Douglas PARTNERS

GROUNDED EXPERTISE

Report on Preliminary Geotechnical Site Investigation

Proposed Manufactured Home Estate

27-31 Metford Road, Tenambit NSW

Prepared for Regal Hunter Properties Pty Ltd

Project 225276.00

13 June 2024

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

Signature		Date
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Douglas Partners acknowledges Australia's First Peoples as the Traditional Owners of the Land and Sea on which we operate. We pay our respects to Elders past and present and to all Aboriginal and Torres Strait Islander peoples across the many communities in which we live, visit and work. We recognise and respect their ongoing cultural and spiritual connection to Country.

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Report on Preliminary Geotechnical Site Investigation Proposed Manufactured Home Estate

27-31 Metford Road, Tenambit NSW

1. Introduction

Douglas Partners Pty Ltd (Douglas) has been engaged by Regal Hunter Properties Pty Ltd to prepare this Preliminary Geotechnical Site Investigation (contamination) (PSI) undertaken for a Proposed Manufactured Home Estate for the site at 27-31 Metford Road, Tenambit NSW (the site). The site is shown on Drawing 1, Appendix A.

The investigation was undertaken with reference Douglas' proposal 225276.00.P.001.Rev1 dated 17 January 2024.

It is understood that the proposed development of the site includes the construction of a manufactured home estate (MHE) comprising of 101 dwelling sites. Associated works include the demolition of existing dwellings and structures, vegetation clearing, bulk earthworks, construction of roads, stormwater infrastructure and landscaping works. The approximate site extent is shown in Figure 1 below.

The aim of the investigation was to provide a preliminary assessment of soil salinity, potential acid sulfate soils and preliminary assessment of soil characteristics for basin construction (clay core and keyway requirements). The assessment requirements were outlined in pre-DA lodgement meeting minutes with Maitland City Council and the client, dated 31 August 2023.

The investigation included the excavation of eight test pits and laboratory testing of selected samples for general geotechnical properties, salinity characteristics and soil dispersion and sodicity. The details of the field work are presented in this report, together with comments on the items listed above.

This report must be read in conjunction with all appendices including the notes provided in Appendix B.

2. Site Description

At the time of fieldwork, the site was identified as Lots 7 and 8 DP810442 and part Lot 11 DP597659 (27-31 Metford Road, Tenambit). The site contained two rural residential properties and open rural land. Scattered mature trees were present, with generally cleared undergrowth and some scattered vegetation surrounding the residential properties and predominantly cleared grassland for the remainder of the site. A shallow surface drainage channel was observed running north-west to south-east through the centre of the site.

The site falls to the east to south-east, with the northern section of the site slopping more directly east. Elevation ranges from approximately RL 25 AHD at the western site boundary and RL 6 to 8 AHD in the south eastern and eastern parts of the site.

Figure 1: Site boundary (in yellow)

Site identification information is provided in Table 1 below.

Table 1: Site identification

Item	Details
Allotment Identification	Lots 7 and 8 DP810442 and part Lot 11 DP597659
Street Address	27-31 Metford Road
Locality	Tenambit NSW
Site Area	6.625 ha
Local Government Area	Maitland City Council
Zoning	RU2 Rural Landscape
Current Land use	Residential / vacant
Current Owner	Regal Hunter Properties Pty Ltd

3. Published Data

3.1 Geology

Published mapping indicates that the site is underlain by the Permian aged Tomago Coal Measures, generally comprising very fine to medium-grained grey lithic sandstone, sporadically interbedded with laminated to carbonaceous shale and mudstone, siltstone, coal with sporadic interbeds of carbonaceous shale, claystone, sideritic bands, rare pebble paraconglomerate.

3.2 Hydrogeology

Based on the regional topography and the inferred flow direction of nearby watercourses, the anticipated flow direction of groundwater beneath the site is towards the south-east towards Four Mile Creek and the associated unnamed water body to the south-east of the site.

3.3 Soil landscape

Published mapping indicates that the site is underlain by the residual Beresfield soil landscape. It comprises undulating low hills and rises on Permian sediments in the East Maitland Hills region.

Limits to these soils include high foundation hazard, water erosion hazard, seasonal waterlogging and high run-on localised lower slopes, highly acid soils of low fertility.

3.4 Acid sulfate soils

Published acid sulfate soils (ASS) risk mapping indicates that the site is outside mapped ASS data. It is noted, however, that an area of mapped high probability of ASS occurring within 1 m of the ground surface is located approximately 85 m southeast of the site.

Figure 2: Acid sulfate soil mapping

3.5 **Salinity**

Reference to the NSW Central Resource for Sharing and Enabling Environmental Data (SEED) information system eSPADE indicates limited data in the immediate vicinity of the site. However, other data within about 1 km to 1.5 km of the site are shown as having evident to strongly evident saline indicators within available soil profiles.

