ATTACHMENT 9 – SITE INVESTIGATION AND PAVEMENT DESIGN

McMahon EARTH SCIENCE

SITE INVESTIGATION & PAVEMENT DESIGN

REPORT 2020

121 FERNLEIGH ROAD
TURVEY PARK NSW 2650

JOB NO: 6705

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GEOTECHNICAL INVESTIGATION AND PAVEMENT DESIGN 121 FERNLEIGH ROAD TURVEY PARK NSW 2650

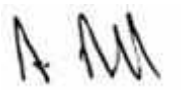
April 2020

Project brief

At the request of Croft Developments Pty Ltd, soil sampling, analysis and reporting was carried out to assess the site on 26 February 2020. The document provides information about the site and soil conditions from field observations and laboratory analysis.

Site identification
Address: 121 Fernleigh Road, Turvey Park NSW 2650
Real property description: Part Lot 1 DP1254451
Centre co-ordinate: 531710E 6112427N MGA GDA94 z55H
Property size: 1.64ha approx.
Owner: Croft Developments Pty Ltd
Local Government Area: Wagga Wagga City Council
Present use: Vacant Land
Development Application Reference: Unknown
Report Identification: 6705

Certification

Name	Signed	Date	Revision Number
David McMahon CEnvP BAppSc SA GradDip WRM MEnvMgmt		2/04/2020	0
Alexander Rudd BSc MAGS MEIANZ		2/04/2020	0

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1.0 Introduction

This report presents the results of a geotechnical investigation carried out by DM McMahon Pty Ltd (McMahon) for an extension of the adjacent proposed aged care facility at 20 Hely Avenue into 121 Fernleigh Road, Turvey Park NSW.

The geotechnical investigation was undertaken to support design and construction of a proposed aged care facility. The objectives of the investigation were to:

- Assess the subsurface conditions at the proposed site;
- Provide indicative geotechnical material characteristics for proposed design purposes;
- Provide pavement design; and
- Provide recommendations for earthworks on in situ soils and fill materials.

The geotechnical investigation work was commissioned by Croft Developments and was undertaken in general accordance with our proposal 'DMM_Croft_GI_190220' dated 19 February 2020.

2.0 Characteristics of the site

A desktop review and investigation of the topography, hydrology, soil, lithology, geology and hydrogeology of the site has been undertaken and are as follows:

2.1 Topography

The Lake Albert 1:25,000 Topographic Map (Sheet 8327-1-S) indicates that the site is located at an elevation range of approximately 190 to 220m AHD. The site landform is classed as gentle to undulating rises, foot slopes, plains and a few low hills while stream channels are erosional, tributary and widely spaced with moderately broad drainage depressions. No local crests are present on site, the closest local crest is approximately 200m to the southeast with a height of 218-220m AHD. Slope on the site is fairly consistent with the majority of the site sloping generally towards the north west, the northern portion of the site flattens out with a very gradual slope to the west.

2.2 Vegetation

The site is home to annual and perennial grasses with scattered clusters of Eucalyptus trees observed throughout. Limited understorey shrubs were also present.

2.3 Weather

The average rainfall for Wagga Wagga is approximately 526.8mm per annum, with the wettest months being October, June and July respectively. Annual mean evaporation for the region is 1716.3mm with mean daily evaporation ranges from 1.2mm in July to 9.2mm in January. Wagga Wagga is characterised by cold wet winters and hot dry summers with mean maximum temperatures ranging from 11.9ºC in July to 31.5 ºC in January and mean minimum temperatures ranging from 3.0ºC in July to 17.0ºC in February. Rainfall, temperature and evaporation data observed from Wagga Wagga Agricultural Institute site 73127 (www.bom.gov.au).

2.4 Hydrology

The site is part of the Murrumbidgee River catchment with overland flow in a general northwest direction. The Murrumbidgee River is located approximately 2.6km north of the site. There is little run-on water to the site owing to the WWCC stormwater system. All surface waters would eventually end up in the WWCC stormwater system. Due to the incline and surface of the site, rainfall is likely to both run off and infiltrate the permeable topsoils. The site has nil flood risk owing to the distance from and high elevation above the flood plain as identified in WWCC online mapping (2018).

