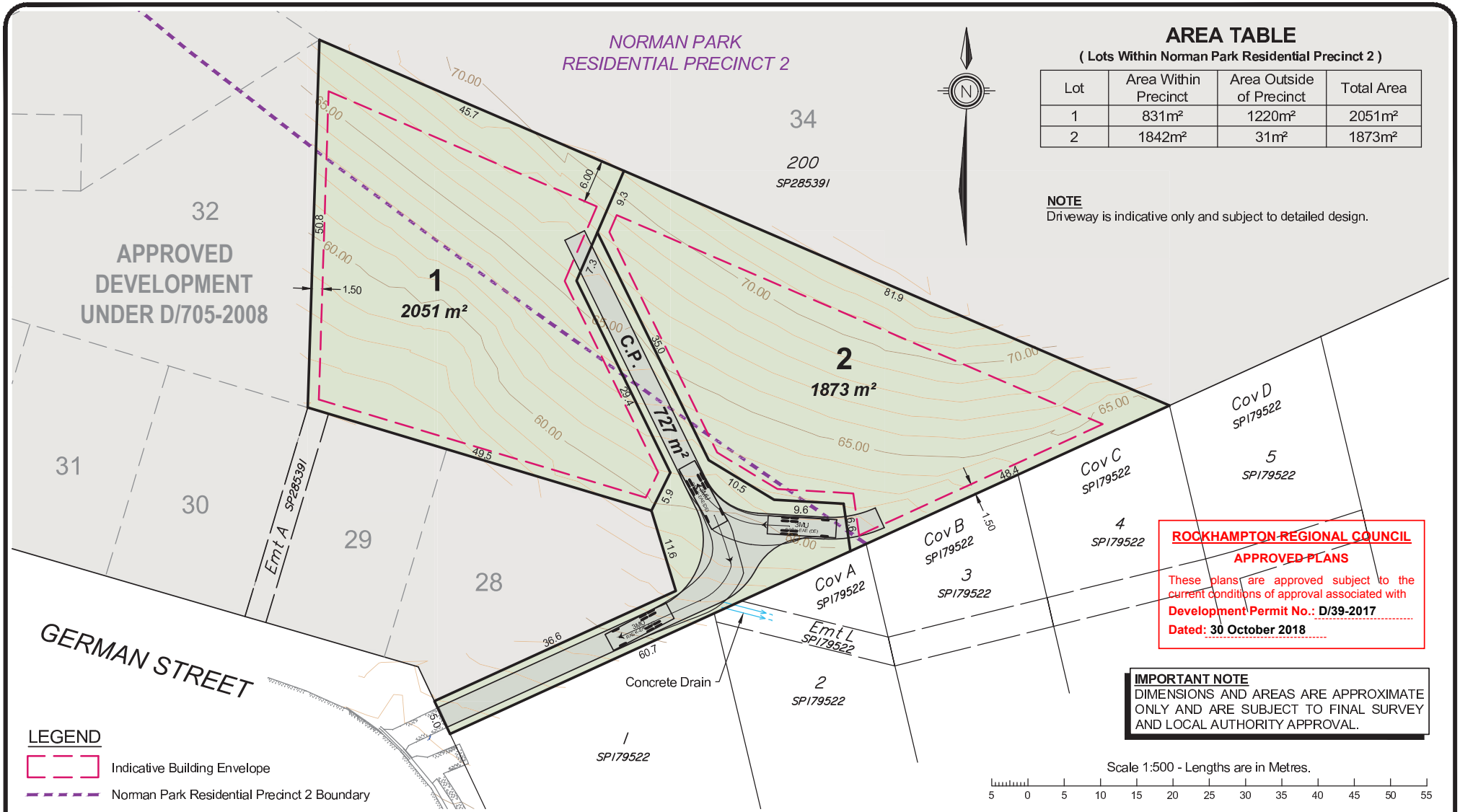

AREA TABLE

(Lots Within Norman Park Residential Precinct 2)

Lot	Area Within Precinct	Area Outside of Precinct	Total Area
1	831m²	1220m²	2051m²
2	1842m²	31m²	1873m²

NOTE
Driveway is indicative only and subject to detailed design.

ROCKHAMPTON REGIONAL COUNCIL
APPROVED PLANS
These plans are approved subject to the current conditions of approval associated with
Development Permit No.: D/39-2017
Dated: 30 October 2018

IMPORTANT NOTE
DIMENSIONS AND AREAS ARE APPROXIMATE ONLY AND ARE SUBJECT TO FINAL SURVEY AND LOCAL AUTHORITY APPROVAL.

Rev	Description	Drawn	Checked	Date
H	Amend lot layout	AD	BF	16/07/2018
G	Add building envelopes	AD	BF	23/01/2018
F	Update boundary layout	AD	BF	3/11/2017
E	Add 'Norman Park Residential Precinct 2' boundary, tabulate areas	AD	BF	14/03/2017
D	Remove Emts A - C	AD	BF	9/03/2017
C	Add Emts A - C, update lot layout & driveways	AD	BF	03/02/2017

PROPOSAL PLAN

PROJECT: Proposed Subdivision

LOCATION: German Street, Norman Gardens
Real Property Description: Lot 35 on SP285391

CLIENT: Blue Dolphin Pty. Ltd.

Horiz. Datum:	MGA Zone 56	Scale:	1 : 500 @ A3
Vert. Datum:	AHD	Drawn:	AD
Local Authority:	Rockhampton Regional	Surveyor:	N/A
Contour Interval:	1m	Drawing No:	16025-PP-01
		Sheet:	1 of 3
		Revision:	H

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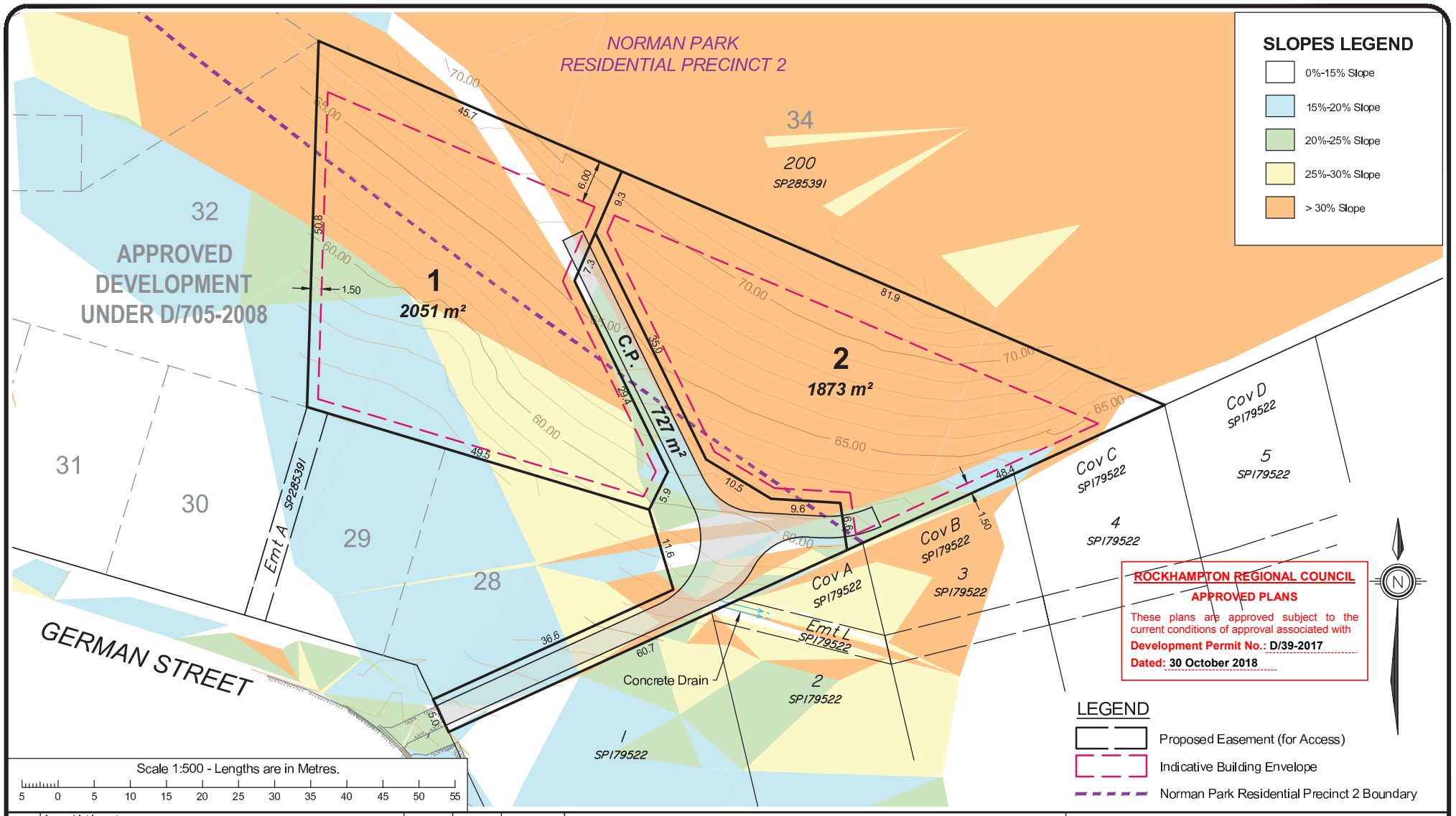

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D	Remove Emts A - C	AD	BF	9/03/2017
C	Add Emts A - C, update lot layout & driveways	AD	BF	03/02/2017

This plan was prepared as a proposed subdivision and should not be used for any other purpose. The dimensions, areas and total number of lots shown hereon are subject to field survey and also to the requirements of Council and any other authority which may have requirements under any relevant legislation. In particular, no reliance should be placed on the information on this plan for any financial dealing involving the land. This note is an integral part of the plan.

PROPOSAL PLAN

PROJECT: Proposed Subdivision

LOCATION: German Street, Norman Gardens

Real Property Description: Lot 35 on SP285391

CLIENT: Blue Dolphin Pty. Ltd.

Horiz. Datum:	MGA Zone 56		
Vert. Datum:	AHD		
Local Authority:	Rockhampton Regional	Contour Interval:	1m

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Scale:	1 : 500 @ A3	Drawing No:	16025-PP-01
Drawn:	AD	Sheet:	3 of 3
Surveyor:	N/A	Revision:	H

SLOPE STABILITY ASSESSMENT AND REPORT

P.531

Prepared for: Blue Dolphin Pty Ltd
PO Box 941
Airlie Beach QLD 4802

Project: Slope Stability Assessment
Lot 35 on SP285391,
German Street
Norman Gardens, QLD 4701

Job Reference: 2128E.P.531

Date: 18th May 2017

ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/39-2017

Dated: 30 October 2018

Construction Sciences

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Document Information

Prepared for	Blue Dolphin Pty Ltd
Project Name	Insert project name
Commission	Geotechnical Investigation and Report
File Reference	2128E.P.531
Job Reference	P.531
Date	18/05/2017

Document Control

Version	Date	Description of Revision	Prepared By	Prepared (Signature)	Reviewed By	Reviewed (Signature)
A	18/05/2017	FINAL REPORT	P.Kilaverave		D.Stirling	

Version	Reason for Issue	Approved for Release By	Approved (Signature)	Approved Release Date
A	FOR ISSUE	D.Stirling		18/05/2017

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TABLES

APPENDICES

1.0 INTRODUCTION

A broad scale geotechnical and slope stability investigation was carried out for the proposed subdivision development at Lot 35 on SP 285391 German Street, Norman Gardens, on behalf of Blue Dolphin Pty Ltd.

We understand the project involves the development of a four (4) lot yield residential subdivision.

The primary objective of this investigation was to satisfy the general requirements of Council which requires a slope stability assessment of the site in order to determine whether the site is suitable and feasible for development based on the existing geotechnical conditions. This includes ensuring long term stability for the development works associated with earthwork batters, retaining structures, access driveways and house pads. However, exact earthwork levels and house pad levels were not known at this time and therefore cannot be addressed in detail in our report.

The following methodology was undertaken by our Geotechnical Engineer in order to achieve the objective above.

- Carried out literature research of known areas of landslip and assessed whether this site was located within an area of instability.
- Carried out a general site walk over and general mapping of existing soil/rock conditions.
- Provided indicative site classifications as per AS2870.
- Provided recommendations on the building type considered suitable for this site.
- Commented on material encountered in relation to its use as structural fill.

At the completion of the investigation work an engineering report was prepared which included all the data gathered. The information was analysed and discussed, and conclusions and recommendations presented to satisfy the objectives of the investigation.

Authorisation to proceed with the investigation was received by this office on the 13th March 2017 from Brian Forrester representing Blue Dolphin Pty Ltd.

This report must be read in conjunction with our attached *'General Notes'*, and *'Guidelines for Hillside Construction'*, Australian Geomechanics Society Journal, Volume 37, No. 2, May 2002.

2.0 SITE DESCRIPTION

The site was located on the northern side of German Street with the proposed development set back approximately 30m from the existing roadway.

The site was bound by vacant allotments to the south, west and north. Vegetation to the south and west comprised grasses and occasional large trees while areas to the north were generally thinly forested. Developed allotments were located to the east comprising single storey and dual storey homes with established gardens.

The sloping surface was generally planar in shape with a minor gully developing approximately half-way down the slope towards the southern boundary of the proposed allotment 2 block. Firebreaks have been constructed along the proposed common access as indicated on Vision Surveys Drawing No: 16025-PP-01 Rev C dated 03/02/2017, allowing access to the sites from a gated entrance. The existing slopes were measured onsite to range between 27-37%.

Refer to plates 1 and 2 for typical site conditions encountered during our investigation.

Plate 1: View of the site from German Street to the North

Plate 2: View of the site from German Street to the North-East

3.0 INVESTIGATION WORK

3.1 Background Search

As part of the slope stability assessment for the site, a literature research investigation was carried out to determine whether the site had any known published historical landslips within its boundaries.

Aerial photographic interpretation, using stereographic projection, was also carried out to assess if any physical evidence of previous landslips on the site could be observed.

3.2 Fieldwork

Fieldwork for the investigation was carried out on the 5th April 2017 and included the excavation of four (4) test pits at the locations shown on the Site Investigation Location Plan included in Appendix B. The material encountered at each location is described on the test pit logs included in Appendix C.

The subsurface profile was logged in general accordance with AS1726 *"Geotechnical Site Investigations".* Strata identification was based on inspection of materials recovered from the excavated material. Insitu testing comprised Dynamic Cone Penetrometer (DCP) testing undertaken to determine the allowable bearing capacity available in the soil strata encountered. The results of DCP testing are shown on the test pit logs in Appendix C.

Disturbed samples were recovered during the field work and returned to our NATA accredited Rockhampton laboratory.

3.3 Laboratory Testing

Samples of representative strata were recovered and returned to our NATA accredited soils laboratory. The following tests were carried out on selected samples;

- Particle Size Distribution
- Atterberg Limits
- Point Load – Irregular Lump

The laboratory test results are included in Appendix D. Laboratory testing was carried out in accordance with Australian Standard AS1289 *'Laboratory Testing For Engineering Purposes'*.

4.0 SUBSURFACE CONDITIONS

4.1 Subsurface Strata

The fieldwork indicated that the surface was underlain by varying ground conditions. Surface soils appeared to be of varying origin while the depth to weathered rock was dependent on the location of the excavated test pit of the slope.

Test pits TP1 and TP4 were undertaken on the lower end of the slope within proposed allotments 1 and 3 respectively, and intersected similar ground conditions. A mixture of clayey sands and gravelly clayey sands of colluvial origin were observed to overlay the weathered rock layers generally encountered at 0.8m below ground level. Soils of residual origin were only encountered at TP1 location made up of sandy clay composition with medium to high plasticity fines and hard in consistency.

TP2 and TP3 were excavated on the upper slopes of proposed allotments 3 and 4 respectively with weathered rock encountered at near surface between 0.3m to 0.6m. The overburden colluvium material generally comprised a mixture of sandy clays and sandy silts of varying plasticity and consistency.

The logs in Appendix C should be referred to for the detailed description of material encountered at each investigation location. A summary of conditions encountered at each investigation location is detailed in Table 1 below.

Table 1: Summary of Subsurface Strata

Location	COLLUVIUM					RESIDUAL	ROCK		TD (m)	Termination Condition
	SANDY CLAY (CI)	SANDY CLAY/GRAVELLY CLAYEY SAND (SC)	SILTY SAND (SM)	SANDY SILT (ML)	SANDY CLAY (CI/CH)	SANDY CLAY (CI/CH)	XW/DW	DW		
TP1	0.0-0.4	-	-	-	-	0.4-0.8	0.8-1.6	1.6-RD	2.9	RIPPER REFUSAL
TP2	-	0.0-0.3	-	-	-	-	-	0.3-RD	0.8	RIPPER REFUSAL
TP3	-	-	0.0-0.2	0.2-0.6	-	-	-	0.6-RD	1.2	RIPPER REFUSAL
TP4	-	0.0-0.3	-	-	0.3-0.8	-	0.8-1.6	1.6-RD	2.7	RIPPER REFUSAL

NOTES:

TD = Termination Depth
RD = Refusal Depth
All depths were measured from the existing surface level at the time of the investigation.
XW – Extremely Weathered
DW – Distinctly Weathered

No groundwater was encountered in any of the test pits during the investigation. However, it is possible that seepage could occur along the soil/rock interface during and after periods of wet weather.