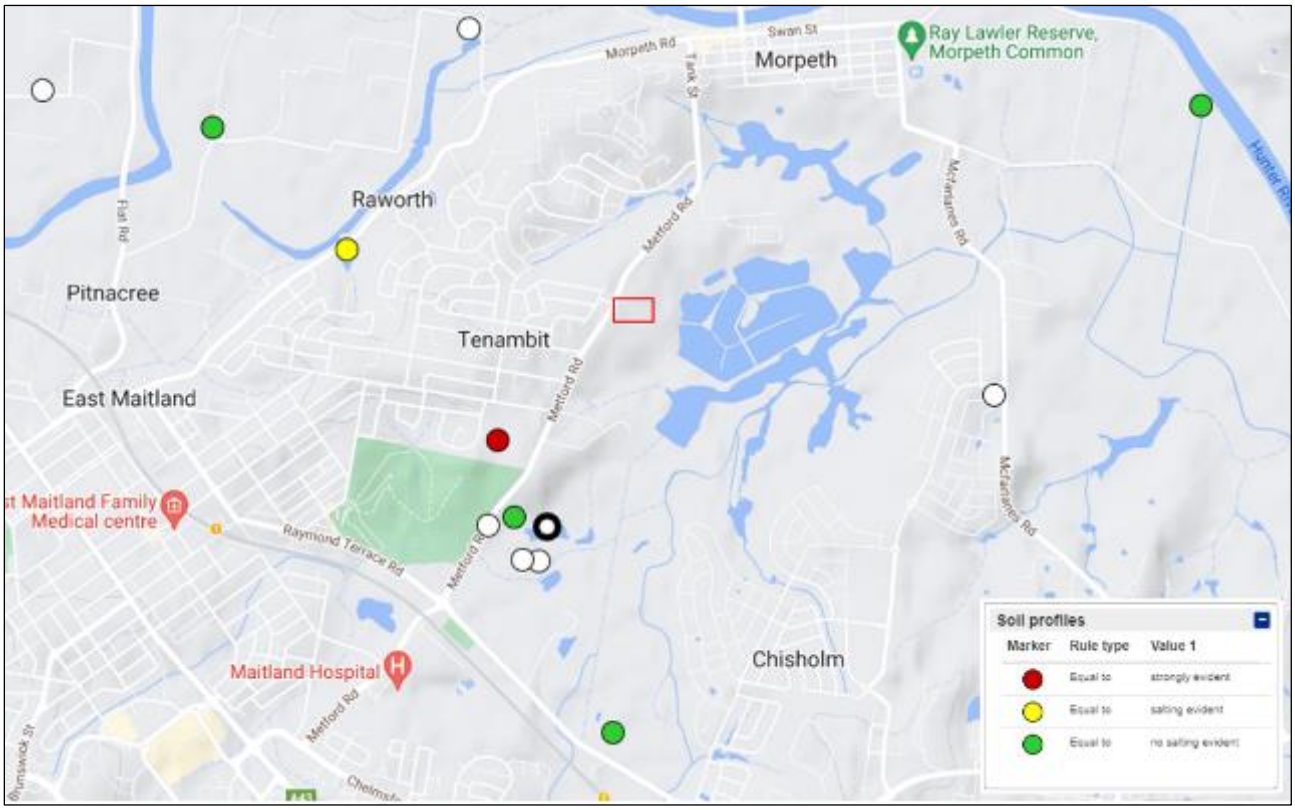

Figure 3: Extract from eSPADE - soil profiles with salinity potential with approximate site extents shown in red outline

Reference to the Australia Dryland Salinity Assessment Spatial Data (1:2,500,000) map, shown in Figure 4 below, indicates that there is a 'high hazard or risk' of dryland salinity (highlighted as orange) in the western corner of the site, along with areas to the north, west and south of the site. The straight boundaries between risk zones on the mapping suggest that the methods used to delineate the zones were approximate and do not reflect geological or topographical boundaries.

Figure 4: Australia Dryland Salinity Assessment Spatial Data

4. Field work

4.1 Field work methods

The field work comprised:

- Eight test pits (Pits 101 to 108) excavated using a 5 t excavator. The pits were generally excavated to a target depth of 2 m to 2.5 m, or prior refusal;
- Regular collection of samples for identification and laboratory testing purposes;
- Pocket penetrometer tests performed at selected depths and locations;
- Collection of two surface water samples to the south-east of the site and one surface water sample at the location of Pit 108 for field screening.

The test locations were set out by a geo-environmental engineer from Douglas prior to the fieldwork whilst service locating for underground services. The test locations were set out to target areas of interest, to provide coverage in areas of proposed development, including the area of proposed basin construction (Pit 106) in the south-eastern portion of the site.

4.2 Field work results

The subsurface conditions encountered are presented in detail in the test pit logs, Appendix B. These should be read in conjunction with the accompanying notes which explain the descriptive terms and classification methods used in the reports. The following is a summary of these subsurface conditions.

The subsurface conditions at the site comprised silty sand topsoil and upper silty sand, underlain by very stiff to hard clay (likely residual clay), which graded to weathered rock at variable depth. Surficial topsoil was encountered at most locations, and fill was encountered in Pit 104 (fill pad), generally comprising silty sand with intermixed crushed brick, tile and glass.

Most test pits recorded that the residual clay profile was grading to weathered rock below depths of about 0.9 m to 1.3 m. Pits 101 to 104, 106 and 108 were all terminated prior to the target depth on account of slow progress in the rock (with a 5 t excavator). Pits 105 and 107 were both terminated at a depth of 2 m and the profile was grading into weathered rock.

The following table summarises some of the key observations in the test pits.

Table 2: Approximate depth to rock at the test locations

Locations	Approx Level (AHD)	Depth to rock, below ground level (m)	Approx. Rock level, AHD
Pit 101	20.0	1.3	18.7
Pit 102	21.5	1.6	19.9
Pit 103	18.5	0.9	17.6
Pit 104	13.5	1.3	12.2
Pit 105	13.5	>2.0	-
Pit 106	8.0	0.9	7.1
Pit 107	13.0	>2.0	-
Pit 108	16.0	1.0	15.0

No free groundwater was observed during excavation of test pits. Surface water flowed into Pit 108 from the adjacent surface water drainage channel during pit excavation. It should be noted that groundwater levels are affected by factors such as climatic conditions and soil permeability and will therefore vary with time.

Field screening of surface waters was conducted on 27 March 2024 at three surface water locations within and outside the site, as indicated on Drawing 1, Appendix A.

Table 3: Surface water field screening, 27 March 2024

Location	pH	Electrical Conductivity (µS/cm)	Dissolved Oxygen (%)	Turbidity (NTU)	Redox (mV)	Observations
SW1	5.9	1050	55.1	7.2	186	Light brown surface water
SW2	6.9	2200	94.5	80.1	174	Dark brown surface water
SW3 (Pit 108)	7.0	154	61.2	20.6	145	Inflow from adjacent surface water into Pit 108

5. Laboratory Testing

Laboratory testing comprised the following:

- Three Emerson Class Tests (soil dispersion screening tests);
- Two pinhole dispersion tests;
- Three Atterberg limits tests;
- Five exchangeable sodium percentage (ESP) and cation exchange capacity (CEC) tests;
- Three soil aggressiveness tests (pH, EC, chlorides and sulfates); and
- Ten additional pH and EC tests for screening of salts in soil for preliminary salinity assessment.

The detailed soil test results are attached in Appendix C, and are summarised in the following tables:

Table 4: Results of Laboratory Testing - Emerson Class and Pinhole Dispersion

Pit	Depth (m)	Description	Moisture Content (%)	Emerson Class No	Pinhole Dispersion Testing
106	0.0-0.3	Silty Sand	18.1	2	NT
106	0.4-0.5	Sandy clay	21.7	2	D2 – Dispersive
106	0.6 - 0.8	Sandy clay	13.8	2	D2 – Dispersive

Table 5: Results of Laboratory Testing – Plasticity Index

Pit	Depth (m)	Description	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
106	0.0-0.3	Silty Sand	18.1	27	18	9
106	0.4-0.5	Sandy clay	21.7	46	19	27
106	0.6 - 0.8	Sandy clay	13.8	30	18	12

Table 6: Electrical conductivity, cation exchange capacity, chloride and sulfate testing

