve:

- Installation of drainage measures such as subsoil drains or horizontal drains to promote drainage of the slope and prevent buildup of pore water pressures within the slope;
- Regrading of the failed outer slope to allow control of erosion and remove soils that appear prone to short term onset of instability;
- Installation of mesh, topsoil, and anchors to stabilise the disturbed soil mantle directly upslope of the development area.

7.2 Daydawn Avenue landslide area

Prior to development of the slopes off the western end of Daydawn Avenue, the identified landslide zone delineated on Figure 8 will require remediation prior to incorporation in the development area as a road easement. Remedial measures are likely to involve:



- Installation of drainage measures such as subsoil drains and horizontal drains to promote drainage of the slope and prevent buildup of pore water pressures within the slope;
- Regrading of the failed area to reduce locally steep slope angles.

7.3 Investigation and design of remedial measures

Further investigation and monitoring will be required in order to obtain the information required to design the appropriate measures. This will include drilling of boreholes at the northern end of the site to allow refinement of the slope model and obtain samples for laboratory testing so that appropriate design parameters can be adopted, and test pitting at the Daydawn Avenue end of the site to further define the depth and distribution of colluvial soils, presence of the coal seam, and identification of zones of water inflow within the profile.

Subsequent monitoring of inclinometers and piezometers would then be undertaken to identify water levels and possible movement horizons within the slope that would allow compilation of a more accurate subsurface model upon which to base the design of the remedial works.

8 LIMITATIONS

The findings presented in the report and used as the basis for recommendations presented herein were obtained using normal, industry accepted geotechnical practises and standards. To our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points. If site conditions encountered during construction vary significantly from those discussed in this report, Regional Geotechnical Solutions Pty Ltd should be contacted for further advice.

This report alone should not be used by contractors as the basis for preparation of tender documents or project estimates. Contractors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

If you have any questions regarding this project, or require any additional consultations, please contact the undersigned.

For and on behalf of

Regional Geotechnical Solutions Pty Ltd

Steven Morton Principal



References:

- 1. Australian Geomechanics Society Practice Note Guidelines for Landslide Risk Management, Journal and News of the Australian Geomechanics Society, Vol 42, No 1, March 2007
- 2. Bashi & Associates Pty Ltd 19 Daydawn Avenue, Warners Bay, Site Stability Design Report, 7 October 2016
- 3. Fell, R, Sullivan, TD, and Parker, C The Speers Point Landslides in Soil Slope Instability and Stabilisation, Walker & Fell eds, 1987



Figures



*As per supplied drawing by client titled " Existing Contours"



Client	Pulver Cooper Blackley Pty Ltd	
Project:	Residential Subdivision Geotechnical Assessment	
	19 Daydawn Ave and 40 Rayford Street, Warners Bay	
Title:	Test Pit Location Plan - Rayford Street	

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7 /						
Legend						
Test Pit Location						
Job No. RG\$01426.1						
Drawn By:	SRM					
Date: 30-May-17						
Drawing No. Figure 1						



*Locations of previous investigations on 19 Daydawn Avenue, reproduced from Drawing 2 of Bashi report (Ref 2)

APPROXIMATE LOCATION OF TEST PIT & BOREHOLE

(INVESTIGATION FOR 1992 PhD THESIS BY K S WILLIAMS-SWEENEY)

APPROXIMATE LOCATION OF TEST PIT (INVESTIGATION BY COFFEY & PARTNERS PTY LTD, FEB 1984)

APPROXIMATE LOCATION OF TEST PIT (INVESTIGATION BY COFFEY GEOTECHNICS, JUN 2009)

APPROXIMATE LOCATION OF TEST PIT & BOREHOLE WITH GROUNDWATER MONITORING WELL (INVESTIGATION BY COFFEY & PARTNERS PTY LTD, DEC 1984)

DD4

- BH18

PT13 PD3

15

TP12____

LP3

	Client	Pulver Cooper Blackley Pty Ltd	Job No.	RGS01426.1
	Project:	Residential Subdivision Geotechnical Assessment	Drawn By:	SRM
		19 Daydawn Ave and 40 Rayford Street, Warners Bay	Date:	30-May-17
	Title:	Locations of Previous Investigations - Daydawn Avenue	Drawing No.	Figure 2







Job No.RGS01426.1Drawn By:SRMDate:30-May-17Drawing No.Figure 4					
Job No.RGS01426.1Drawn By:SRMDate:30-May-17	Drawing No.	Figure 4			
Job No. RGS01426.1 Drawn By: SRM	Date:	30-May-17			
Job No. RG\$01426.1	Drawn By:	SRM			
	Job No.	RGS01426.1			



Inferred subcrop of Great Northern Seam

Lower, depositional zone or debris lobe

COLLUVIAL PROFILE

RESIDUAL TUFF/CLAYSTONE

RESIDUAL CONGLOMERATE ZONE

PREVIOUS LANDSLIDE

Drawing No.	Figure 5
Date:	30-May-17
Drawn By:	SRM
Job No.	RGS01426.1





Colluvial midslope area. Installation of subsoil drains recommended if development proposed in this area.

Area of previous instability No residential development in this area. Possible use as road easement if remedial measures are undertaken. Further investigation required to define extent of landslide and to assist in design of remedial measures.



Upper, active zone of instability No development in this area	
	Infer of Gr
TP2	TP11 TP10 TP10 TP10 TP12 TP10 TP10 TP10 TP10 TP10 TP10 TP10 TP10
	Remainder colluvial for developm good hillsid and appropri
	(No f

rred subcrop reat Northern Seam

ler of residual slope and otslope areas feasible for nent in accordance with de construction practice priate geotechnical design

<u>):</u> fill)

1	
Client	Pulver Cooper Blackley Pty Ltd
Project:	Residential Subdivision Geotechnical Assessment
	19 Daydawn Avenue & 40 Rayford Street, Warners Bay
Title:	Geotechnical Zones

er, depositional zone or oris lobe. Development sible following remedial measures