4.2 Laboratory Test Results

Laboratory testing was undertaken on the predominant soil type to assess the potential reactivity ranges which could be expected and as such what indicative site classifications could result based on anticipated earthworks.

A summary of the laboratory test results are shown in Table 2 below.

Table 2: Summary of Laboratory Test Results

Sample Location	Sample Depth (m)	Liquid Limit %	Linear Shrinkage %	Plasticity Index %	% Passing As Sieve (mm)		
					2.36	0.425	0.075
TP1	0.4-0.8	43	8.0	19	82	54	43
TP2	1.8-2.2	37	7.0	18	19	11	8

Table 3: Point Load Test Results on Irregular Lump

Sample Location	Sample Depth (m)	Is (50) MPa
TP3	0.6-0.9	0.41
TS02	2.7	4.40

5.0 GEOTECHNICAL ASSESSMENT

5.1 Earthworks

5.1.1 Site Preparation

All site preparation work should be carried out in accordance with AS3798-2007 *'Guidelines on Earthworks for Commercial and Residential Developments'*.

Proposed cut/fill levels were not known at the time of preparation of this report for building platforms or lot access.

All soil containing grass and root material should be stripped from the building sites and access areas prior to construction. This material is not considered suitable for use as structural fill but may be stockpiled for possible future landscaping purposes, if required. Stripping depths will generally be in the order of around 0.2m. However, isolated areas may require a deeper stripping depth. Further, colluvium was encountered between 0.3m to 0.8m depth. It is recommended that all colluvium be excavated and recompacted where required. However, if left in place, the colluvium layer may be expected to creep further and no loading is to be placed on any colluvium.

Where any existing fill is encountered during construction stage, it is expected that this fill was not placed in accordance with recognised standards and as such must be deemed to *'uncontrolled'*. As such, removal of this fill and recompaction of the fill to the standards discussed below is recommended.

Prior to the placement of any structural fill, all colluvium must be removed and the site should be proof rolled using a minimum 10 tonne vibrating padfoot roller. Should isolated soft/loose areas be encountered during this process, this material should be removed and replaced with select fill. It is likely that where soft to firm clays, loose to medium dense sands were encountered or colluvium, that the removal of these materials will alleviate potential handling, settlement or creep issues during and after construction.

Depressions formed by the removal of vegetation should have all disturbed soil cleaned out and be backfilled with compacted select fill material.

Construction Sciences should be engaged to confirm the suitability of the stripping depth and confirm the adequacy of the newly exposed soil for fill placement.

5.1.2 Structural Fill Placement

With the exception of the topsoil stratum, all materials encountered during the investigation are considered acceptable for use as structural fill provided that any pre-treatment (moisture conditioning, removal of oversize), is carried out prior to fill placement. It must be stressed that the clays on site are high plasticity and could be expected to result in stiff raft foundation types if encountered in significant thicknesses or where used as fill.

To minimise the potential for post compaction volume change due to moisture content variations, any structural clay bearing fill should be placed in loose layers not greater than 200mm thick at a moisture content in the range -2% to +3% of the standard optimum moisture content, and be compacted to a minimum dry density ratio of 95% standard compaction as per AS1289 5.1.1.

Filling should not be undertaken over colluvium strata.

Measures should be adopted to ensure that this clay fill material is not allowed to dry out prior to the placement of succeeding layers of fill and final covering with building slabs and road pavements.

It is recommended that the placement of all structural fill be inspected, tested and certified by Construction Sciences to Level 1 requirements, during the earthworks operations to ensure that all fill is placed in a *'controlled manner'*, in accordance with AS3798-2007.

Where filling is to be carried out over sloping land (slope > 8H:1V), the surface of the natural material should be benched so that the fill can be *'keyed'* into the slope, allowing for a good bonding interface between structural fill and the natural. The maximum height of the step must not exceed 0.5m, and the benching must be sloped to ensure free drainage.

5.1.3 Excavatability

Soils above excavator refusal depth should be able to be excavated using a small dozer (e.g. Cat D6 or similar) in bulk excavations and a medium size backhoe in trench excavations. Below excavator refusal depths, larger plant, including pneumatic/hydraulic equipment, may be required in order to achieve cut depths below those achieved during our investigation.

5.2 Batter Slopes

For initial design purposes, previous experience in the area has indicated that the following maximum unprotected batter slopes may be adopted for the cut and fill batters on the site.

Table 4: Maximum Unprotected Batter Slopes

Material Type	Short Term (Maximum)	Long Term (Maximum)
Residual Clays (cut)	1V:1H	1V:2H
Colluvium	1:2H	1:3H
Fill Batters(1)	1V:2H	1V:2H
Weathered Rock	1V:1H	*

Notes:

(1) All fill batters should be overfilled, compacted and cut back at the maximum angles recommended above and with some form of erosion protection to minimise any potential unnecessary scour effects due to weathering.

* Denotes requirement for detailed stability assessment.

5.3 Building Footings

The results of investigations and testing show that in its undisturbed state, the site would be classified as Class S - "Slightly Reactive" in accordance with *AS2870-2011 'Residential Slabs and Footings'*, with predicted ground surface movement of less than 20mm. However, due to the presence of colluvium strata and possible soil slip movement, the site would be classified as **"Class P".**

The presence of trees and their potential impact on building footings should be taken into account during the structural foundation design.

5.3.1 Footing Design Parameters

Based on the nature of the proposed dwelling and the subsurface conditions encountered, it is recommended that the proposed dwelling be founded into the underlying **weathered bedrock** profile. Any cut/fill areas on site will have the potential for differential settlement across the floor slab and shall be taken into consideration in the design stage.

The maximum allowable bearing capacities shown in Table 5 below are suggested for the design of high level pad or strip footings.

Table 5: Maximum Allowable Bearing Capacities for Shallow Footings

Founding Material	Maximum Allowable Bearing Capacity (kPa)
Dense GRAVELLY CLAY SAND (SC) (COLLUVIUM)	NR
Stiff SANDY CLAY (CI/CH) (COLLUVIUM)	NR
Very Stiff to Hard SANDY CLAY (GP) (RESIDUAL)	NR
EXTREMELY WEATHERED ROCK	450

NOTES:

NR = Not Recommended

*A footing inspection shall be carried out by this office to ensure bearing capacity and cleanliness at the base of the footing.

6 SLOPE STABILITY ASSESSMENT

Fieldwork for this component of the investigation was carried out by a Geotechnical Engineer on 5th April 2017.

The fieldwork exercise included a broadscale inspection, where possible, of the entire site to assess the following;

- Determine slope angle
- Observe vegetation
- Note any evidence of tension cracking
- Note any evidence of seepage
- Note any evidence of soil creep
- Note any evidence of previous slips
- Geological features
- Subsurface conditions
- Drainage issues

The presence of colluvium indicates previous movement on site has occurred. No other physical evidence of previous movement, seepage, soil creep etc was observed during the mapping exercise across the site.

Reference to the Queensland Department of Mines' 1:100,000 geological series Rockhampton sheet indicates that the site is underlain by the Lakes Creek Formation comprising siltstone and lithic sandstone.

Slope angles across the site varied from approximately 16° (27%) to about 21° (37%) and generally increasing from west to east.

No architectural plans were available during the preparation of this report, however all residential buildings proposed to be constructed within the subject allotments should adopt a pole type construction founded into the underlying weathered rock profile.

All footings of the building must be founded into the underlying weathered rock profile. It is anticipated that material won from cutting during construction may be used as fill material. The use of this material as fill will be dependent upon its ability to satisfy the required specifications. No fill should be placed over the colluvium. The colluvium may be expected to creep further downslope and thus, if left in place, must not support any loads.

Where earthworks involve some cutting of the site, engineered retaining walls should be adopted to provide stability. For any retaining structures that form part of the main building structure, the conditions for material retained should be considered 'at rest' given that the retaining wall will have little tolerance for movement. All retaining walls will need to be founded into the underlying weathered bedrock strata.

Further to these parameters, in consideration for retaining structures, it is important to enable good drainage behind the structure itself to prevent excessive hydrostatic pressure. It is recommended to utilise clean granular backfill behind the wall itself and drain pipes at the base of the structure to release any water. The design should also allow for water pressure acting on the retaining structure to at-least one third the wall height in order to ensure stability in extreme situations.

In addition, material directly behind the structure should not be heavily compacted, otherwise adverse effects from increased earth pressures may affect the in service use of the structure. Compaction by hand-held equipment is recommended when placing these layers.

Any retaining wall design for the building should take into consideration the loads that may apply from adjacent sites (buildings, driveways, etc.).

The construction type as described above would be considered acceptable for this site providing the recommendations outlined in this stability assessment report are implemented and maintained for the life of

the structure. Furthermore, it is recommended that all cut batter slopes associated with the construction of these allotments be vegetated to provide additional strength and resistance to erosion potential and surficial slipping.

The stability of an area under construction will largely be a function of adequate drainage control. Therefore, it is assumed that stormwater management will be designed and constructed in accordance with recognised building practices/standards to control all drainage issues. It is strongly recommended that adequate drainage paths are installed at the top and base of the cut batters in order to control and direct runoff away from the area.

It is recommended that removal of vegetation (with the exception of topsoil stripping) be kept to a minimum and that any vegetation removal only be undertaken where it is necessary in order to construct building platforms. Furthermore, where stripping is undertaken across the building and earthworks area, re-vegetation and/or batter protection should be a requirement in order to reduce the effects of erosion.

Based on the background search and the mapping exercise, the presence of colluvium indicated previous creep movement and potential future creep movement across the site. This must be considered in the design of the structural footings.

Further to the above, a quantitative risk assessment has been assigned to the site based on the required format provided by the *AGS 'Guidelines for Landslide Risk Management 2007'*. The results of this assessment indicated that the lot has a stability risk level of 'moderate'. For details of this analysis, refer to Appendix E.

A slope stability analysis was carried out using Slope/W modelling software and results indicate that the current factor of safety at the site was calculated to be 3.15, which is above the acceptable limit of 1.5. The slope analysis can be viewed in Appendix F.

From this analysis, some surficial creep may be expected to occur in the colluvium over the long term. Provided that the building is founded into the underlying weathered rock, the building should have a sufficient factor of safety against slip failure for the long-term. Furthermore, it is recommended that the building foundations be imbedded into the weathered rock profile to resist any lateral forces that may be applied from this surficial creep. There will still remain the potential for creep or slippage of the colluvium across the site.

The construction of the proposed dwelling and the driveway access road on this site is not expected to adversely affect the current global stability provided the recommendations above are adhered to and adequate civil/hydraulic and structural issues are addressed. Given the results of our assessment, provided the above recommendations are adhered to, the site is considered acceptable for its proposed usage with regards to stability. Effective subsurface and surface drainage will be critical in the maintenance of stability of the site.

7 CONSTRUCTION INSPECTIONS

It is recommended that placement of all structural fill and cut/fill batters be inspected, tested and certified where necessary, by Construction Sciences to ensure recommendations made in this report have been adhered to.

Should subsurface conditions other than those described in this report be encountered, Construction Sciences should be consulted immediately and appropriate modifications developed and implemented if necessary.

8 CONCLUSIONS AND RECOMMENDATIONS

The following is a summary of the conclusions and recommendations in regard to the geotechnical investigation for the proposed subdivision development at Lot 35 on SP 285391 German Street, Norman Gardens. However, the preceding sections of this report should be read for a full description of the conclusions and recommendations.

1. The subsurface conditions, at the investigation locations generally consisted a mixture gravel, sands and clays of colluvium origin overlying weathered rock. Weathered rock was encountered at generally shallow depths between 0.3m to 0.8m with the only residual soils of sandy clay composition encountered at TP1 location from 0.6m to 0.8m interval.

2. Earthworks should be carried out in accordance with *AS3798-2007 'Guidelines on Earthworks for Commercial and Residential Developments'*. It is recommended all uncontrolled fill be replaced with controlled fill. Refer to Section 5.1 for details on full recommendations for earthwork operations.

3. Refer to section 5.2 for recommendations on maximum unprotected cut/fill batter angles for the site.

4. The results of investigations and testing show that in its undisturbed state, the site would be classified as Class S - "Slightly Reactive" in accordance with *AS2870-2011 'Residential Slabs and Footings'*, with predicted ground surface movement of less than 20mm. However, due to the presence of colluvium and potential further creep, the site would be classified as **'Class P'**.

5. It is recommended that the building be founded into the underlying weathered rock profile and footings be designed using the parameters provided in Section 5 and 6.

6. Based on our quantitative hazard rating assessment, the site has a 'moderate' risk likelihood of instability. Refer to Appendix E for results of this quantitative assessment.

7. Based on the background search, fieldwork results and the site 'walkover', evidence of previous movement was noted by the presence of colluvium. Provided the recommendations in this report are adhered to, it is considered that the site is acceptable for its proposed usage in regards to stability.

8. Effective subsurface and surface drainage will be critical in the maintenance of stability on the site.

We trust that this information is helpful. Please contact our office with any queries or if further information is required.

Yours faithfully,

Poka Kilaverave
Geotechnical Engineer
For Construction Sciences

David Stirling
Senior Geotechnical Engineer

Construction Sciences

APPENDIX A

General Notes

GENERAL NOTES

GENERAL

This report comprises the results of an investigation carried out for a specific purpose and client as defined in the introduction section(s) of the document. The report should not be used by other parties or for other purposes as it may not contain adequate or appropriate information.

BOREHOLE/TEST PIT LOGGING

The information on the borehole/test pit logs has been based on a visual and tactile assessment except at the discrete locations where test information is available (field and/or laboratory results).

Reference should be made to our standard sheets for the definition of our logging procedures (Soil and Rock Descriptions).

GROUNDWATER

Unless otherwise indicated the water levels noted on the borehole/test pit logs are the levels of free water or seepage recorded at the given time of measuring. The actual groundwater level may differ from this recorded level depending on material permeabilities. Further variations of this level could occur with time due to such effects as seasonal and tidal fluctuations or construction activities. Final confirmation of levels can be only made by appropriate instrumentation techniques and programmes.

INTERPRETATION OF RESULTS

The discussion and recommendations contained within this report are normally based on a site evaluation from discrete borehole/test pit data. Generalised or idealized subsurface conditions (including any cross-sections contained in the report have been assumed or prepared by interpolation/extrapolation of this data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in the generalised ground conditions used for this report can occur, particularly between discrete borehole/test pit locations. Furthermore, certain design or construction procedures may have been assumed in assessing the soil structure interaction behaviour of the site.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed in this report should be referred to this firm for appropriate assessment and comment.

FOUNDATION DEPTH

Where referred to in the report, the recommended depth of any foundation (piles, caissons, footings, etc.) is an engineering estimate of the depth to which they should be constructed. The estimate is influenced and perhaps limited by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The depth remains, however, an estimate and therefore liable to variation. Footing drawings, designs and specifications based upon this report should provide for variations in the final depth depending upon the ground conditions at each point of support.

REPRODUCTION OF REPORTS

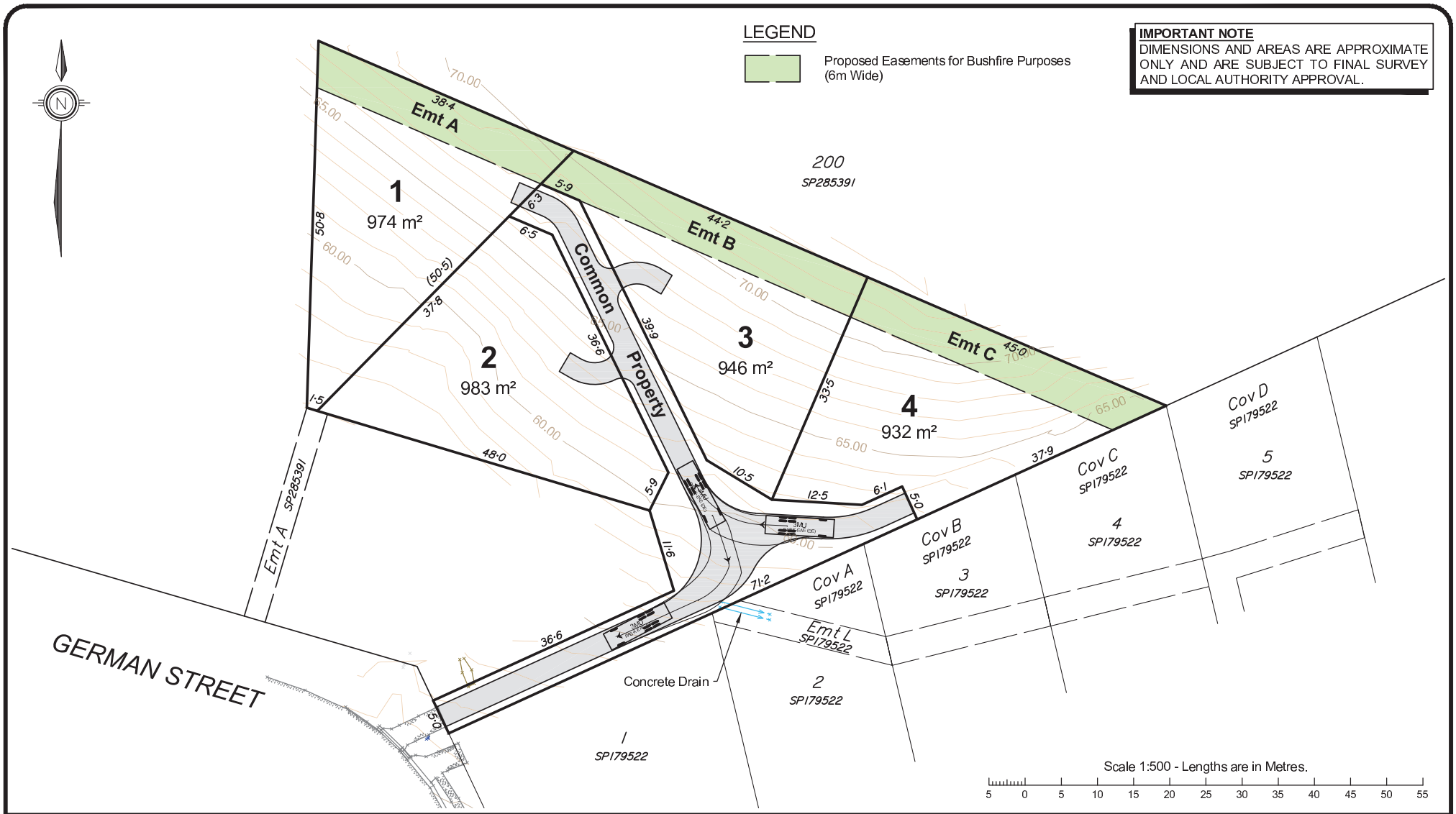
Where it is desired to reproduce the information contained in this report for the inclusion in the contract documents or engineering specification of the subject development, such reproduction should include at least all the relevant borehole/test pit logs and test data, together with the appropriate standard description sheets and remarks made in the written report of a factual or descriptive nature.