				pH, EC and CEC						Additional PhysChem								
				pH 1:5 soil:water	Cation Exchange Capacity	Electrical Conductivity 1:5 soil:water	Electrical Conductivity 1:5 soil:water	Extract Electrical Conductivity ECe [a]	Soil Salinity Class [b]	Chloride	Sulphate	Aggressivity concrete	Aggressivity steel	Exchangeable Ca	Exchangeable K	Exchangeable Mg	Exchangeable Na	Sodicity Rating [c]
			PQL		1	1				10	10			0.1	0.1	0.1	0.1	
Sample ID	Depth	Description	Sample Date	pH Units	cmol/kg	µs/cm	dS/m			mg/kg	mg/kg			cmol/kg	cmol/kg	cmol/kg	cmol/kg	
102	0.1 - 0.2 m	Silty sand	20/03/24	**5.6**	**2.8**	**64**	**0.064**	**0.896**	**non-saline**	NT	NT			**0.6**	**0.5**	**1.4**	**0.3**	**non-sodic**
102	0.4 - 0.9 m	Clay	20/03/24	**4.9**	**5.9**	**260**	**0.26**	**1.82**	**non-saline**	**140**	**200**			**1.5**	**0.4**	**3.4**	**0.7**	**non-sodic**
103	0.1 - 0.3 m	Silty sand	20/03/24	**5.5**	-	**59**	**0.059**	**0.826**	**non-saline**	NT	NT			NT	NT	NT	NT	NT
103	0.5 - 0.8 m	Clay	20/03/24	**5**	-	**230**	**0.23**	**1.61**	**non-saline**	NT	NT			NT	NT	NT	NT	NT
104	0.4 - 0.6 m	Silty sand	20/03/24	**6.9**	-	**290**	**0.29**	**4.06**	**moderately saline**	<10	**83**			NT	NT	NT	NT	NT
104	0.7 - 1.2 m	Clay	20/03/24	**5.1**	-	**120**	**0.12**	**0.84**	**non-saline**	NT	NT			NT	NT	NT	NT	NT
106	0 - 0.3 m	Silty sand	20/03/24	**5.8**	-	**73**	**0.073**	**1.022**	**non-saline**	NT	NT			NT	NT	NT	NT	NT
106	0.4 - 0.5 m	Sandy clay	20/03/24	**5.3**	**9.7**	**100**	**0.1**	**0.7**	**non-saline**	NT	NT			<0.1	**0.3**	**6.9**	**2.4**	**non-sodic**
107	0 - 0.2 m	Clayey silt	20/03/24	**5.8**	-	**140**	**0.14**	**1.26**	**non-saline**	NT	NT			NT	NT	NT	NT	NT
107	0.4 - 1 m	Clay	20/03/24	**4.8**	**39**	**440**	**0.44**	**3.08**	**slightly saline**	**300**	**360**			**1.8**	**1.3**	**27**	**8.7**	**Sodic**
108	0 - 0.05 m	Silty sand	20/03/24	**5.4**	-	**66**	**0.066**	**0.924**	**non-saline**	NT	NT			NT	NT	NT	NT	NT
108	0.1 - 0.4 m	Silty clay	20/03/24	**5.2**	-	**87**	**0.087**	**0.609**	**non-saline**	NT	NT			NT	NT	NT	NT	NT
108	0.6 - 0.9 m	Clay	20/03/24	**5.1**	-	**150**	**0.15**	**1.05**	**non-saline**	NT	NT			NT	NT	NT	NT	NT

Notes:

a EC multiplied by soil-specific factor. Refer to DLWC. (2002b). Site Investigations for Urban Salinity. Department of Land and Water Conservation: 2002.

Silty sand multiplier = 14

Clay multiplier = 7

Clayey silt multiplier = 9

b Soil Salinity class from DLWC. (2002b). Site Investigations for Urban Salinity. Department of Land and Water Conservation: 2002.

Salinity Class:

Non Saline ECe<2dS/m

Slightly Saline ECe 2-4 dS/m

Moderately Saline 4-8 dS/m

Very Saline 8-16 dS/m

Highly Saline >16 dS/m

c Sodicity rating from DLWC. (2002b). Site Investigations for Urban Salinity. Department of Land and Water Conservation: 2002.

Sodicity Class:

Non-sodic ESP<5%

Sodic ESP 5-15%

Highly Sodic >15%

6. Comments

6.1 General

In regards to the requested information in the pre-lodgement minutes dated 31 August 2023, the following comments are made:

- Subsurface conditions generally comprise very stiff to hard clay over weathered rock. Localised fill was encountered in one test pit (Pit 104);
- Soils at the site are considered to be slightly to moderately saline. Preparation of a salinity management plan (SMP) should be considered as part of development documentation;
- Dispersive soils are present at the proposed detention pond location although signs of erosion / dispersion were not noted elsewhere at the site, possibly due to the sound grass cover. Care will be required to ensure adequate erosion protection measures are used during construction, with ongoing maintenance likely to need to be considered;
- Based on the mapped site features and observations made during the subsurface investigation, acid sulfate soils were not encountered during the investigation.

Additional comments are provided in the following sections.

6.2 Soil Salinity

As provided in Section 3.5, mapping for the site and surrounds suggests some potential for soil salinity for the site.

With reference to published guidelines, a conversion factor based on soil type has been used to convert the laboratory measured electrical conductivity values to "EC_e" values for the purpose of assessing the salinity level and the soil salinity class with reference to published guidelines (DLWC, 2002). These conversions and interpretations are shown in Table 6 above.

The results of field and laboratory testing indicate:

- The majority of soils tested were 'non-saline' ;
- One silty sand sample (Pit 104, beneath fill) indicated a 'moderately saline' salinity class;
- One clay sample indicated a 'slightly saline' salinity class;
- Field EC screening indicated adjacent surface water to be 'fresh' and not saline.

On the basis of the above, some of the soils at the site are potentially slightly to moderately saline, and development at the site should be undertaken with reference to a salinity management plan (SMP) which would require more detailed testing to allow delineation of saline areas across the site.

Future design and construction should be undertaken with reference to good practices for development on saline sites (DLWC, 2002), which typically includes:

- Installation of a damp-proof course, or equivalent, within each building;
- Waterproofing building slabs (if applicable);
- The use of higher strength concrete with thicker cover and exposure class masonry;

- Provision of adequate floor ventilation beneath buildings if they are constructed on bearers and joists;
- Maintaining good drainage and minimising excessive infiltration;
- Ensuring that paths which are provided around buildings slope away from the building;
- Careful design of landscaping and landscape watering methods;
- Adequate drainage behind retaining walls; and
- Regular monitoring of pipes, etc, for leaks.

Most of the above features are consistent with the residential slabs and footing standard (AS 2870, 2011).

6.3 **Soil Aggressiveness**

The results of laboratory testing of soil samples collected during field work have been compared to the exposure classifications for steel and concrete as outlined in the piling standard (AS2159, 2009). The following table summarises the exposure classifications for each of the samples tested.

Table 7: Soil Aggressiveness Exposure Classification (AS2159, 2009)

Pit	Depth (m)	Description	Soil Condition	pH (concrete)	pH (steel)	Resistivity[1] (Ω.cm) (steel)	SO3 (ppm) (concrete)	Cl (ppm) (steel)
102	0.4-0.9	Clay	B	4.9	4.9	3846	200	140
104	0.4-0.6	silty sand	B	6.9	6.9	3448	83	<10
107	0.4-1.0	Clay	B	4.8	4.8	2273	360	300

Notes to Table 7

Non-aggressive
Mildly aggressive
Moderately aggressive
Severely Aggressive
Very Severe

1 Resistivity calculated based on inverse of conductivity in aqueous solution results

Scale of aggressivity based on threshold values given in AS 2159 – 2009: Piling – Design and Installation.

The results in Table 6 above suggest non-aggressive to mildly aggressive soil conditions for buried steel and concrete.

6.4 Soil Dispersion and Erosion

6.4.1 Soil Sodicity Characteristics

Sodicity is the level of exchangeable sodium in a soil, and relates to the likely dispersion on wetting and to shrink/swell characteristics. Sodic soils are prone to:

- Severe surface crusting;
- Low infiltration and hydraulic conductivity;
- Hard subsoils;
- Gully and tunnel erosions; and
- Restricted root growth and shallow rooting for plants.