2.5 Soil & Landform

The site lies within the mapping unit **pu** from the Soil Landscapes of the Wagga Wagga 1:100 000 Sheet (DLWC, 1997). The mapping unit **pu** is described as follows:

pu - Pulletop (Erosional landscape)

Landscape: undulating rises of Ordovician metasedimentary rocks. Local relief 15 - 40 m; slope gradients 3 - 10%. Broad crests and ridges, long, waning slopes and moderately broad drainage depressions. Extensively to completely cleared tall woodland.

Soils: shallow to moderately deep (40 - 100 cm) Mesotrophic Red Chromosols on crests, ridges and upper slopes; moderately deep (80 - 150 cm) bleached and Haplic Red Chromosols on mid to lower slopes, and moderately deep (80 - 150 cm) mottled Subnatric Brown Sodosols in drainage lines.

Limitations: erosion hazard, foundation hazard (localised), salinity (localised), strongly acid and locally shallow and stony soil.

2.6 Hydrogeology

From the Geoscience Australia hydrogeology dataset, the groundwater beneath the site is described as mainly porous, extensive and highly productive aquifers. Groundwater is likely to flow in a northerly direction with a medium level of connection between the surface and groundwater which is consistent with the water sharing plan for the Lachlan Fold Belt Murray Darling Basin.

3.0 Geotechnical Investigation Scope of Works

The specification for the geotechnical investigation as proposed by DM McMahon Pty Ltd are as follows:

Table 1: *Scope of works*

Item	Description	
1.	Where available, review plans and other general related documents provided to us to gain a comprehensive understanding of the proposed project.	
2.	Undertake a desktop study of local landform, geological, lithological & hydrogeological conditions.	
3.	Conduct Dial Before You Dig search and utilise a service locator onsite.	
4.	Carry out field investigations by reference to AS1726:2017 Geotechnical Site Investigations.	Allowed: 6 x boreholes to 1.5m deep (or refusal) 1 x borehole to 6m deep (or refusal) and installation of a groundwater monitoring bore 6 x DCP tests for bearing capacity
5.	Analyse soils in situ and at our NATA accredited laboratory to AS/RMS methods.	Allowed: 12 x Linear Shrinkage 6 x Atterberg Limits 2 x Particle Size Distribution 2 x CBR/PI (Composite)
6.	Generate laboratory reports and review results.	
7.	Compile results in report detailing methodology, desktop study, physical conditions, field work results, test locations, bore logs, in-situ test results, laboratory results, allowable bearing capacity, design CBR, earthworks recommendations and discussion.	

As follows is an aerial image of the site with approximate soil investigation points and proposed development plan overlay, **Figure 1**.

Figure 1: *Geotechnical investigation map - boreholes*

The bore logs can be seen in the attachments with the coordinates of the test locations provided in Map Grid of Australia (MGA) GDA94 Zone 55.

4.0 Subsurface Conditions

A judgemental sampling pattern was employed to assess the subsurface conditions across the site, whereby sample points were chosen on the basis of the investigator's knowledge of probable distribution of the site and utilises site history, field observations and any plans or design proposals provided by the client. As such, investigation locations were selected based on preliminary design drawings of the proposed aged care facility provided by Croft Developments Pty Ltd and the proximity of existing vegetation, services and infrastructure.

Subsurface conditions encountered across the site were generally consistent with the landscape forming processes, presenting thin colluvial topsoils overlying thick residual clays derived from parent materials. Investigation locations generally presented fine grained inorganic clay subsoils varying from low to high plasticity. All soils investigated are considered naturally occurring from 0.3m to the maximum investigated depth.

Topsoils can be described as thin (<0.1m) silty organic clays of moderate to high plasticity and firm to stiff consistency. Topsoils are derived from colluvial deposition of residual soils upslope. Subsoils generally consist of a thick (~0.5-1.0m) layer of silty sandy clay of moderate to high plasticity and firm to stiff consistency, silts in this horizon are likely from eluvial movement through the profile. Residual soils below 1.0m are generally consistent in texture and consist of moderately to highly plastic clays of stiff consistency. The extremely weathered horizon can be identified where highly weathered coarse aggregates or Ordovician Metasedimentary core stones are found. Saprolite gives presence of trace silts on the outer weathering surfaces of core stones.

The underlying geology of the site consists of Ordovician Metasedimentary bedrock. Bedrock was not encountered during the investigation; however highly decomposed core stones were identified as coarse fragments during subsurface investigations and were consistent with underlying geology. Soils are expected to be thinner on upper slopes where residual soils are present over Ordovician Metasedimentary bedrock from which they are derived. The soil solum is expected to increase in depth with lower elevation.