COLLUVIAL PROFILE

RESIDUAL TUFF/CLAYSTONE

RESIDUAL CONGLOMERATE ZONE

PREVIOUS LANDSLIDE

Drawing No.	Figure 8
Date:	30-May-17
Drawn By:	SRM
Job No.	RGS01426.1



Appendix A Test Pit Logs

					NGI	NEE	RIN	IG LOG	- TEST F	PIT			т	EST	PIT N	IO:	TP1
ΙF	REC	SIONA	4L	/ c	LIENT	:		Pulver C	Cooper Black	kley Pty Ltd			Р	AGE	:		1 of 1
ĞE	OTECH	ÍNÍCAL SOLÚT	riðns	P	ROJE	CT NA	ME:	Propose	ed Subdivisio	on Geotechnic	cal Assessn	nent	J	OB I	NO:		RGS01426.1
17				s	ITE LO	CATI	ON:	40 Rayf	ord Street, V	Varners Bay			L	OGC	GED B	Y:	CN
				т	EST L	OCAT	ION:	Refer to	Figure 1				D	ATE	:		7/11/16
E T	QUIPI Est f	MENT TYP PIT LENGT	PE: 'H:	8 T Ex 3.0 m	cavato W	or 'IDTH:	(0.6 m		EASTING: NORTHING	6:	؛ ا	SURF	ACE M:	RL:	AHD	
	Dr	illing and Sa	mpling					Material des	scription and p	rofile information				Fiel	d Test		
Q	R			DEDTU	₽.	ATION						JRE ION	ENCY	ype	ŧ	Structu	ire and additional
t METHO	d WATE	SAMPLES	(m)	(m)	GRAP	CLASSIFIC SYMB0		IATERIAL DI charac	ESCRIPTION: teristics,colour	Soil type, plastic	city/particle ents	MOISTL	CONSIST	Test Ty	Resu		bservations
ucket	Itered				<u>I</u> KIIKI	GP GP	0.05m	TOPSOIL: grained, gr	Sandy GRAV rey, fine to coa	EL, fine to mediu rse grained San	um d, some Silt /	D M				COLLUVI	UM
600mm Tooth								GRAVEL: trace fine to Gravel	Fine to coarse o coarse grain	grained, grey, b ed Sand, subrou	orown, unded					Side wall o	collapsing
/2016 12:21 8.30.004 Datgel Lab and In Situ 100/							1.50m	Hole Term	inated at 1.50	m							
EHOLE - IESI PII RGS01426.1 DRAF1.GPJ < <drawingfile>> 10/11</drawingfile>				2.0													
BORE	GEND	:		Notes, Sa	mples a	nd Tes	ts				Consister VS V	ncy ery Soft		<u>U</u> <2	CS (kPa 25	a) <u>Moistu</u> D	re Condition Dry
	wa	ater Level			50mn	n Diame	ter tuk	be sample			S S	oft		25	5 - 50	M	Moist
	(Da	ate and time s	shown)	E	Enviro	onmenta	al sam	iple			St S	tiff		50 10) - 100)0 - 200	W _p	Plastic Limit
	— Wa ◀ Wa	ater Inflow ater Outflow		ASS B	Acid S Bulk S	Sulfate S Sample	Soil Sa	ample			VSt V H H	ery Stiff ard		20 >4)0 - 400 100	W	Liquid Limit
B St	rata Cl	nanges		Eicht T							Fb F	riable				Der: "	Index <150/
4.3.GL	;	Gradational or	ata	Field Tes PID	<u>is</u> Photo	ionisatio	on det	ector reading	(ppm)		Density	V L	Ve Lo	ery Lo bose	oose	Density Density	Index <15% Index 15 - 35%
B 1.0	[Definitive or di	istict	DCP(x-y) HP	Dynai Hand	nic pen Penetro	etrometer	eter test (test	depth interval s Pa)	hown)		ME) M	ediun	n Dense	e Density	Index 35 - 65%
RGL	S	strata change			, and	. chout	motel	(000 Kr	~/			VD	v Vi	ery D	ense	Density	Index 85 - 100%

Γ						NGI	NEE	RIN	G LOG	- TEST	PIT				т	EST	PIT N	Ю:	TP2	
	RE	ΞG	SIONA	AL.	/ c		:		Pulver C	ooper Blac	ckley Pty L	td			Р	AGE			1 of 1	
	GEŌŢ	ECHN	NICAL SOLUT	10NS	F	ROJE	CT NA	ME:	Propose	d Subdivis	ion Geoteo	chnical	Assessn	nent	J	OBI	NO:		RGS01426.1	
	_				s	ITE LC	CATI	ON:	40 Rayfo	ord Street,	Warners E	Bay			L	OGG	GED B	Y:	CN	
					Т	EST L	OCAT	ION:	Refer to	Figure 1					D	ATE	:		7/11/16	
	EQU	JIPN ST PI		'E: 'H·	8 T Ex	cavato w	or IDTH·	0) 6 m		EASTI	NG: HING [.]		9	SURF	ACE M·	RL:	AHD		
┢		Drill	ling and Sar	molina	0.0 11				Material des	cription and	profile inform	ation		-		Field	d Test	7.110		
┢							z								~					
	MEIHOU	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATIC SYMBOL	MA	ATERIAL DE charact	ESCRIPTION teristics,colo	I: Soil type, p ur,minor com	plasticity/ ponents	/particle	MOISTURE CONDITION	CONSISTENC ^V DENSITY	Test Type	Result	Structuo	ire and additional bservations	I
4 Daggel Lab and in Situ Tool	600mm Tooth Bucket	Not Encountered			0.5 0.5		GM	0.05m	TOPSOIL: grey, brown Sandy GR, pale brown coarse Sar	Silty GRAVE	EL, fine to me	edium gra	ained, ange, to	M				TOPSOIL	UM	
3.30.00					1.5	00.	•	1.50m	Hole Termi	inated at 1.50) m									
5 NON-CORED BOREHOLE - TEST PIT RGS01426.1 DRAFT.GPJ < <drawingfile>> 10/11/2016 12:21 8</drawingfile>	LEGEND: Water Water Level (Date and time shown) ► Water Inflow Water Inflow Wat							ter tube for CBR al samp Soil Sam	e sample R testing ole mole				Consister VS V S S F F St S VSt V	ncy ery Soft oft tiff		<u>U</u> <2 50 10 20	CS (kP2 25 5 - 50 - 100 00 - 2000 0 - 400	a) <u>Moistu</u> D M W W _p W,	re Condition Dry Moist Wet Plastic Limit Liouid Limit	
RG LIB 1.04.3.GLB Log RG	Strat	Wat a Cha G tra D st	ter Outflow anges radational or ansitional stra efinitive or di rata change	ata istict	B Field Tes PID DCP(x-y) HP	Bulk S Bulk S Photo Dynar Hand	ionisationisationic penetro	on deter etromet ometer t	ctor reading ter test (test test (UCS kF	(ppm) depth interval ²a)	shown)	-	H H Fb F Density	iard riable V L D VD	Vi Lo D D D	ery Lo pose ediun ense ery De	n Dense	Density Density Density Density Density Density	Index <15% Index 15 - 35% Index 35 - 65% Index 65 - 85% Index 85 - 100%	

						INGI	NEE	RIN	IG LOG	- TEST	PIT				т	EST		ю: Т	ГР3
	RF	G		11		LIENT	:		Pulver (Cooper Blac	kley Pty Ltd				P	AGE	:	1	of 1
Ġ	EOTE	CHN	ICAL SOLUT	IONS	F	ROJE	CT NA	ME:	Propose	ed Subdivisi	on Geotechni	ical /	Assessr	nent	J	ові	NO:	F	RGS01426.1
1 ·				_//	s	ITE LO	CATI	ON:	40 Rayf	ord Street, V	Warners Bay				L	OGG	GED E	Y: 0	CN
					Т	EST L	OCAT	ION:	Refer to	Figure 1					D	ATE	:	7	/11/16
F	QU	IPN	IENT TYP	E:	8 T E	cavato	or				EASTING:	:			SURF	ACE	RL:		
ר	EST	T PI	T LENGT	H:	3.0 m	W	IDTH:	(0.6 m		NORTHIN	G:		I	DATU	M:		AHD	
		Drill	ing and Sar	npling					Material des	scription and p	orofile information	n				Fiel	d Test		
	20	ER		PI	DEPTH	HIC	CATION			ESCRIPTION	· Soil type plasti	ticity/r	article	URE TION	IENCY ITY	ype	ult	Structur	e and additional
МЕТЦ		WAT	SAMPLES	(m)	(m)	GRAP	CLASSIFIC SYMB		charac	teristics,colou	r,minor compon	nents		MOIST	CONSIST	Test T	Resi	00	servations
600mm Taath Budat		Not Encountered			0.5		GM	0.50m	TOPSOIL: dark brown coarse gra	Silty GRAVE 1, grey, Silt of ined Sand	L, fine to mediur low plasticity, so	m gra ome fi	ined, ne to	M				TOPSOIL	COLLUVIUM
Situ Tool							GP	0.50m	Sandy GR brown, fine plasticity, s	AVEL: Fine to to coarse Sa subrounded G	o medium graine ind, trace Clay o ravel	ed, or	ange, Jium	M				COLLUVIL	JM
5 12:21 8.30.004 Datgel Lab and In 9					1. <u>5</u>		CI	1.30m 1.65m	Gravelly C pale grey, subrounde Sand	LAY: Medium trace red, fine ed, iron oxide s	n plasticity, oran to medium grain stain, some fine t	ige, ye ined C to coa	ellow, Gravel, arse	M ~ WP	VSt			RESIDUAL HPP = 220	- Ikpa
/11/201									Hole Term	inated at 1.65	m								
EHOLE - TEST PIT_RGS01426.1 DRAFT.GPJ_< <drawingfile>> 10</drawingfile>	LEGEND:																		
L BORE	.EGE	ND:	_		Notes, Sa	mples a	ind Test	ts	_	_			Consiste	ncy /ery Soft		<u>U</u> <2	CS (kP a 25	a) <u>Moisture</u> D	e Condition Dry
		- Wat (Dat Wat Wat	er Level e and time s er Inflow er Outflow	hown)	U₅₀ CBR E ASS B	50mn Bulk s Envire Acid s Bulk s	n Diame sample f onmenta Sulfate S Sample	eter tub for CBI al sam Soil Sa	be sample R testing ple ample				S S F F St S VSt V H F	Soft Firm Stiff Very Stiff Iard		25 50 10 20 >4	5 - 50) - 100)0 - 200)0 - 400 400	M W W _p W _L	Moist Wet Plastic Limit Liquid Limit
B Loc	strata	h Cha	anges		Field Tee	te						⊢	Fb F	riable	1/		060	Density	ndev <15%
RG LIB 1.04.3.GL		- Gi tra - De sti	radational or ansitional stra efinitive or di rata change	ata stict	PID PID DCP(x-y) HP	<u>us</u> Photo Dynai Hand	ionisatio nic pene Penetro	on dete etrome ometer	ector reading eter test (test r test (UCS kl	(ppm) depth interval : Pa)	shown)		<u>vensity</u>	V L ME D VF	Ve Lo D M De Ve	ery Lo bose ediun ense erv Dr	n Dense ense	Density I Density I Density I Density I Density I	Index < 15% Index 15 - 35% Index 35 - 65% Index 65 - 85% Index 85 - 100%