Construction Sciences

APPENDIX B

Site Investigation Location Plan

Lot 35 German Street, Norman Gardens



Rev	Description	Drawn	Checked	Date
C	Add Emts A - C, update lot layout & driveways	AD	BF	03/02/2017
B	Update boundaries	AD	BF	15/11/2016
A	Original Issue	AD	BF	15/11/2016

This plan was prepared as a proposed subdivision and should not be used for any other purpose. The dimensions, areas and total number of lots shown hereon are subject to field survey and also to the requirements of Council and any other authority which may have requirements under any relevant legislation. In particular, no reliance should be placed on the information on this plan for any financial dealing involving the land. This note is an integral part of the plan.

PROPOSAL PLAN

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CLIENT: Blue Dolphin Pty. Ltd.

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		Revision:	C

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APPENDIX C

Borehole Logs
with Explanatory Notes

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101 High Street
4701
Telephone: 49280044
Fax: 49261286

TEST PIT NUMBER TP1

CLIENT Blue Dolphin Pty Ltd **PROJECT NAME** Slope Stability Assessment

PROJECT NUMBER 2128E.P.531 **PROJECT LOCATION** Lot 35 on SP285391 German Street, Norman Gardens

DATE STARTED 5/4/17 **COMPLETED** 5/4/17 **R.L. SURFACE** _____ **DATUM** _____

EXCAVATION CONTRACTOR Jeff Thompson Excavator Hire **SLOPE** --- **BEARING** ---

EQUIPMENT 12T Excavator **TEST PIT LOCATION** Refer to Site Plan in Appendix B

TEST PIT SIZE 0.85 X 3.0 **LOGGED BY** M.Walters **CHECKED BY** P.Kilaverave

NOTES _____

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
Bucket			0.0		CI	SANDY CLAY (COLLUVIUM) medium plasticity, dark brown, dry, very soft, fine to medium sand, with rootlets.		2
								1
								1
			0.5		CI/CH	SANDY CLAY (RESIDUAL) medium to high plasticity, brown, moist, very stiff to hard, fine to coarse sand, traces of fine to medium gravel, sub-angular.		1
								21
			1.0		XW/DW	EXTREMELY TO DISTICNTLY WEATHERED ROCK extremely low to low strength, brown/dark brown, moderately fractured, fine to coarse grained, granular texture, excavates as sandy gravel, fine to coarse gravel with cobbles/boulders, MPS 300mm.		22+
			1.5					
Ripper					DW	DISTINCTLY WEATHERED ROCK medium to high strength, brown/dark brown, moderately fractured, fine to coarse grained, granular texture, excavates as cobbles/boulders, MPS 600mm.		
			2.0					
			2.5					
			3.0			Test Pit Terminated at 2.9m (Ripper Refusal)		
			3.5					
			4.0					
			4.5					
			5.0					

Test Pit TP1

Cardno Construction Sciences
101 High Street
4701
Telephone: 49280044
Fax: 49261286

TEST PIT NUMBER TP2

CLIENT Blue Dolphin Pty Ltd **PROJECT NAME** Slope Stability Assessment

PROJECT NUMBER 2128E.P.531 **PROJECT LOCATION** Lot 35 on SP285391 German Street, Norman Gardens

DATE STARTED 5/4/17 **COMPLETED** 5/4/17 **R.L. SURFACE** **DATUM**

EXCAVATION CONTRACTOR Jeff Thompson Excavator Hire **SLOPE** --- **BEARING** ---

EQUIPMENT 12T Excavator **TEST PIT LOCATION** Refer to Site Plan in Appendix B

TEST PIT SIZE 0.85 X 3.0 **LOGGED BY** M.Walters **CHECKED BY** P.Kilaverave

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
Bucket					SC	SANDY CLAY/CLAYEY SAND with GRAVEL (COLLUVIUM) low to medium plasticity, brown, moist, very soft, fine to coarse sand, fine to medium gravel, sub-angular, with rootlets.		2
								3
Ripper			0.5			DISTINCTLY WEATHERED ROCK high strength, brown/yellow, moderately to slightly fractured, fine to coarse grained, granular texture, excavates as sandy gravel with cobbles/boulders, MPS 600mm.		22+
			1.0			Test Pit Terminated at 0.8m (Ripper Refusal)		
			1.5					
			2.0					
			2.5					
			3.0					
			3.5					
			4.0					
			4.5					
			5.0					

Test Pit TP2

Cardno Construction Sciences
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Fax: 49261286

TEST PIT NUMBER TP3

CLIENT Blue Dolphin Pty Ltd **PROJECT NAME** Slope Stability Assessment

PROJECT NUMBER 2128E.P.531 **PROJECT LOCATION** Lot 35 on SP285391 German Street, Norman Gardens

DATE STARTED 5/4/17 **COMPLETED** 5/4/17 **R.L. SURFACE** **DATUM**

EXCAVATION CONTRACTOR Jeff Thompson Excavator Hire **SLOPE** --- **BEARING** ---

EQUIPMENT 12T Excavator **TEST PIT LOCATION** Refer to Site Plan in Appendix B

TEST PIT SIZE 0.85 X 3.0 **LOGGED BY** M.Walters **CHECKED BY** P.Kilaverave

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
Bucket			0.0		SM	SILTY SAND (COLLUVIUM) low plasticity, dark brown, moist, very loose, fine to coarse sand, trace of fine to medium gravel and cobbles, sub-angular, with rootlets.		2
Ripper					ML	SANDY SILT (COLLUVIUM) low plasticity, brown, moist, dense, fine to medium sand, traces of fine to medium gravel and cobbles/boulders, sub-angular.		3
			0.5					22+
					DW	DISTINCTLY WEATHERED ROCK medium strength, orange/brown mottled pale grey, moderately fractured, fine to coarse grained, granular texture, excavates as cobbles/boulders, MPS 1.3m.		
			1.0		DW	DISTINCTLY WEATHERED ROCK high strength, brown, moderately to slightly fractured, fine to coarse grained, granular texture, excavates as cobbles/boulders, MPS 0.6m		
						Test Pit Terminated at 1.2m (Ripper Refusal)		
			1.5					
			2.0					
			2.5					
			3.0					
			3.5					
			4.0					
			4.5					
			5.0					

Test Pit TP3

Cardno Construction Sciences
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TEST PIT NUMBER TP4

CLIENT Blue Dolphin Pty Ltd **PROJECT NAME** Slope Stability Assessment

PROJECT NUMBER 2128E.P.531 **PROJECT LOCATION** Lot 35 on SP285391 German Street, Norman Gardens

DATE STARTED 5/4/17 **COMPLETED** 5/4/17 **R.L. SURFACE** **DATUM**

EXCAVATION CONTRACTOR Jeff Thompson Excavator Hire **SLOPE** --- **BEARING** ---

EQUIPMENT 12T Excavator **TEST PIT LOCATION** Refer to Site Plan in Appendix B

TEST PIT SIZE 0.85 X 3.0 **LOGGED BY** M.Walters **CHECKED BY** P.Kilaverave

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
Bucket					SC	GRAVELLY CLAYEY SAND (COLLUVIUM) low plasticity, dark grey, moist, loose to medium dense, fine to coarse sand, fine to coarse gravel, sub-angular, with rootlets.		2
								2
					CI/CH	SANDY CLAY (COLLUVIUM) medium to high plasticity, orange/brown, moist, firm, fine to medium sand, trace of fine to coarse gravel, sub-angular.		3
			0.5					5
								3
								3
					XW/DW	EXTREMELY TO DISTINCTLY WEATHERED ROCK extremely low to low strength, seams of low to med strength, extremely fractured, fine to coarse grained, granular texture, excavates as clayey gravel, moist, medium to coarse gravel, angular.		4
			1.0					5
								14
			1.5					22+
Ripper					DW	DISTINCTLY WEATHERED ROCK medium strength, brown, extremely to moderately fractured, seams of XW rock elow to vlow strength, fine to coarse grained, granular texture, excavates as gravel with cobbles, MPS 200mm.		
			2.0					
			2.5		DW	DISTINCTLY WEATHERED ROCK high strength, brown/dark brown, moderately to slightly fractured, fine to coarse grained, granular texture, excavates as cobbles/boulders, MPS 500mm.		
						Test Pit Terminated at 2.7m (Ripper Refusal)		
			3.0					
			3.5					
			4.0					
			4.5					
			5.0					

Test Pit TP4

NOTES, DESCRIPTION & CLASSIFICATION OF SOIL

The methods of description and classification of soils used in this report are generally based on Australian Standard AS1726-1993 *Geotechnical Site Investigations*.

Soil description is based on an assessment of disturbed samples, as recovered from bores and excavations, or from undisturbed materials as seen in excavations and exposures or in undisturbed samples. Descriptions given on report sheets are an interpretation of the conditions encountered at the time of investigation.

In the case of cone or piezocone penetrometer tests, actual soil samples are not recovered and soil description is inferred based on published correlations, past experience and comparison with bore and/or test pit data (if available).

Soil classification is based on the particle size distribution of the soil and the plasticity of the portion of the material finer than 0.425mm. The description of particle size distribution and plasticity is based on the results of visual field estimation, laboratory testing or both. When assessed in the field, the properties of the soil are estimated; precise description will always require laboratory testing to define soil properties.

Where soil can be clearly identified as FILL this will be noted as the main soil type followed by a description of the composition of the fill (e.g. FILL – yellow-brown, fine to coarse grained gravelly clay fill with concrete rubble). If the soil is assessed as possibly being fill this will be noted as an additional observation.

Soils are generally described using the following sequence of terms. In certain instances, not all of the terms will be included in the soil description.

MAIN SOIL TYPE (CLASSIFICATION GROUP SYMBOL)
- strength/density, colour, structure/grain size, secondary and minor components, additional observations

Information on the definition of descriptive and classification terms follows.

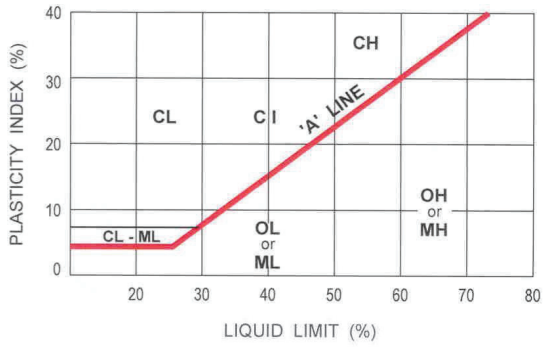
SOIL TYPE and CLASSIFICATION GROUP SYMBOLS

	Major Divisions	Particle Size	Classification Group Symbol	Typical Names
COARSE GRAINED SOILS (more than half of material is larger than 0.075 mm)	BOULDERS	> 200mm		
	COBBLES	63 – 200mm		
	GRAVELS (more than half of coarse fraction is larger than 2.36mm)	Coarse: 20 – 63mm Medium: 6 – 20mm Fine: 2.36 – 6mm	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels.
			GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (more than half of coarse fraction is smaller than 2.36mm)	Coarse: 0.6 – 2.36mm Medium: 0.2 – 0.6mm Fine: 0.075 – 0.2mm	SW	Well graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands.
			SM	Silty sands, sand-silt mixtures.
			SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS (more than half of material is smaller than 0.075 mm)	SILTS & CLAYS (liquid limit <50%)		ML	Inorganic silts and very fine sands, silty/clayey fine sands or clayey silts with low plasticity.
			CL and CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS & CLAYS (liquid limit >50%)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils.
			CH	Inorganic clays of high plasticity.
			OH	Organic clays of medium to high plasticity, organic silts.
	HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.

Construction Sciences

NOTES, DESCRIPTION & CLASSIFICATION OF SOIL

PLASTICITY CHART FOR CLASSIFICATION OF FINE GRAINED SOILS



(Reference: Australian Standard AS1726-1993 *Geotechnical site investigations*)

DESCRIPTIVE TERMS FOR MATERIAL PROPORTIONS

Coarse Grained Soils		Fine Grained Soils	
% Fines	Modifier	% Coarse	Modifier
< 5	Omit, or use 'trace'	< 15	Omit, or use trace.
5 – 12	Describe as 'with clay/silt' as applicable.	15 – 30	Describe as 'with sand/gravel' as applicable.
> 12	Prefix soil as 'silty/clayey' as applicable	> 30	Prefix soil as 'sandy/gravelly' as applicable.

STRENGTH TERMS – COHESIVE SOILS

Strength Term	Undrained Shear Strength	Field Guide to Strength
Very soft	< 12kPa	Exudes between the fingers when squeezed in hand.
Soft	12 – 25kPa	Can be moulded by light finger pressure.
Firm	25 – 50kPa	Can be moulded by strong finger pressure.
Stiff	50 – 100kPa	Cannot be moulded by fingers, can be indented by thumb.
Very stiff	100 – 200kPa	Can be indented by thumb nail.
Hard	> 200kPa	Can be indented with difficulty by thumb nail.

DENSITY TERMS – NON COHESIVE SOILS

Density Term	Density Index	SPT "N"	CPT Cone Resistance
Very loose	< 15%	0 – 5	0 – 2MPa
Loose	15 – 35%	5 – 10	2 – 5MPa
Medium dense	35 – 65%	10 – 30	5 – 15MPa
Dense	65 – 85%	30 – 50	15 – 25MPa
Very dense	> 85%	> 50	> 25MPa

COLOUR

The colour of a soil will generally be described in a 'moist' condition using simple colour terms (eg. black, grey, red, brown etc.) modified as necessary by "pale", "dark", "light" or "mottled". Borderline colours will be described as a combination of colours (eg. grey-brown).

EXAMPLE

e.g. CLAYEY SAND (SC) – medium dense, grey-brown, fine to medium grained with silt.
Indicates a medium dense, grey-brown, fine to medium grained clayey sand with silt.

NOTES, DESCRIPTION & CLASSIFICATION OF ROCK

The methods of description and classification of rock used in this report are generally based on Australian Standard AS1726-1993 *Geotechnical Site Investigations*.

Rock description is based on an assessment of disturbed samples, as recovered from bores and excavations, or from undisturbed materials as seen in excavations and exposures, or in core samples. Descriptions given on report sheets are an interpretation of the conditions encountered at the time of investigation.

Notes outlining the method and terminology adopted for the description of rock defects are given below, however, detailed information on defects can generally only be determined where rock core is taken, or excavations or exposures allow detailed observation and measurement.

Rocks are generally described using the following sequence of terms. In certain instances not all of the terms will be included in the rock description.

ROCK TYPE (WEATHERING SYMBOL), strength, colour, grain size, defect frequency

Information on the definition of descriptive and classification terms follows.

ROCK TYPE

In general, simple rock names are used rather than precise geological classifications.

ROCK MATERIALS WEATHERING CLASSIFICATION

Term	Weathering Symbol	Definition
Residual soil	RS	Soil developed from extremely weathered rock; the mass structure and substance fabrics are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely weathered	XW	Rock is weathered to such an extent that it has 'soil' properties, ie. it either disintegrates or can be remoulded in water.
Distinctly weathered *	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Highly weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock, usually as a result of iron leaching or deposition. The colour and strength of the original fresh rock substance is no longer recognisable.
Moderately weathered	MW	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock may be no longer recognisable.
Slightly weathered	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	FR	Rock shows no sign of decomposition or staining.