Generally, soils across the site were dry to moderately moist and this is a reflection of the current climatic factors. In some areas, it is expected that moisture conditioning may be required during earthworks. Subsurface soil moisture condition has a considerable effect on soil bearing capacity determination using a dynamic cone penetrometer.

Soils types encountered on site have been classified and grouped as per AS1726: Geotechnical Site Investigations as fine or coarse grained soils for ease of identification and will be further referenced by the categories presented in **Table 2** below. Depth measurements presented in **Table 2** are the depths of the upper limit of the soil horizon from the finished level at the time of the investigation. Note that some layers are not able to be classified under the AS1726 classification system and may have been omitted from the table.

Table 2: *Summary of borelogs*

Group Symbol	AS1726 Soil Category Description	BH01 (m)	BH02 (m)	BH03 (m)	BH04 (m)	BH05 (m)	BH06 (m)
OH	Organic Clay of medium to high plasticity, organic silt	**0.0-0.1**	**0.0-0.1**	**0.0-0.1**	**0.0-0.1**	**0.0-0.1**	**0.0-0.1**
SC	Sand -clay mixtures	**0.1-0.6**	**-**	**-**	**-**	**1.1-1.5**	**-**
CL	Inorganic clay of low to medium plasticity, gravelly clay, sandy clay	**-**	**-**	**-**	**-**	**-**	**-**
CI		**-**	**0.1-0.5**	**0.1-0.8**	**0.1-0.6**	**0.1-0.8**	**0.1-0.7**
CH	Inorganic clay of high plasticity	**0.6-1.5**	**0.5-1.5**	**0.8-1.5**	**0.6-1.5**	**0.8-1.1**	**0.7-1.5**

A summary of the laboratory results can be seen below, **Table 3**.

Table 3: *Results summary of laboratory testing and soil physical characteristics*

Sample ID	Site	Sample Depth (m)	Field Consistency	Linear Shrinkage (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index
6705-1/1	**BH01**	**0.3**	**Firm**	**6.0**	**-**	**-**	**-**
6705-1/2	**BH01**	**1.0**	**Stiff**	**8.0**	**36**	**15**	**21**
6705-2/1	**BH02**	**0.3**	**Firm**	**5.0**	**-**	**-**	**-**
6705-2/2	**BH02**	**1.0**	**Stiff**	**9.5**	**38**	**15**	**23**
6705-3/1	**BH03**	**0.3**	**Firm**	**5.0**	**-**	**-**	**-**
6705-3/2	**BH03**	**1.0**	**Stiff**	**8.0**	**31**	**11**	**20**
6705-4/1	**BH04**	**0.3**	**Firm**	**3.5**	**-**	**-**	**-**
6705-4/2	**BH04**	**1.0**	**Stiff**	**9.0**	**34**	**13**	**21**
6705-5/1	**BH05**	**0.3**	**Firm**	**5.0**	**-**	**-**	**-**
6705-5/2	**BH05**	**1.0**	**Stiff**	**10.0**	**42**	**18**	**24**
6705-6/1	**BH06**	**0.3**	**Firm**	**4.0**	**-**	**-**	**-**
6705-6/2	**BH06**	**1.0**	**Stiff**	**10.0**	**42**	**16**	**26**
6705-CBR 1	**Comp.**	**0.3-1.0**	**-**	**-**	**36**	**14**	**22**
6705-CBR 2	**Comp.**	**0.3-1.0**	**-**	**-**	**39**	**15**	**24**

CBR 1 - Composite of BH01, BH03 & BH05
CBR 2 - Composite of BH02, BH04 & BH06

5.0 Comments and Recommendations

The discussion and recommendations provided below are based on field observations and laboratory testing at discrete locations. Laboratory reports can be seen attached in the appendix.

5.1 Site Classification

For the purpose of general characteristic, the site is classed as **H1-D** which is: **Highly reactive clay sites, which may experience high ground movement from moisture changes** by reference to AS2870:2011.

5.2 Salinity

A total of six soil samples were obtained across the site and tested for electrical conductivity. Results can be seen summarised in **Table 4** below, with laboratory reports attached.

