Proposed Subdivision - Preliminary Geotechnical Assessment

Lochinvar Ridge, Stages 8 to 14
Lots 2 & 3 DP1256730,
70 Christopher Road, Lochinvar

NEW17P-0034A-AF.Rev2
21 October 2021

Qualtest
LABORATORY (NSW) PTY LTD

GEOTECHNICAL I LABORATORY I EARTHWORKS I QUARRY I CONSTRUCTION MATERIAL TESTING

21 October 2021

Barker Ryan Stewart
Unit 1, 17 Babilla Close
BERESFIELD NSW 2322

Attention: Ms Hope O'Dea

Dear Hope,

RE: PROPOSED RESIDENTIAL SUBDIVISION - LOCHINVAR RIDGE, STAGES 8 TO 14 LOTS 2 & 3, DP1256730, 70 CHRISTOPHER ROAD, LOCHINVAR, NSW PRELIMINARY GEOTECHNICAL ASSESSMENT

Please find enclosed our Preliminary Geotechnical Assessment report for the proposed residential subdivision of Lochinvar Ridge, Stages 8 to 14, located at Lots 2 & 3, DP1256730, 70 Christopher Road, Lochinvar.

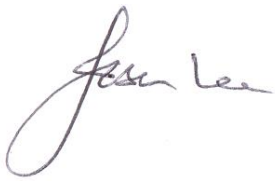
It is understood that development consent has already been issued for Stage 1 to 7 of the proposed subdivision under a separate Development Application (DA), and Stages 15 to 18 will be assessed at a later date. Stages 1 to 7 and Stages 15 to 18 are not included in this report. The purpose of the Preliminary Geotechnical Assessment is to support a Development Application (DA) submission to Maitland City Council for Stages 8 to 14.

The report includes preliminary recommendations for suitability of the site for development from a geotechnical perspective including assessment of the risk of slope instability and associated geotechnical constraints.

Additional detailed geotechnical investigation work will be required for design purposes at a later stage, including site classification for footings and pavement design for subdivision roads.

If you have any questions regarding this report, please do not hesitate to contact Shannon Kelly or the undersigned.

For and on behalf of Qualtest Laboratory (NSW) Pty Ltd



Jason Lee
Principal Geotechnical Engineer

Table of Contents:

Attachments:

Figures: Figure AF1.Rev2: Site Location & Approximate test Locations

Overall Master Plan (ref: Plan No: 196344, File Ref: 14/46, Sheet No: 1 to 3, Issue: M, dated: 18/10/21, by Barker Ryan Stewart)

Appendix A: Results of Field Investigations

Appendix B: Results of Laboratory Testing

Appendix C: AGS 2007 Excerpts

1.0 Introduction

Qualtest Laboratory NSW Pty Ltd (Qualtest) is pleased to present this report to Barker Ryan Stewart (BRS) for Stages 8 to 14 of the proposed Lochinvar Ridge residential subdivision to be located at Lots 2 & 3, DP1256730, 70 Christopher Road, Lochinvar.

Qualtest previously completed a Preliminary Geotechnical Assessment (PGA, ref. NEW17P-0034-AA, 3 May 2017), which included the current site as well as additional lots to the north (Stages 1 to 7) and to the southwest (Stages 15 to 18).

It is understood that development consent has already been issued for Stage 1 to 7 under a separate DA, and Stages 15 to 18 will be assessed at a later date. Stages 1 to 7 and Stages 15 to 18 are not included in this report.

BRS has requested updated geotechnical assessment to satisfy Maitland City Council's requirements to accompany the DA for Stages 8 to 14.

This report is based upon the previous PGA report by Qualtest, which has been reviewed and modified based upon an amended 'Overall Master Plan' (ref: Plan No: 196344, File Ref: 14/46, Sheet No: 1 to 3, Issue: M, dated: 18/10/21, by Barker Ryan Stewart) provided by BRS in an email dated 19 October 2021, recent experience on nearby developments including Stages 1 to 7 of this subdivision, and results of an additional site walkover.

Based on the brief and amended subdivision plan from BRS, the proposed Stages 8 to 14 development is understood to comprise subdivision into approximately 304 residential lots, drainage reserves, parks and construction of associated internal subdivision roads.

The objectives of the work were to provide recommendations on the following:

- Risk of slope instability and associated geotechnical constraints;
- Suitability of the site for development from a geotechnical perspective.

This report presents the results of the field work investigations, laboratory testing, and provides recommendations for the scope outlined above.

2.0 Scope of Work

In order to meet the objective, the following scope of work was carried out:

- Desktop study, including:
    - Review of Regional Geology Maps, Acid Sulfate Soil Risk Map and Department of Soil Conservation Soil Landscape Maps and Publications;
    - Review of a previous Phase 1 and 2 Contamination Assessment report by Coffey Environments Australia Pty Ltd (Coffey), report reference ENAUWARA04581AA-R01, dated 4 February 2015.
- Field and laboratory investigations, including:
    - Site walkover and field mapping of surface features;
    - Drilling of three hand auger boreholes and Dynamic Cone Penetrometer (DCP) tests;
    - Laboratory testing of two samples for Emerson Dispersion tests;
- Engineering analysis and reporting.

3.0 Desktop Study

3.1 Geology and Acid Sulfate Soil Risk Maps

Reference to the 1:100,000 Cessnock Regional Geology Series Sheet 9132 indicates the site to be underlain by the "Lochinvar" Formation of the "Dalwood" Group, which is characterised by lithic feldspathic sandstone, siltstone, shale, tuff, basalt flows and erratics.

The 1:25,000 Greta Acid Sulfate Soil Risk Map shows the site is located in an area of no known occurrence of Acid Sulfate Soils.

3.2 Previous Phase 1 and 2 Contamination Assessment Report

Coffey carried out a Phase 1 and 2 Contamination Assessment for Lot 2 DP 718712 and Lot 32 DP 1132263. Lot 2 DP 718712 is not included in the current preliminary geotechnical assessment and is surrounded by Lot 32 DP 1132263 to the north, east and south.

The assessment comprised:

- A desktop study and historical review of past activities at the site with the potential to cause contamination;
- An assessment of the site topography, geology and hydrogeology;
- Collection of 11 surface soil samples, three sediment samples and three surface water samples;
- Laboratory analysis of the soil, sediment and surface water samples for metals, hydrocarbons, herbicides and pesticides;
- Preparation of a Phase 1 and 2 Contamination Assessment report.

An addendum to the Phase 1 and 2 Contamination Assessment by Coffey has been prepared concurrently to this updated PGA by Qualtest (ref. NEW17P-0034-AE.Rev2, October 2021). Reference should be made to those reports for further details.

4.0 Field Work

The field work investigations were carried out carried on 21 March 2017 and comprised of:

- DBYD search of the site area was undertaken to clear proposed test locations for the presence of underground services;
- Site walkover to make observations of surface features at the property and in the immediate surrounding area;
- The drilling of three boreholes, (BH03 to BH05), using hand auger methods to depths of 0.5m to 0.7m to assess subsurface profiles;
- Dynamic Cone Penetrometer (DCP) tests were undertaken adjacent to the borehole locations (DCP3 to DCP5) to assist in the interpretation of the in-situ consistency of the soil and assess conditions below the depth of termination of the boreholes;
- Collection of disturbed samples from the boreholes considered representative of site conditions for subsequent laboratory testing.

Investigations were carried out by an experienced Geotechnical Engineer from Qualtest who located the boreholes and DCP tests, carried out the testing and sampling, produced field logs of the boreholes, and made observations of the site surface conditions.

Boreholes and DCP tests were located in the field by handheld GPS and relative to existing site features including topographic features, lot boundaries, existing developments and trees.