** Subdivision of this weathering grade into highly and moderately may be used where applicable.*

STRENGTH OF ROCK MATERIAL

Term	Symbol	Point Load Index I_s (50)	Field guide to strength
Extremely low	EL	< 0.03MPa	Easily remoulded by hand to a material with soil properties.
Very low	VL	0.03 – 0.1MPa	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low	L	0.1 – 0.3MPa	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	M	0.3 – 1.0MPa	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	H	1.0 – 3.0MPa	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very high	VH	3.0 – 10.0MPa	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely high	EH	> 10MPa	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Notes:

1. *These terms refer to the strength of the rock material and not to the strength of the rock mass which may be considerably weaker due to the effect of rock defects.*
2. *The field guide visual assessment for rock strength may be used for preliminary assessment or when point load testing is not available.*
3. *Anisotropy of rock may affect the field assessment of strength.*

NOTES, DESCRIPTION & CLASSIFICATION OF ROCK

COLOUR

The colour of a rock will generally be described in a 'moist' condition using simple colour terms (eg. black, grey, red, brown, etc) modified as necessary by 'pale', 'dark', 'light' or 'mottled'. Borderline colours will be described as a combination of colours (eg. grey-brown).

GRAIN SIZE

Descriptive Term	Particle Size Range
Coarse grained	0.6 – 2.0mm
Medium grained	0.2 – 0.6mm
Fine grained	0.06 – 0.2mm

DEFECT FREQUENCY

Where appropriate, a defect frequency may be recorded as part of the rock description and will be expressed as the number of natural (or interpreted natural) defects present in an equivalent one metre length of core.

EXAMPLE

e.g. SANDSTONE (XW) – low strength, pale brown, fine to coarse grained, 3 defects per metre.

ROCK DEFECTS

Defects are discontinuities in the rock mass and include joints, sheared zones, cleavages and bedding partings. The ability to observe and log defects will depend on the investigation methodology. Defects logged in core are described using the abbreviations noted in the following tables.

The *depth* noted in the description is measured in metres from the ground surface, the *defect angle* is measured in degrees from horizontal, and the defect *thickness* is measured normal to the plane of the defect and is in millimetres (unless otherwise noted).

Defects are generally described using the following sequence of terms:

Depth, Defect Type, Defect Angle (dip), Surface Roughness, Infill, Thickness

DEFECT TYPE

B Bedding
J Joint
S Shear Zone
C Crushed Zone

SURFACE ROUGHNESS

i. rough or irregular, stepped
ii. smooth, stepped
iii. slickensided, stepped
iv. rough or irregular, undulating
v. smooth, undulating
vi. slickensided, undulating
vii. rough or irregular, planar
viii. smooth planar
ix. slickensided, planar

INFILL

Infill refers to secondary minerals or other materials formed on the surface of the defect and some common descriptions are given in the following table together with their abbreviations.

Ls limonite staining
Fe iron staining
Cl clay
Mn manganese staining
Qtz quartz
Ca calcite
Clean no visible infill

EXAMPLE

3.59m, J, 90, vii, Ls, 0.1mm

Indicates a joint at 3.59m depth that is at 90° to horizontal (i.e. vertical), is rough or irregular and planar, limonite stained and 0.1mm thick.

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APPENDIX D

Laboratory Test Reports

Construction Sciences

Construction Sciences Pty Ltd
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Address:
101 High Street,
North Rockhampton QLD 4701

Laboratory: Rockhampton Laboratory
Phone: 07 4928 0044 **Fax:** 07 4926 1286

Email: Rockhampton@constructionsciences.net

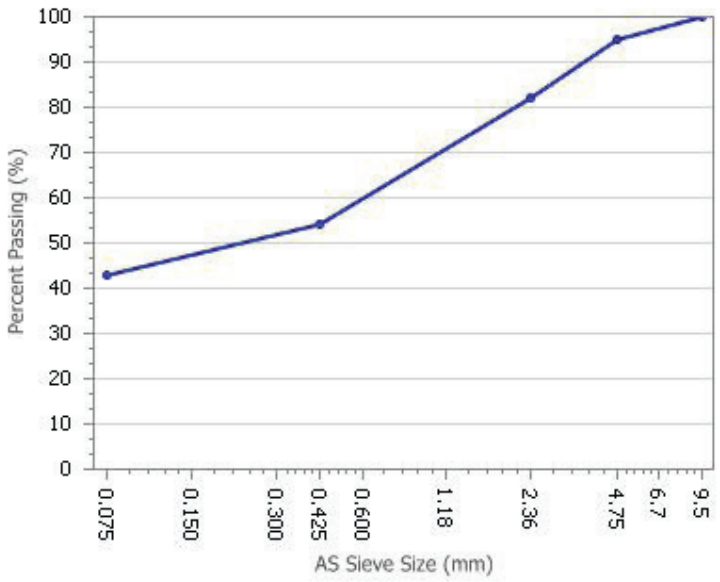
QUALITY OF MATERIALS REPORT

Client:	CARDNO CONSTRUCTION SCIENCES - RTON	Report Number:	2128/R/34627-1
Client Address:	ROCKHAMPTON, 101 High Street, North Rockhampton	Project Number:	2135/P/415
Project:	General Testing - Engineering	Lot Number:	35
Location:	North Rockhampton	Internal Test Request:	2128/T/14216
Component:	BLUE DOLPHIN PTY LTD	Client Reference/s:	2128E/CC/150 - 2128E/P/531
Area Description:		Report Date / Page:	7/04/2017 Page 1 of 1

Test Procedures	AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.2.1.1, AS 1289.3.3.1		
Sample Number	2128/S/58539	Test Pit No:	TP1
Sampling Method	Tested As Received	Depth (m)	0.4-0.8
Date Sampled	5/04/2017		German Street
Sampled By	Client Sampled		North Rockhampton
Date Tested	6/04/2017	Material Source	Insitu
Att. Drying Method	Oven Dried	Material Type	Insitu
Atterberg Preparation	Dry Sieved	Material Description	-

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
9.5		**100**	
4.75		**95**	
2.36		**82**	
0.425		**54**	
0.075		**43**	

PARTICLE SIZE DISTRIBUTION GRAPH



Test Result	Specification Minimum	Result	Specification Maximum	Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		**43**		0.075/0.425 Fines Ratio		**0.80**	
Plastic Limit (%)		**24**		PI x 0.425 Ratio (%)		**1035.5**	
Plastic Index (%)		**19**		LS x 0.425 Ratio (%)		**436.0**	
Linear Shrinkage (%)		**8.0**		Linear Shrinkage Defects	-		

Remarks

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025

Accreditation Number: 1986
Corporate Site Number: 2128

Approved Signatory: Daniel Bryce
Form ID: W85Rep Rev 1

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
101 High Street,
North Rockhampton QLD 4701

Laboratory: Rockhampton Laboratory
Phone: 07 4928 0044 **Fax:** 07 4926 1286

Email: Rockhampton@constructionsciences.net

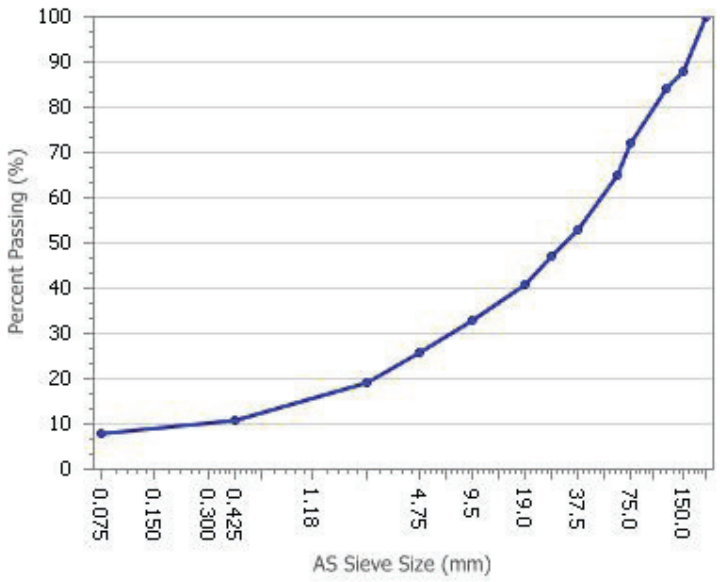
QUALITY OF MATERIALS REPORT

Client:	CARDNO CONSTRUCTION SCIENCES - RTON	Report Number:	2128/R/34628-1
Client Address:	ROCKHAMPTON, 101 High Street, North Rockhampton	Project Number:	2135/P/415
Project:	General Testing - Engineering	Lot Number:	35
Location:	North Rockhampton	Internal Test Request:	2128/T/14216
Component:	BLUE DOLPHIN PTY LTD	Client Reference/s:	2128E/CC/150 - 2128E/P/531
Area Description:		Report Date / Page:	7/04/2017 Page 1 of 1

Test Procedures	AS1289.3.6.1, AS1289.3.1.2, AS1289.3.2.1, AS1289.3.4.1, AS1289.2.1.1, AS 1289.3.3.1		
Sample Number	2128/S/58540	Test Pit No:	TP4
Sampling Method	Tested As Received	Depth (m)	1.8-2.2
Date Sampled	5/04/2017		German Street
Sampled By	Client Sampled		North Rockhampton
Date Tested	7/04/2017	Material Source	Insitu
Att. Drying Method	Oven Dried	Material Type	Insitu
Atterberg Preparation	Dry Sieved	Material Description	-

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
200.0		**100**	
150.0		**88**	
120.0		**84**	
75.0		**72**	
63.0		**65**	
37.5		**53**	
26.5		**47**	
19.0		**41**	
9.5		**33**	
4.75		**26**	
2.36		**19**	
0.425		**11**	
0.075		**8**	

PARTICLE SIZE DISTRIBUTION GRAPH



Test Result	Specification Minimum	Result	Specification Maximum	Test Result	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)		**37**		0.075/0.425 Fines Ratio		**0.70**	
Plastic Limit (%)		**19**		PI x 0.425 Ratio (%)		**196.2**	
Plastic Index (%)		**18**		LS x 0.425 Ratio (%)		**76.3**	
Linear Shrinkage (%)		**7.0**		Linear Shrinkage Defects	-		

Remarks

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025

Accreditation Number: 1986
Corporate Site Number: 2128

Approved Signatory: Daniel Bryce
Form ID: W85Rep Rev 1

Rockhampton Laboratory
101 High Street, North Rockhampton, Q4701
Phone : (07) 4928 0044
Fax: (07) 4926 1286

REPORT - POINT LOAD STRENGTH INDEX

Client:	CARDNO CONSTRUCTION SCIENCES - RTON	Report No:	2128/R/14216-2
Address:	101 High Street, North Rockhampton QLD 4701	Project No:	2128/P/415
Project:	General Testing - Engineering	Request No:	2128/T/14216

Sampled By:	Client	Method:	As Received	Date:	05-Apr-17
Tested By:	DB	Method:	AS 4133.4.1	Date:	06-Apr-17

Laboratory Number		2128/S/58541	2128/S/58542				
Lot Number:		**35**	**35**				
Borehole/Location:		**3**	**4**				
Section Tested (m):		**0.6 - 0.9**	**2.7**				
Specimen Type:		Lump ~50mm	Lump ~50mm				
Manner of Testing:		Lump	Lump				
I_S - Uncorrected Point Load Strength (MPa)		0.36	3.70				
$I_{S(50)}$ - Point Load Strength Index (MPa)		**0.41**	**4.40**				
Failure Mode:		Axial Splitting	Single Shear				
Storage History:		As Received	As Received				
Moisture Condition:		Dry/Moist	Dry/Moist				
Lithology		Rock	Rock				
Weakness Planes (if any)	Orientation	-	-				
	Nature	-	-				
Specimen Remarks:		-	-				
Lot Remarks:		CLIENT: BLUE DOLPHIN PTY LTD, PROJECT - German Street					

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory Number: 1986
NATA Corporate Site Number: 2128
This document is issued in accordance with NATA accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Name: Daniel Bryce
Function: Authorised Signatory
Date: 19-Apr-17

Construction Sciences

APPENDIX E

Landslip Hazard Analysis

LANDSLIDE FREQUENCY ANALYSIS

Analysis No.: 1

NATURAL SHALLOW LANDSLIDES

Lot 35 on SP285391, German Street, Norman Gardens

1 Basic Frequency -

2 Slope Angle

Site		Level	Factor
	Less than 5° (8.75%)	L	0.1
	Between 5° and 15° (26.8%)	M	0.5
x	Between 15° and 30° (57.7%)	M	0.8
	Between 30° and 45° (100%)	H	1.2
	More than 45°	M	0.8

3 Slope Shape

Site		Level	Factor
	Crest or ridge	L	0.7
x	Planar	M	0.9
	Convex	M	0.9
	Concave	H	1.5

4 Site geology

Site		Level	Factor
	Volcanic rock	H	1.1
x	Sedimentary rock	M	1
	Low grade metamorphic rock	M	1
	High grade metamorphic rock	L	0.9
	Granitic rock	M	1

5 Material strength

Site		Level	Factor
	Rock at surface	VL	0.1
x	Residual soil < 1 m deep	L	0.5
	Residual soil 1-3 m deep	M	0.9
	Residual soil > 3 m deep	H	1.5
	Colluvial soil < 1 m deep	H	1.5
	Colluvial soil 1-3 m deep	VH	2
	Colluvial soil > 3 m deep	VH	4
	Fill (slope regrading)	VH	5

6 Concentration of surface water

Site		Level	Factor
	Ridge	L	0.7
	Crest	M	0.8
	Upper slope	M	0.9
	Mid slope	H	1.2
x	Lower slope	H	1.5

7 Evidence of groundwater

Site		Level	Factor
x	None apparent	L	0.7
	Minor moistness	M	0.9
	Generally wet	H	1.5
	Surface springs	VH	3

8 Evidence of instability

Site		Level	Factor
x	No sign of instability	L	0.5
	Trees bent	H	1.5
	Minor irregularity	VH	2
	Major irregularity	VH	5
	Scarps	VH	10

Summary

		Factor
2	Slope Angle	0.8
3	Slope Shape	0.9
4	Site geology	1
5	Material strength	0.5
6	Concentration of surface water	1.5
7	Evidence of groundwater	0.7
8	Evidence of instability	0.5