							NEE	RIN		G - TES	ΓΡΙΤ				т	EST	PIT N	Ю:	TP4
	RI	FG		71	/ c		:		Pulver	Cooper Bl	ackley Pty Lt	d			Р	AGE	:		1 of 1
	GE0	TECHN	NICAL SOLUT	IÒNS	P	ROJE	CT NA	ME:	Propos	ed Subdiv	ision Geotec	hnical	Assessn	nent	J	ові	NO:		RGS01426.1
	-				s	ITE LO	CATI	ON:	40 Ray	/ford Stree	t, Warners B	ay			L	OGG	GED B	Y:	CN
					т	EST L	OCAT	ION:	: Refer to	o Figure 1					D	ATE	:		7/11/16
ŀ	EQ	UIPN	IENT TYP	E:	8 T E>	cavato	or				EASTIN	IG:		;	SURF	ACE	RL:		
	TES	ST PI	T LENGT	H:	3.0 m	W	IDTH:	(0.6 m		NORTH	IING:			DATU	M:		AHD	
		Drill	ing and Sar	mpling				1	Material de	escription and	d profile informa	ation				Fiel	d Test		
	METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	M	/ATERIAL [chara	DESCRIPTIC acteristics,co	DN: Soil type, pl lour,minor comp	lasticity/ ponents	/particle	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structu c	ure and additional bbservations
	600mm Tooth Bucket	Not Encountered			-		GM SM	0.30m	TOPSOIL grey, dark coarse gr Silty SAN	-: Silty GRAV k brown, Silt rained sand	/EL, fine to mee of low plasticity. nedium grained	dium gr , some , grey, j	ained, fine to pale	D	-			TOPSOIL	/COLLUVIUM
					0.5			0.50m	grey, som	ne fine to me	dium gravel, su	ibround	led						
		°,°,°, G -,°,°,°,°,°,°,°,°,°,°,°,°,°,°,°,°,°,°,°					GC		Clayey G pale grey fine to coa	RAVEL: Fin , yellow, Clay arse Sand	e to coarse gra y of medium pla	ined, or asticity, :	range, some					RESIDUA	AL.
							-	0.80m 0.90m	CLAYST	ONE: Pale b	rown to orange	, pale g	Irey					CLAYST Extremely	DNE - Tuffaceous / to Highly
								Hole Terr Due to re	ninated at 0. fusal	90 m							vveatriere		
D BOREHOLE - TEST PIT RGS01426.1 DRAFT.GPJ < <drawingfile>> 10/11/2016 12:21 8.30.004 Datgel Lab and In Stu Tool</drawingfile>	LEG	END:			- - - - - - - - - - - - - - - - - - -	- - - - - - - - -	nd Test	ts					<u>Consister</u> VS V	DCY Pery Soft			CS (kPa 25	a) <u>Moistu</u> D	re Condition Dry
g RG NON-CORED		Wat (Dat Wat Wat	er Level e and time s er Inflow er Outflow	hown)	U ₅₀ CBR E ASS B	50mn Bulk s Envire Acid s Bulk s	n Diame sample f onmenta Sulfate S Sample	eter tub for CB al sam Soil Sa	be sample 3R testing nple ample				S S F F St S VSt V H H	oft irm tiff ery Stiff ard	-	25 50 10 20 >4	5 - 50 0 - 100 00 - 200 00 - 400 400	M W W _p W _L	Moist Wet Plastic Limit Liquid Limit
SLB LC	<u>Strat</u>	ta Cha	anges radational or		<u>Field Te</u> s	t <u>s</u>						ŀ	Fb Fi Density	riable V	V	ery Lo	ose	Density	/ Index <15%
C LIB 1.04.3.C		tra De st	ansitional stra efinitive or dia rata change	ata stict	PID DCP(x-y) HP	Photo Dynai Hand	ionisatio mic peno Penetro	on dete etrome ometer	tector reading leter test (tes r test (UCS I	g (ppm) st depth interv kPa)	al shown)			L MI D VF	La D M D D	oose lediun ense erv D	n Dense	Density Density Density	/ Index 15 - 35% / Index 35 - 65% / Index 65 - 85% / Index 85 - 100%