Sodic soils are hard when dry, and slow to wet up and can be soft and boggy when wet.

Sodicity or exchangeable sodium percentage (ESP) has been estimated based on the results of laboratory testing, as outlined in Table 6, based on published guidelines (DLWC, 2002).

The results generally indicate that of the samples tested, only one sample (107/0.4-1.0, clay) are considered to be sodic.

This suggests that the particles under these sodic conditions may disperse when they become wet, and that the on-site soils will have a relatively low permeability. The site soils are also likely to be susceptible to erosion.

Typically, calcium in the form of gypsum can be added to sodic soils to address the balance between sodium and calcium in the soil, and reduce the risk of erosion. Other erosion control measures are discussed in Section 6.4.3.

6.4.2 Soil Dispersion Characteristics

The results of the laboratory testing in Table 4 above indicate that there are dispersive soils at the location of the detention basin (Pit 106). These results combined with the result of sodic soils (Refer Section 6.4.2) suggest dispersive soils are likely to be present across the overall site

Emerson testing indicated an Emerson class number of 2 for the tested soils. Soils with an Emerson class number of less than 4 are generally considered to have a higher risk of dispersion, although it is noted that the Emerson test is a screening test, providing qualitative interpretations.

Two pinhole dispersion tests also indicated that the tested soils were considered to be dispersive.

6.4.3 Soil Dispersion Management

Soil dispersion and erosion risk will need to be taken into account in the design of sediment and erosion control plans for the site and can generally be managed through construction and engineering controls.

Dispersive soils can generally be managed by:

- Maintaining vegetation cover, and possibly adding organic matter and/or gypsum, particularly for dam construction;
- Ensuring good control of moisture and compaction during earthworks;
- Appropriate erosion and sediment control measures are included in the final construction;
- Adequate erosion control is included in areas where higher water velocities could be expected (eg unlined drainage channels etc).

6.4.4 Detention Basins

Detention basins will be constructed as part of the proposed development, however details regarding their configurations were not known at the time of this report. It is assumed that detention basins will generally be constructed through a combination of excavation of the basin area and fill for embankment construction. The current investigation has included only general consideration of the properties of the on-site soils for potential use in detention basin construction. Additional targeted investigation should be undertaken once the location and configuration of detention basins are known.

There are several key geotechnical considerations for typical earth-dam construction such as detention basins that are typical for residential subdivision construction, including those proposed for this site, as follows:

- The propensity of the soils to disperse when in contact with fluid intended to be retained;

- The need for a zoned embankment. A zoned embankment includes several different material zones, each with different functions. A homogeneous embankment comprises a single material type for the whole embankment;
- A zoned earthfill detention basin embankment would typically include a zone of low permeability material, either on the upstream face or as a central core, with the other embankment material often able to comprise a range of earthfill materials from a local borrow area. Zoned embankments generally provide an improved degree of control of internal erosion and piping, and in some cases an improved control of pore pressure for stability, compared to a homogeneous embankment. A zoned embankment requires a high degree of control over the material quality being used in different areas of the embankment. A zoned embankment is also adopted when there is a limited amount of a particular material type such as the material for the clay core or if selective treatment of a layer is required such as for dispersion;
- A homogeneous embankment, however, provides no filter control, and seepage at the downstream face / toe is a risk. There is also a poor degree of control of pore pressures for embankment stability. If the consequence of detention basin embankment failure is low, a homogeneous embankment could be considered;
- Inclusion of a keyway beneath the detention basin embankment. This is generally considered an important component of most earthfill water retention structures, with the purpose of the keyway being to create a controlled foundation which interrupts potential seepage paths, and "keys" the embankment into the natural site soils or rock. The keyway should be constructed using a low permeability, non-dispersive soil, similar to that which would be used for clay core / clay liner, and should be included irrespective of whether the embankment is constructed as a zoned or homogeneous embankment;
- The construction of pipes through detention basin embankments. These are areas that provide increased risk of piping and detention basin embankment failure if not properly constructed. This can, at times, include a requirement to concrete-encase pipes through the embankment in combination with a specifically designed filter medium around the pipe backfill zone. The specifications for a filter medium are a function of the characteristics of the 'parent material' from which the embankment has been constructed, and requires targeted geotechnical testing, analysis and design.

If the consequences of detention basin failure could include loss of life and/or damage to property downstream, then the detention basin should be constructed as a zoned embankment, with a clay core and keyway. If the consequences of detention basin failure are insignificant, then a homogeneous embankment could be considered.

It is assumed that the detention basin embankment fill material will be won from on-site excavations. Based on the results of the test pits, the natural site material is anticipated to include high plasticity clay and ripped rock.

The following tables summarise the recommended material property guidelines for a clay core (zoned embankment), keyway and/or homogeneous detention basin embankment.

Table 8: Recommended Material Properties - Clay Core / Keyway / Homogeneous Embankment

Material Property		Specification
Grading	Maximum Particle Size	50 mm
	% Passing 2.36 mm sieve	60% to 100%
	% Passing 75 μm sieve	>30%
Plasticity	Plasticity Index (PI)	CH-CI-CL clay fines (ie above the 'A-line')
Dispersion	Emerson Class	> 4

The following tables summarise the recommended material property guidelines for general shoulder embankment fill if a zoned embankment is constructed.

Table 9: Recommended Material Properties – General Embankment Shoulder Fill (Zoned Embankment)

Material Property		Specification
Grading	Maximum Particle Size	100 mm
	% Passing 75 μm sieve	>15%
Plasticity	Plasticity Index (PI)	CH-CI-CL clay fines (ie above the 'A-line')
Dispersion	Emerson Class	> 4

It is noted that soils with Emerson Class 1 to 4, as encountered on this site, need to be treated with extra caution if they are to be used in detention basin embankment construction (Fell, et al., 2005). Dispersive soils are a major contributor to piping failure within embankments when used in embankments which retain water.

Of the materials assessed as part of the current investigation:

- Particle size distribution testing was not conducted on the samples, however it is likely that the on-site clays contain more than 30% fines (ie <75 μm), so are likely to satisfy the grading requirements for clay core / keyway / homogeneous embankment;
- All clay samples tested during the current investigation had an Atterberg limit that placed the result above the 'A-line' for CH-CI-CL fines;
- The results of the Emerson class number tests indicated Emerson number of 2 for all samples tested, indicating dispersive soils. The risks associated with dispersive soils can be reduced through the addition of gypsum. Dispersive soil risks can also, in part, be managed through construction controls such as tight control of compaction and moisture, as well as the provision of appropriate erosion controls, and consideration of where the material is to be used in the embankment.

The results of testing of soils, conducted in the approximate location of the proposed detention basin (i.e. Pit 106 in the south-eastern corner of the site), indicated the presence of clayey dispersive soils. On-site clayey soils could be considered for use in detention basin embankment construction, subject to addressing the issue of soil dispersion.

