Site Classification and Fill Assessment Report

Stage 4A, Sophia Waters, Chisholm NSW

Prepared for: Allam Development No1 Pty Ltd
EP3162.003 8 December 2024

Citation Certification ISO 9001 Quality management system

Citation Certification ISO 45001 OH&S management system

Citation Certification ISO 14001 Environment management system

EP RISK

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Stage 4A, Sophia Waters, Chisholm NSW

Allam Development No1 Pty Ltd
Level 5, & Macquarie Place
Sydney NSW 2000

8 December 2024

Our Ref: EP3162.003

LIMITATIONS

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QUALITY CONTROL

Version	Author	Date	Reviewer	Date	Quality Review	Date
v1	J. Young	29/11/2024	O. Pruteanu	03/12/2024	J. Young	08/12/2024

DOCUMENT CONTROL

Version	Date	Reference	Submitted to
1	*08/12/2024*	*EP3162.002*	*Allam Development No1 Pty Ltd*

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1 Introduction

This report presents the results of geotechnical investigation undertaken by EP Risk Management Pty Ltd (EP Risk) for Stage 4A Lot 12 DP 1283071, Sophia Waters Chisholm. The work was undertaken at the request of Mr Ross Hyde-Smith on behalf of Allam Development No 1 Pty Ltd (the Developer).

The report details the findings of the geotechnical investigation, including a description of surface and subsurface conditions encountered at the Site, and a statement regarding filling and Site Classification for lots 101 to 132, 203 to 232 (noting lots 201 and 202 were consolidated into lot 205) and 301 to 328 in accordance with Standards Australia AS 2870-2011, *Residential slabs and footings*[1] (AS 2870-2011) for Stage 4A of the Sophia Waters Residential Subdivision in their existing condition following regrade at the time of fieldwork.

For the investigation, a set of Civil Drawing for Sophia Waters Stage 4A (stages 1,2 & 3) Lot 12 D.A 1283071 Raymond Terrace Road, Chisholm D.A 2019/652 by ADW Johnson Pty Ltd (ADWJ) Reference 240294(40)123-ENG-001 to 906 Rev 5 dated 23.05.2024 was provided and an extract of plans are attached as **Appendix A – Plan Extracts**.

This report includes the classification of early delivery lots 206 to 214 and lots 304 to 328 of the development, previously provided under separate title and commentary on earthwork and construction testing.

Geotechnical Investigation was previously undertaken by EP Risk and is detailed in Report on "Preliminary *Geotechnical Assessment Lot 12 D.A 1283071 Raymond Terrace Road, Chisholm*", Ref EP2508.004v8 dated 30 August 2023 and is referenced herein.

2 Site Identification

The Site comprises of a large almost rectangular shaped allotment located on the northern side of Raymond Terrace Road, at Chisholm with surrounding land currently consisting of a mix of residential and rural land (predominantly grazing) use.

The site has been cleared with the exception of the riparian corridor. A small watercourse exists in the northern portion of the site that flows west to east. The site has a gently sloping gradient of <2° from approximately 21m AHD in the western portion of the site to 12 m AHD in the eastern portion of the site. Site drainage is considered to consist of surface runoff migrating across the Site following surface contours as overland flow to the stormwater system and drainage to an ephemeral drainage line that connects to a series of basins in the adjacent Sophia Waters Stage 3A development on the corner of McFarlanes and Raymond Terrace Road to the east.

3 Earthworks

The majority of Bulk Earthworks for the development was undertaken between July 2023 to February 2024 with the civil works continuing by Daracon Group (Daracon) to November 2024 which included: Development for the ninety-two (92) residential lots 101 to 132, 203 to 232 and 301 to 328 and associated pavements and inground services.

The earthworks for lots 101 to 132, 203 to 232 and 301 to 328 included regrade across the lots, predominantly by cutting as shown on regrade plans attached as **Appendix B – Regrade Plan**. All material used in filling was Site won material from regrade activities with a nett surplus that was exported from site.