Γ					Ē	NGI	NEE	RIN	IG LOG -	TEST PIT				т	EST	PIT N	0:	TP5
F	RE	G	IONA	۱L,	/ c	LIENT	:		Pulver Co	oper Blackley	Pty Ltd			Р	AGE			1 of 1
G	EOTE	CHN	IICAL SOLUT	IONS	P	ROJE	CT NA	ME:	Proposed	Subdivision (Geotechnical	Assessm	nent	J	OB I	NO:		RGS01426.1
					S	ITE LO	CATI	ON:	40 Rayfor	rd Street, War	ners Bay			L	OGO	SED B	Y:	CN
					Т	EST L	OCAT	ION:	Refer to F	Figure 1				D	ATE	:		7/11/16
E	EQUI	IPM		E: н.	8 T E>	cavato	or Inth:		0.6 m	E	EASTING:		с Г	SURF	АСЕ м.	RL:	АНП	
H		Drilli	ng and Sar	npling	0.0 11				Material desc	ription and profile	information				Fiel	d Test	AID	
F			<u> </u>				z							≻				
METHOD		WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATIC SYMBOL	M	IATERIAL DES characte	SCRIPTION: Soi eristics,colour,mir	type, plasticity, or components	/particle s	MOISTURE CONDITION	CONSISTENC DENSITY	Test Type	Result	Structu o	ire and additional bservations
to to t	- ICKEI	itered					GM	0.10m	TOPSOIL: S grey, dark br	Silty GRAVEL, fin rown, Silt of low p	e to medium gr blasticity, some	ained, fine to	D				TOPSOIL	
đ		Icoun			-		SP	0.1011	Coarse Sand	ND: Fine to coar	se arained are	/	D				COLLUVI	UM
		ш ў					· · · · · ·		brown, fine to trace Clay of	ND: Fine to coar o medium graine f low plasticity	se grained, gre d gravel, subro	y, punded,						
							GC	0.90m	Clayey GRA	VEL: Fine to me	dium grained, j	pale	D - M				RESIDUA	L
┢		_			1.0	°/_ °/_		1.00m	coarse grain	led Sand	iow, some line							
HOLE - TEST PIT RCS01426.1 DRAFT.GPJ < <drawingfile>> 10/112016 12:21 8.30.004 Datget Lab and in Stu Tool</drawingfile>									Due to refus weathered e	al - Claystone of ncountered	Highly to Mode	erately						
T D BORI	.EGEI <u>Vater</u>	ND:			Notes, Sa	mples a	nd Tes	<u>ts</u>				Consister VS V	ncy ery Soft		<u>U(</u> <2	CS (kPa 25	1) <u>Moistu</u> D	re Condition Dry
CORE		Wate	er Level		U₅₀ CBR	50mm Bulk s	n Diame ample t	eter tub for CB	e sample R testing			S S F Fi	oft rm		25 50	5 - 50) - 100	M W	Moist Wet
NON D	- 1	(Date Wate	e and time s er Inflow	nown)	E ASS	Enviro Acid S	onmenta Sulfate S	al sam Soil Sa	ple ample			St St VSt Ve	tiff ery Stiff		10 20)0 - 200)0 - 400	W _p W _i	Plastic Limit Liquid Limit
og RC	- 4 \	Wate	er Outflow		В	Bulk S	Sample		P 7			H H	ard		>2	100		4
LIB 1.04.3.GLB L	<u>itrata</u>	Cha Gr tra De	inges adational or insitional stra efinitive or dis rata chance	ata stict	Field Test PID DCP(x-y) HP	<u>ts</u> Photo Dynar Hand	ionisati nic pen Penetro	on dete etrome	ector reading (p eter test (test de r test (UCS kPa	opm) epth interval show	n)	Density	V L ME D	V La D M D	ery Lo bose lediun ense	oose n Dense	Density Density Density Density Density	Index <15% Index 15 - 35% Index 35 - 65% Index 65 - 85%
S S		ຣແ	ala change										VD) V	ery De	ense	Density	Index 85 - 100%

Γ						NGI	NEE	RIN	IG LOG	- TEST F	PIT			Т	EST	PIT N	Ю:	TP6
	R	EG	IONA	۱L	/ c	LIENT	:		Pulver C	ooper Black	kley Pty Ltd			P	AGE	:		1 of 1
	ĠEŌ	TECHN	NICAL SOLUT	IÒNS	P	ROJE	CT NA	ME:	Propose	d Subdivisio	on Geotechnic	al Asses	sment	J	OB	NO:		RGS01426.1
					S	ITE LO	CATI	ON:	40 Rayfo	ord Street, V	Warners Bay			L	OGO	GED B	Y:	CN
					т	EST L	OCAT	ION:	Refer to	Figure 1				C	ATE			7/11/16
	EQ TES	UIPN ST PI	IENT TYP	'E: H:	8 T Ex 3.0 m	cavato W	or IDTH:	(0.6 m		EASTING: NORTHING	:		SURF.	ACE M:	RL:	AHD	
F		Drill	ing and Sar	npling					Material des	cription and p	rofile information				Fiel	d Test		
			J				z							~				
	t METHOD	d WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATIC SYMBOL	м	IATERIAL DI charac	ESCRIPTION: teristics,colour	: Soil type, plastici r,minor componer	ity/particle nts	MOISTURE	CONSISTENC	Test Type	Result	Structu	ire and additional bservations
	ucke	ntere					GM SP	0.05m	\grey, dark	Silty GRAVEL brown, Silt of I	_, fine to medium low plasticity, som	grained, ne fine to		-			COLLUVI	UM
	oth B	ncon				0 0 0 0			Coarse gra	AND: Fine to	coarse grained, g	rey, fine						
	n To	lot E			-	0 0			to medium	grained grave	el, subrounded							
	00mr	2			-	0 0 0 0												
	9		0.40m			000		0.40m										
					0.5		СН		CLAY: Mee	dium to high p some fine to r	lasticity, orange, y nedium grained g	yellow, ravel.	× K	VSt			RESIDUA	L
			1150		0.5				subrounde	d	iouiuni granica g	uro,	Σ					
			050		-												HPP = 22	0-250kpa
			0.70m					0.70m									1111 - 22	0 200804
						E==			CLAYSTO	NE: Pale grey	, pale brown		M				CLAYST0 Extremely	ONE - Tuffaceous
					-	E==	-											
					-	ŧ==												
					1.0	E==												
						E==												
0					-	E==												
Situ To			1.20m	1	-	<u> </u>												
and In						<u>E=</u>												
el Lab			D			===												
4 Datg						E==												
.30.00			1.50m		1.5	E==												
2:21 8					-	===												
2016 1						E==												
10/11/						E==	-											
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rawing					-	===												
Q≈ Γ					2.0	===												
FT.GP						<u>E=</u> =	-											
.1 DR/					-	E==												
\$01426									Hole Termi	inated at 2 20	m		_		-			
T RG																		
EST P																		
OLE - T]												
OREHC	LEG	END:			Notes, Sa	mples a	nd Tes	<u>ts</u>				Consis	stency		U	 CS (kPa	a) <u>Moistu</u>	re Condition
RED B(Wate	er			U ₅₀	50mn	n Diame	eter tub	be sample			VS S	Very So Soft	ft	<2	25 5 - 50	D M	Dry Moist
N-COI	-	vVat (Dat	er Level te and time s	hown)	CBR	Bulk s	ample f	for CBI	R testing			F	Firm Stiff		50 10) - 100)0 <u>- 200</u>	W	Wet Plastic Limit
RG NC	►	Wat	er Inflow		ASS	Acid S	Sulfate S	Soil Sa	ample			VSt	Very St	ff	20)0 - 400	WL	Liquid Limit
Log	<u>Stra</u>	vvat ta Cha	er Outflow anges		В	Bulk	ample					н Fb	Hard Friable		>4	+00		
.3.GLE		G	radational or	ata	Field Tes PID	<u>ts</u> Phota	ionisatio	on dete	ector readina	(ppm)		Densit	y ∨ L	V L	ery Lo bose	oose	Density Density	Index <15% Index 15 - 35%
IB 1.04		tra De	efinitive or di	ata stict	DCP(x-y) но	Dynai	nic pen	etrome	eter test (test	depth interval s	shown)		N		lediur	n Dense	e Density	Index 35 - 65%
RG LI		st	rata change		11F	nand		JUICIE	1003 KF	u)			L V		ense ery D	ense	Density	Index 85 - 100%