9	Relative Frequency (2x3x4x5x6x7x8)	0.19

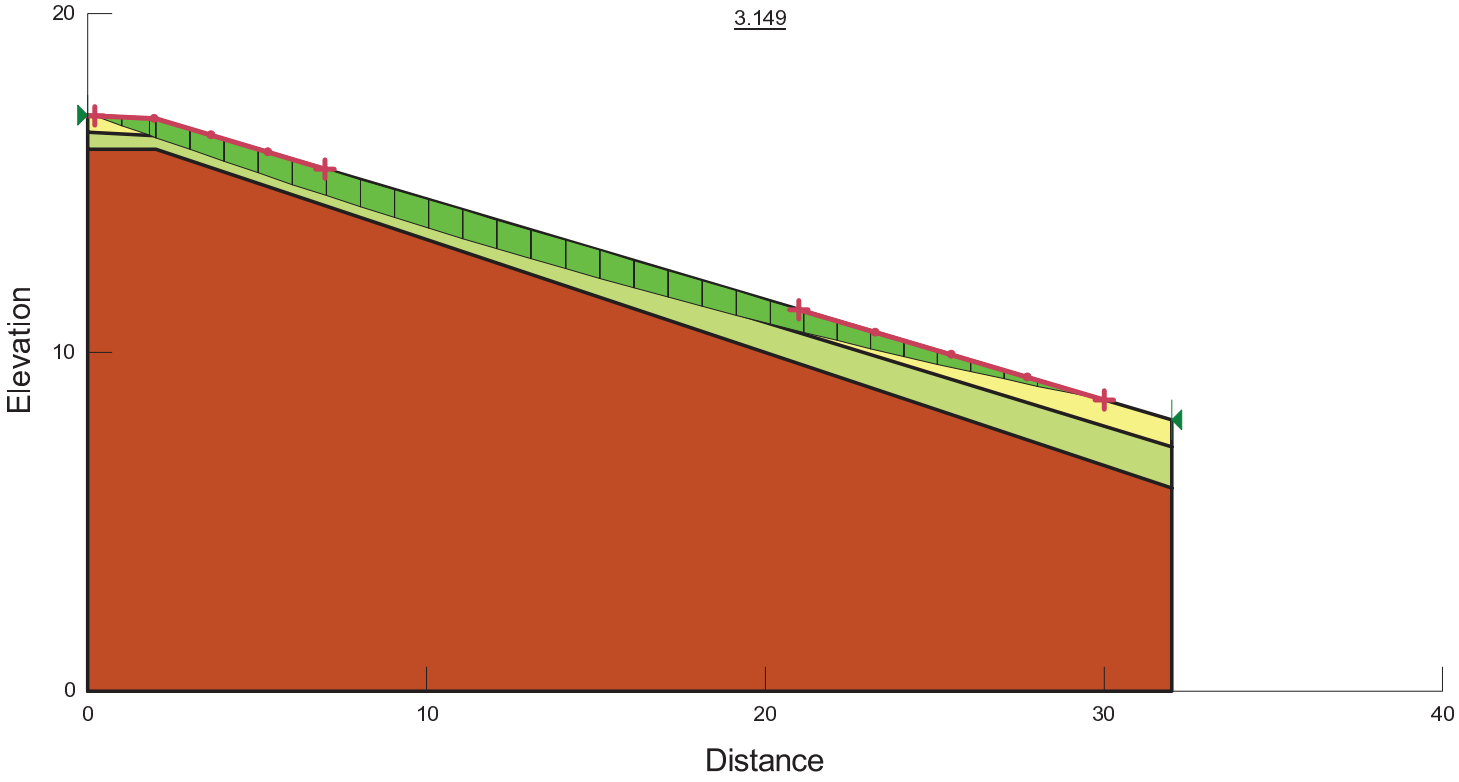
Site Frequency (1 x 9) -

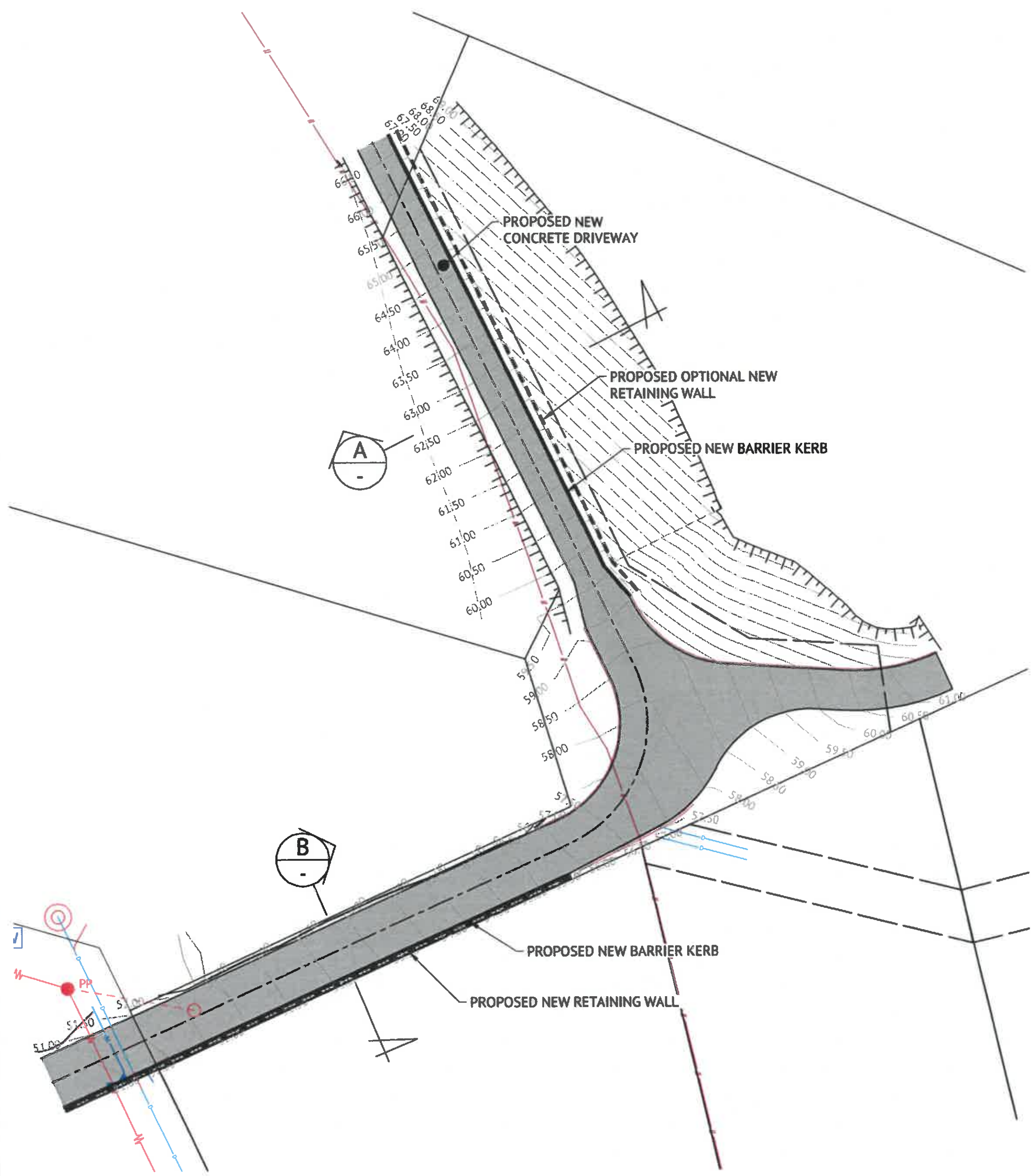
Construction Sciences

APPENDIX F

Slope Model Analysis

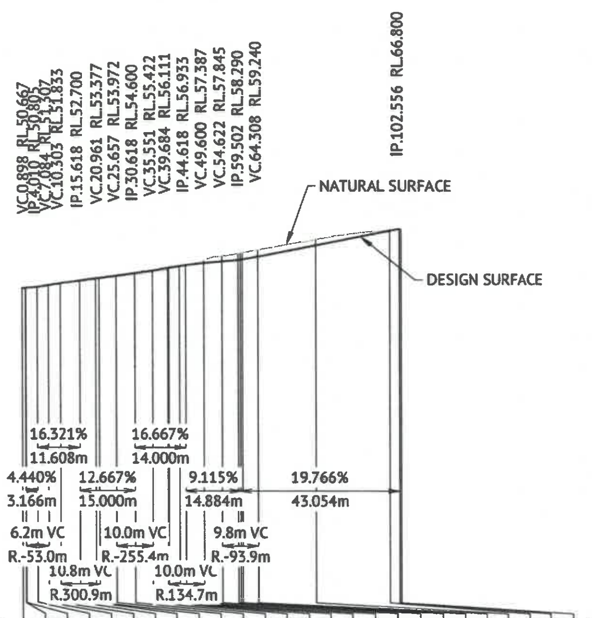
Lot 35 on SP285391 German Street
Name: gravelly clayey sand (Colluvium) Model: Mohr-Coulomb Unit Weight: 17 kN/m³ Cohesion': 3 kPa Phi': 28 °
Name: sandy clay (Residual) Model: Mohr-Coulomb Unit Weight: 16 kN/m³ Cohesion': 5 kPa Phi': 24 °
Name: XW rock Model: Mohr-Coulomb Unit Weight: 19 kN/m³ Cohesion': 15 kPa Phi': 35 °





CONCEPT LAYOUT PLAN

SCALE 1:500



VERTICAL GEOMETRY GRADE
VERTICAL GRADE LENGTH

VERTICAL CURVE LENGTH
VERTICAL CURVE RADIUS

DATUM RL.-40.000

CONTROL LINE CHAINAGE	EXISTING NATURAL SURFACE LEVEL	CUT / FILL DEPTH TO EXISTING	CONTROL LINE DESIGN LEVEL
0	50.546	0.004	50.550
0.844	50.664	0.001	50.665
0.898	50.666	0.001	50.667
4.01	50.992	-0.094	50.897
7.084	51.602	-0.295	51.307
10.303	51.961	-0.128	51.833
15.618	52.381	0.270	52.651
20	52.919	0.334	53.253
20.961	53.046	0.331	53.377
25.657	53.664	0.308	53.972
30.618	54.243	0.407	54.649
35.551	55.006	0.416	55.422
39.684	55.715	0.396	56.111
40	55.787	0.376	56.163
42.96	56.373	0.243	56.616
44.618	56.743	0.097	56.840
49.6	58.001	-0.614	57.387
54.622	59.305	-1.460	57.845
58.931	59.931	-1.593	58.339
59.502	60.041	-1.622	58.419
60	60.136	-1.644	58.492
64.308	60.948	-1.708	59.240
80	63.826	-1.484	62.342
100	66.540	-0.245	66.295
102.556	66.864	-0.064	66.800
103.012	66.921		

DRIVEWAY LONGITUDINAL SECTION

SCALE 1:1000

LEGEND:

- PROPOSED NEW CONCRETE DRIVEWAY
- DESIGN SURFACE CONTOUR
- DESIGN TOP OF BATTER
- DESIGN BOTTOM OF BATTER
- EXISTING PROPERTY BOUNDARY
- EXISTING EASEMENT BOUNDARY
- EXISTING OVERHEAD ELECTRICAL
- EXISTING STORMWATER DRAINAGE
- EXISTING FENCE
- EXISTING WATERMAIN AND FITTINGS
- EXISTING TELSTRA PIT
- PROPOSED NEW KERB
- PROPOSED NEW RETAINING WALL
- OPTIONAL NEW RETAINING WALL
- PROPOSED NEW DRIVEWAY CENTRELINE

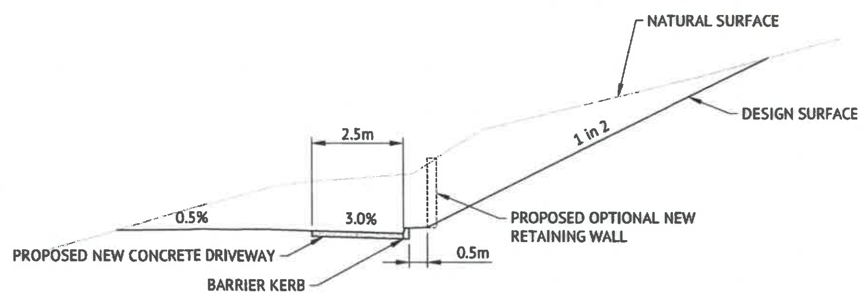
ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

These plans are approved subject to the current conditions of approval associated with

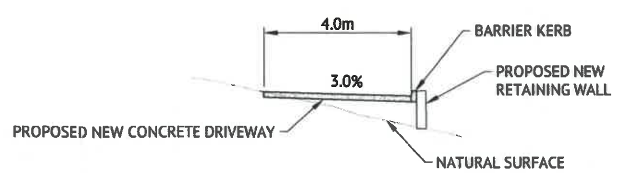
Development Permit No.: D/39-2017

Dated: 30 October 2018



TYPICAL SECTION A

SCALE 1:100



TYPICAL SECTION B

SCALE 1:100

0 2.0 4.0 6.0m
SCALE 1:100

0 10.0 20.0 30.0m
SCALE 1:500

0 20.0 40.0 60.0m
SCALE 1:1000

INFORMATION ONLY

THE INFORMATION PRESENTED ON THIS PRELIMINARY PLAN IS FOR DISCUSSION PURPOSES ONLY AND IS SUBJECT TO FURTHER ENGINEERING REVIEW.

PRELIMINARY ISSUE NOT FOR CONSTRUCTION

DATE	REV	DESCRIPTION	REC	APP
13/12/17	1	FOR INFORMATION ONLY		

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DESIGNED A. BAKER
CHECKED
PROJECT MANAGER
PROJECT DIRECTOR
RPEQ
SCALE

CLIENT BLUE DOLPHIN PTY LTD
PROJECT 1 INTO 2 LOT SUBDIVISION
LOCATION GERMAN STREET, NORMAN GARDENS
SHEET TITLE CONCEPT GENERAL ARRANGEMENT PLAN

JOB CODE VIS-0018
SHEET NUMBER SKC006
REV 1

Premise

WATER

BLUE DOLPHIN PTY LTD

RECONFIGURATION OF A LOT - 1 INTO 2
229 GERMAN STREET, NORMAN GARDENS

SITE BASED STORMWATER MANAGEMENT PLAN

Report No: VIS0018/ R01
Rev: B
Date: 8 February 2018

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APPENDICES

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DOCUMENT AUTHORISATION					
Revision		**Rev. Date**		**Report Details**	
B		8 February 2018		Amended for updated Proposal Plan	
A		15 December 2017		Site Based Stormwater Management Plan	
Prepared By		**Reviewed By**		**Authorised By**	
Jay Horvat		David Verroen		Chris Porter	

1 EXECUTIVE SUMMARY

This Site Based Stormwater Management Report discusses the impacts likely to arise in terms of stormwater quantity for the proposed reconfiguration of Lot 35 on SP285391, German Street Norman Gardens, Rockhampton. Pre- and post-development stormwater modelling has been carried out using the Rational Method to identify potential worsening effects of downstream catchments and infrastructure. Mitigation measures compliant with Rockhampton Regional Council (RRC) and Capricorn Municipal Design Guidelines (CMDG) were selected to reduce potential impacts.

The key aims of this Site Base Stormwater Management Report are to identify the site's 'lawful points of discharge', and calculate the peak discharge from the existing and developed site to ensure no worsening effect to downstream catchments and infrastructure.

2 INTRODUCTION

Premise Mackay Pty Ltd (ABN: 80 145 564 852) t/as Premise (Premise) have been commissioned by Blue Dolphin Pty Ltd to undertake the preliminary stormwater management plan for the German Street development site. This stormwater management plan has been produced to summarise and highlight the effect of developing Lot 35 on SP285391 German Street in North East Rockhampton. The development will consist of subdividing Lot 35 into two (2) land parcels of 2,051m^2 and 2,600m^2 with a concrete driveway for access. The proposed development site is shown in Figure 1.

Figure 1: Aerial of proposed development site

The existing catchment was assessed to identify its 'lawful points of discharge' and quantify the effects on neighbouring properties and downstream stormwater infrastructure (if any at all) when factoring for the proposed development. This will determine the impact of developing the site and provide insight into infrastructure required to cater for any changes.

Recommendations are made in the following sections on the infrastructure that will best manage stormwater flows from the German Street development.

3 EXISTING STORMWATER INFRASTRUCTURE

There is currently no stormwater drainage infrastructure at the top of German Street where the proposed development lies. The closest infrastructure is in Meyenberg Court approximately 130m south off German Street. Kerb and channel currently exists up until the access handle from the south and then does not exist for a further 80m to the north-west.

An existing concrete lined cut-off drain exists in the adjacent Lot 2 in Easement L on SP179522, which cut's off flow from the eastern side of the subject site, as well as the adjacent catchment and drains to the east into Sunset Drive.

4 STORMWATER ANALYSIS - QUANTITY

4.1 Methodology

Hydraulic calculations for the site have been undertaken for both pre- and post-development scenarios to ensure there will be no worsening effect. The rational method has been used to estimate design flood discharges for a 100-year ARI at each of the identified 'lawful points of discharge'.

4.2 Pre-development

The catchments that currently contribute to stormwater flows are distributed to German Street in the western and southern direction as well as Easement L part way down the subject site. The catchments include the proposed development site, uphill of the proposed development site, and the area between the proposed development site and German Street. Analysis of aerial photography determined appropriate fraction impervious values for the existing site and were taken as 0% for the whole site. The pre-development site and adjacent catchments can be seen in Appendix A – Catchment Plans.

The existing catchments are shown in Figure 2 below. The existing Q100 flows in these catchments are summarised in Table 1. The lawful points of discharge comprise of German Street in the western and southern direction and Easement L on the eastern boundary of the site.

Figure 2: Pre-development catchment plan

4.3 Post-development

Due to the number and size of lots, the site has been classified as 'rural-residential' in accordance with Table 4.05.1 in the Queensland Urban Drainage Manual (QUDM). The proposed setout of the development is shown in Figure 3 with resulting the post development catchments shown in Figure 4.