Testing was undertaken on Lot filling in accordance with Section 8 of AS3798-2007 *Guidelines on Earthworks for Commercial and Residential Developments* [2]. Laboratory results for lot undertaken during development of Stages 4A are included as **Appendix C – Coffey Level 1 Summary Report and Compaction Test Results.**

3.1 Material Quality

Materials encountered onsite generally comprised predominantly of clayey sand, sandy clay, silty clay, sandy gravelly clay, gravelly clayey sand and sandy clayey sandy gravel (extremely weathered and distinctly weathered sandstone). Onsite materials other than topsoil were deemed suitable for use as general fill. Earthworks were undertaken utilising onsite materials from regrade and placed on lots as controlled fill.

3.2 Methodology

Regrade/ filling operations were undertaken by Daracon and included excavating the natural in-situ soils following stripping of topsoil so that the soil was free of significant organic matter and suitable for placement and use as controlled fill. Natural surfaces were inspected, and proof rolled using a compactor or wheeled construction equipment that was available at the time of inspection. Unsuitable materials were removed and replaced with select site won material. As discussed previously only minor filling occurred on lots 106 to 119, 327 and 328.

Site won material from excavation on site was placed in approximate 200 - 300mm layers and compacted to a minimum of 95% standard relative density (SRD) within the lots and 100% SRD within 500mm of design subgrade level within the road alignments. Compaction results are included in **Appendix C.**

Fill operations were undertaken by placing layers of approximately 200mm-300mm thickness and compacting to specified limits using pad foot and smooth drum rollers. Compacted fill layers were then tested for compaction in accordance with the guidelines indicated in AS 3798-2007[2]. Table 5.1 Item 1 of AS 3798-2007[2] was adopted as the appropriate compaction criteria for the work with a minimum relative compaction of 95% standard required as appropriate for residential lots and 100% standard for deeper fill area greater than 1m depth. The cut pads were ripped and recompacted.

Fill was tested in accordance with Table 8.1 *Frequency of Field Density Tests for Type 1 Large Scale and Type 2 Small Operations* [2]. Placement and compaction of fill was undertaken by Daracon with EP Risk, Coffey Testing Pty Ltd (Coffey) and Australian Soil and Concrete Testing (ASCT) site personnel providing onsite inspection and testing services during earthworks activities that satisfy the requirements of Level 1 and 2 Inspection & Testing as per Section 8. of AS3798-2007[2] with test results satisfying the compaction criteria for controlled fill as defined in AS2870-2011[1]. Due to the sporadic nature of earthworks, testing of lots was undertaken as required. The majority of lots were subject to regrade during development either by predominantly cutting or minor filling and both in some cases refer to regrade plans in **Appendix B – Regrade Plans**.

3.3 Results of Compaction Testing

3.3.1 Lot Regrade

Results of compaction testing of regrade areas (primarily road fill) undertaken by Coffey indicate that the filling operations have satisfied the compaction criteria for “controlled fill” as defined in Clause 1.8.13 of AS 2870-2011[1].

All testing has either met with or exceeded the specification adopted of 95% Standard Relative Density for lot fill and 98% for deep fill with compaction at moisture contents required to gain compaction at the time of placement with any failures being re-worked and retested. Compaction results indicate a characteristic density > 98% standard. It is noted that the lots comprised entirely of cut, except minor filling at the front of lots 327 and 32b.

Geotechnical services provided during regrade comply with AS 3798-2007[2], with testing undertaken to the minimum frequency as indicated in Table 8.1 for Type 1 - Large Scale (bulk Earthworks) and Type 2 Small Scale Operation (individual lots).

Seventy-two (72) compaction tests were undertaken during regrade operations mainly associated with road fill activities and lots 112-119. Compaction and DCP test results are shown on National Association of Testing Authorities (NATA) accredited test certificates, are attached in **Appendix C– Coffey Level 1 Summary Report and Compaction results.**

Pavement test results along with inground services testing is provided as part of the contractor's quality assurance package.

4 Investigation Methodology

Field investigation of lots 206 to 214 and 304 to 328 was undertaken between 13 June and 18 June 2024 and comprised of drilling a total of sixty-eight (68) test bores at locations shown on Coffey Figures 1 with and additional sixty-six (66) bores drilled in November 2024 for the remaining lots in Stage 4A with logs provided in **Appendix D – Borehole Logs**. Test bores were drilled using ute mounted drill rig fitted with a 300 mm spiral auger to the target depths of 1.8 m below ground level (m BGL). sixty four (64) out of the one hundred and thirty-four (134) test bores in total encountered bedrock and practical refusal within the depth of the investigation. The depth of practical refusal on extremely weathered rock ranged from 0.2m below ground level (m BGL) in lots 206 to >1.8m.