					NGI	NEE	RIN	G LOG	- TEST P	PIT			т	EST		ю:	ГР7
1 F	REG	GIONA	AL.	 c	LIENT	:		Pulver C	ooper Black	kley Pty Ltd			Р	AGE	:	1	of 1
Ġŧ	OTECH	NICAL SOLUT	TIÒNS	P	ROJE	CT NA	ME:	Propose	d Subdivisio	on Geotechnica	al Assess	ment	J	OB I	NO:	F	RGS01426.1
1-				S	ITE LO	CATI	ON:	40 Rayfo	ord Street, W	Varners Bay			L	OGC	GED B	Y: C	CN
				т	EST L	OCAT	ION:	Refer to	Figure 1				D	ATE		7	//11/16
E	QUIPI		E:	8 T E>	cavato	or				EASTING:		1	SURF	ACE	RL:		
	EST P	IT LENGT	H:	3.0 m	W	IDTH:	C).6 m		NORTHING			DATU	M:		AHD	
	Dri	Iling and Sar	mpling	-		-		Material des	cription and pr	ofile information				Fiel	d Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	м	ATERIAL DE charact	ESCRIPTION: teristics,colour,	Soil type, plasticit ,minor componer	ty/particle hts	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structur ob	e and additional servations
cket	ered					ML		TOPSOIL:	Sandy SILT, k	ow plasticity, grey I Gravel	, dark	D				TOPSOIL	
th Bu	count			-		SP	0.10m	Gravelly S	AND: Fine to c	coarse grained, g	rey, fine	м				COLLUVIL	JM
600mm Toot	Not End						0.50m	to medium low to medi	grained Grave	el, subrounded, tra	ace Clay of						
		0.60m				СН		CLAY: High orange	n plasticity, gre	ey, trace pale brow	wn to	× K	St - VSt			RESIDUAL	-
		0.0011		-								Σ				HPP = 170	-250kpa
		D															
		0.90m															
				1.0													
_																	
Situ Toc																	
and In S																	
el Lab a							1.40m										
t Datge				-	===	-	1.4011	CLAYSTO	NE: Pale brow	n to orange, pale	grey	М	VSt -	1		CLAYSTO	NE - Tuffaceous
.30.002				1.5	===	-										Extremely	
2:21 8					E==	-											
2016 1					<u> </u>	-											
10/11/					<u> </u>	-											
JFile>>				-	===	-											
Drawing				-	E==	-											
]>> [d				2.0	EEE	-											
CAFT.G					<u>E=</u>	-											
26.1 DF					<u>=</u> =	-	2.00										
GS014;					<u> </u>	-	2.20M	Hole Termi	nated at 2.20 r	m							
PIT R					-												
- TEST					-												
HOLE											1						
	GEND: ater	:		<u>Notes, Sa</u>	mples a	nd Test	<u>is</u>				VS VS	ency Very Sof	:	<u>U</u> <2	CS (kPa 25	a) <u>Moisture</u> D	e Condition Dry
	V a	iter Level		U₅₀ CBR	50mm Bulk s	n Diame sample f	ter tub or CBF	e sample R testing			S S	Soft Firm		25 50	5 - 50 0 - 100	M W	Moist Wet
	(Da — Wa	ate and time s iter Inflow	shown)	E ASS	Enviro Acid 9	onmenta Sulfate 9	al samp Soil Ser	ple			St St	Stiff Verv Stiff	:	1(20	00 - 200 00 - 400	W _p	Plastic Limit Liquid Limit
- og RG	◀ Wa	ter Outflow		В	Bulk S	Sample						Hard		>4	400		
- St	rata Ch	ianges Gradational or		Field Tes	ts						Density	V	V	ery Lo	oose	Density I	ndex <15%
1.04.3.	tr	ransitional str Definitive or di	ata	PID DCP(x-y)	Photo Dynai	ionisationisation	on dete etrome	ector reading (eter test (test of	(ppm) depth interval sł	hown)		L M	Lo D M	oose lediun	n Dense	Density I Density I	ndex 15 - 35% ndex 35 - 65%
RG LIB	s	trata change		HP	Hand	Penetro	meter	test (UCS kP	'a)			D VD	D V	ense ery D	ense	Density I Density I	ndex 65 - 85% ndex 85 - 100%

						NGI	NEE	RING	LOG	- TEST P	IT			Т	EST	PIT N	IO:	TP8
	RE	G	IONA	۱L	/ c	LIENT	:		Pulver Co	ooper Black	ley Pty Ltd			P	AGE	:		1 of 1
Ğ	GEOTE	CHN	NICAL SOLUT	IÒNS	P	ROJE	CT NA	ME:	Proposed	1 Subdivision	n Geotechnica	al Assessn	nent	J	OB I	NO:		RGS01426.1
					S	ITE LO	CATI	ON:	40 Rayfo	rd Street, W	arners Bay			L	ogo	GED B	Y:	CN
					т	EST L	OCAT	ION:	Refer to I	Figure 1				D	ATE	:		7/11/16
E	EQUI			E:	8 T E>	cavato	or				EASTING:		9	SURF/	ACE	RL:		
Ľ	IES I			H:	3.0 M	VV		0.6	5 m		NUR I HING:		I	JATU			AHD	
		Drill	ing and Sar	npling			7	Ma	aterial desc	ription and pro	ofile information				Field	d lest		
METHOD		WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MAT	rerial de characte	SCRIPTION: S eristics,colour,i	Soil type, plasticit minor componen	ty/particle its	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structu o	ire and additional bservations
+0,10	icket.	tered					ML	T b	TOPSOIL:	Sandy SILT, lo to coarse grair	w plasticity, grey ned Sand, some	, dark fine to	D				TOPSOIL	
4		count					SP	0.10m	nedium gra	ined Gravel, s	ubrounded	/	м				COLLUVI	UM
COD mm Tool		Not End			-			0.45m	Gravel, sub	Counded, some	e to medium grai	ned n plasticity						
			0.50m		0.5		СН	C	CLAY: High	plasticity, pale	e grey, pale brow	'n	× ×	St - VSt			RESIDUA	L
			1150										Σ					
			050														HPP = 17	0-260kpa
			0.7011		-													
					1.0													
								1.05m										
						===	-		CAYSTON prange	IE: Pale grey,	grey, pale brown	i to	м	Н			Extremely	to Highly
itu Too						===	-										vveatnere	d
nd In S						===	-	1.30m										
0.004 Datgel Lab a					1.5_	-		H C e	Iole Termir Jue to High	ated at 1.30 m ly to Moderate	n Iy Weathered Cla	aystone						
/11/2016 12:21 8.3						-												
< <drawingfile>> 10</drawingfile>						-												
426.1 DRAFT.GPJ																		
EST PIT RGS01																		
DLE - T					-	1												
L REH	EGE	ND:			Notes, Sa	mples a	Ind Test					Consiste	ncy		<u>U</u>	CS (kPa	<u>) Moistu</u>	re Condition
V RED B	Nater	\ \ \	or Louis		U ₅₀	50mm	n Diame	ter tube s	sample			VS V S S	ery Soft		<2 25	25 5 - 50	D M	Dry Moist
N-COL	<u> </u>	vvat (Dat	er Level e and time s	hown)	CBR	Bulk s	sample f	for CBR t	esting			F F	irm tiff		50) - 100)0 - 200	W	Wet Plastic Limit
RG NC		Wat	er Inflow	·	ASS	Acid S	Sulfate S	Soil Sample	ple			VSt V	ery Stiff	:	20)0 - 400 100	W _L	Liquid Limit
Bol S	Strata	vVat Cha	er Outflow anges		В	Bulk S	sample					H H Fb F	iard riable		>2	+00		
-3.GLB		G	radational or	ata	Field Tes PID	<u>ts</u> Phota	ionisatio	on detect	or reading (ppm)		Density	V	Ve	ery Lo bose	oose	Density Densitv	Index <15% Index 15 - 35%
B 1.04		De	efinitive or di	ata stict	DCP(x-y) µр	Dynai	nic pen	etromete	r test (test d	epth interval sh	iown)		ME) M	ediun	n Dense	e Density	Index 35 - 65%
RG L		st	rata change		11F	ndhù	, eneur	metel te	SI (UUS KP	·/			VD) Ve	ense ery De	ense	Density	Index 85 - 100%