Engineering logs of the boreholes and DCP test results are presented in Appendix A.

Approximate borehole and DCP test locations are shown on the attached Figure AF1.Rev2.

The site was revisited on 26 February 2021 by an experienced Senior Geotechnical Engineer from Qualtest who carried out site walkover to make observations of surface features at the property and in the immediate surrounding area.

Barker Ryan Stewart, Drawings Sheets 1 to 3 titled 'Overall Master Plan', showing the proposed subdivision and lot layout are also attached for reference.

5.0 Site Description

5.1 Surface Conditions

The site of proposed Stages 8 to 14 comprises Lots 2 & 3, DP1256730, respectively known as No. 799 New England Highway, and No. 70 Christopher Road, Lochinvar. The site comprises an irregular shape with a total plan area of about 38 ha, approximately 0.6km long by 0.7km wide at its widest and longest points, as shown on the attached figures. Dams/ponds and fill mounds shown on Figure AF1.Rev2 are labelled for consistency with the preliminary contamination assessment.

The site is bounded to the south by proposed future Stages 15 to 18 of the subdivision, currently comprising bushlands and open fields, to the east and west by lightly trafficked rural roads and lots containing low density rural-residential housing, and to the north by recently subdivided residential allotments, low density rural-residential housing and the proposed Stages 1 to 7 of the subdivision.

The site is located within a region of gently undulating topography, on undulating local hills / spurs intersected by three main creek tributaries / drainage depressions. The depressions generally drain towards the northwest roughly in line with the farm dams / ponds shown on Figure AF1.Rev1, then draining towards the north into Lochinvar Creek. Some flows from the eastern parts of the site are likely to divert towards Stony Creek which flows to the east.

With reference to the Spatial Information Exchange maps, and subdivisions plans by PCB, ground levels are understood range from about RL40m (AHD) at the locations where the western two creeks / drainage depressions exit the western boundaries of the site, up to about RL70m near the eastern boundary of the site.

The site generally slopes towards the tributaries connecting the dams / ponds. Surface slopes are typically in the order of between 2° and 6°, with some locally steeper slopes on the edges of dams, mounds and locally steeper areas on the edges of drainage depressions.

There are multiple farm dams located across the site. Dam 1 is located on the tributary in the north-eastern portion of the site; Ponds 1 and 4 are located on the central tributary.

The majority of the site is undeveloped. The site is divided into several paddocks by timber post and wire fencing.

There are several stockpiles of fill scattered across the site, which may be associated with the excavation of the nearby dams and underground service routes. There is evidence of recent soil disturbance due to a pipeline installation, running in an east-west direction north of Dam 1. Two stockpiles of fill from the excavation of the pipeline trench were observed adjacent to the pipeline.

Vegetation generally comprises of moderate grass cover and some scattered trees, as shown on Figure AF1.Rev2. An area of lighter coloured and longer grass was observed in the central part of the site, near the dams.

The site was judged to have good trafficability by way of 4WD vehicle on the day of the field investigation. The site was generally judged to be moderately drained mostly by way of surface runoff and infiltration into the near surface soils. Some water was ponded at the low points in drainage depressions, and an area of wet/boggy ground was observed in the northern area possibly associated with concentrated runoff from the adjacent residence and shed.

Photographs of the site taken on 26 February 2021 during the site walkover and mapping by Qualtest Senior Geotechnical Engineer are shown below.

Photograph 1: From northern portion of site (proposed Stage 8) facing south.

Photograph 2: From northern portion of site (proposed Stage 8) facing southwest.

Photograph 3: From northern portion of site (north of Dam 1) facing southeast.

Photograph 4: From northern portion of site (north of Dam 1) facing south.

Photograph 5: From eastern portion of site (near south-western corner of Lot 261 DP 564455) facing northwest.

Photograph 6: From eastern portion of site (near south-western corner of Lot 261 DP 564455) facing north.

Photograph 7: From south-eastern portion of site (near northern boundary of Lot 312 DP 1135580) facing northwest.

Photograph 8: From south-eastern portion of site (near northern boundary of Lot 312 DP 1135580) facing north.

Photograph 9: From southern portion of site (near north-western boundary of Lot 312 DP 1135580) facing north.

Photograph 10: From southern portion of site (near north-western boundary of Lot 312 DP 1135580) facing northeast.

Photograph 11: Facing northwest towards Pond 1.

Photograph 12: Facing south from western edge of Pond 1.

Photograph 13: From northwest of Pond 1 facing northwest. Visible gully erosion and areas of ponded water in drainage depression.

Photograph 14: From northwest of Pond 1 facing southeast towards Pond 1.

Photograph 15: From north-western portion of site (near SP1) facing west.

Photograph 16: From north-western portion of site (near SP1) facing south.

Photograph 17: From north-western portion of site, facing northeast towards SP2.

Photograph 18: From northern portion of site (proposed Stage 8) facing north towards area of wet/boggy ground.

5.2 Subsurface Conditions

The typical soil types encountered at the borehole locations during the field investigation have been divided into geotechnical units as summarised in Table 1.

Table 2 contains a summary of the distribution of the geotechnical units at borehole locations.

TABLE 1 – SUMMARY OF GEOTECHNICAL UNITS AND SOIL TYPES

Unit	Soil Type	Description
1	FILL	No fill was observed in the boreholes. The approximate locations of fill stockpiles observed during the current field investigation are shown on Figure AF1.
2	TOPSOIL	Sandy CLAY / CLAY – medium plasticity, brown to dark brown, fine to medium grained sand, firm to stiff. Root affected.
3	SLOPEWASH	CLAY – medium plasticity, brown, fine to medium grained sand stiff to very stiff consistency.
4	COLLUVIUM	Sandy CLAY / CLAY – medium plasticity, brown, fine to medium sand, stiff to very stiff consistency.
5	RESIDUAL SOIL	Sandy CLAY / CLAY – medium to high plasticity, brown to yellow-brown, fine to medium sand, stiff to very stiff consistency.

TABLE 2 – SUMMARY OF GEOTECHNICAL UNITS ENCOUNTERED AT EACH BOREHOLE LOCATION

Location	Unit 1 Fill	Unit 2 Topsoil	Unit 3 Slopewash	Unit 4 Colluvium	Unit 5 Residual
	Depth (metres)				
BH03	-	0.0 - 0.2	-	-	0.2 - 0.7*
BH04	-	0.0 - 0.1	0.1 - 0.6	-	0.6 - 0.7*
BH05	-	0.0 - 0.2	-	-	0.2 - 0.5*
Note:	** Borehole terminated due to slow progress of the hand auger.*				

The DCP tests DCP3, DCP4 and DCP5 were terminated at depths of 1.50m, 0.90m, and 0.75m respectively due to the high blow counts and practical refusal "hammer bouncing", indicating extremely weathered rock, a large rock floater or underlying bedrock.

No groundwater was observed in any of the hand auger boreholes during the limited time that they remained open on the day of the investigation.

It should be noted that groundwater conditions can vary due to rainfall and other influences including regional groundwater flow, temperature, permeability, recharge areas, surface condition, and subsoil drainage.

6.0 Laboratory Testing

Samples collected during the field investigations were returned to our NATA accredited Warabrook Laboratory for testing which comprised two Emerson Crumb tests. Results of the testing are presented in Appendix B, with a summary of the results presented in Table 3

TABLE 3 – SUMMARY OR LABORATORY TESTING RESULTS

Location	Depth (m)	Material Description	Emerson Number
BH04	0.60 - 0.70	(CI) Sandy CLAY	4
BH05	0.30 – 0.40	(CI) Sandy CLAY	4

Results of the laboratory testing indicate that the site soils to have an Emerson Class 4, which can generally be described as having the following properties:

- Is susceptible to slaking (breaking up upon absorbing water from oven-dried condition);
- Will not disperse (allow the clay fraction of the soil to dissolve) when submerged in water;
- Contains calcite or gypsum.