Dynamic Cone Penetrometer (DCP) tests were conducted adjacent to and within test bores to aid in the assessment of subsurface strength conditions. Disturbed and undisturbed samples of selected materials from the bores were collected for subsequent laboratory testing.

All fieldwork, including logging of subsurface profiles and collection of samples, was carried out by Coffey on behalf of EP Risk with inspection of the lots undertaken by EP Risk Principal Geotechnical Scientist prior. Test bores were located by reference to lot boundaries with the boundaries as shown on bore logs and Site Identification sketch attached in **Appendix D – Borehole Logs**. Subsurface conditions are summarised in **Section 5.2** of this report, with detailed logs presented as Appendix E of this report.

Laboratory testing on selected samples recovered during fieldwork comprised the determination of the shrink-swell index (*Iss*) and Atterberg limits correlation carried out on undisturbed and disturbed samples of recovered soils encountered at the Site to measure soil volume change over an extreme soil moisture content range. Due to the granular nature of the soils, undisturbed samples were difficult to obtain due to the gravelly and sandy nature of site materials and shrink swell testing was limited. Site reactivity was undertaken by correlation with Atterberg limits testing undertaken on nineteen (19) disturbed samples and shrink-swells testing undertaken on three (3) undisturbed samples from previous investigation. Results of laboratory testing are detailed in the reports sheets provided as **Appendix E - Laboratory Test Results** and summarised in **Section 5.3**.

5 Investigation Findings

5.1 Site Geology

Based on the geological data sourced from the NSW Department of Industry, Resources and Energy (www.minview.geoscience.nsw.gov.au) the Site is underlain by two main geological units. Most of the Site is underlain by Guadalupian aged Mulbring siltstone (**Pmtm**), with a dominant siltstone lithology consisting of medium to dark grey siltstone, minor claystone, sporadic thin cherty beds, rare thin sandstone and limestone beds and sporadic marine fossils. A small northern portion of the Site is underlain by quaternary aged alluvial valley deposits (**Q_av**) with the dominant lithology being clastic sediment described as silt, clay (fluvially deposited), lithic to quartz lithic sand and gravel. An excerpt of the geological map with the geological units is shown in **Figure 1**.

Figure 1. Geological Map Excerpt (Pmtm-Mulbring Siltstone-green, Qav-alluvial clastic sediments-yellow)

5.2 Subsurface Conditions

The subsurface conditions encountered in the test bores excavated across the Site are detailed in Coffey log sheets attached as Appendix E. The subsurface profile generally comprised fill/topsoil (sandy clay, sandy gravelly clay) overlying residual soil (sandy clay, sandy gravelly clay, gravelly sand) overlying extremely and distinctly weathered SANDSTONE.

At the time of fieldwork, the natural soils were assessed to be slightly wet to slightly dry of Standard Optimum Moisture Content (SOMC) and based on DCP blow counts, generally ranged from stiff to very stiff/hard (cohesive soils) and dense to very dense (non-cohesive soils).

A general summary of the subsurface conditions encountered across the site is presented in Table 1.

Table 1 – Observed Geological Units			
Unit #	**Origin**	**Material**	**Description**
Unit 1	Fill	Sandy CLAY / Sandy Gravelly CLAY	Medium to high plasticity, pale brown to yellow brown occasionally dark brown fine to coarse grained sand, fine to coarse grained, sub-angular to angular gravel.
		Gravelly SAND	Fine to coarse grained, pale brown to yellow brown, sub-angular to angular gravel.
		Clayey SAND	Fine to coarse, pale brown, medium plasticity clay
Unit 2	Residual Soil	Clayey SAND / Clayey Gravelly SAND / Gravelly SAND	Fine to coarse grained, yellow, pale brown, fine to coarse grained, sub-angular to angular gravel
		Sandy CLAY / Silty CLAY/ Sandy Gravelly CLAY	Medium plasticity, pale brown, pale red/ white, fine to coarse grained sand, fine to coarse grained, sub-angular to angular gravel
Unit 3	Extremely & Distinctly Weathered Material	Sandstone	Variable depending on site elevation and areal extent

The depth to rock was variable across the lots due to regrade activities undertaken. The depths to rock encountered at test bore locations are detailed in log sheets and attached as **Appendix D – Borehole Logs**.