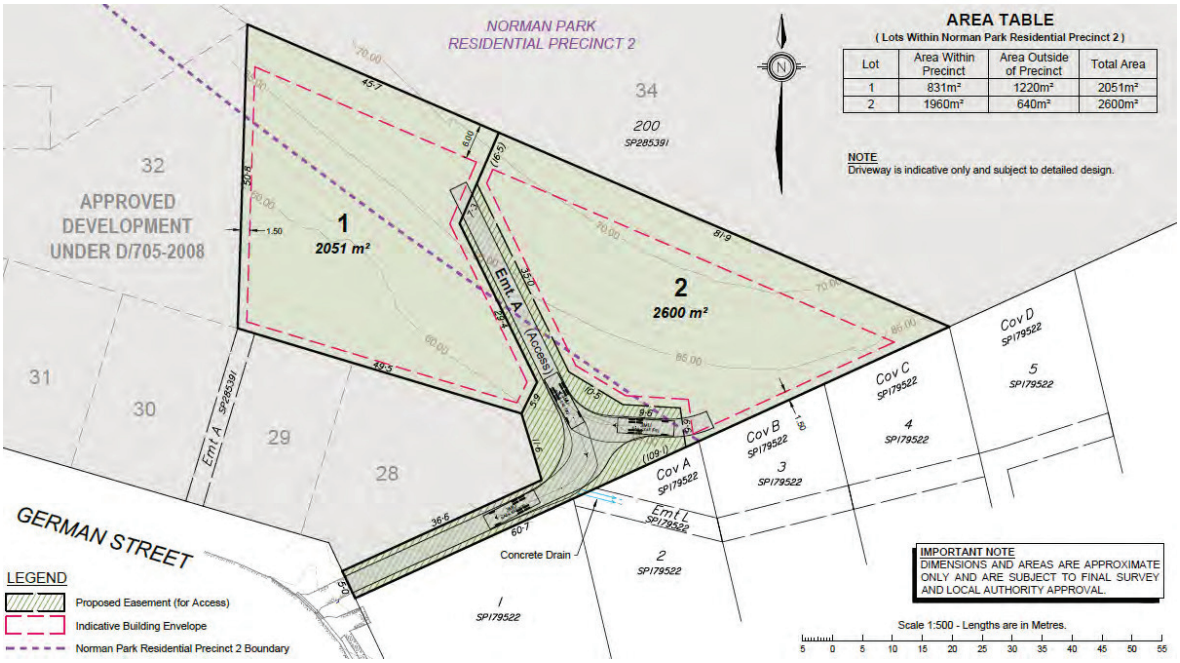


Figure 3: Proposed development layout

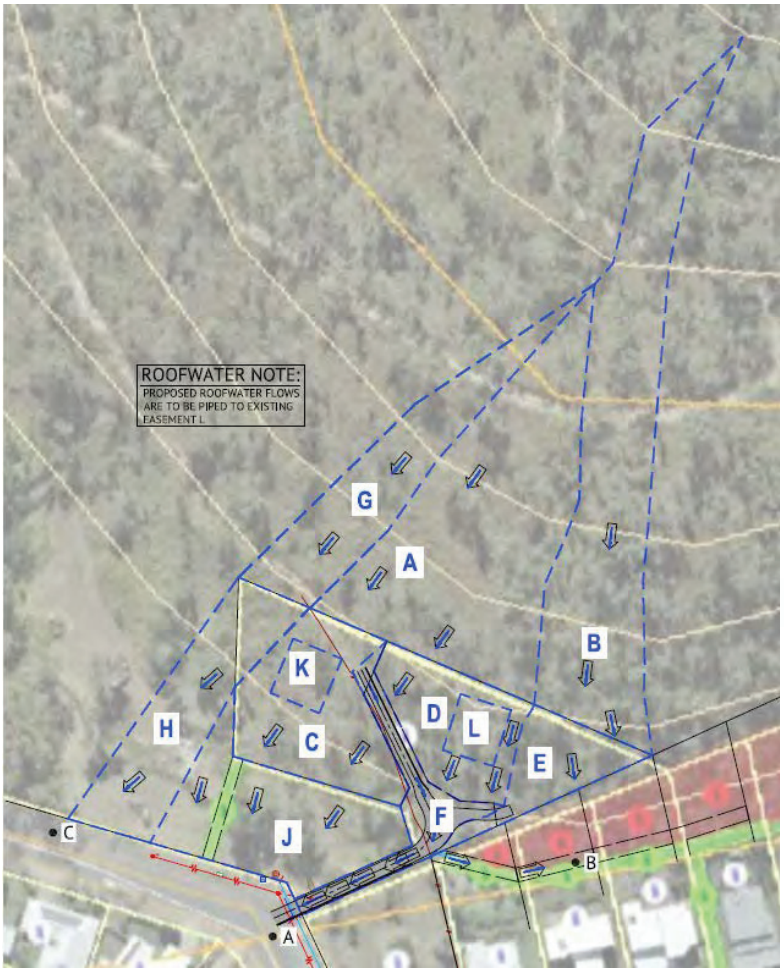


Figure 4: Post-development catchment plan

Pre- and post-development hydraulic calculations are shown in Table 1 below. Corresponding catchment plans can be found in Appendix A.

	Lawful Point of Discharge		
	D1 – German St South	**D2 – Easement L**	**D3 – German St West**
Time of concentration (mins)	5.0	5.0	5.0
I100 (mm/hr)	321	321	321
Contributing Area pre-development (ha)	0.747	0.451	0.281
Contributing catchments pre-development	1	2	3
Q100 pre-development (m^3/s)	0.666	0.402	0.250
Contributing Area post-development (ha)	0.772	0.422	0.281
Contributing catchments post-development	A+C+D+F+J	B+E+K+L	H+G
Q100 post-development (m^3/s)	0.666	0.402	0.250
Flow Variation (m^3/s, %)	**0.022, 3.36%**	**-0.025, -6.32%**	**0, 0%**

Table 1: Q100 Data Table

The post-development flows remain the same going to German Street west as the catchment size does not change and nor does the fraction impervious. The flows going to German Street South increase by 0.022m^3/s which equates to 3.36%, which is deemed as negligible and has a non-worsening effect. The flows to Easement L are reduced by 0.025m^3/s which equates to a reduction of 6.32%.

The change in flow rate is due to the adjusted 10-year coefficient of discharge (C_{10}) due to the adjusted fraction impervious. The value of C_{10} is determined from Tables 4.05.2 (a) and 4.05.3 (b) in QUDM.

4.4 Suggested Infrastructure

McMurtrie Consulting Engineers, Engineering Report dated 28 March 2017, proposes the lowest building pad level of RL 61.0m AHD. Refer to Appendix B. While the development configuration has changed, this building level represents a conservative estimate for the future dwellings under the new development proposal. Adopting this floor level and conservatively assuming single level construction only yields a roof level of approximately RL 63.5m AHD. This is sufficient to allow for all roof flow to be directed to easement L through internal pipework.

The driveway will be graded to capture and direct all other upstream runoff to German Street. This will ensure all impervious surface flows other than water captured on the rooves are directed down the driveway which will be constructed with kerb and channel. As a result, flow paths will remain the same compared to the pre-development scenario. Refer to Appendix C for a copy of the internal driveway's concept.

5 STORMWATER ANALYSIS - QUALITY

5.1 Stormwater Quality Treatment (Construction Phase)

Various pollutants are generated during the construction phase that can enter stormwater runoff. These pollutants can affect the quality of the stormwater runoff and therefore pollute both the site and the downstream receiving environment if no preventative measures are taken.

Major sources of construction phase pollutants include:

- Litter such as construction packaging, paper, food packaging and off cuts;
- Sediment from erosion of exposed soils and stockpiles;
- Hydrocarbons from spills and leaks of fuel and oil from construction equipment;
- Toxic Materials such as cement slurry, solvents, cleaning agents and wash waters; and
- pH altering substances such as cement slurry and wash waters.

Erosion and sediment control measures used during the construction phase of the development will be designed and installed in accordance with International Erosion Control Association (Australasia) Best Practice Erosion & Sediment Control for building and construction sites (IECA 2008) and Rockhampton Regional Council's requirements for Erosion and Sediment Control.

Temporary sediment basins will be constructed to cater for runoff from disturbed areas during construction. The sediment basins will be sized based on the maximum disturbance area within the catchment during construction. The basin will be designed to retain sediment laden water for extended periods allowing adequate time for the gravitational settlement (or flocculation if required) of the fine particles. Table 2 details post-storm criteria for dewatering of sediment basins and typical construction phase water quality objectives.

Appropriate flocculation of the sediment basin may be required if collected water needs to be released where the water does not meet the required 50 mg/L water quality standard for TSS. Erosion and Sediment Control Management Plans will be generated at the detailed design phase of each stage of the development.

Post-storm de-watering of wet sediment basins
at least 80% of the average annual runoff volume of the contributing catchment treated (i.e. 80% hydrological effectiveness) to 50mg/L Total Suspended Solids (TSS) or less
pH 6.5 to 8.5
Hydrocarbons – No visible sheen on receiving water
Litter – No visible little washed from site

Table 2: Typical construction phase water quality objectives

5.2 Stormwater Quality Treatment (post-development)

Rockhampton falls within the Central Queensland (south) climatic region for the purposes of the State Planning Policy (SPP). The SPP applies to developments that meet the following criteria:

- Are built on premises 2,500m^2 or greater in size and:
  - will result in six or more dwellings; or
  - an impervious area greater than 25 per cent of the net developable area.

- Reconfiguration involves premises 2,500m^2 or more and will result in six or more lots.

The development will result in two (2) separate lots with a total area of approximately 4800m^2. An average roof in this part of Rockhampton has an area of 250m^2 and the proposed driveway and access has a total area of 405m^2. This results in a total impervious area of 905m^2 which is approximately 19% of the net developed area.

As the development will not result in an impervious area greater than 25 percent of the net development area and will result in less than six (6) new dwellings being created, the requirements of the SPP are not triggered. However, water quality measures will still need to be implemented during construction phase.

6 CONCLUSION

In conclusion the proposed development has a non-worsening effect on downstream and adjacent properties and stormwater infrastructure. It is therefore recommended that the proposed two-lot subdivision of Lot 35 on SP285391 should be accepted subject to further discussion with RRC and detailed design in accordance with the recommendations of the report.

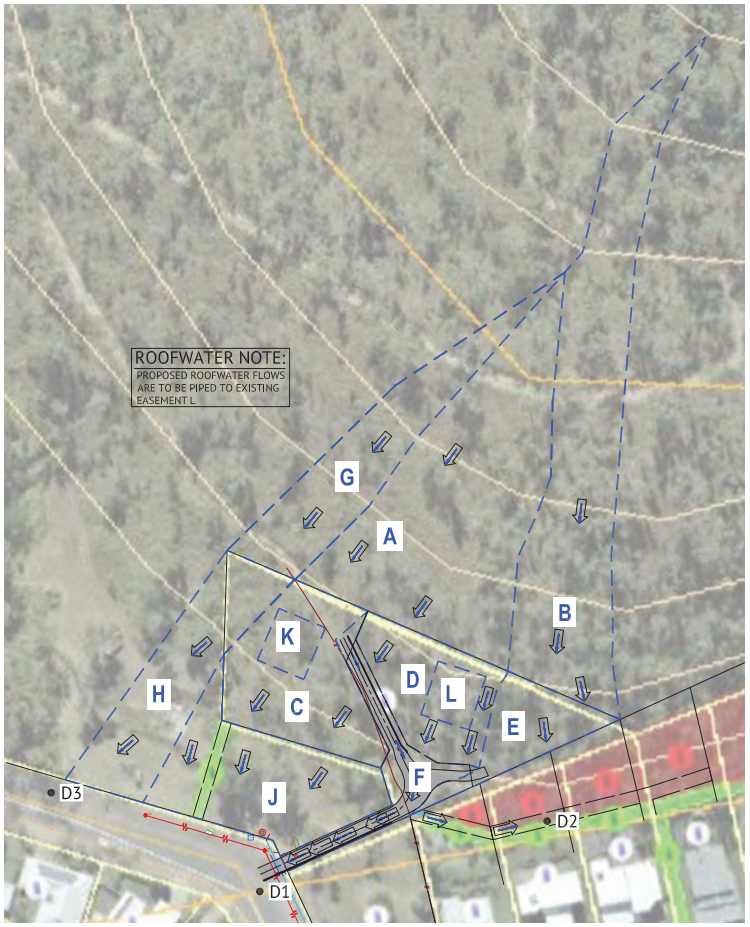
APPENDIX A
CATCHMENT PLANS

Q100 - DATA TABLE

DESIGN POINT	CATCHMENTS CONTRIBUTING	E.I.A (Ha)	Tc (mins)	I100 (mm/hr)	Q100 (m3/s)	PRE DEVELOPMENT FLOW (m3/s)	FLOW COMPARISON (m3/s)	NOTES
D1	1	0.747	5.0	321	0.666	0.666	0.000	FLOW TO GERMAN STREET SOUTH
D2	2	0.451	5.0	321	0.402	0.402	0.000	FLOW TO EASEMENT L
D3	3	0.281	5.0	321	0.250	0.250	0.000	FLOW TO GERMAN STREET WEST
D1	A+C+D+F+J	0.772	5.0	321	0.688	0.666	0.022	3.36% INCREASE IN FLOW
D2	B+E+K+L	0.422	5.0	321	0.377	0.402	-0.025	6.32% DECREASE IN FLOW
D3	H+G	0.281	5.0	321	0.250	0.250	0.000	FLOW EQUAL TO PREDEVELOPMENT CASE

N

PRE DEVELOPMENT CATCHMENT PLAN
SCALE 1:750



POST DEVELOPMENT CATCHMENT PLAN
SCALE 1:750

CATCHMENT DATA

CATCHMENT NAME	AREA (Ha)	C100	E.I.A (Ha)
1	0.890	0.840	0.747
2	0.537	0.840	0.451
3	0.334	0.840	0.281
A	0.409	0.840	0.344
B	0.398	0.840	0.334
C	0.144	0.840	0.121
D	0.094	0.840	0.079
E	0.075	0.840	0.063
F	0.071	1.000	0.071
G	0.171	0.840	0.144
H	0.163	0.840	0.137
J	0.188	0.840	0.158
K	0.025	1.000	0.025
L	0.025	1.000	0.025

LEGEND:

- PROPOSED NEW KERB
- PROPOSED NEW RETAINING WALL
- PROPOSED NEW DRIVEWAY CENTRELINE
- PRE DEVELOPMENT CATCHMENT
- PRE DEVELOPMENT MAJOR FLOW PATH
- PRE DEVELOPMENT MINOR FLOW PATH
- POST DEVELOPMENT CATCHMENT
- POST DEVELOPMENT MAJOR FLOW PATH
- POST DEVELOPMENT MINOR FLOW PATH
- EXISTING MINOR CONTOUR
- EXISTING MAJOR CONTOUR
- EXISTING PROPERTY BOUNDARY
- EXISTING EASEMENT BOUNDARY
- EXISTING OVERHEAD ELECTRICAL
- EXISTING FENCE
- EXISTING WATERMAIN AND FITTINGS
- EXISTING TELSTRA PIT
- 1 STORMWATER DESIGN POINT

INFORMATION ONLY

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PRELIMINARY ISSUE NOT FOR CONSTRUCTION

DATE	REV	DESCRIPTION	REC	APP
14/12/17	1	FOR INFORMATION ONLY		

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DESIGNED A. BAKER
CHECKED
PROJECT MANAGER
PROJECT DIRECTOR
RPEQ
SCALE 0 15.0 30.0 45.0m
SCALE 1:750

CLIENT BLUE DOLPHIN PTY LTD
PROJECT 1 INTO 2 LOT SUBDIVISION
LOCATION GERMAN STREET, NORMAN GARDENS
SHEET TITLE POST AND PRE DEVELOPMENT CATCHMENT FLOWS

JOB CODE VIS-0018
SHEET NUMBER SKC005
REV 1

4.0 Management and Mitigation Measures

This Bushfire Assessment and Management Plan has identified that BAL-40 construction standards will be applicable to structures constructed immediately adjacent a proposed 6m easement along the boundary of the proposed Lot 1, Lot 3 and Lot 4. BAL-40 construction standards are stringent and must be complied to for all structures that are adjacent to the easement. Lower construction standards will apply with increasing distance from the north-east boundary. Measures to manage bushfire risk for this development have been outlined in Table 10.

Table 10: Bushfire management plan

Item	Issue	Recommended bushfire management measures
Construction of dwelling building / structures	Bushfire construction requirements	• All structures / buildings should be compliant with the relevant construction requirements as outlined in AS3959-2009. Setbacks for relevant construction standards are outlined in Table 9. Generally structures/buildings constructed immediately adjacent to the easement will be provided with a 6m setback and must be constructed to BAL-40. Structures that are built 3m from the easement can be constructed to BAL-29 • The easement should be maintained as a fuel-free zone to protect buildings / structures from bushfire attack. • Overhanging trees and shrubs must be cleared from buildings and structures. • Any flammable items should be stored well away from buildings / structures (e.g. woodpiles, boxes, paper). • Roofs and gutters should be cleaned and free of dry leaf debris to eliminate an ignition source for embers. • Surrounding lawns should be regularly mowed.
Site access	Access to buildings / structures for fire-fighting purposes	• The road layout allows for public road access for residents and emergency access vehicles. • All firebreaks should be slashed or cleared regularly to keep fuel levels (grass, leaf litter, etc) to a minimum and maintain site access for 4WD vehicles and emergency vehicles. Firebreaks should be maintained to the satisfaction of the local fire authority / brigade.
Water supply	Water supply for fire-	• Adequate water supply is critical for effective fire-fighting. The site is on a reticulated water

Item	Issue	Recommended bushfire management measures
	fighting purposes	supply and this will be sufficient to provide water supply for fire-fighting purposes. • If water tanks are to be installed they will not be constructed of any material which may fail when exposed to excessive heat (i.e. plastic). Water tanks should be located on the side of the building which is furthermost away from the hazard source or appropriately shielded. All above ground water pipes external to the dwelling should be metal, or protected from the effects of radiant heat, including and up to any taps. • Water pumps are to be shielded from radiant heat and embers. • Pumps should be of a size and capacity to achieve a minimum water pressure to allow for a fire demand of 15L/s. • All static water sources within the site should be suitably identified and marked so that fire-fighters can locate them at all hours. • Clear access must be maintained to water supply for fire-fighting personnel and vehicles.
Fire-fighting infrastructure and equipment	Adequate equipment and infrastructure for fire-fighting purposes	• Regularly check that all fire-fighting equipment is operational and in good working order. • Pumps and generators should be checked regularly to ensure they are in good working order. • A suitable connection for firefighting purposes should be made available at all onsite static water sources. It is recommended that Queensland Rural Fire Services be consulted during the planning and design stages to ensure adequate infrastructure is included in the development to ensure appropriate fittings and connections are included. • A fire extinguisher/s should be installed in the dwelling and as required in plant and equipment. All extinguishers must be maintained in good working order as per regulations. • A long hose/s should be readily available outside the dwelling with appropriate fittings / connections to allow for rapid response in the event of a bushfire. Hoses should be long enough to reach all external areas of the building/s. • Fire alarms must be installed in the dwelling as per regulations. • It is strongly recommended that additional fire-fighting apparatus, such as fire blankets, also be stored inside the dwelling and readily available for use in the event of a fire.