Based on the results of fieldwork and laboratory testing, it is assessed that levels of soil erosion should be able to be maintained within normally acceptable levels by adopting good soil erosion and sedimentation control practices, including:

- Minimise the area and duration of soil exposure by staged development and controlled clearing;
- Stockpile stripped soil for reuse and protect from erosion;
- Control storm water run-off by diverting clean run-off from denuded areas, minimising slope gradient, length and run-off velocities;
- Trap soil and water pollutants using silt traps, sediment basins, perimeter banks, silt fences and nutrient traps as appropriate;
- Re-vegetate as soon as is practicable.

7.0 Discussion and Recommendations

7.1 General

The site is considered suitable for the proposed development from a geotechnical viewpoint provided that development is carried out in accordance with sound engineering principles and good hillside practice (as set out in Appendix C), and with respect to the constraints and recommendations of this report, including geotechnical input during the design and construction phases.

Based upon the limited site testing and observations carried out during this preliminary assessment, geotechnical issues affecting site capability for the proposed development identified at the site include the presence of drainage depressions, farm dams and other localised wet/boggy areas. These areas may be affected by abnormal moisture conditions associated with prolonged wet conditions, and possibly layers of inadequate bearing capacity. It is recommended that these potential issues are addressed during earthworks prior to filling and footing construction.

Further geotechnical investigation and/or advice should be carried out during detailed design phase including for site classification, earthworks procedures, footing/retention design conditions and pavement design where required.

7.2 Slope Stability and Recommended Geotechnical Constraints

7.2.1 Basis of Assessment

The risk of slope instability has been assessed from the observed site conditions using methods consistent with those presented in the Australian Geomechanics Society (AGS) publication "*Practice Note Guidelines for Landslide Risk Management, 2007*". Based on those methods, the risks to property associated with slope instability on the subject area have been assessed using the terms presented in AGS 2007, *Landslide Risk Assessment Qualitative Terminology for Use in Assessing Risk to Property*, extracts of which are attached in Appendix C.

The report provides an assessment of the risk of slope instability on the proposed development area. The report also recommends some geotechnical constraints for the site development in light of the slope instability assessment. The assessed risk to the proposed development is based on the geotechnical constraints and recommendations provided in this report being implemented. The onus is on the owner, potential owner, or interested party to decide whether the assessed level of risk is acceptable taking into account the likely consequences of the risk and the recommended geotechnical constraints.

7.2.2 Principal Site Features and Evidence of Instability

The assessment of the risk of slope instability has been based on the site observations recorded in Section 3 and the principal site features summarised below:

- Site situated in an area of gently undulating topography, across a series of gently rounded hill forms with relatively low relief;
- Ground surface slopes are generally in the order of about 2° to 6° across the majority of the site, with localised steeper slopes up to about 10° to 15° near the banks of gullies, and sloping dam embankments;
- Soil depths are assessed to generally be in the range of about 0.5m to 2.0m;
- Soil profile generally comprising topsoil to depths in the order of 0.2m, overlying slopewash, colluvium, and residual clay soils typically of stiff to very stiff consistency;
- The northern and western sections of the site drain to the north, while the eastern-most area of the site drains to the east;
- No evidence of seepage was observed and the site generally appeared moderately to well drained, mostly by way of downhill surface runoff. Some water was ponded at the low points of drainage depressions;
- No evidence of deep soil erosion was observed at the site at the time of the field work;
- No obvious evidence of overall slope instability or significant damage attributable to ground movement was observed on or in the vicinity of the site during the field work.

7.2.3 Hazard Identification

Elements at risk for the identified hazards are the proposed subdivision developments, which may include proposed residences, sheds, swimming pools, driveways and / or other site infrastructure.

The following hazards that could potentially impact on this site are assessed as follows:

H1. Potential broad deep seated instability;

H2. Potential shallow instability such as overloading of slopes by excessive loads, unsuitable batters/support or unsuitable founding depths, or failure of fill not placed in a proper manner or subject to erosion by concentrated surface flows.

H3. Potential shallow ground 'creep' movements or slumping.

7.2.4 Risk Evaluation for the Proposed Development

The matrix below evaluates the hazards outlined above and their likelihood of occurring based on the proposed development of the site, and assuming the geotechnical constraints and recommendations of this report are implemented. If these recommendations are not followed, the likelihood of hazards occurring may increase and the level of risk may change. Further advice should be sought where necessary.

Hazard	Location	Consequence	Likelihood	Risk
H1	Overall Site	Major	Rare	Low
H2	Overall Site	Major	Rare	Low
H3	Overall Site	Minor	Unlikely	Low

Based on the above, the proposed development is assessed as having a **"Low"** risk of slope instability.

It would be normal practice in the Maitland City Council local government area for development to proceed on a site with a risk level classification of Low.

Development should be carried out in accordance with sound engineering principles and good hillside practice (as set out in Appendix B), and the geotechnical constraints outlined in this report.

7.2.5 Recommended Geotechnical Constraints for Residential Development

Type of Structure:

There are no particular geotechnical constraints on the type of structures provided they are founded on footings designed and constructed in accordance with AS2870, '*Residential Slabs and Footings*'.

Area for Development:

All of the site is considered feasible for development from a slope stability viewpoint.

Development of the site should be undertaken in accordance with good hillside construction practice and sound engineering principles as presented in the excerpts from AGS 2007 provided in Appendix C.

Care should be taken in the design of any developments in the vicinity of any existing excavations, fill platforms, embankments, retaining walls and dams, particularly if they involve surcharge loads or excavations.

Foundation Type:

Strip / pad footings, pier and beam systems or split level raft slabs would be feasible from a slope stability viewpoint (broad raft slabs may not be suited to sloping areas of the site due to the slope modifications required).

Footings should not be founded within any existing uncontrolled fill. If uncontrolled fill is encountered, this will require piered foundations founded beneath the fill, removal of the fill, or removal and replacement of the fill to engineering specification.

Foundations should be designed and constructed in accordance with the recommendations and advice of AS2870, '*Residential Slabs and Footings*'.

Foundations near the crest of excavations should be taken to rock or founded behind or below a 1V:2H projection from the toe of the excavation.

Footings are to be founded outside of or below all zones of influence resulting from existing or future service trenches.

Excavations:

Excavations should be supported by properly designed and constructed retaining walls or else battered at 1V:2H or flatter and protected from erosion.

Excavations in competent bedrock (below the level of backhoe / excavator refusal) may be battered at 1V:1H.

Temporary excavations to depths of up to 1.2m in competent compact material with sufficient cohesion, such as clay of stiff consistency or better may be battered vertically, subject to inspection during excavation by the geotechnical authority.

The safe working procedures of Work Cover NSW Excavation work code of practice, dated January 2020 should be followed

Excavations should be designed for surcharge loading from slopes, retaining walls, structures and other improvements in the vicinity of the excavation.

Care should be taken not to disturb or destabilise existing underground services or structures. Excavations should remain outside a 1V:2H projection from the base of any structural footings.

Drainage measures should be implemented above and behind all temporary and permanent excavations to avoid concentrated water flows on the face of the cut or infiltration into the soil/rock profile behind the cut. Surface water flows from upslope areas should be diverted away from the cut face.

Filling:

The depth of unsupported fill on the site should preferably not exceed 1.5m and should be battered at 1V:2H or flatter and protected against erosion. All fill greater than 1.5m deep should preferably be supported by engineer designed retaining walls.