No groundwater or seepage was encountered in the test bores at the time of fieldwork. It should be noted that groundwater levels are likely to fluctuate with variations in climatic and site condition.

5.3 Laboratory Test Results

The results of the laboratory tests undertaken on samples of the natural and fill soils are detailed in **Appendix E – Laboratory Test Results** and are summarised below in Table 2.

Table 2 – Summary of Atterberg Limits / Shrink Swell Comparison Test Results							
Lot & BH No.	**Depth (m)**	**Soil Type**	**LL (%)**	**PL (%)**	**PI (%)**	**LS (%)**	**Iss (%)***
107	0.6	Sandy CLAY	65	30	35	18.5	**3.2**
110	0.4-0.6	Sandy CLAY	73	27	46	18.0	**3.8**
114	0.6-1.0	Sandy CLAY	62	27	35	17.0	**3.0**
117	0.8	Sandy CLAY	54	22	32	15.5	**2.4**
126	0.5	Silty CLAY	52	18	34	8.0	**2.3**
131	1.2	Silty CLAY	42	29	23	7.0	**1.5**
206-1	0.2-0.4	Sandy CLAY	37	19	18	8	**1.6**
207-2	0.2-0.4	Silty CLAY	51	23	28	13.5	**2.7**
209 -2	0.4-0.5	Clayey SAND	35	17	17	7	**1.7**
211-1	0.4-0.6	Silty CLAY	39	19	19	8.5	**1.5**
214 -1	0.4-0.8	Silty CLAY	42	19	23	7	**1.4**
223	0.6-0.8	Silty CLAY	49	18	31	9.0	**2.0**
227	0.6-0.8	Silty Clay	43	18	25	8.0	**1.6**
310 -2	0.8-0.9	Clayey SAND	33	18	15	7	**1.4**
312-2	1.1-1.2	Clayey SAND	36	19	17	7.5	**1.5**
313 -2	0.8-0.9	Clayey SAND	36	18	18	7	**1.4**
319 -1	0.8-0.9	Clayey SAND	33	18	15	7.5	**1.5**
320 -1	0.6-0.7	Clayey SAND	31	17	14	6.5	**1.3**
324 -1	1.1-1.2	Clayey SAND	35	19	16	7	**1.4**
LL = Liquid limit, PL = Plastic Limit LS = Linear Shrinkage, PI =Plasticity Index, *Iss = Shrink-Swell Index Correlation from Reynolds [5]							

The results of the laboratory shrink swell tests undertaken on samples of the natural and fill clay soils are detailed on the laboratory test report sheets attached in **Appendix E – Laboratory Test Results** and are summarised below in Table 3.

Table 3 – Summary of Shrink Swell Test Results

Lot No	Depth (m BGL)	Soil Type	Shrinkage Moisture Content (%)	Shrinkage (%)	Swell Moisture Content Before (%)	Swell Moisture Content After (%)	Swell (%)	Shrink-Swell Index I_{ss} (%)
115	0.8-1.2	Sandy CLAY	26.6	6.5	31.0	34.8	0.1	3.7
117	0.8-1.1	Sandy CLAY	20.7	9.4	31.5	35.8	0.5	5.4
119	0.4-0.7	Gravelly CLAY	20.7	3.5	23.0	29.4	1.6	2.4
TP34*	0.2-0.7	Sandy CLAY	27.4	6.8	27.4	28.6	-0.3	3.8
TP35*	0.5-1.0	Sandy CLAY	31.2	9.1	31.6	35.7	0.2	5.1

*from EP Risk report EP2588.001v3 dated 29/08/2022

6 Comments and Recommendations

6.1 Site Classification

EP Risk were requested to provide Site Classification in accordance with AS 2870-2011[1] for lots 1 to 132, 203 to 232 and 301 to 328 inclusive within the Sophia Waters Residential Development. Along with the one hundred and thirty four (134) test bores undertaken thirty-four (34) disturbed and undisturbed samples were secured from various depths within the test bores of material considered representative of the soil profile encountered during the investigation. Undisturbed (u50) samples were difficult to obtained due to the dry and friable nature of material. Twenty-two (22) samples were tested to determine the correlation with shrinkage Index (*Iss*) correlation of the soil to allow Site Classification.