						INGI	NEE	RIN	IG LOG - TEST PIT				Т	EST	PIT N	o: TP9
	RE	ECHN	ION/	L IONS /			: 	ME-	Pulver Cooper Blackley Pty I	Ltd	1 Acor	+	P.			1 of 1
									40 Revford Street Warners	echnica Rov	Assessn	nent	J		NO:	RGS01426.1
					с т	EST			Refer to Figure 1	Бау			ח		SCD B	7/11/16
\vdash				_												/////0
	ES	T PI	T LENGT	'E: H:	8 T EX 3.0 m	kcavato W	or IDTH:		0.6 m NORT	ing: 'Hing:		۲ د	DATU	ACE M:	RL:	AHD
		Drilli	ing and Sar	npling					Material description and profile inform	nation				Fiel	d Test	
						0	NOI					шz	5			
METHOL		WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICAT SYMBOL	N	IATERIAL DESCRIPTION: Soil type, characteristics,colour,minor co	plasticity nponent	//particle s	MOISTURE	CONSISTEN DENSITY	Test Type	Result	Structure and additional observations
+040		tered					GM		TOPSOIL: Silty GRAVEL, fine to m arev. Silt of low plasticity, some fine	edium g	rained,	D				TOPSOIL
0 4		coun					GP	0.10m	grained Sand	rained		D				COLLUVIUM
	3	ot En				0.00 0.00			brown, fine to coarse grained Sand	, trace C	lay					
1400		z				0.00										
Ű						o o o o		0.40m								
					0.5		SC		Clayey Gravelly SAND: Fine to co pale brown to orange, grey, Clay of	arse gra medium	ined, 1	M				
									plasticity, fine to medium grained G subrounded	iravel,						
							2									
			0.70m	-												
		D														
		D 100m 10 %														
					_	0/0/0										
0						0/0/0										
Situ To																
and In																
gel Lab																
04 Dat					15											
8.30.0					1.0	/0 /0										
6 12:21							1									
/11/201																
e>> 10																
wingFilk							2	1.90m								
< <dra< th=""><td></td><td></td><td></td><td></td><td>2.0</td><td></td><td>SC</td><td></td><td>Clayey SAND: Fine to coarse grain medium plasticity, some fine to coarse grain medium plasticity medium p</td><td>ned, grey Irse grair</td><td>v, Clay of ned</td><td>M</td><td></td><td></td><td></td><td>RESIDUAL</td></dra<>					2.0		SC		Clayey SAND: Fine to coarse grain medium plasticity, some fine to coarse grain medium plasticity medium p	ned, grey Irse grair	v, Clay of ned	M				RESIDUAL
FT.GPJ					-	1.1.			Gravel, subrounded							
1 DRA						1.1.	:									
S01426																
PIT RG									Hole Terminated at 2.20 m							
- TEST F									THE TETTINALEU AL 2.30 III							
SEHOLE	FGF	ND.		L	Notee Sr						Consisto				CS (kP-) Moisture Condition
	Vater	r.			110103, 38	50~	nu 162	<u></u>	ne sample		VS V	ery Soft		<2	25 5 - 50	D Dry M Moiet
N-COR		Wate (Dat	er Level e and time s	hown)	CBR	Bulk s	sample 1	for CB	R testing			irm		20 50) - 100) - 100	W Wet
RG NO	_	Wat	er Inflow	,	ASS	Acid S	Sulfate S	ai sam Soil Sa	ample		St S VSt V	un ery Stiff		10 20	0 - 200 00 - 400	W _L Liquid Limit
E Log	- Trata	vvate a Cha	er Outflow anges		В	Bulk S	sample				нн FbF	ard riable		>2	ŧUU	
4.3.GLF		- Gr	adational or	ata	Field Tes PID	<u>ts</u> Photo	ionisatio	on det	ector reading (ppm)		<u>Density</u>	V L	Ve Lo	ery Lo bose	ose	Density Index <15% Density Index 15 - 35%
LIB 1.0		- De	efinitive or di ata change	stict	DCP(x-y) HP	Dynai Hand	mic pen Penetro	etrom ometei	eter test (test depth interval shown) r test (UCS kPa)			ME D	D M	ediun ense	n Dense	Density Index 35 - 65% Density Index 65 - 85%
С С		54										VD	Ve	ery De	ense	Density Index 85 - 100%

Γ						INGI	NEE	RIN	G LOG	- TEST P	т			т	EST	PIT N	o: 1	FP10
	R	EG	IONA	۱L	/ c	LIENT	:		Pulver C	ooper Blackl	ey Pty Ltd			Ρ	AGE			1 of 1
	ĞEŌ1	TECHN	NICAL SOLUT	IÓNS	F	ROJE	CT NA	ME:	Proposed	d Subdivisior	n Geotechnica	l Assessr	nent	J	OB I	NO:		RGS01426.1
	-				s	SITE LO	CATI	ON:	40 Rayfo	rd Street, W	arners Bay			L	OGG	GED B	Y:	CN
					Т	EST L	OCAT	ION:	Refer to	Figure 1				D	ATE	:		7/11/16
	EQI TES	UIPN ST PI	IENT TYP	E: H:	8 T Ex 3.0 m	kcavato W	or 'IDTH :	: (0.6 m		EASTING: NORTHING:		: 	SURF	ACE M:	RL:	AHD	
┢		Drill	ing and Sar	npling					Material desc	cription and pro	file information				Field	d Test		
							z			<u> </u>				~				
	METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATIO SYMBOL	М	ATERIAL DE characte	SCRIPTION: S eristics,colour,r	ioil type, plasticity ninor component	y/particle ts	MOISTURE CONDITION	CONSISTENC DENSITY	Test Type	Result	Structu o	ire and additional bservations
	ucket	ntered					GM	0.10m	TOPSOIL: grey, Silt of	Silty GRAVEL, low plasticity, s	fine to medium g ome fine to coar	jrained, se	D				TOPSOIL	
	oth B	incour				0 0	GP		grained Sar	Nd AVEL: Fine to n	nedium grained,	grey,	D	1			COLLUVI	UM
	m To	Not E				0 0 0 0			brown, fine	to coarse grain	ed Sand, trace C	Clay						
	600r					°/°/°	SC	0.30m	Clayey Gra	velly SAND: Fi	ine to coarse gra	ined,	М	-				
						0.0			plasticity, fir	to orange, grey te to medium g	rained Gravel	1						
		0.50m 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5																
		D 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2																
		0.80m																
		0.80m																
					1. <u>0</u>													
						0/0/0												
00																		
n Situ 7					-													
ab and					-													
atgel Lá																		
004 D					1.5		,											
21 8.30						0/0/0												
16 12:2					-													
0/11/20					-	/ /	SC	1.70m	Clayey SAM	ND: Fine to me	dium grained, gre	ey, Clay	М	1			RESIDUA	L
e>> 1						///			of medium Gravel, sub	plasticity, some rounded	fine to medium of	grained						
awingFi						. :/. /.												
J ∧ <d< th=""><th></th><th></th><th></th><th></th><th>2.0</th><th>///</th><th>></th><th>2.00m</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></d<>					2.0	///	>	2.00m										
FT.GP	T								Hole Termir	nated at 2.00 m								
.1 DRA						1												
S01426						-												
IT RG						-												
TESTP																		
OLE -																		
SOREH	LEG	END:	1	- 1	Notes, Sa	mples a	nd Tes	ts				Consiste	ncy		U	CS (kPa) <u>Moistu</u>	re Condition
ORED (wate	er Wat	er Level			50mm	n Diame	eter tub	e sample			S S	Soft	L	25	5 - 50	M	Moist
10N-CC	_	(Dat	te and time s	hown)	E	Bulk s Envire	sample i onmenta	tor CBI al sam	к testing ple			F F St S	rm Stiff		50 10) - 100)0 - 200	W W _p	vvet Plastic Limit
g RG ∣	–	vVat Wat	er inflow er Outflow		ASS B	Acid S Bulk S	Sulfate S Sample	Soil Sa	mple			VSt V H F	/ery Stiff Iard		20 >4)0 - 400 100	WL	Liquid Limit
ilb Lo	<u>Strat</u>	ta Cha	anges radational ca		<u>Field</u> Tes	<u>ts</u>						Fb F Density	riable V	V	ery Lo	ose	Densitv	Index <15%
.04.3.G		tra	ansitional stra	ata	PID DCP(x-v)	Photo	ionisatio	on dete	ector reading (ppm) lepth interval sev	wn)		L M	Lo Lo	oose ledium	1 Dense	Density	Index 15 - 35% Index 35 - 65%
3G LIB 1		_ D st	rata change	SUCT	HP	Hand	Penetro	ometer	test (UCS kPa	a)	···,		D	D) V	ense erv De	ense	Density	Index 65 - 85%