Topsoil, silty sand and organic-rich soils are not suitable for use in the embankment. Weathered rock excavated from the site, that has been subjected to mechanical breakdown to satisfy the maximum particle size requirements, is expected to be suitable for use in shoulder zone embankment fill if a zoned embankment is constructed.

Once the proposed detention basin configurations are known, geotechnical comments regarding proposed batter slopes should be reviewed.

It is recommended that exposed batter slopes be protected against erosion by topsoiling and grassing.

In areas where high water velocities are expected (ie around filling points) erosion resistance measures other than grassing may be required, eg rip rap material, grasses grown with a stabilised mesh or reinforcing blanket.

Detention basin fill embankment heights are not known but are assumed to be less than 3 m vertical height. It is also assumed that excavations will be in the order of 2 m depth or less. If the proposed geometry exceeds either of these values, the recommendations below should be reviewed and revised if necessary.

The following general procedure should be considered detention basin construction:

- Preparation for the basin should include removal of the surface vegetation, uncontrolled fill, topsoil and silty and sandy soils from the area of the proposed basin;
- Excavate to design depth. The embankment foundation should be excavated an additional 0.5 m depth (subject to geotechnical inspection, ie below any shrinkage cracks) along the embankment alignment to provide a key and help restrict seepage. The keyway excavation should be battered no steeper than 45° (1H:1V);
- Exposed clay should be tyned to at least 200 mm depth and re-compacted to at least 95% dry density ratio standard at a moisture content within the range OMC to OMC +3% (wet). Where extremely weathered bedrock is encountered at the base and on the batters of the basin, the rock should be tyned and re-compacted for at least 200 mm depth;
- Clay should not be allowed to dry and crack before placement of fill. If desiccation cracking occurs, the clay should be tyned, moisture conditioned and re-compacted;
- The foundation key material should be placed in 250 mm loose thickness horizontal layers to the same density and moisture content as described above;
- The embankment crest and batters should be protected against erosion by grass cover or other suitable methods;
- If the basin will include an emergency spillway or similar, it is recommended that adequate measures be designed and constructed to minimise erosion and scour of the embankment. The integrity of the embankment should be maintained in the event that the spillway is overtopped;
- If rock is exposed in the base of the basin, a clay layer of approximately 300 mm thickness may need to be placed and compacted;
- Detention basin batters should generally be no steeper than about 3H:1V without additional geotechnical assessment.

Care will be required when constructing the embankments to ensure adequate compaction is achieved and good bonding between fill layers, and also between embankment fill and natural ground. Where fill is to be placed on natural slopes, benching into the existing slope will be required to allow horizontal layers to be placed and compacted. It is also recommended that the embankment fill be placed and compacted beyond the final slope line, and then trimmed back to the design slope line. Poor compaction of fill to the full extent of the embankment presents an increased risk of slope instability, particularly if the slope becomes wet.

It is important that the embankment key and foundation are constructed in 'dry' conditions. Temporary cut-off drains or similar may need to be installed ahead of construction of the embankment to divert any surface water run on away from the embankment foundation prior to construction. If the embankment foundation is saturated, it will not be possible to achieve compaction of the embankment foundation.

Detention basin embankments should be constructed under Level 1 earthworks supervision (AS 3798, 2007).

7. References

AS 2159. (2009). *Piling - Design and Installation.* Standards Australia.

AS 2870. (2011). *Residential Slabs and Footings.* Standards Australia.

AS 3798. (2007). *Guidelines on Earthworks for Commercial and Residential Developments.* Standards Australia.

AS2159. (2009). *Piling – Design and Installation.* Standards Australia.

DLWC. (2002). *Site Investigations for Urban Salinity.* NSW Department of Land and Water Conservation: 2002.

DPE. (undated). *Book 2 Dryland Salinity: Identifying Saline Sites.* NSW Department of Planning and Environment: Available on NSW Department of Planning and Environment website, but otherwise unrefernced and undated.

Fell, R., MacGregor, P., Stapleton, D., & Bell, G. (2005). *Geotechnical Engineering of Dams.* AA Balkema.

8. Limitations

Douglas Partners Pty Ltd (Douglas) has prepared this report for this project at 27-31 Metford Road, Tenambit NSW with reference to Douglas' proposal dated 17 January 2024 and acceptance received from Regal Hunter Properties Pty Ltd dated 6 February 2024. The work was carried out under Douglas' Engagement Terms. This report is provided for the exclusive use of Regal Hunter Properties Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above,

and without the express written consent of Douglas, does so entirely at its own risk and without recourse to Douglas for any loss or damage. In preparing this report Douglas has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after Douglas' field testing has been completed.

Douglas' advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by Douglas in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

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

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

Appendix A

Drawing 1: Test Location Plan

SITE LOCATION

LEGEND

- Test Pit Location
- Surface Water Monitoring Location
- Site Boundary

0 20 40 60 80 100 m

NOTE:

1. Drawing projection in GDA2020 / MGA zone 56, adapted from aerial imagery from "Metromap" dated 15.10.2023, drawing provided by HDB Town Planning and Design, Ref 22159(PC) Rev C dated 9.3.2023.
2. Test locations are approximate only and were located using existing site features.

Douglas PARTNERS	CLIENT: Regal Hunter Properties	TITLE: **Test Location Plan, Preliminary Geotechnical Investigation Proposed Manufactured Home Estate 27-31 Metford Road, Tenambit, NSW**	PROJECT: 225276.00
	OFFICE: Newcastle / DRAWN BY: PLH		DRAWING No: 1
	SCALE: 1:3000 @A3 / DATE: 04.June.2024		REVISION: 0

DP.QGIS.A3LandscapeDrawingLayout.Rev3 - P:\225276.00 - TENAMBIT, Metford Road Prelim Contam\7.0 Drawings\7.2 Out\225276.00.D.001.Mapping.qgz

Appendix B

About this Report

Test Pit Logs – Pits 1 to 8

About this Report

November 2023

Introduction

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

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

Copyright

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

continued next page

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

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TEST PIT LOG

CLIENT: Regal Hunter Properties Pty Ltd
PROJECT: Proposed Manufactured Home Estate
LOCATION: 27-31 Metford Road, Tenambit, NSW

SURFACE LEVEL: 20.0 AHD
COORDINATE:
DATUM/GRID:
DIP/AZIMUTH: 90°/---°

LOCATION ID: 101
PROJECT No: 225276.00
DATE: 20/03/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN[#]	CONSIS.[*] / DENSITY.[*]	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
20/03/24 no free groundwater observed	0.05	Silty SAND (SM), trace gravel: light brown; fine; with rootlets.		RS	NA	M						
		Silty SAND (SM), with gravel: light brown; fine to medium; trace rootlets.		RS	NA	M						
	0.50	Silty CLAY (CL): dark brown mottled orange; low plasticity; trace rootlets.		RS	H	w<PL				1	PP	>400kPa
	1											
	1.10	Gravelly CLAY (CL): light brown mottled orange white; low plasticity; grading to bedrock.		RS	NA	w<PL						
	2	Test Pit discontinued at 1.30m depth. Virtual refusal on rock.										