Where fill is to be placed on slopes in excess of 1V:8H (7°), a prepared surface should be benched or stepped into the slope.

Care should be taken during backfilling of any dams, gully areas or drainage depressions to reduce the risk of leaving a preferential underground drainage path which could result in softening of the surrounding area, piping erosion and/or localised seepage.

Potential effects of slope modifications on groundwater flowing from upslope should also be considered, with provision of subsurface drainage to intercept and redirect groundwater where assessed to be necessary. It is likely that excavation of over-wet material will be required prior to placement of fill in dams, gully areas or drainage depressions.

Earthworks should be carried out in accordance with the recommendations outlined in AS3798-2007 '*Guidelines for Earthworks for Commercial and Residential Developments*'.

It is recommended that existing fill on site in any areas of proposed settlement sensitive development be removed and replaced with approved clean materials. The placement of such fill should be witnessed and documented by a geotechnical authority, carried out to 'Level 1' criteria as defined in Clause 8.2 – Section 8, of AS3798-2007.

Geotechnical advice should be sought with regards to site preparation and fill construction procedures at the time of detailed geotechnical investigations and design.

Retaining Walls

All structural retaining walls and all landscaping walls in excess of 1.0m should be designed by an experienced engineer familiar with the site conditions.

All retaining walls should be designed for surcharge loading from slopes, structures and other existing/future improvements in the vicinity of the wall. Adequate subsurface and surface drainage should be provided behind all retaining walls.

Excavations for the construction of retaining walls result in a temporary reduction in the stability of the adjacent area particularly during wet weather until the wall is complete. This increased risk can be managed or reduced by appropriate construction planning, using temporary support, staged excavation and control of drainage.

Drainage and Sewage Disposal:

Adequate surface and storm water drainage should be installed and maintained on the site in accordance with local government requirements.

All collected stormwater run-off should be piped into the street / inter-allotment drainage system or discharged into existing storm water drains or watercourses in a controlled manner that limits erosion. Surface and sub-soil drains may be required to improve drainage. Septic wastes should be connected to the reticulated disposal system.

Other:

Inspection should be carried out by a geotechnical authority during construction to confirm the conditions assumed in this report and in the design.

Additional recommendations may be provided during further stages of the project.

7.3 Acid Sulfate Soils

Acid Sulfate Soils (ASS) are soils which contain significant amounts of pyrite which, when exposed to oxygen, in the presence of sufficient moisture, oxidises, resulting in the generation of sulphuric acid. Unoxidised pyritic soils are referred to as potential ASS. When the soils are exposed, the oxidation of pyrite occurs and sulphuric acids are generated, and the soils are said to be actual ASS.

Pyritic soils typically form in waterlogged, saline sediments rich in iron and sulfate. Typical environments for the formation of these soils include tidal flats, salt marshes and mangrove swamps below about RL 5m AHD. They can also form as bottom sediments in coastal rivers and creeks. Key points with regards to the likelihood of ASS being present on site are:

- Reference to the relevant Acid Sulfate Soil Risk Map (Greta, 1:25,000 scale, 1997 edition supplied by the NSW Government Office of Environment and Heritage) indicates that the site and surrounding area in the vicinity of the site is within an area of "no known occurrence" of acid sulfate soil conditions.
- Surface levels typically within the range of about RL 40m AHD to RL 70m AHD across the site, (i.e. significantly greater than RL 5m AHD).
- Subsurface soil materials encountered are of residual origin, (i.e. not estuarine).

It is considered unlikely that acid sulfate soils would be present at the site, and it is assessed that the proposed development presents a low risk of disturbance of acid sulfate soils.

Therefore Potential or Actual ASS are not considered likely to be encountered at the site as part of proposed site developments, and on this basis there is no requirement for an ASS Management Plan.

7.4 Site Classification to AS2870-2011

Site classification in accordance with the classification system presented in AS2870-2011 '*Residential Slabs and Footings*' should be undertaken following further detailed geotechnical investigation of the site once site layout and site regrade designs are known.

Site classification will depend on a number of factors including depth of topsoil, depth of fill and residual soil, depth to rock, and reactivity of the natural soil and any fill material placed. Based upon experience with nearby projects including Stages 1 to 7 of this subdivision, a preliminary indication is that lots may potentially be mostly classified Class 'H2' or 'E'.

All structural elements should be supported on footings founded beneath all uncontrolled fill, layers of inadequate bearing capacity, soft/loose, or other potentially deleterious material.

If any areas of uncontrolled fill of depths greater than 0.4m are encountered during construction, footings should be designed in accordance with engineering principles for Class 'P' sites.

7.5 Road Pavements

Pavement design should be carried out following further detailed geotechnical investigation of the site. The existing residual clay soils are generally expected to be suitable for subgrade support subject to moisture conditions at the time of construction.

Due to the gently to moderately sloping nature of the site, road construction is generally anticipated to be on grade or within about 1m or existing surface levels, with only minor cut into soil or weathered rock, on-grade construction, and/or minor filling.

8.0 Limitations

The findings presented in the report and used as the basis for recommendations presented herein were obtained using normal, industry accepted geotechnical design practices and standards. To our knowledge, they represent a reasonable interpretation of the general conditions of the site.

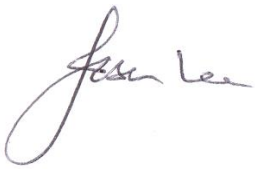
The extent of testing associated with this assessment is limited to discrete test locations. It should be noted that subsurface conditions between and away from the test locations may be different to those observed during the field work and used as the basis of the recommendations contained in this report.

If subsurface conditions encountered during construction differ from those given in this report, further advice should be sought without delay.

Data and opinions contained within the report may not be used in other contexts or for any other purposes without prior review and agreement by Qualtest. If this report is reproduced, it must be in full.

If you have any further questions regarding this report, please do not hesitate to contact Shannon Kelly or the undersigned.

For and on behalf of Qualtest Laboratory (NSW) Pty Ltd.