Australian Standard AS 2870-2011[1] establishes performance requirements and specific designs for common foundation conditions as well as providing guidance on the design of footing systems using engineering principles. Site classes as defined on Table 2.1 and 2.3 of AS 2870-2011[1] are presented in Table 4.

Table 4 – General Definition of Site Classes

Site Class	Foundation	Characteristic Surface Movement
A	Most sand and rock sites with little or no ground movement from moisture changes	
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes	0 –2 0 mm
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes	20 – 40 mm
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes	40 – 60 mm
H	Highly reactive clay sites, which may experience very high ground movement from moisture changes	60 – 75 mm
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes	> 75 mm
A to P	Filled sites (refer to clause 2.4.6 of AS 2870-2011)	
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.	

Reactive sites are sites consisting of clay soils that swell on wetting and shrink on drying, resulting in ground movements that can damage lightly loaded structures. The amount of ground movement is related to the physical properties of the clay and environmental factors such as climate, vegetation and watering. A higher probability of damage can occur on reactive sites where abnormal moisture conditions occur, as defined in AS 2870-2011[1], due to factors such as:

1 Presence of trees on the building site or adjacent site, removal of trees prior to or after construction, and the growth of trees too close to a footing. The proximity of mature trees and their effect on foundations should be considered when determining building areas within each allotment (refer to AS 2870-2011[1]);

2 Failure to provide adequate site drainage or lack of maintenance of site drainage, failure to repair plumbing leaks and excessive or irregular watering of gardens; and

3 Unusual moisture conditions caused by removal of structures, ground covers (such as pavements), drains, dams, swimming pools, tanks etc.

In regard to the performance of footings systems, AS 2870-2011[1] states “footing systems designed and constructed in accordance with this Standard on a normal site (see Clause 1.3.)[1] that is

(a) not subject to abnormal moisture conditions; and

(b) maintained such that the original site classification remains valid and abnormal moisture conditions do not develop;

are expected to experience usually no damage, a low incidence of damage category 1 and an occasional incidence of damage category 2."

Damage categories are defined in Appendix C of AS 2870-2011[1], which is reproduced in CSIRO Information Sheet BTF 18*, Foundation Maintenance and Footing Performance: A Homeowner's Guide.*

The laboratory testing to determine the shrink swell index results summarised in **Table 2** and **Table 3** indicate that the tested natural and fill soils are slightly to highly reactive, with I_{ss} values in the range of 1.3% to 5.4%. which are in expectation of site conditions and previous testing of similar materials.

The lots were impacted by significant filling with regrade as part of final shaping for lots. Site regrade undertaken for lost 101 to 238 is shown on site regrade plan in **Appendix B – Regrade Plans**.

As specified in AS 2870-2011[1] Clause 2.5.3, the classification of sites with controlled fill of depths greater than 0.4 m (deep fill) comprising of material other than sand would be Class P. However, an alternative classification may be given to the site with consideration to controlled fill.

Based on the soil profiles encountered in the test bores, and laboratory testing bases on reactivity alone the lots would be classified as Class S, slightly reactive to Class H2 highly reactive. The lots in their existing condition and in the absence of abnormal moisture conditions have received site classifications of **Class M**, moderately reactive to **Class H2**, highly reactive depending on depth to rock as shown on logs in Appendix D. The recommended Site Classifications for footing and slab design are detailed below in Table 5**.**