NOTES: [#] Soil origin is "probable" unless otherwise stated. [*] Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 450mm bucket with teeth
METHOD:
REMARKS: AHD based on contour plan provided by the client

OPERATOR: (Foster Excavations)
LOGGED: Grosvenor

Refer to explanatory notes for symbol and abbreviation definitions

TEST PIT LOG

CLIENT: Regal Hunter Properties Pty Ltd
PROJECT: Proposed Manufactured Home Estate
LOCATION: 27-31 Metford Road, Tenambit, NSW

SURFACE LEVEL: 21.5 AHD
COORDINATE:
DATUM/GRID:
DIP/AZIMUTH: 90°/---°

LOCATION ID: 102
PROJECT No: 225276.00
DATE: 20/03/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
20/03/24 no free groundwater observed	0.05	TOPSOIL / Silty SAND (SM): brown; fine to medium; with rootlets.		TOP	NA	M		D/ES		0.05		
		Silty SAND (SM), with clay: brown grey; fine to medium; trace roots.		RS	NA	M		D/ES		0.10 0.20		
	0.30	CLAY (CH), trace gravel: orange mottled grey; high plasticity; fine to medium gravel; trace rootlets.		RS	H	w>PL		D/ES		0.40 0.90	PP	>400kPa
	1.00	Sandy CLAY (CL), with gravel: grey mottled orange; low plasticity.		RS	VSt	w<PL		D/ES		1 1.20	PP	200-400kPa
		1.50m: grading to rock								1.50		
		Test Pit discontinued at 1.60m depth. Virtual refusal on rock.										

NOTES: (#) Soil origin is "probable" unless otherwise stated. (*) Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 450mm bucket with teeth
METHOD:
REMARKS: AHD based on contour plan provided by the client

OPERATOR: (Foster Excavations)
LOGGED: Grosvenor

Refer to explanatory notes for symbol and abbreviation definitions

TEST PIT LOG

CLIENT: Regal Hunter Properties Pty Ltd
PROJECT: Proposed Manufactured Home Estate
LOCATION: 27-31 Metford Road, Tenambit, NSW

SURFACE LEVEL: 18.5 AHD
COORDINATE:
DATUM/GRID:
DIP/AZIMUTH: 90°/---°

LOCATION ID: 103
PROJECT No: 225276.00
DATE: 20/03/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN[#]	CONSIS.[*] / DENSITY.[*]	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
20/03/24 no free groundwater observed	0.05	TOPSOIL / Silty SAND (SM): brown; fine to medium; with rootlets.		TOP	NA	M		D/ES		0.05		
		Silty SAND (SM), with gravel: light brown; fine to medium; trace rootlets.		RS	NA	M		D/ES		0.10 0.30		
	0.40	CLAY (CH), trace sand: grey mottled orange; high plasticity; trace rootlets, grading to sandstone.		RS	H	w=PL		D/ES		0.50 0.80	PP	>400kPa
	0.90	SANDSTONE: white mottled orange; highly weathered.		RS	NA	NA		D/ES		0.90 1		
	1	Test Pit discontinued at 1.10m depth. Refusal on rock virtual.								1.10		

NOTES: [#] Soil origin is "probable" unless otherwise stated. [*] Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 450mm bucket with teeth
METHOD:
REMARKS: AHD based on contour plan provided by the client

OPERATOR: (Foster Excavations)
LOGGED: Grosvenor

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Soil Log

TEST PIT LOG

CLIENT: Regal Hunter Properties Pty Ltd
PROJECT: Proposed Manufactured Home Estate
LOCATION: 27-31 Metford Road, Tenambit, NSW

SURFACE LEVEL: 13.5 AHD
COORDINATE:
DATUM/GRID:
DIP/AZIMUTH: 90°/---°

LOCATION ID: 104
PROJECT No: 225276.00
DATE: 20/03/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN[#]	CONSIS.[*] / DENSITY.[*]	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
20/03/24 no free groundwater observed		FILL / Silty SAND (SM): brown; fine to medium; trace brick, tile, gravels, glass.		FILL	NA	M		D/ES		0.30		
	0.40	Silty SAND (SM), with gravel, trace clay: brown; fine to medium; trace rootlets.		RS	NA	M		D/ES		0.40 0.60		
	0.60	CLAY (CH): grey mottled orange; high plasticity; trace rootlets, grading to sandstone.		RS	VSt	w=PL		D/ES		0.70 1 1.20	PP	200-400kPa
	1.30	SANDSTONE: white mottled orange; highly weathered.		RS	NA	NA		D/ES		1.30		
		Test Pit discontinued at 1.50m depth. Virtual refusal on rock.								1.50		

NOTES: [#] Soil origin is "probable" unless otherwise stated. [*] Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 450mm bucket with teeth
METHOD:
REMARKS: AHD based on contour plan provided by the client

OPERATOR: (Foster Excavations)
LOGGED: Grosvenor

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Soil Log

TEST PIT LOG

CLIENT: Regal Hunter Properties Pty Ltd
PROJECT: Proposed Manufactured Home Estate
LOCATION: 27-31 Metford Road, Tenambit, NSW

SURFACE LEVEL: 13.5 AHD
COORDINATE:
DATUM/GRID:
DIP/AZIMUTH: 90°/---°

LOCATION ID: 105
PROJECT No: 225276.00
DATE: 20/03/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN[#]	CONSIS.[*] / DENSITY.[*]	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
20/03/24 no free groundwater observed	0.20	TOPSOIL / Silty SAND (SM), with gravel: brown; fine to medium gravel; with rootlets.		TOP	NA	M		D/ES		0.20		
		CLAY (CH), trace sand: brown mottled red; high plasticity; fine sand.		RS	VSt	w>PL		D/ES		0.30	PP	200-400kPa
	1.00	CLAY (CH), trace sand: grey mottled red; high plasticity; coarse sand; grading to claystone.		RS	St	w<PL		D/ES		0.90 1 1.10	PP	100-200kPa
	2	Test Pit discontinued at 2.00m depth.								1.90		

NOTES: [#] Soil origin is "probable" unless otherwise stated. [*] Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 450mm bucket with teeth
METHOD:
REMARKS: AHD based on contour plan provided by the client

OPERATOR: (Foster Excavations)
LOGGED: Grosvenor

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Soil Log

TEST PIT LOG

CLIENT: Regal Hunter Properties Pty Ltd
PROJECT: Proposed Manufactured Home Estate
LOCATION: 27-31 Metford Road, Tenambit, NSW

SURFACE LEVEL: 8.0 AHD
COORDINATE:
DATUM/GRID:
DIP/AZIMUTH: 90°/---°

LOCATION ID: 106
PROJECT No: 225276.00
DATE: 20/03/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN[#]	CONSIS.[*] / DENSITY.[*]	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
20/03/24 no free groundwater observed	0.10	TOPSOIL / Silty SAND (SM), with gravel: brown; fine to medium gravel; with rootlets.		TOP								
		Silty SAND, with gravel: brown; fine to medium gravel; trace rootlets.		RS	NA	M		D/ES		0.30		
	0.40	Sandy CLAY: brown mottled orange.		RS	St	w>PL		D/ES		0.40 0.50	PP	100-200kPa
	0.60	Sandy CLAY: orange mottled grey; coarse sand; grading to claystone.		RS	St	w<PL		D/ES		0.60 0.80	PP	100-200kPa
	0.90	CLAYSTONE: grey mottled red; highly weathered.		RS	NA	NA						
	1	Test Pit discontinued at 1.00m depth. Virtual refusal on rock.										
	2											