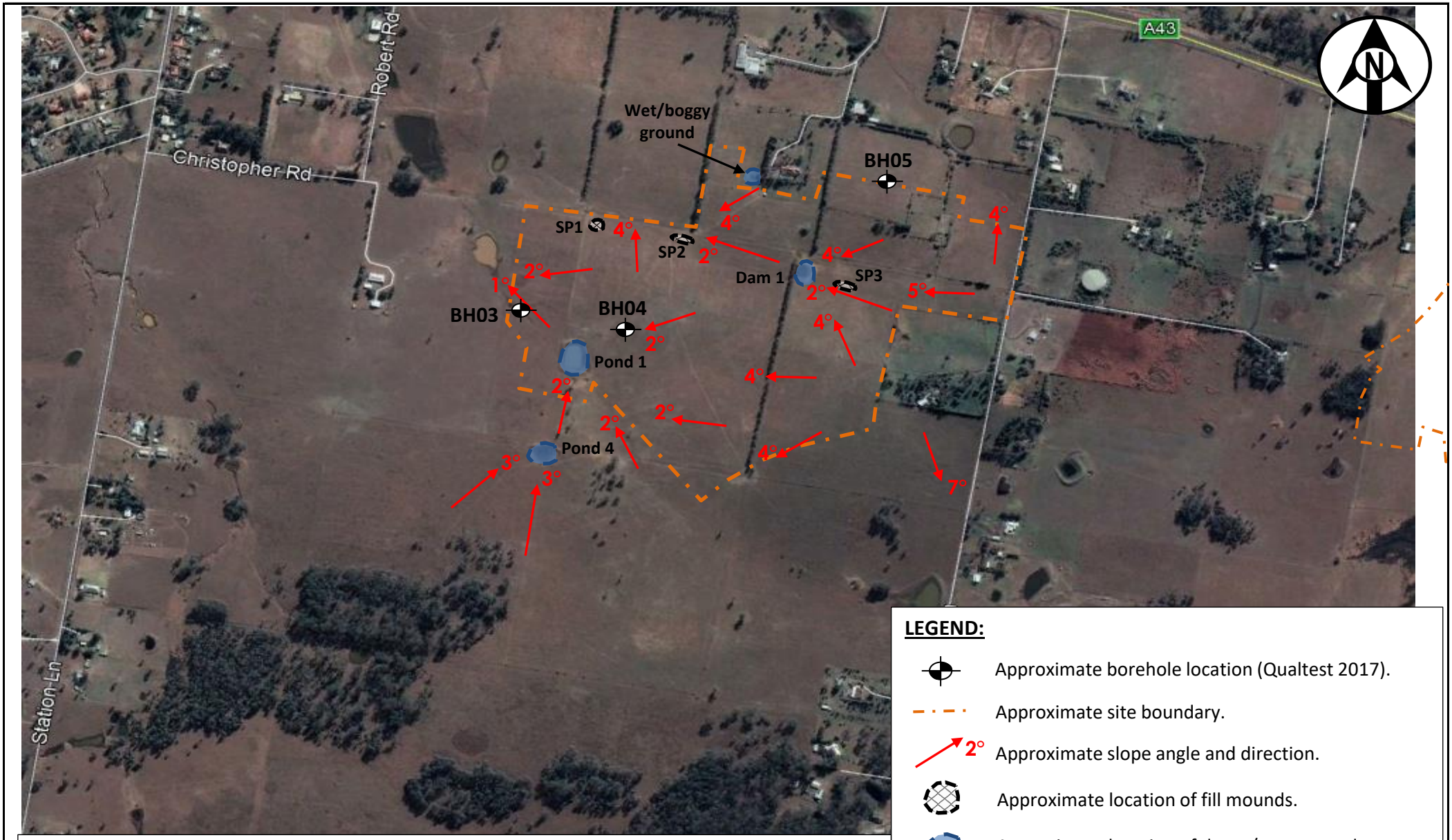


Jason Lee
Principal Geotechnical Engineer

FIGURES:

FIGURE AF1.Rev2: Site Location & Approximate Test Locations

Overall Master Plan (ref: Plan No: 196344, File Ref: 14/46, Sheet No: 1 to 3, Issue: M, dated: 18/10/21, by Barker Ryan Stewart)



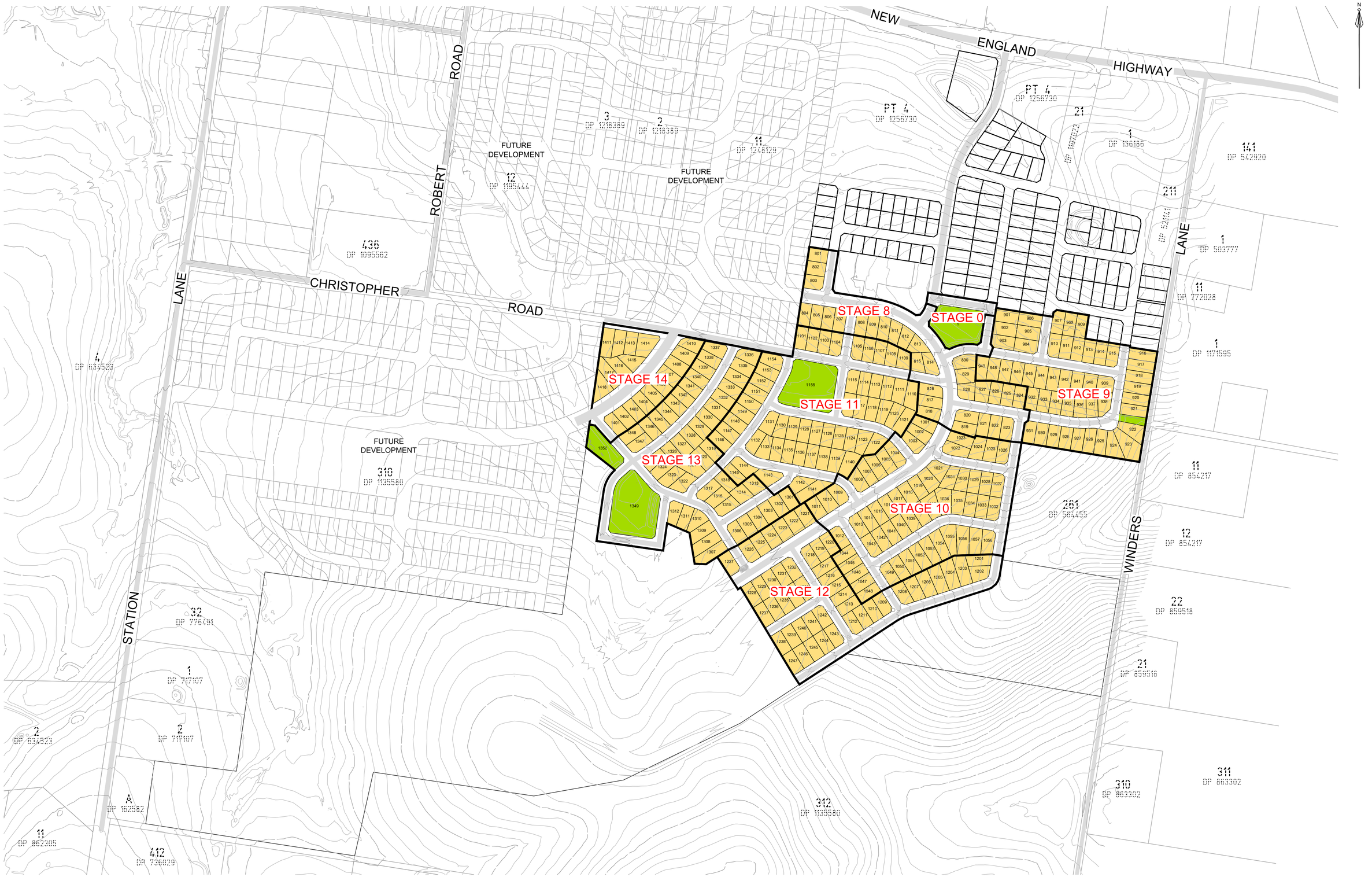
Based on image from Near Maps (2021).

LEGEND:

- Approximate borehole location (Qualtest 2017).
- Approximate site boundary.
- 2° Approximate slope angle and direction.
- Approximate location of fill mounds.
- Approximate location of dams / wet ground.