ENGINEERING LOG - TEST PIT								TEST PIT NO: TP11							
						:	Pu	Pulver Cooper Blackley Pty Ltd				PAGE: 1 of 1			1 of 1
ĠE	GEOTECHNICAL SOLUTIONS PROJECT NAME:					ME: Pr	Proposed Subdivision Geotechnical Assessment			nent	JOB NO:			RGS01426.1	
-	SITE LOCATION:					DN: 40	40 Rayford Street, Warners Bay				LOGGED BY: CN			Y: CN	
	TEST LOCATION:					ON: R	efer to Figure 1				D	ATE	:	7/11/16	
EC			'Е: 'Н'	8 T Ex 3 0 m	Excavator			EASTING:			с Г		ACE M·	RL:	АНД
<u> </u>	Dri	lling and Sar	molina	0.0 11			Mate	erial description and prof	ile information		27		Field Test		
_						z	mate					~	TION		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATIC SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components			/particle s	MOISTURE CONDITION	CONSISTENC) DENSITY	Test Type	Result	Structure and additional observations
ucket	Itered					GM	TO 0 10m gre	PSOIL: Silty GRAVEL, f	ine to medium gi plasticity, some	rained, fine to					TOPSOIL
th Bu	coun			-		GP		arse Grained Sand	edium grained	/	D - M				COLLUVIUM
Toc	ot En			-	0.0 0.0		bro	wn, fine to coarse Sand,	trace Clay	groy,					
0mn	Ž			-	0.0 0.0										
90					0.0 0.0		0.40m								
				-	/./	SC	Cla	ayey SAND: Fine to coar	se grained, pale	grey,	М				
				0.5			plas	sticity, some fine to coar	se grained Grave	el,					
				-			enc	countered							
					1.1.										
				-	//										
				-	/ /										
				1. <u>0</u>											
					11										
0				-											
Situ To				-											
and In				-	/ /.										
el Lab					/ /.										
F Datg				-	///										
30.004				1. <u>5</u>	///										
2:21 8.				-		2									
2016 12					/./.										
10/11/2				-	/ //										
					<u>/ /. :</u>		1.80m Hol	le Terminated at 1.80 m			-				
rawing				-	-										
				2.0											
FT.GF															
.1DRA				-	1										
01426				-	-										
T RGS															
ST PI															
ТЕ - ТЕ				-	1										
	GEND	:	L	<u>Notes,</u> Sa	mples a	nd Test	<u>s</u>			<u>Consister</u>	ncy		U	C <u>S (k</u> Pa) Moisture Condition
	<u>iter</u>				50mm	Diame	er tube ser	mple		VS V	ery Soft		<2	25	D Dry M Moist
-cor	Wa	iter Level	hown	CBR	Bulks	ample f	or CBR tes	sting		FF	irm		20 50) - 100	W Wet
	– Wa	iter Inflow		E ASS	Enviro Acid S	onmenta Sulfate S	sample	•		St S VSt V	tiff ery Stiff		10 20	10 - 200 10 - 400	W _p Plastic Limit W _L Liquid Limit
Log R	◀ Wa	iter Outflow		В	Bulk S	Sample				H H Fb F	ard riable		>4	00	
	<u>ata Ch</u>	Gradational or	.	Field Test	ts Dhat	ion! 1'	n data da	reading (read)		Density	V	Ve	ery Lo	ose	Density Index <15%
1.04.3	tr	ransitional str Definitive or di	ata istict	PID DCP(x-y)	Photo Dynar	ionisatio nic pen	n aetector trometer te	reading (ppm) est (test depth interval sho	wn)		L MC	Lo M	oose edium	n Dense	Density Index 15 - 35% Density Index 35 - 65%
RG LIB	strata change			HP	Hand	Penetro	meter test	(UCS kPa)			D VD	De Ve	ense ery De	ense	Density Index 65 - 85% Density Index 85 - 100%

	ENGINEERING LOG - TEST PIT							TEST PIT NO: TP12							
ΙF						Р	Pulver Cooper Blackley Pty Ltd				PAGE:			1 of 1	
GE						ME: P	Proposed Subdivision Geotechnical Assessment				JOB NO:			RGS01426.1	
-				s	ITE LO	CATI	ON : 4	40 Rayford Street, Warners Bay				LOGGED B			Y: CN
	TEST LOCATION:					ION: R	Refer to Figure 1				DATE:			7/11/16	
				8 T E	reavat				EASTING	2.				DI ·	
	EST	PIT LENGT	Ъ. Н:	3.0 m	W	/IDTH:	0.6	m	NORTHI	NG:	DATUM:			NL.	AHD
	D	rilling and Sa	mpling				Mate	erial description	and profile informati	on		Field Tes		d Test	
						z				-		~			
Ð	R		RI	ПЕРТН	UHC UHC	CATIC	ΜΔΤΕ		TION: Soil type, play	sticity/narticle	URE	LENC IT≺	ype	Ħ	Structure and additional
U L	NAT	SAMPLES	(m)	(m)	LOI	SSIFL		characteristics,	colour,minor compo	onents		USIS NSIS	est T	Res	00001140010
					0	CLA					≥õ	0			
ket	ered				BIB	GM	0.05m TC	PSOIL: Silty GR	AVEL, fine to medi	um grained,	D				TOPSOIL
Buc	ounte				0 0	GP	\gre Sa	ey, brown, Silt of andy GRAVEL: F	iow plasticity	ned, grey,	D				COLLUVIUM
Loot	Enc				0 0	2	fine	e to coarse grain	ed Sand						
	Not				0.00 0.00 0.00		0.25m	avev SAND: Fin	a to coarse grained	nale brown	м				
600				-			to	orange, pale gre	y, Clay of medium p	lasticity, some					
					1.			e to medium grai	neu Glavei						
				0.5	1.1										
						,									
				-	<u>, , , , , , , , , , , , , , , , , , , </u>	SC	0.60m	ayey SAND: Find	e to coarse grained,	grey, pale	-				RESIDUAL
							gre Gr	ey, Clay of mediu avel. subrounde	im plasticity, some f	ine to medium					
					1.1.			,							
				-											
				-	ו / · ·	-	0.90m	AYSTONE: Gre	v. pale brown		-				CLAYSTONE - Tuffaceous
				1.0	===	-	1.00m		, paie 2.0111						Highly to Moderately Weathered
							Ho Du	le Terminated at le to refusal	1.00 m						
0				-											
Situ To				-	-										
ul bri				_											
Lab a															
Datge				-	-										
0.004				1. <u>5</u>	-										
21 8.3															
12:2				-	1										
11/201				-	-										
\$ 10															
1gFile:															
Drawii					-										
° Cd				2.0	-										
AFT.G															
3.1 DR				-											
s0142(-	-										
T RG															
ESTPI															
LE - T				-	1										
Hand Le	GENI	 D:	<u> </u>	Notes. Sa	mples a	Ind Tes	lts			Consister	l ncv		U	CS (kP:	a) Moisture Condition
<u>w</u>	ater				E0	Diam				VS V	ery Soft		<2	25	D Dry
-COR	w w	ater Level	hours	CBR	oumn Bulk s	sample	for CBR tes	sting		F F	irm		25 50) - 50) - 100	W Wet
NON 6	(L) — W	ater Inflow	muwn)	E ASS	Enviro Acid 9	onmenta Sulfate S	al sample Soil Sample	e		St S VSt V	tiff ery Stiff		10 20)0 - 200)0 - 400	W _p Plastic Limit
	∢ w	ater Outflow		В	Bulk	Sample	pr			H H	ard		>4	100	
I St	rata C	hanges Gradational o	,	Field Tes	<u>ts</u>					Fb Fi Density	riable V	Ve	ery Lo	ose	Density Index <15%
.04.3.(transitional str	ata	PID DCP(x-v)	Photo	nic nen	on detector	reading (ppm) test (test depth inte	erval shown)		L M	Lo) M	ose edium	1 Dense	Density Index 15 - 35%
		Definitive or d strata change	ISTICT	HP	Hand	Penetro	ometer test	i (UCS kPa)			D	D	ense	. 2013	Density Index 65 - 85%
									VD	v Ve	ery De	ense	Density Index 85 - 100%		