NOTES: [#] Soil origin is "probable" unless otherwise stated. [*] Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 450mm bucket with teeth
METHOD:
REMARKS: AHD based on contour plan provided by the client

OPERATOR: (Foster Excavations)
LOGGED: Grosvenor

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

TEST PIT LOG

CLIENT: Regal Hunter Properties Pty Ltd
PROJECT: Proposed Manufactured Home Estate
LOCATION: 27-31 Metford Road, Tenambit, NSW

SURFACE LEVEL: 13.0 AHD
COORDINATE:
DATUM/GRID:
DIP/AZIMUTH: 90°/---°

LOCATION ID: 107
PROJECT No: 225276.00
DATE: 20/03/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN[#]	CONSIS.[^] / DENSITY.[^]	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
20/03/24 no free groundwater observed	0.30	TOPSOIL / Clayey SILT: brown; with rootlets.		TOP	NA	M		D/ES		0.20		
	1	CLAY: brown mottled dark brown.		RS	F	w>PL		D/ES		0.40	PP	50-100kPa
	1.20	Sandy CLAY: grey mottled orange; grading to claystone.		RS	NA			D/ES		1.00 1.30		
	2	Test Pit discontinued at 2.00m depth.								2.00		

NOTES: [#] Soil origin is "probable" unless otherwise stated. [^] Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 450mm bucket with teeth
METHOD:
REMARKS: AHD based on contour plan provided by the client

OPERATOR: (Foster Excavations)
LOGGED: Grosvenor

Refer to explanatory notes for symbol and abbreviation definitions

Generated with CORE-GS by Geroc - Soil Log

Douglas PARTNERS

TEST PIT LOG

CLIENT: Regal Hunter Properties Pty Ltd
PROJECT: Proposed Manufactured Home Estate
LOCATION: 27-31 Metford Road, Tenambit, NSW

SURFACE LEVEL: 16.0 AHD
COORDINATE:
DATUM/GRID:
DIP/AZIMUTH: 90°/---°

LOCATION ID: 108
PROJECT No: 225276.00
DATE: 20/03/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m) / DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN[#]	CONSIS.[*] / DENSITY.[*]	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
20/03/24 no free groundwater observed	0.05	TOPSOIL / Silty SAND (SM), with gravel: brown; fine to medium gravel; with rootlets.		TOP	NA	M		D/ES		0.05		
		Silty CLAY (CL): brown mottled red; low plasticity; trace rootlets.		RS	VSt	w<PL		D/ES		0.10	PP	200-400kPa
	0.50	CLAY (CH), trace sand: brown mottled orange; high plasticity; coarse sand; trace rootlets, grading to sandstone.		RS	St	w>PL		D/ES		0.40 0.60	PP	100-200kPa
	1.00	SANDSTONE: grey mottled orange; highly weathered.		RS	NA	NA		D/ES		0.90 1 1.20		
	2	Test Pit discontinued at 1.70m depth. Virtual refusal on rock.								1.70		

NOTES: [#] Soil origin is "probable" unless otherwise stated. [*] Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 450mm bucket with teeth
METHOD:
REMARKS: AHD based on contour plan provided by the client

OPERATOR: (Foster Excavations)
LOGGED: Grosvenor

Refer to explanatory notes for symbol and abbreviation definitions

Appendix C

Laboratory Testing Reports

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 348011

Client Details

Client	Douglas Partners Newcastle
Attention	Patrick Heads
Address	Box 324 Hunter Region Mail Centre, Newcastle, NSW, 2310

Sample Details

Your Reference	**225276.00 - Tenambit**
Number of Samples	13 Soil
Date samples received	04/04/2024
Date completed instructions received	04/04/2024

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	11/04/2024
Date of Issue	10/04/2024

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Jenny He, Senior Chemist
Loren Bardwell, Development Chemist

Authorised By
Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		348011-1	348011-2	348011-3	348011-4	348011-5
Your Reference	UNITS	102	102	103	103	104
Depth		0.1-0.2	0.4-0.9	0.1-0.3	0.5-0.8	0.4-0.6
Date Sampled		20/03/2024	20/03/2024	20/03/2024	20/03/2024	20/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	04/04/2024	04/04/2024	04/04/2024	04/04/2024	04/04/2024
Date analysed	-	08/04/2024	08/04/2024	08/04/2024	08/04/2024	08/04/2024
pH 1:5 soil:water	pH Units	5.6	4.9	5.5	5.0	6.9
Electrical Conductivity 1:5 soil:water	µS/cm	64	260	59	230	290
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	140	[NA]	[NA]	<10
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	200	[NA]	[NA]	83

Misc Inorg - Soil						
Our Reference		348011-6	348011-7	348011-8	348011-9	348011-10
Your Reference	UNITS	104	106	106	107	107
Depth		0.7-1.2	0-0.3	0.4-0.5	0-0.2	0.4-1
Date Sampled		20/03/2024	20/03/2024	20/03/2024	20/03/2024	20/03/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	04/04/2024	04/04/2024	04/04/2024	04/04/2024	04/04/2024
Date analysed	-	08/04/2024	08/04/2024	08/04/2024	08/04/2024	08/04/2024
pH 1:5 soil:water	pH Units	5.1	5.8	5.3	5.8	4.8
Electrical Conductivity 1:5 soil:water	µS/cm	120	73	100	140	440
Chloride, Cl 1:5 soil:water	mg/kg	[NA]	[NA]	[NA]	[NA]	300
Sulphate, SO4 1:5 soil:water	mg/kg	[NA]	[NA]	[NA]	[NA]	360

Misc Inorg - Soil				
Our Reference		348011-11	348011-12	348011-13
Your Reference	UNITS	108	108	108
Depth		0-0.05	0.1-0.4	0.6-0.9
Date Sampled		20/03/2024	20/03/2024	20/03/2024
Type of sample		Soil	Soil	Soil
Date prepared	-	04/04/2024	04/04/2024	04/04/2024
Date analysed	-	08/04/2024	08/04/2024	08/04/2024
pH 1:5 soil:water	pH Units	5.4	5.2	5.1
Electrical Conductivity 1:5 soil:water	µS/cm	66	87	150

ESP/CEC					
Our Reference		348011-1	348011-2	348011-8	348011-10
Your Reference	UNITS	102	102	106	107
Depth		0.1-0.2	0.4-0.9	0.4-0.5	0.4-1
Date Sampled		20/03/2024	20/03/2024	20/03/2024	20/03/2024
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	09/04/2024	09/04/2024	09/04/2024	09/04/2024
Date analysed	-	09/04/2024	09/04/2024	09/04/2024	09/04/2024
Exchangeable Ca	meq/100g	0.6	1.5	<0.1	1.8
Exchangeable K	meq/100g	0.5	0.4	0.3	1.3
Exchangeable Mg	meq/100g	1.4	3.4	6.9	27
Exchangeable Na	meq/100g	0.3	0.7	2.4	8.7
Cation Exchange Capacity	meq/100g	2.8	5.9	9.7	39
ESP	%	10	11	25	22