Qualtest LABORATORY (NSW) PTY LTD

Client:	BARKER RYAN STEWART PTY LTD	Drawing No:	FIGURE AF1.REV2
Project:	STAGES 8 to 14, LOCHINVAR RIDGE	Project No:	NEW17P-0034A
Location:	LOT 3 DP1256730, 70 CHISTOPHER ROAD, LOCHINVAR	Scale:	N.T.S.
Title:	SITE LOCATION & APPROXIMATE TEST LOCATIONS	Date:	21/10/2021



REV	AMENDMENT	ISSUED	DATE
M	ADDED STAGES 0 & 14	MAC	18/10/21

BARKER RYAN STEWART
TOTAL PROJECT SOLUTIONS
ENGINEERING | PLANNING | PROJECT MANAGEMENT | SURVEYING | CERTIFICATION

SYDNEY P: 02 9659 0005
CENTRAL COAST P: 02 4325 5255
HUNTER P: 02 4966 8388
S.E. QLD P: 07 5582 6555

www.brs.com.au
mail@brs.com.au
ABN: 26 134 067 842

Client:

URBAN LAND & HOUSING PTY LTD

OVERALL MASTER PLAN
LOTS 2 & 3 DP 1256730
NEW ENGLAND HIGHWAY & CHRISTOPHER ROAD
LOCHINVAR

Designed: DE
Drawn: RJG
Checked: DE

Scales: Plan 1:3000

Datum: N/A

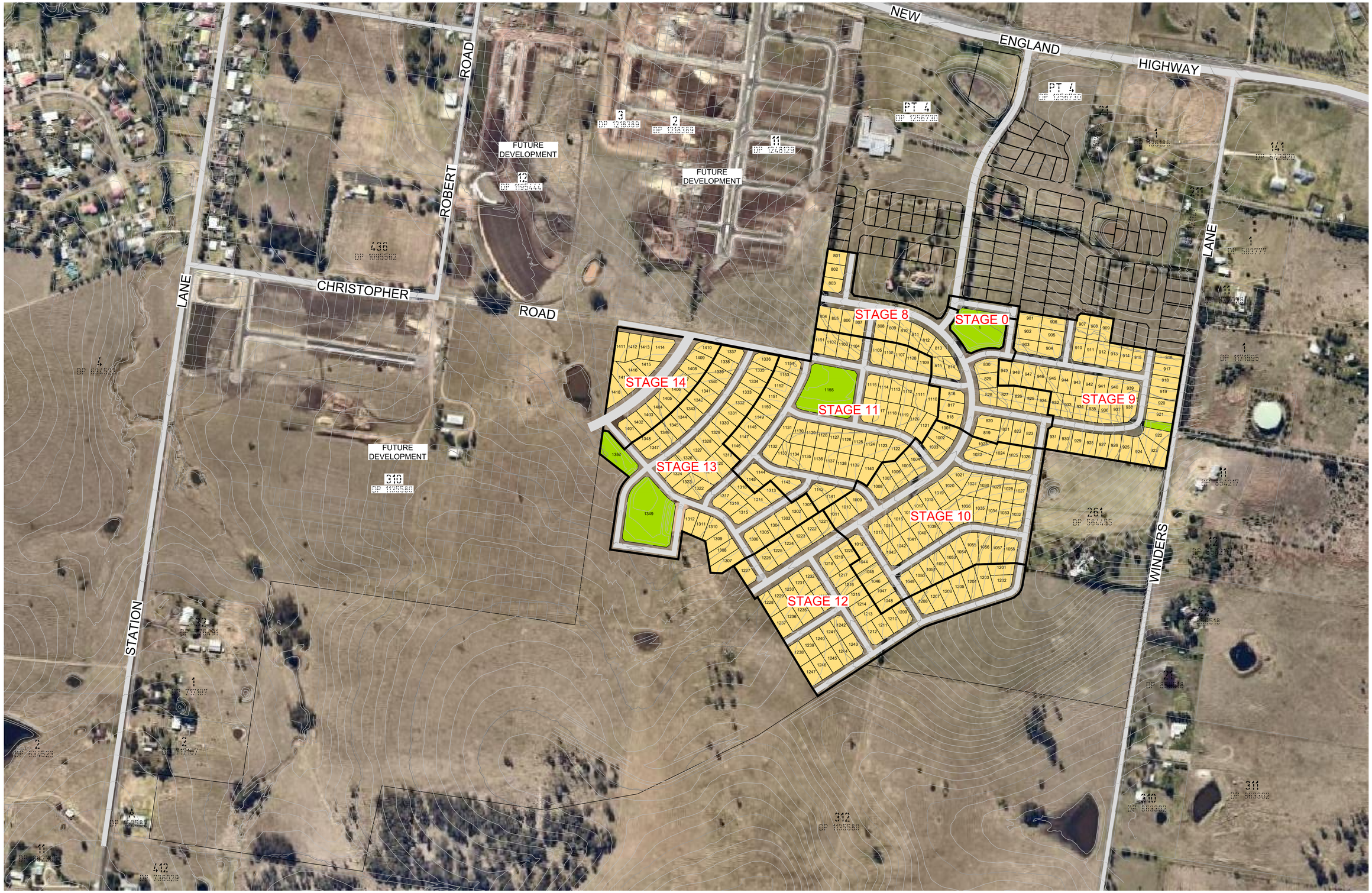
Plan No. ID196344

Sheet No. 1

File Ref. 14/46

REV. M

Plot Date: 18/10/2021 Cad File: 14_46 – Subdivision Plan MASTER PLAN (ID 121214)



REV	AMENDMENT	ISSUED	DATE
M	ADDED STAGES 0 & 14	MAC	18/10/21

BARKER RYAN STEWART
TOTAL PROJECT SOLUTIONS
ENGINEERING | PLANNING | PROJECT MANAGEMENT | SURVEYING | CERTIFICATION

SYDNEY P: 02 9659 0005
CENTRAL COAST P: 02 4325 5255
HUNTER P: 02 4966 8388
S.E. QLD P: 07 5582 6555
www.brs.com.au
mail@brs.com.au
ABN: 26 134 067 842

Client:

URBAN LAND & HOUSING PTY LTD

OVERALL MASTER PLAN
LOTS 2 & 3 DP 1256730
NEW ENGLAND HIGHWAY & CHRISTOPHER ROAD
LOCHINVAR

Designed: DE
Drawn: RJG
Checked: DE

Scales: Plan 1:3000

Datum: N/A

Plan No. ID196344
Sheet No. 2
File Ref. 14/46
REV. M

Plot Date: 18/10/2021 Cad File: 14_46 – Subdivision Plan MASTER PLAN (ID 121214)

STAGE	8	9	10	11	12	13	14	Total
700-799	10	5	8	7	19	14	6	69
800-899	19	40	41	40	23	30	7	200
900-999	1	1	5	5	2	1	1	16
1000-1499	0	2	4	2	3	3	4	18
1500+	0	1	0	0	0	0	0	1
Total	30	49	58	54	47	48	18	304

REV	AMENDMENT	ISSUED	DATE
M	ADDED STAGES 0 & 14	MAC	18/10/21

BARKER RYAN STEWART
TOTAL PROJECT SOLUTIONS
ENGINEERING | PLANNING | PROJECT MANAGEMENT | SURVEYING | CERTIFICATION

SYDNEY P: 02 9659 0005
CENTRAL COAST P: 02 4325 5255
HUNTER P: 02 4966 8388
S.E. QLD P: 07 5582 6555

www.brs.com.au
mail@brs.com.au
ABN: 26 134 067 842

Client:

URBAN LAND & HOUSING PTY LTD

OVERALL MASTER PLAN
LOTS 2 & 3 DP 1256730
NEW ENGLAND HIGHWAY & CHRISTOPHER ROAD
LOCHINVAR

Designed: DE
Drawn: RJG
Checked: DE

Scales: Plan 1:1500

Datum: N/A

Plan No. ID196344

Sheet No. 3

File Ref. 14/46

REV. M

Plot Date: 18/10/2021 Cad File: 14_46 – Subdivision Plan MASTER PLAN (ID 121214)

APPENDIX A:

Results of Field Investigations

ENGINEERING LOG - HAND AUGER

CLIENT: JIM AIRD & RICHARD HVIRF
PROJECT: PROPOSED RESIDENTIAL SUBDIVISION
LOCATION: NEW ENGLAND HIGHWAY, LOCHINVAR

HAND AUGER NO: BH03
PAGE: 1 OF 1
JOB NO: NEW17P-0034
LOGGED BY: BB
DATE: 21/3/17

DRILL TYPE: HAND AUGER
BOREHOLE DIAMETER: 80 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
HA	Not Encountered	B 0.20m				CI	CLAY - medium plasticity, brown, some fine to medium grained sand, root affected. 0.20m			HP	120	TOPSOIL / SLOPE WASH
				0.5		CI	CLAY - medium plasticity, brown, some fine to medium grained sand. 0.70m	M > w_P	St - VSt	HP	150	RESIDUAL SOIL
				1.0			Hole Terminated at 0.70 m					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - HAND AUGER

CLIENT: JIM AIRD & RICHARD HVIRF
PROJECT: PROPOSED RESIDENTIAL SUBDIVISION
LOCATION: NEW ENGLAND HIGHWAY, LOCHINVAR

HAND AUGER NO: BH04
PAGE: 1 OF 1
JOB NO: NEW17P-0034
LOGGED BY: BB
DATE: 21/3/17

DRILL TYPE: HAND AUGER
BOREHOLE DIAMETER: 80 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
HA	Not Encountered					CL	Sandy CLAY - low plasticity, dark brown, fine to medium grained sand, root affected.					TOPSOIL
							0.10m			HP	150	
							CLAY - medium to high plasticity, brown, some fine to medium grained sand.					SLOPE WASH / COLLUVIUM
				0.5		CH		$M > w_P$	St	HP	150	
							0.60m			HP	200	
						CH	Sandy CLAY - medium to high plasticity, brown, fine to medium grained sand.		St - VSt			COLLUVIUM / RESIDUAL SOIL
							0.70m					
				1.0			Hole Terminated at 0.70 m					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - HAND AUGER

CLIENT: JIM AIRD & RICHARD HVIRF
PROJECT: PROPOSED RESIDENTIAL SUBDIVISION
LOCATION: NEW ENGLAND HIGHWAY, LOCHINVAR

HAND AUGER NO: BH05
PAGE: 1 OF 1
JOB NO: NEW17P-0034
LOGGED BY: BB
DATE: 21/3/17

DRILL TYPE: HAND AUGER
BOREHOLE DIAMETER: 80 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
HA	Not Encountered	B 0.20m				CI	Sandy CLAY - medium plasticity, dark brown, fine to medium grained sand, root affected.	$M > w_P$				TOPSOIL
							0.20m					
		B 0.40m				CI	Sandy CLAY - medium plasticity, yellow to brown, fine to medium grained sand.		St			RESIDUAL SOIL
				0.5			sand content increasing, grading into Clayey SAND with depth.	D				
							0.50m					
							Hole Terminated at 0.50 m					
				1.0								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Qualtest
LABORATORY (NSW) PTY LTD

8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

DYNAMIC CONE PENETROMETER - TEST REPORT

Client: J. AIRD & R. HVIRF c/- PCB
Principal:
Project: RESIDENTIAL SUBDIVISION
Location: LOT 32 DP 1132263, LOT 310 DP 1034974 & LOT 311 DP 1135580

Project Number: NEW17P-0034
Sheet No: *1 of 1*
Test Date: 21/03/2017
Tested By: BB

Test Method: AS1289 6.3.2 ☑ Cone Tip
Drop Height: 510 ± 5mm ☐ Blunt Tip

Depth Below Surface (mm)	Test Number								Test Location / Comments
	DCP1	DCP2	DCP3	DCP4	DCP5				
									DCP locations are as shown on attached plan
150	3	2	2	3	3				
300	3	4	2	5	4				
450	4	5	3	13	7				
600	7	3	3	16	19				
750	24	10	6	18	30+ (b)				
900	30+ (ref)	10	7	30+ (b)					
1050		10	13						
1200		9	16						
1350		12	16						
1500		13	30+ (b)						
1650		14							
1800		discont.							
1950									
2100									
2250									
2400									
2550									
2700									
2850									
3000									
3150									
3300									
3450									
3600									
3750									
3900									
4050									
4200									
4350									
4500									

Comments: Readings recorded in blows per 150mm increments.
(b) denotes "bouncing" observed
(ref) denotes refusal

APPENDIX B:

Results of Laboratory Testing

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Material Test Report

Report No: MAT:NEW17W-1224--S03
Issue No: 1

Client: E.J. Aird & R. Hvirf
C/- Pulver Cooper & Blackley
98 Lawes Street, East Maitland NSW 2323

Principal:
Project No.: NEW17P-0034
Project Name: Proposed Residential Subdivision

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

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 30/03/2017

Sample Details

Sample ID:	NEW17W-1224--S03
Sampling Method:	AS1289.1.2.1 cl 6.5
Date Sampled:	21/03/2017
Source:	On-Site
Material:	Sandy Clay
Specification:	No Specification
Project Location:	New England Highway, Lochinvar
Sample Location:	BH04 - (0.6 - 0.7m)

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	4	
Soil Description		Brown Sandy Clay	
Type of Water		Demineralised	
Temperature of Water (°C)		24.0	

Comments

N/A

QUALTEST Laboratory (NSW) Pty Ltd (20708)
8 Ironbark Close Warabrook NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: MAT:NEW17W-1224--S04
Issue No: 1

Material Test Report

Client: E.J. Aird & R. Hvirf
C/- Pulver Cooper & Blackley
98 Lawes Street, East Maitland NSW 2323

Principal:
Project No.: NEW17P-0034
Project Name: Proposed Residential Subdivision

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

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 30/03/2017

Sample Details

Sample ID:	NEW17W-1224--S04
Sampling Method:	AS1289.1.2.1 cl 6.5
Date Sampled:	21/03/2017
Source:	On-Site
Material:	Sandy Clay
Specification:	No Specification
Project Location:	New England Highway, Lochinvar
Sample Location:	BH05 - (0.3 - 0.4m)

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	4	
Soil Description		Brown Sandy Clay	
Type of Water		Demineralised	
Temperature of Water (°C)		24.0	

Comments

N/A

APPENDIX C:

Selected Excerpts from AGS 2007 - Practice Note Guidelines for Landslide Risk Management

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

Approximate Annual Probability		Implied Indicative Landslide Recurrence Interval		Description	Descriptor	Level
Indicative Value	Notional Boundary					
10^{-1}	$5x10^{-2}$	10 years	20 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	$5x10^{-3}$	100 years	200 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	$5x10^{-4}$	1000 years	2000 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10^{-4}	$5x10^{-5}$	10,000 years	20,000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	$5x10^{-6}$	100,000 years	200,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10^{-6}		1,000,000 years		The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

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

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate Cost of Damage		Description	Descriptor	Level
Indicative Value	Notional Boundary			
200%	100%	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	CATASTROPHIC	1
60%	40%	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	MAJOR	2
20%	10%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	MEDIUM	3
5%	1%	Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.	MINOR	4
0.5%		Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

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

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

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

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

QUALITATIVE RISK ANALYSIS MATRIX – LEVEL OF RISK TO PROPERTY

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

Notes: (5) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.
(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