Table 5 – Recommended Preliminary Site Classifications

Lot Numbers	Recommended Site Classification
101, 102, 103	**Class H1,** highly reactive
104, 105	**Class M,** moderately reactive
106	**Class H1,** highly reactive
107, 108,	**Class M,** moderately reactive
109, 110, 111	**Class H1,** highly reactive
112, 113,114, 115, 116, 117, 118, 119	**Class H2,** highly reactive
120, 121, 122, 123, 124, 125,	**Class H1,** highly reactive
126, 127	**Class M,** moderately reactive
128, 129, 130, 131, 132	**Class H1,** highly reactive
203, 204, 205, 206, 207, 208, 209, 210	**Class M,** moderately reactive
211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222	**Class H1,** highly reactive
223,4, 225, 226, 227, 228, 229, 230,231, 232	**Class M,** moderately reactive
301, 302, 304, 305,	**Class M,** moderately reactive
303, 306	**Class H1,** highly reactive
307, 308, 309, 310, 311, 311, 313, 314, 315, 316, 317,318, 319, 320, 321, 322, 323, 324, 325, 326, 327	**Class M,** moderately reactive
328	**Class H1,** highly reactive
Lots where footings are founded uniformly on weathered rock	**Class S** or **Class A**
It is noted that many of these lots approach the upper limit of moderately reactive and the adoption of Class H1 should be considered due to the deeper soil profile where rock was not encountered within 1.8m	

The above classifications assume that all foundations are founded below any topsoil, uncontrolled fill or slope wash and on natural soil profile or on engineered fill. Characteristic surface movements in the range of 10mm to 85 mmhave been calculated for the lots in their existing condition at the time of investigation. However, due to the differential depth to rock and filling depth across the lots, the potential for differential movement and the elimination of the cracked zone by regrade activities, **Class M** and **Class H2**, are recommended for footing and slab design unless founded uniformly on rock where **Class S** or **Class A** could be adopted. The classification provided also considers the length of time since bulk earthworks were undertaken.

The Site Classification assumes that all footings (edge beams, internal beams and load support thickenings) are founded below any topsoil, slopewash, uncontrolled fill or other deleterious material and have been based on assumed waffle type slab construction. Where footings are uniformly founded in the shallow bedrock, the adoption of a Class A of Class S could be considered.

As noted in **Section 2** the Site was devoid of trees. Clause 1.3.3 of AS 2870-2011[1] nominates that the presence of trees could result in abnormal moisture conditions at the Site should the trees be located within the building areas (including new planting and street landscaping). In such situations, AS 2870-2011[1] nominates adoption of a Class P classification.

It should be appreciated that the Site Classifications provided above are based on test bores and laboratory testing of multiple layers over the depth of total soil suction change in the soil profile. Soil conditions are not expected to vary significantly, excluding depth to rock which varied across the Site and filling where undertaken to provide level lots. The above site classifications and footing recommendations are for the site conditions present at the time of fieldwork and consequently the site classifications may need to be reviewed with consideration of any site works that may be undertaken after the investigation and this report.

Site works may include:

- Changes to the existing soil profile by cutting and filling.
- Landscaping, including trees removed or planted in the general building area; and
- Drainage and watering systems.

Designs and design methods presented in AS 2870-2011[1] are based on the performance requirement that significant damage can be avoided provided that site conditions are properly maintained. Performance requirements and foundation maintenance are outlined in Appendix B of AS 2870-2011[1]. The above site classification assumes that the performance requirements as set out in Appendix B of AS 2870-2011[1] are acceptable and that site foundation maintenance is undertaken to avoid extremes of wetting and drying.

Details on appropriate site and foundation maintenance practices are presented in Appendix B of AS 2870-2011[1] and in CSIRO Information Sheet BTF 18*, Foundation Maintenance and Footing Performance: A Homeowner's Guide*, which is attached as **Appendix G** – **CSIRO BTF 15** of this report.

Adherence to the detailing requirement outlined in Section 5 of AS 2870-2011[1] is essential, in particular Section 5.6 *Additional requirements for Classes M, H1 and H sites*, including architectural restrictions, plumbing and drainage requirements.

6.2 Footings

All foundations should be designed and constructed in accordance with 2870-2011[1], *Residential Slabs and Footings*[1] with reference to site classifications as presented in Table 5. The designer must satisfy themselves of the suitability of the information provided for design purposes and the presence of trees on adjacent properties should be considered.