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-OES analytical finish.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			04/04/2024	2	04/04/2024	04/04/2024		04/04/2024	[NT]
Date analysed	-			08/04/2024	2	08/04/2024	08/04/2024		08/04/2024	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	2	4.9	4.9	0	100	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	2	260	270	4	101	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	140	160	13	99	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	200	190	5	98	[NT]

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	12	04/04/2024	04/04/2024		[NT]	[NT]
Date analysed	-			[NT]	12	08/04/2024	08/04/2024		[NT]	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	12	5.2	5.2	0	[NT]	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	[NT]	12	87	86	1	[NT]	[NT]

QUALITY CONTROL: ESP/CEC						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			09/04/2024	[NT]	[NT]	[NT]	[NT]	09/04/2024	[NT]
Date analysed	-			09/04/2024	[NT]	[NT]	[NT]	[NT]	09/04/2024	[NT]
Exchangeable Ca	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	100	[NT]
Exchangeable K	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	104	[NT]
Exchangeable Mg	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	103	[NT]
Exchangeable Na	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	113	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

MISC_INORG_DRY:pH 1:5 soil:water/Electrical Conductivity:Samples were out of the recommended holding time for this analysis.

Material Test Report

Report Number:	**225276.00-1**
Issue Number:	1
Date Issued:	07/05/2024
Client:	Regal Hunter Properties Pty Ltd
	33 Metford Road, Tenambit NSW
Project Number:	225276.00
Project Name:	Proposed Manufactured Home Estate
Project Location:	27-31 Metford Road, Tenambit NSW
Work Request:	11414
Sample Number:	NC-11414A
Date Sampled:	20/03/2024
Dates Tested:	04/04/2024 - 12/04/2024
Sampling Method:	Sampled by Engineering Department
	The results apply to the sample as received
Sample Location:	**106 , Depth: 0.0-0.3m**
Material:	Silty Sand

Douglas Partners Pty Ltd
Newcastle Laboratory
15 Callistemon Close Warabrook Newcastle NSW 2310
Phone: (02) 4960 9600
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Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Peter Gorseski
Laboratory Manager
Laboratory Accreditation Number: 828

Moisture Content (AS 1289 2.1.1)		Min	Max
Moisture Content (%)	18.1		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	27		
Plastic Limit (%)	18		
Plasticity Index (%)	**9**		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	Silty Sand		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	21		

Material Test Report

Report Number:	**225276.00-1**
Issue Number:	1
Date Issued:	07/05/2024
Client:	Regal Hunter Properties Pty Ltd
	33 Metford Road, Tenambit NSW
Project Number:	225276.00
Project Name:	Proposed Manufactured Home Estate
Project Location:	27-31 Metford Road, Tenambit NSW
Work Request:	11414
Sample Number:	NC-11414B
Date Sampled:	20/03/2024
Dates Tested:	04/04/2024 - 12/04/2024
Sampling Method:	Sampled by Engineering Department
	The results apply to the sample as received
Sample Location:	**106 , Depth: 0.4-0.5m**
Material:	Sandy Clay

Moisture Content (AS 1289 2.1.1)		Min	Max
Moisture Content (%)	21.7		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	46		
Plastic Limit (%)	19		
Plasticity Index (%)	**27**		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	Sandy Clay		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	21		

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Material Test Report

Report Number:	**225276.00-1**
Issue Number:	1
Date Issued:	07/05/2024
Client:	Regal Hunter Properties Pty Ltd
	33 Metford Road, Tenambit NSW
Project Number:	225276.00
Project Name:	Proposed Manufactured Home Estate
Project Location:	27-31 Metford Road, Tenambit NSW
Work Request:	11414
Sample Number:	NC-11414C
Date Sampled:	20/03/2024
Dates Tested:	04/04/2024 - 12/04/2024
Sampling Method:	Sampled by Engineering Department
	The results apply to the sample as received
Sample Location:	**106 , Depth: 0.6-0.8m**
Material:	Sandy Clay

Moisture Content (AS 1289 2.1.1)		Min	Max
Moisture Content (%)	13.8		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	30		
Plastic Limit (%)	18		
Plasticity Index (%)	**12**		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	Sandy Clay		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	21		

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Material Test Report

Report Number:	**225276.00-1M**
Issue Number:	1
Date Issued:	23/04/2024
Client:	Regal Hunter Properties Pty Ltd
	33 Metford Road, Tenambit NSW
Project Number:	225276.00
Project Name:	Proposed Manufactured Home Estate
Project Location:	27-31 Metford Road, Tenambit NSW
Work Request:	11414
Sample Number:	NC-11414B
Date Sampled:	20/03/2024
Dates Tested:	04/04/2024 - 19/04/2024
Sampling Method:	Sampled by Engineering Department
	The results apply to the sample as received
Sample Location:	**106 , Depth: 0.4-0.5m**
Material:	Sandy Clay

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Laboratory Accreditation Number: 828

Pinhole Dispersion Classification (AS 1289.3.8.3)	
Pinhole Dispersion Classification	D2 Dispersive
Rate of Flow on completion (mm/s)	0.5
Natural Moisture Content (%)	21.7
Moisture Content Before Testing (%)	19.4
Standard Maximum Dry Density (t/m^3)	
Time Matured in Cylinder (hh:mm)	48:00
Method of Moisture Determination for Remoulding	Plastic Limit
Source of Water Used	Distilled
Was Hole Reformed at 50mm Head	N
No MDD/OMC details provided. Sample remoulded to estimated MDD.	

Material Test Report

Report Number:	**225276.00-1M**
Issue Number:	1
Date Issued:	23/04/2024
Client:	Regal Hunter Properties Pty Ltd
	33 Metford Road, Tenambit NSW
Project Number:	225276.00
Project Name:	Proposed Manufactured Home Estate
Project Location:	27-31 Metford Road, Tenambit NSW
Work Request:	11414
Sample Number:	NC-11414C
Date Sampled:	20/03/2024
Dates Tested:	04/04/2024 - 19/04/2024
Sampling Method:	Sampled by Engineering Department
	The results apply to the sample as received
Sample Location:	**106 , Depth: 0.6-0.8m**
Material:	Sandy Clay

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Pinhole Dispersion Classification (AS 1289.3.8.3)	
Pinhole Dispersion Classification	D2 Dispersive
Rate of Flow on completion (mm/s)	0.6
Natural Moisture Content (%)	13.8
Moisture Content Before Testing (%)	17.5
Standard Maximum Dry Density (t/m^3)	
Time Matured in Cylinder (hh:mm)	48:00
Method of Moisture Determination for Remoulding	Plastic Limit
Source of Water Used	Distilled
Was Hole Reformed at 50mm Head	N
No MDD/OMC details provided. Sample remoulded to estimated MDD.	