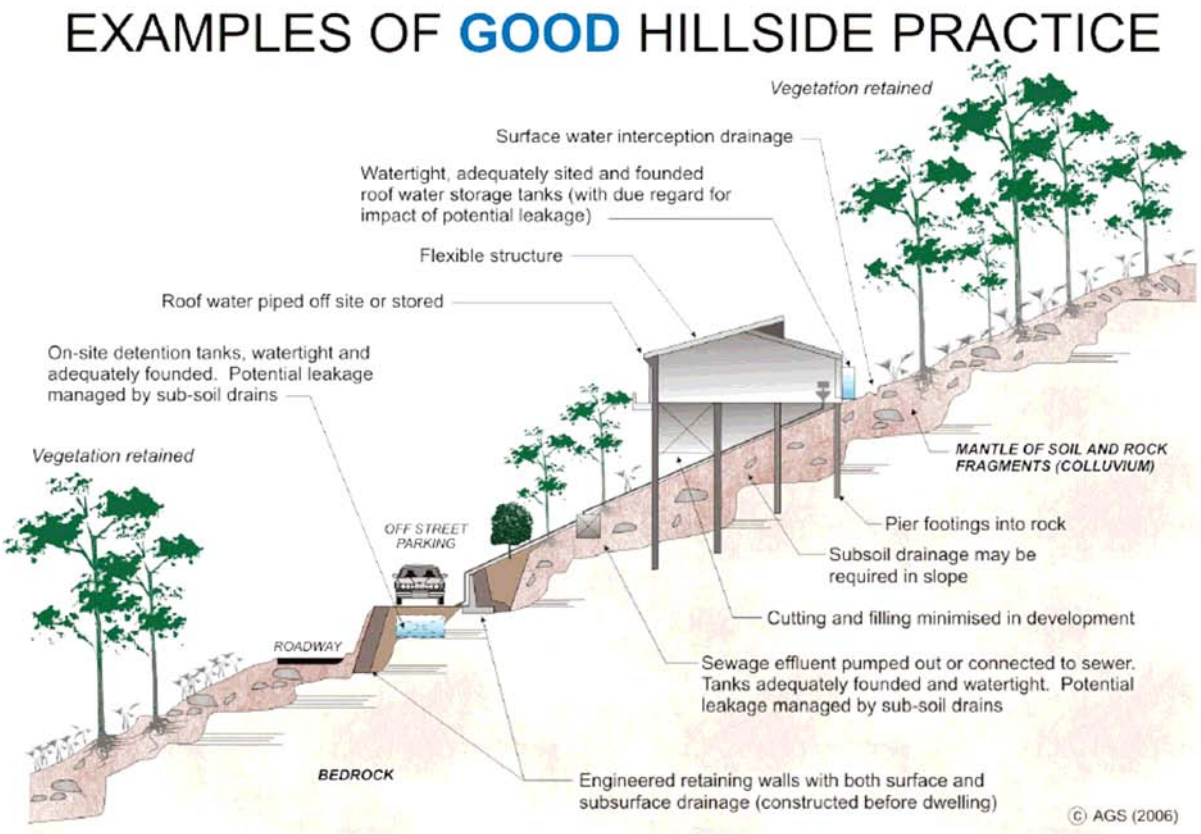
RISK LEVEL IMPLICATIONS

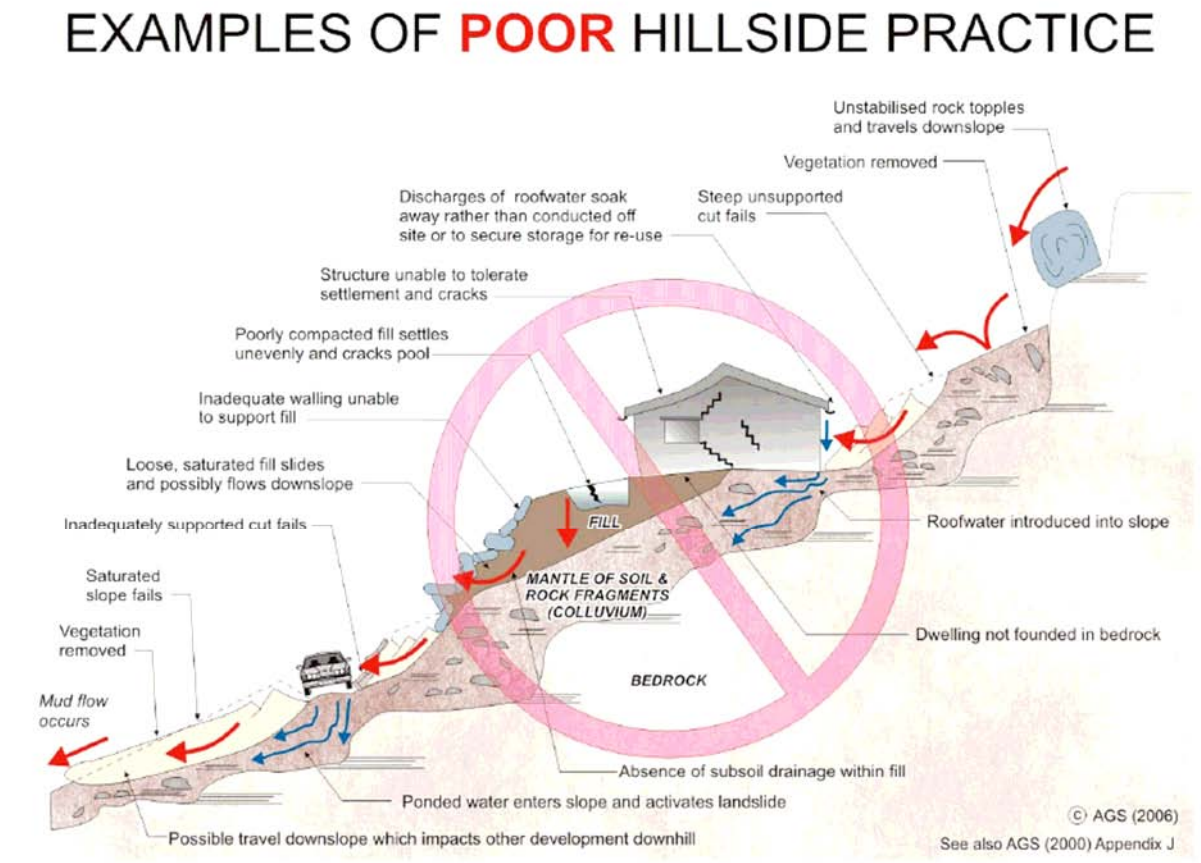
Risk Level		**Example Implications** (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the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

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

APPENDIX G - SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

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


EXAMPLES OF GOOD HILLSIDE PRACTICE
Vegetation retained
Surface water interception drainage
Watertight, adequately sited and founded roof water storage tanks (with due regard for impact of potential leakage)
Flexible structure
Roof water piped off site or stored
On-site detention tanks, watertight and adequately founded. Potential leakage managed by sub-soil drains
Vegetation retained
MANTLE OF SOIL AND ROCK FRAGMENTS (COLLUVIUM)
OFF STREET PARKING
Pier footings into rock
Subsoil drainage may be required in slope
Cutting and filling minimised in development
ROADWAY
Sewage effluent pumped out or connected to sewer. Tanks adequately founded and watertight. Potential leakage managed by sub-soil drains
BEDROCK
Engineered retaining walls with both surface and subsurface drainage (constructed before dwelling)
© AGS (2006)


EXAMPLES OF POOR HILLSIDE PRACTICE
Unstabilised rock topples and travels downslope
Vegetation removed
Discharges of roofwater soak away rather than conducted off site or to secure storage for re-use
Steep unsupported cut fails
Structure unable to tolerate settlement and cracks
Poorly compacted fill settles unevenly and cracks pool
Inadequate walling unable to support fill
Loose, saturated fill slides and possibly flows downslope
Inadequately supported cut fails
FILL
Roofwater introduced into slope
Saturated slope fails
MANTLE OF SOIL & ROCK FRAGMENTS (COLLUVIUM)
Vegetation removed
Dwelling not founded in bedrock
BEDROCK
Mud flow occurs
Absence of subsoil drainage within fill
Ponded water enters slope and activates landslide
© AGS (2006)
Possible travel downslope which impacts other development downhill
See also AGS (2000) Appendix J