Item	Issue	Recommended bushfire management measures
Landscaping	Occurrence of vegetation in close proximity to buildings / structures	• No tree or shrub should be in contact with or overhanging buildings / structures. Gutters should be cleaned regularly. Alternatively, gutter plugs may be installed. • Lawns and gardens within 10m of existing buildings should be maintained at a height of no more than 50mm. • Grassed areas and lawns surrounding buildings and within the setback zone should be mowed regularly and maintained at a maximum height of 150mm. • All other grassed areas should be maintained at no greater than 200mm. • Where possible, local provenance fire-wise plant species should be used in landscaping. • Where possible, trees of shrubs with smooth or tightly attached bark should be used. Species which shed bark on an annual basis should be avoided to reduce fuel levels. • Species with high moisture content should be selected where possible. • Species with less dense, open or loosely branching foliage are preferred. • Maintain the site, and especially the setback zone free of weeds. • Landscaping should be designed or modified and maintained to reduce opportunities for spot fires via ember attack and to maintain adequate defendable space around each building. • Excess debris and litter, resulting from extreme storm events and cyclones, near buildings / structures should be cleared away as soon as practicably possible following the storm to reduce fuel loads in the vicinity of the buildings / structures.
Fencing	Fencing materials can have a considerable impact on the propagation of fire. Likewise, some fencing materials can alleviate exposure to radiant heat.	• For this site, if fencing is to be erected, it is recommended that rural mesh fencing (with either a metal or timber frame) be used to minimise flame propagation potential. • Timber paling fencing should not be used. • Colorbond or masonry fencing is also acceptable. The use of such fencing materials offers benefits in terms of reducing the opportunity for fire to propagate along the fence line.

Item	Issue	Recommended bushfire management measures
Bushfire awareness	Loss and / or damage to life and property	• It is the responsibility of the owner of, or person occupying a building in Queensland, to ensure the safety of any person in that building in the event of a fire. • Planning ahead of any perceived bushfire event is essential, and understanding what to do in the event of bushfire emergency is critical. Thus, prior knowledge as to the steps to take during the lead up to a fire event, during the passage of bushfire and what to do immediately after the fire front has passed is also critical. • The Queensland Fire and Emergency Services has developed a 'Fire Safety Management Tool' and associated Advisory Notes, comprising a series of checklists to assist owners/occupiers in managing their compliance with *Fire and Emergency Services Act 1990* and the *Building Fire Safety Regulation 2008*. This management tool (Appendix 1) provides a series of checklists to ensure that fire safety installations are compliant with relevant legislation. • The Rural Fire Service Queensland (RFSQ) 'Bushfire Survival Plan' (Appendix 2) provides detailed information on how to prepare for the bushfire season and how to take action to survive in the event of bushfire. • RFSQ have also produced a 'Rural Property Fire Management Guide' (Appendix 3) to assist landowners in protecting their rural properties from the threat of bushfire. • Be prepared to evacuate the site if necessary.

5.0 Conclusions and Recommendations

This report considers the vegetation and bushfire management requirements for the proposed subdivision of Lot 35 on SP285391, 229-237 German Street, Norman Gardens from one lot into two four. Based on observations during the site inspection and from analysis a range of pathways forward and bushfire mitigation measures have been identified as follows:

- A 10m setback as outlined in the Rockhampton 2005 Planning Scheme Bushfire Risk Minimisation Code is not applied because all vegetation with any bushfire hazard is located upslope at significant gradients (approximately 30-50%). This greatly minimises bushfire risk.
- Instead a 6m minimum setback is provided to significant vegetation located upslope and to the north-east of the proposed rear boundary of Lot 1, Lot 3 and Lot 4. This is in accordance with the Australian Standard AS3959 Construction of buildings in bushfire-prone areas.
- All structures built immediately adjacent to the setback zone must be constructed to BAL-40 requirements.
- Increasing distance of buildings from the upslope vegetation to the north-east of the development site will allow less strict construction standards to be applied. Distance thresholds from this vegetation are outlined in Table 9.
- Roads must be maintained and kept clear to allow rapid egress from the subdivision
- Reticulated water supply should have a supply rate of 15L/sec as a minimum
- Suitable fittings must be installed at all static water sources to allow for replenishment of fire-fighting tankers and connection of fire-fighting hoses.
- Fire-fighting infrastructure and equipment must be maintained and tested in accordance with obligatory requirements.
- Landscaping must be designed and maintained in accordance with the recommendations of this Bushfire Management Plan. The setback zone should be kept clear of overhanging branches and large vegetation at all times.
- Land owners / occupiers should prepare a personal bushfire safety plan so they know how to respond quickly and safely in the event of a bushfire.
- If reticulated water is not supplied a minimum of 20,000L of water must be readily available at all times for the purposes of fire-fighting. Suitable fittings must be installed at all static water sources to allow for replenishment of fire-fighting tankers and connection of fire-fighting hoses.

In addition, it is significant to note that bushfire remains a natural process of the Australian bush and it remains subject to a range of contributing factors which are variable almost on a daily basis. It is extremely difficult to predict the behaviour and intensity of a fire event at any given time. On this basis, it remains of the upmost importance that residents within identified bushfire prone areas obtain knowledge and remain aware of their options in the event of a bushfire to ensure the preservation of both life and property.

6.0 References

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Management and mitigation measures

As it has been identified that the proposed development is subject to bushfire hazards, the following management and mitigation measures have been included to ensure that the risk is reduced to an acceptable or tolerable level. These have been described in accordance with the Bushfire Hazard Overlay Code (RRPS 2015), AS 3959-2009 and SPP Bushfire Hazard Model Code provisions. Bushfire protection measures have also been adapted from *Planning for bushfire protection: a guide for councils, planners, fire authorities and developers* developed by the Rural Fire Service (2017a).

Separation from bushfire hazard areas

It is important to note that wildfires can break out at any time, however within Queensland, weather supporting critical fire hazard periods occur from late winter to early summer (Department of National Parks, Sport and Racing). As such, it is important to undertake management measures to reduce the risk of fire to assets. The Asset Protection Zone (APZ) is an area surrounding an asset, such as a building, that is managed to reduce bushfire hazard to an acceptable or tolerable level to mitigate the risk of life and property. The APZ can be separated into two management zones:

- Inner 10 m - Fuel Free Inner Zone (FFIZ); and
- Fuel Reduced Outer Zone (FROZ) (refer to Figure 1 and Figure 2).

For the development to achieve BAL-40 (refer to Table 2: BHA – Response to IR (E2M 2018)), the edge of any proposed asset must be setback 4 m from hazardous vegetation. This is less than the recommended inner 10 m of the APZ and as such a FROZ is deemed unnecessary (refer to Figure 1 and Figure 2).

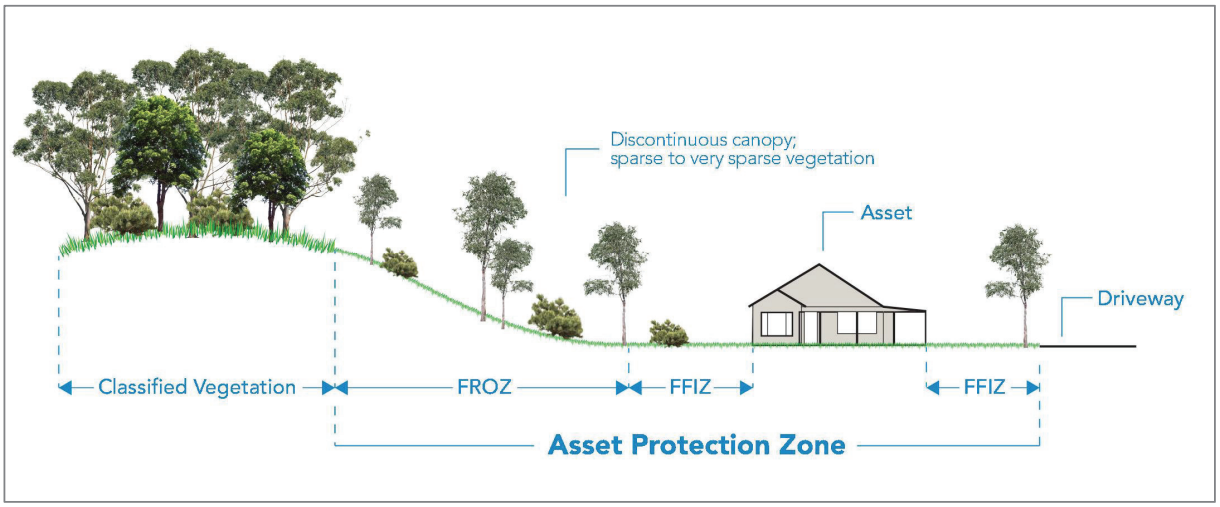


Figure 1: Asset Protection Zone

ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/39-2017

Dated: 30 October 2018

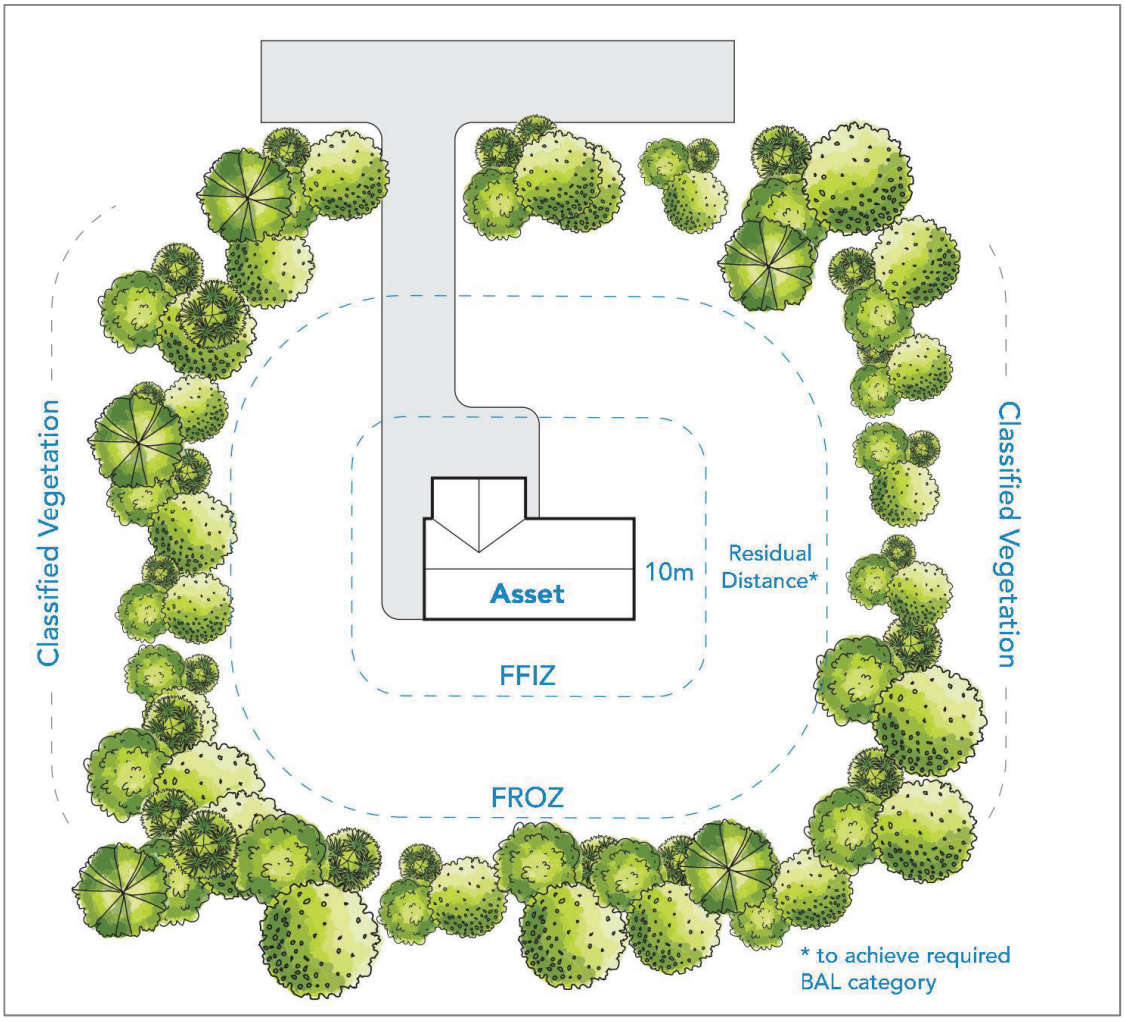


Figure 2: Requirements for Asset Protection Zones

Fuel Free Inner Zone

The FFIZ is known as the defendable space, which serves as an area immediately surrounding an asset where vegetation is modified and maintained to ensure a low fuel state. This reduces the effects of direct flame contact, fuel continuity and radiant heat associated with a bushfire. The area should be free of combustible items and obstructions.

The FFIZ should be regularly maintained to prevent the build-up of fuels. Examples of fuel control include:

- Raking or manual removal of leaf litter and bark (i.e. fine fuels).
- Mowing or slashing grass (including removal of cuttings).
- Removal or pruning of trees, shrubs and the understorey to ensure that:
  - vegetation is not located in front of vulnerable sections of the asset(s) such as window features; and
  - canopies do not overhang the asset(s).

If landscaping is proposed, the abovementioned management strategies are to be implemented.

Construction standards

The outcomes of the BAL assessment identified buildings within the development footprint are exposed to BAL-40, BAL-29, BAL-19 or BAL-12.5 (refer to Appendix 1). As such, buildings are required to be constructed in accordance with the relevant sections of AS 3959-2009. This includes Section 8, Section 7, Section 6 and Section 5 for BAL-40, BAL-29, BAL-19 and BAL-12.5 respectively. BAL-LOW identifies that there is insufficient bushfire hazard risk to warrant specific construction requirements.

Reduction in construction requirements for the next lower BAL may be applied due to shielding provisions. An elevation of the building where the elevation is not directly exposed to the source of bushfire attack (i.e. all straight lines between that elevation and the source of the bushfire attack are obstructed by another part of the building) (Figure 3Figure *3*). Shielding provisions may not be less than that required for BAL- 12.5, except where exposed elevations have been determined as BAL-LOW.

In addition to AS 3959-2009 construction standards, it should be ensured that gas and electricity utilities do not contribute to fire hazard risk or impede upon fire-fighting efforts. That is, the location or design of these services should not result in the potential ignition of vegetation or buildings (catalyst to combustion). Where practicable, electrical transmission and gas lines are to be located underground and metal piping should exclusively be used. If the use of reticulated or bottled gas is proposed, these should be installed and maintained in accordance with Australian / New Zealand Standard (AS/NZS) 1596:2014, shielded from any classified vegetation, kept clear of flammable materials and the safety valves should be directed away from the building.

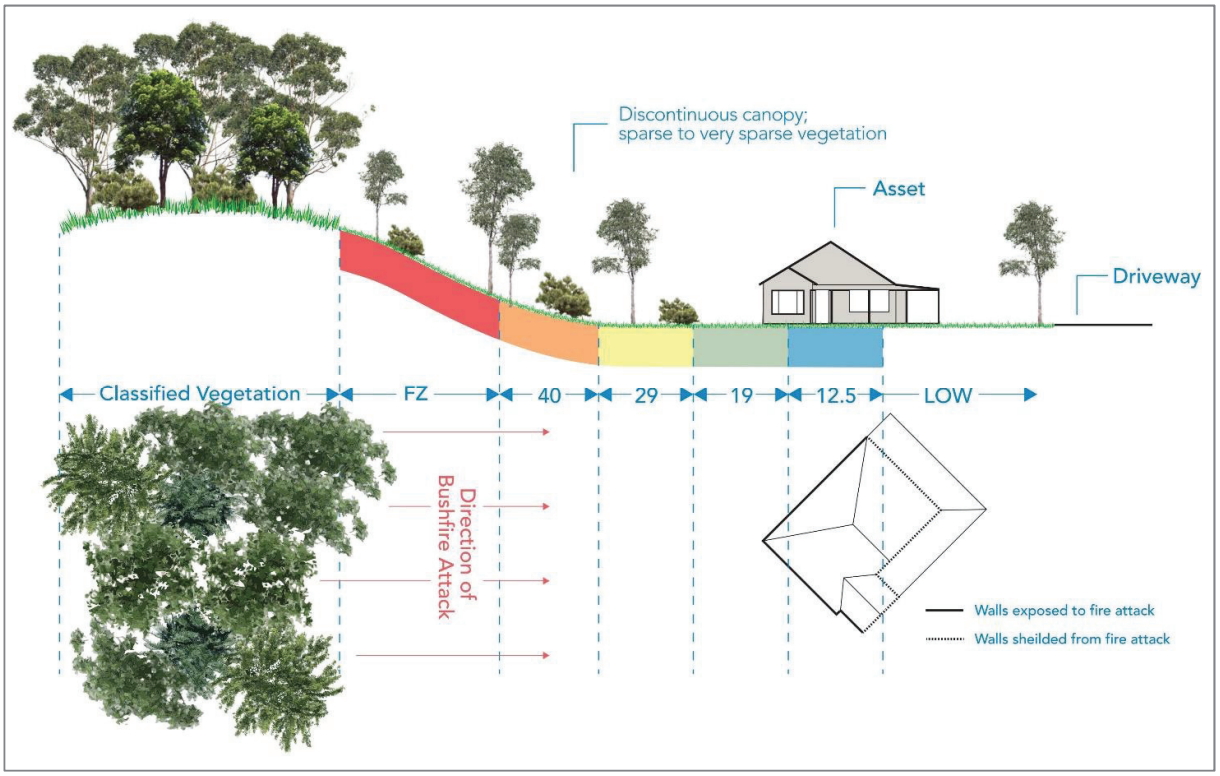


Figure 3: Bushfire Attack Level buffers and shielding provisions

Access Roads

Access roads are to be developed in consideration of the following:

- Bushfire Hazard Overlay Code (RRPS 2015)
- Road Planning and Design Manual (2nd Edition, Department of Transport and Mainroads, July 2013); and
- Capricorn Municipal Development Guidelines – Geometric Road Design (Issue: NO:8-May 2018)

Access roads are to be developed to allow for the safe and efficient access and egress of emergency services and evacuating residents. The maintenance and availability of the proposed access roads or fire maintenance trails must be ongoing. For example, overhanging vegetation should be trimmed back, gate access should be unrestricted, the capacity of road surfaces and any bridge / causeways need to be sufficient to support firefighting vehicles, roads are to be all-weather graded and two-wheel drive accessible (Rural Fire Service 2017b).