All footings should be founded below any topsoil, slopewash, deleterious soils or uncontrolled fill. All footings for the same structure should be founded on strata of similar stiffness and reactivity to minimise the risk of differential movements. Potential for differential movement should be considered due to variation in depth to rock across the Site and articulation incorporated into the design.

6.2.1 High Level Footings

High-level footing alternatives could be expected to comprise slabs on ground with edge beams or pad footings for the support of concentrated loads. Such footings designed in accordance with engineering principles and founded in stiff or better soils (below topsoil, slopewash, uncontrolled fill or other deleterious material) may be proportioned on an allowable bearing capacity of 100 kPa for Sandy Clay / Silty Clay and Clayey Gravelly SAND and 500kPa for weathered Sandstone. Noting isolated zones of lower bearing capacity on lot 106, 107, 111 and 117 were attributed to wet weather preceding investigation and not have been considered in the site classifications.

Where controlled lot filling has been carried out, high-level footing types can be founded below any topsoil onto the engineered fill that is placed and compacted in accordance with AS3798-2007 [2].

Where footings designed in accordance with engineering principles and founded uniformity on competent weathered rock may be proportioned on an allowable bearing capacity of 500 kPa. The founding conditions should be assessed by a geotechnical consultant or experienced engineer to confirm suitable conditions.

6.2.2 Piered Footings

Piered footings are considered as an alternative to deep edge beams or high-level footings and provide an alternate founding solution. It is suggested that bored piered footings, founded in very stiff or better natural clay could be proportioned on an end bearing pressure of 150 kPa or if founded in extremely weathered competent sandstone, could be proportioned on an end bearing pressure of 500 kPa.

All footings should be founded below any topsoil, slopewash, deleterious soils or uncontrolled fill. All footings for the same structure should be founded on strata of similar stiffness and reactivity to minimise the risk of differential movements.

Inspection of high level or pier footings excavations should be undertaken to confirm the founding conditions, and the base should be cleared of fall-in prior to the formation of the footing.

Piered footings for residential type light weight structures do not necessarily need to be founded in the natural soils where fill is undertaken in accordance with AS3798-2007[2] and satisfies the criteria of controlled fill as per AS2870-2011. Where a combination of footing types is employed, and variable fill depths exist, the potential for differential movement should be considered and articulation incorporated into the design.

Dynamic Cone Penetrometer testing undertaken for Retaining Wall RW1 confirmed allowable bearing capacity ≥150kPa at the location and the depth tested.

7 Conclusions

From a geotechnical viewpoint there are no constraints on the type of residential structures that may be constructed on lot 101 to 132, 203 to 232 and 301 to 328 inclusive, provided all foundations are designed and constructed in accordance with AS 2870-2011, Residential Slabs and Footings [2]. Flexible structures such as articulated brick veneer, timber or similar are considered appropriate with articulation provided in the design where appropriate, with slab and footing designed for classifications of **Class M**, moderately reactive or **Class H2**, highly reactive for each lot as shown in Table 5.

Consideration to the adoption of **Class H2** for lots 307 to 327 due to the depth of soil profile and that rock was not encountered during investigation of these lots and the lots are in their natural state following regrade (cutting) with no filling undertaken except minor filling on lot 327 and 328 at the front of lots.

All filling was undertaken in accordance with Section 8 of AS3798-2007[2] with test results satisfying the compaction criteria for controlled fill as defined in AS2870-2011[1].

8 References

[1.] Australian Standard AS2870-2011. *Residential Slabs and Footings.* Standards Australia, 2011.

[2.] Australian Standard AS3798-2007**.** *Guidelines on Earthworks for Commercial and Residential Structures.* Standards Australia, 2007.

[3.] Maitland City Council – Manual of Engineering Standards (MoES).

[4.] EP Risk Report on "*"Preliminary Geotechnical Assessment Lot 12 D.A 1283071 Raymond Terrace Road, Chisholm", Ref EP2508.004v8 dated 30 August 2023*

[5.] "*Engineering Correlations for the Characterisation of Reactive Soil Behaviour for Use in Road Construction*" University of Southern Queensland Faculty of Health, Engineering & Sciences by Peter William Reynolds, October 2013.