Appendix B

AGS2007 Risk Matrix & Hillside Guidelines

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

Approximate Annual Probability Indicative Notional Value Boundary		Implied Indicati Recurrence	ve Landslide Interval	Description	Descriptor	Level
10 ⁻¹	5x10 ⁻² 10 years		20	The event is expected to occur over the design life.	ALMOST CERTAIN	Α
10-2	510 ⁻³	100 years	20 years	The event will probably occur under adverse conditions over the design life.	LIKELY	В
10-3	5x10	1000 years	200 years	The event could occur under adverse conditions over the design life.	POSSIBLE	С
10-4	5x10"	5x10 ⁻⁵ 5x10 ⁻⁵ 100,000 years 5x10 ⁻⁶		The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10-5	5x10 ⁻⁶			The event is conceivable but only under exceptional circumstances over the design life.	RARE	Е
10-6	5710	1,000,000 years	200,000 years	The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

Note: (1) The table should be used from left to right; use Approximate Annual Probability or Description to assign Descriptor, not vice versa.

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate Cost of Damage Indicative Notional Value Boundary		Description	Descriptor	Level
200%	1008/	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	CATASTROPHIC	1
60%	100%	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	MAJOR	2
20%	10%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	MEDIUM	3
5%	1%	Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.	MINOR	4
0.5%	170	Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.

(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional design fees, and consequential costs such as legal fees, temporary accommodation. It does not include additional stabilisation works to address other landslides which may affect the property.

(4) The table should be used from left to right; use Approximate Cost of Damage or Description to assign Descriptor, not vice versa

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPENDIX C: - QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

QUALITATIVE RISK ANALYSIS MATRIX - LEVEL OF RISK TO PROPERTY

LIKELIHO	OD	CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage)							
	Indicative Value of Approximate Annual Probability	1: CATASTROPHIC 200%	2: MAJOR 60%	3: MEDIUM 20%	4: MINOR 5%	5: INSIGNIFICANT 0.5%			
A - ALMOST CERTAIN	10 ⁻¹	VH	VH	VH	Н	M or L (5)			
B - LIKELY	10-2	VH	VH	Н	М	L			
C - POSSIBLE	10 ⁻³	VH	Н	М	М	VL			
D - UNLIKELY	10 ⁻⁴	Н	М	L	L	VL			
E - RARE	10-5	М	L	L	VL	VL			
F - BARELY CREDIBLE	10-6	L	VL	VL	VL	VL			

Notes: (5) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.

(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

RISK LEVEL IMPLICATIONS

	Risk Level	Example Implications (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
Н	HIGH RISK.	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
М	MODERATE RISK	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
L	LOW RISK	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (7) The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

EXAMPLES OF GOOD HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE



APPENDIX G - SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

GOOD ENGINEERING PRACTICE

POOR ENGINEERING PRACTICE

ADVICE		
GEOTECHNICAL	Obtain advice from a qualified, experienced geotechnical practitioner at early	Prepare detailed plan and start site works before
ASSESSMENT	stage of planning and before site works.	geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
DESIGN AND CONS	STRUCTION	
	Use flexible structures which incorporate properly designed brickwork timber	Floor plans which require extensive cutting and
	or steel frames, timber or panel cladding.	filling.
HOUSE DESIGN	Consider use of split levels.	Movement intolerant structures.
	Use decks for recreational areas where appropriate.	
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS &	Satisfy requirements below for cuts, fills, retaining walls and drainage.	Excavate and fill for site access before
DRIVEWAYS	Council specifications for grades may need to be modified.	geotechnical advice.
	Driveways and parking areas may need to be fully supported on piers.	
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminatory bulk earthworks.
	Minimise depth.	Large scale cuts and benching.
CUTS	Support with engineered retaining walls or batter to appropriate slope.	Unsupported cuts.
	Provide drainage measures and erosion control.	Ignore drainage requirements
	Minimise height.	Loose or poorly compacted fill, which if it fails,
	Strip vegetation and topsoil and key into natural slopes prior to filling.	may flow a considerable distance including
D esign	Use clean fill materials and compact to engineering standards.	onto property below.
FILLS	Batter to appropriate slope or support with engineered retaining wall.	Block natural drainage lines.
	Provide surface drainage and appropriate subsurface drainage.	Fill over existing vegetation and topsoil.
		houlders building subble ato in fill
ROCK OUTCRODS	Remove or stabilize boulders which may have unaccentable risk	Distucts, outdoing rubble etc. in fill.
& BOULDERS	Support rock faces where necessary	boulders
CC DOOLDERS	Engineer design to resist applied soil and water forces	Construct a structurally inadequate wall such as
	Found on rock where practicable.	sandstone flagging, brick or unreinforced
RETAINING	Provide subsurface drainage within wall backfill and surface drainage on slope	blockwork.
WALLS	above.	Lack of subsurface drains and weepholes.
	Construct wall as soon as possible after cut/fill operation.	1
	Found within rock where practicable.	Found on topsoil, loose fill, detached boulders
FOOTINGS	Use rows of piers or strip footings oriented up and down slope.	or undercut cliffs.
10011100	Design for lateral creep pressures if necessary.	
	Backfill footing excavations to exclude ingress of surface water.	
	Engineer designed.	
SWINDARNE BOOLS	Support on piers to rock where practicable.	
SWIMMING POOLS	Provide with under-dramage and gravity dram outlet where practicable.	
	may be little or no lateral support on downhill side	
DRAINAGE	hay be hate of no lateral support on dowinin side.	
DidminoL	Provide at tops of cut and fill slopes.	Discharge at top of fills and cuts.
	Discharge to street drainage or natural water courses.	Allow water to pond on bench areas.
SURFACE	Provide general falls to prevent blockage by siltation and incorporate silt traps.	
	Line to minimise infiltration and make flexible where possible.	
	Special structures to dissipate energy at changes of slope and/or direction.	
	Provide filter around subsurface drain.	Discharge roof runoff into absorption trenches.
SUBSURFACE	Provide drain behind retaining walls.	
	Use flexible pipelines with access for maintenance.	
	Prevent inflow of surface water.	Discharge cullage disective and inter-tange
SEPTIC &	osuany requires pump-out or mains sewer systems; absorption trenches may	Use absorption transfor without consideration
SULLAGE	Storage tanks should be water tight and adequately founded	of landslide risk
FROSION	Control erosion as this may lead to instability	Failure to observe earthworks and drainage
CONTROL &	Revegetate cleared area	recommendations when landscaning
LANDSCAPING	teregenie demeo men.	economications when antioscaphilg.
DRAWINGS AND SI	TE VISITS DURING CONSTRUCTION	
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	
INSPECTION AND 3	MAINTENANCE DV OWNED	
INSPECTION AND N	MAINTENANCE BY OWNER	
OWNER'S	Clean drainage systems; repair broken joints in drains and leaks in supply	
	LUIDES	
KESPONSIBILIT I	Where structural distress is evident see advice	