Bushfire easement

The Environmental and Bushfire Review and associated recommendations (VSQ, rev. A, dated 09/02/17) determined The development is not of sufficient scale to provide firebreaks and proposed a 6 m setback be applied to the development to achieve BAL-40 (Method 1). However, the results of the Method 2 assessment determined a minimum APZ of 4 m to achieve BAL-40 (refer to Appendix 1). As such, a minimum 4 m easement along the north-eastern, south-eastern and north-western boundary is required to achieve BAL-40 and can function as a fire break if needed. The easement should be maintained as a fuel-free zone to protect buildings / structures from bushfire attack.

Fire-fighting requirements

In addition to the abovementioned access and egress requirements, adequate infrastructure to support fire-fighting must be provided. This includes the provision of an adequate water supply and fire hydrants as specified within the Bushfire Hazard Overlay Code (RRPS 2015). Examples of fire-fighting requirements include:

- this site is on reticulated water supply and this will be sufficient to provide water supply for fire-fighting purposes.
- unhindered access to a fire-fighting water supply which must be located away from classified vegetation and hazardous materials (e.g. gas bottles).
- if water tanks are to be installed they will not be constructed of any material which may fail when exposed to excessive heat (i.e. plastic). Water tanks should be located on the side of the building which is furthermost away from the hazard source or appropriately shielded. Underground and above-ground tanks need to incorporate relevant access holes and outlet pipes which meet standard rural fire brigade fitting requirements. Above-ground tanks must be manufactured using either concrete or metal and metal piping should exclusively be used.
- a suitable connection for firefighting purposes should be made available at all onsite static water sources. It is recommended that Queensland Rural Fire Services be consulted during the planning and design stages to ensure adequate infrastructure is included in the development to ensure appropriate fittings and connections are included.
- a fire extinguisher/s should be installed in the dwelling and as required in plant and equipment. All extinguishers must be maintained in good working order as per regulations.

- a long hose/s should be readily available outside the dwelling with appropriate fittings / connections to allow for rapid response in the event of a bushfire. Hoses should be long enough to reach all external areas of the building/s.
- fire alarms must be installed in the dwelling as per regulations.
- it is strongly recommended that additional fire-fighting apparatus, such as fire blankets, also be stored inside the dwelling and readily available for use in the event of a fire.
- regularly check that all fire-fighting equipment is operational and in good working order.
- if required, fire hydrant design, spacing, sizing, flow and pressure is to be in accordance with the requirements of AS 2419.1:2005 and Queensland Urban Utilities standards.
- fire hydrants must be located clear of parking areas / bay allocations / road carriageways.

Landscaping and rehabilitation

Landscaping and rehabilitation is to be guided by the requirements of the management and mitigation strategies provided, with particular regard to the APZ. Appropriately managed, retained and planted vegetation can provide many benefits in bushfire prone areas including a reduction in fire intensity, wind speed, deflection and filtering of embers and sheltering from radiant heat. Conversely, improper management, landscaping or rehabilitation could increase the risk of asset damage or loss from a bushfire event.

In addition to the fuel management examples listed in previous sections of management and mitigation measures, the following fuel management strategies should be considered when developing a landscaping and/or rehabilitation plan:

- Avoidance of plants that are combustible or produce fine fuels (e.g. trees with fibrous or paper bark, produce ribbon bark, leaves with a high oil content, plants with fine foliage or branches (thickness ~1-2 mm) etc.)
- Ensure that vegetation placement is not located directly against an asset or near vulnerable sections such as window features, doors or decks.
- Ensure that vegetation is discontinuous vertically and horizontally. For example:
  - Vegetation should be planted/ retained in groups or islands which are to be broken up by design features such as paths or maintained lawns.
  - Minimise the retention or planting of shrubs beneath trees so to restrict the laddering of fire from ground fuels to the canopy.
- All materials against and around the asset(s) should be non-combustible.
- Ground covers should incorporate the use of succulents or herbaceous plants that are shade- or drought-tolerant perennials which maintain a high moisture content and have a low-growing habit.
- Use of shade-tolerant evergreen shrubs that have a moderately dense habit and retain little dead leaves or branches.
- Ensure that environmental or noxious weeds are actively managed and removed from the site.
- Development of a maintenance schedule which incorporates maintenance periods prior to and during the fire season (i.e. late winter to early summer).

Fencing

Fencing materials can have a considerable impact on the propagation of fire. Likewise, some fencing materials can alleviate exposure to radiant heat.

For this site, if fencing is to be erected, it is recommended that:

- rural mesh fencing (with either a metal or timber frame) be used to minimise flame propagation potential.
- Timber paling fencing should not be used
- Colorbond or masonry fencing is also acceptable. The use of such fencing materials offers benefits in terms of reducing the opportunity for fire to propagate along the fence line.

Bushfire awareness

Planning ahead of any perceived bushfire event is essential, and understanding what to do in the event of bushfire emergency is critical. Thus, prior knowledge as to the steps to take during the lead up to a fire event, during the passage of bushfire and what to do immediately after the fire front has passed is also critical.

The Queensland Fire and Rescue Service promote public involvement in bushfire hazard mitigation under a strategy called *PREPARE-ACT-SURVIVE*.

The service promotes preparing for bushfire by preparing a Bushfire Survival Plan, which can be downloaded from: http://www.ruralfire.qld.gov.au. Considerations for preparing for bushfire include but are not limited to:

- Ensuring family members understand the dangers of bushfire
- Ensure family know how to action the recommended Bushfire Survival Plan
- Ensure appropriate insurance for household and vehicles
- Consider items you will take with you if you need to evacuate; and
- Consider how to deal with pets.

It is recommended that future residents prepare a Bushfire Survival Plan for their property, incorporating recommendations made in this report. In addition, a copy of this report is to be provided to future purchasers of the property.

Assumptions and Limitations

The following assumptions and limitations have been made in compiling this assessment:

- Areas of vegetation assumed to be cleared or managed in a low-fuel state must be treated in this way in perpetuity (refer to Table 2 Method 2 BAL assessment: BHA – Response to IR, E2M 2018)
- Any Vegetation Management Plans, Rehabilitation Management Plans and proposed landscaping treatments will adhere to the requirements of the Environmental and Bushfire Review and associated recommendations (VSQ, rev. A, dated 09/02/17); and
- It is not the role of a Bushfire Planning and Design consultant to approve or make determinations on whether a building plan complies with AS 3959-2009 or BCA. This is the responsibility of the building certifier.

This assessment has been made based on bushfire hazards within and adjacent to the site as per the Environmental and Bushfire Review and associated recommendations (VSQ, rev. A, dated 09/02/17).

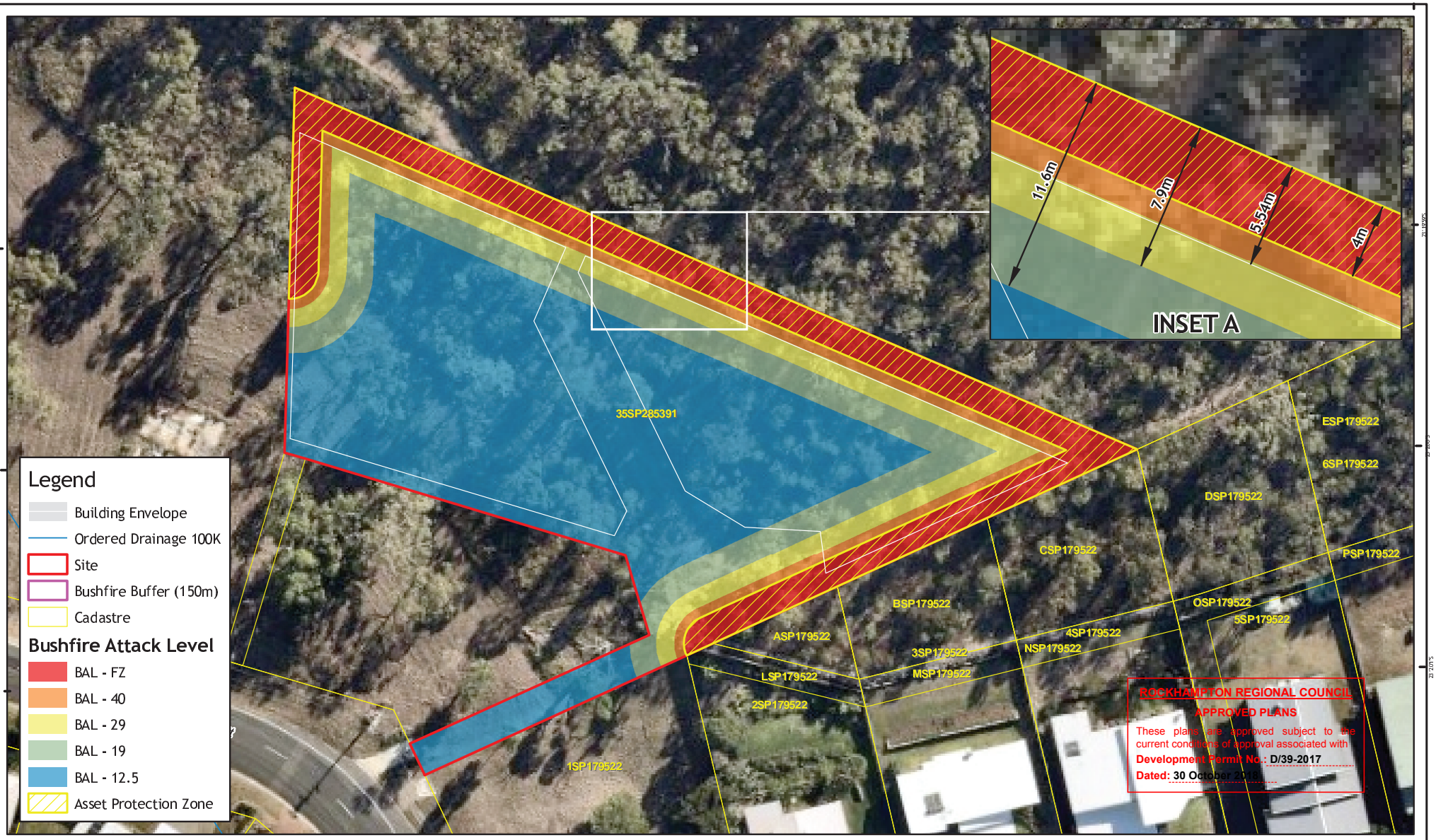
The recommendations provided within this response incorporate appropriate actions to reduce the potential risk to life and risk of damage and/or harm to property in the event of a bushfire on or near the proposed development. However, these recommendations do not and cannot guarantee that the area will not be affected by bushfire.

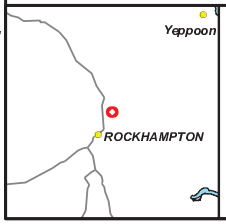
Kind regards

Chris Beavon
Director / Senior Ecologist and Bushfire Consultant
BPAD-40399

BPAD Bushfire Planning & Design Accredited Practitioner Level 1

Appendix A Bushfire Attack Level and Asset Protection Zone figure





N

Scale 1:700 (A4)

0 10 20

Metres

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator

Notes:
Aerial Imagery: © Nearmap 2018
Cadastre: © DNRME 2018
Ordered Drainage: © DNRME 2018
Road: © PSMA 2014

Rev	Description	Drawn	Approved	Date
A	Issued for Review	CD	CB	21/09/2018

FIGURE 4: BUSHFIRE ATTACK LEVEL AND ASSET PROTECTION ZONE

Bushfire Advice
229-237 German Street, Rockhampton

Map Number	Job Number	Rev
1 of 1	QEJ18084	A

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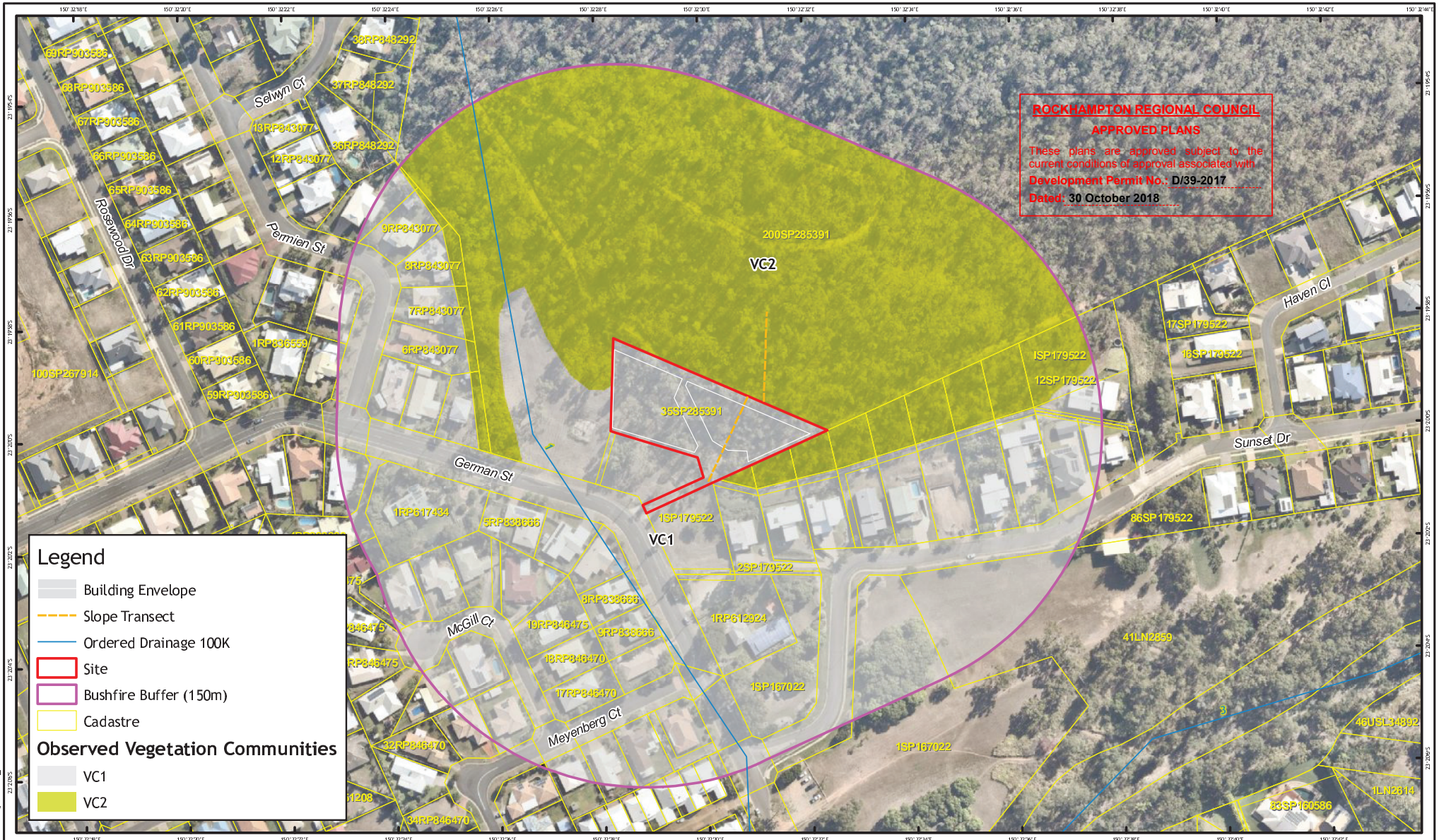

Notes:
Aerial Imagery: © Nearmap 2018
Cadastre: © DNRME 2018
Ordered Drainage: © DNRME 2018
Road: © PSMA 2014

Rev	Description	Drawn	Approved	Date
A	Issued for Review	CD	CB	02/07/2018

FIGURE 2: OBSERVED VEGETATION COMMUNITIES

Bushfire Advice
229-237 German Street, Rockhampton

Map Number	Job Number	Rev
1 of 1	QEJ18084	A

Document Path: X:\JOBS\2018\QEJ18084\GIS\QEJ18084_VHC.mxd