Table 4: *Summary of soil electrical conductivity results.*

Sample ID	Electrical Conductivity (µS/cm)	Multiplier Factor	ECe (dS/m)	Rating^
6705/BH02-1.0m	695	8.6	5.98	Moderately saline
6705/BH02-2.0m	276	8.6	2.37	Slightly saline
6705/BH02-3.0m	169	7.5	1.27	Non-saline
6705/BH02-4.0m	199	7.5	1.49	Non-saline
6705/BH02-5.0m	228	7.5	1.71	Non-saline
6705/BH02-6.0m	275	7.5	2.06	Slightly saline

^Hazelton & Murphy, 2007.

Electrical conductivity results ranged from 169 to 695µS/cm indicating that the soils are generally 'non-saline to moderately saline', Hazelton & Murphy, 2007.

5.3 Bearing Assessment

Six DCP (Dynamic Cone Penetrometer) tests were undertaken by reference to AS1289.6.3.2. From the DCP readings, the Interpreted Allowable Bearing Capacity (IABC) of the soil in kPa can be estimated by reference to Stockwell, 1977. IABC values range across the site from 215 to 400+kPa on subsurface soils indicating stiff to very stiff consistencies.

Note that changes in soil moisture content have an inherent effect on DCP test results, resulting in lower readings where an increase in moisture content is observed. It is recommended that the proposed buildings be founded below 0.4m as determined by observed in situ DCP test results in natural soils and characteristic surface movement. Based on the above it is recommended that a conservative allowable bearing pressure of 100kPa be adopted across the site. An exception to this allowable bearing pressure occurs where free water is observed in subsurface soils during excavation.

5.4 Particle Size Analysis

Two representative samples obtained were selected and tested for particle size analysis under RMS test methods T106 and T107. Site-won materials can be expected to be fine grained sandy CLAY soils and fine-grained CLAY soils with weak extremely weathered Ordovician metasediments at depth. Coarse aggregates present in the samples obtained were all less than 19mm in size when tested in the laboratory. Coarse aggregates generally increased in size with increasing depth. This was also observed during field investigations.

5.5 Maximum Dry Density and Optimum Moisture Content

Laboratory Maximum Dry Density values were obtained under standard compactive effort as per AS1289.5.1.1. Maximum Dry density results ranged from 1.68 t/m^3 to 1.76t/m^3. Optimum moisture content ranged from 18.7% to 18.4%, which are typical values expected for fine grained soils.

5.6 Settlement

It is expected that the total settlement of the foundations founded are likely to be in the range of 5mm to 10mm on natural clayey subsoils. Differential settlement is expected to be half of total settlement.

5.7 Depth of Rock

A total of six boreholes were drilled to 1.5m depth for geotechnical investigation, all boreholes achieved the required target depth of 1.5m and as such were terminated prior to refusal being met. A piezometer was installed in the north western corner of the proposed lot 87 to 6.0m. Refusal was not met at 6.0m and this was the target depth for piezometer installation.

Table 5 below outlines investigation target depths and borehole termination depth across the investigated area. Refusal was not met at any of the investigation locations prior to the target depth being achieved.

Table 5: *Borehole depth to refusal on rock*

Borehole Identification	Target Depth (m)	Termination Depth (m)	Refusal Met?
BH01	1.5	1.5	No
BH02	1.5	1.5	No
BH03	1.5	1.5	No
BH04	1.5	1.5	No
BH05	1.5	1.5	No
BH06	1.5	1.5	No
BH02-Piezometer	6.0	6.0	No

5.8 Depth of Groundwater

Groundwater was identified in Borehole 02-Piezometer only. At the time of the investigation the standing water level was determined to be 5.7m below existing ground level. Groundwater or seepage was not observed at any other investigation point across the site.

5.9 Temporary and Permanent Batter Slopes

Where there is enough space to form batter slopes, we recommend 1V:1H slope for temporary conditions and 1V:2.5H for permanent conditions.

The above slopes are recommended providing:

- Cut and fill slopes are a sufficient distance (at least 2m) from structures in the vicinity of the site.
- The excavation faces are protected appropriately (e.g. vegetating the surface).
- Adequate surface and sub-surface drainage is provided.

5.10 Design CBR Value

Two California Bearing Ratio tests carried out to AS1289.6.1.1 - Determination of the California Bearing Ratio of a soil - Standard laboratory method for a remoulded specimen (4-day soak) were conducted on composite samples with results as follows, Table 6.

Table 6: *CBR, liquid limit and plastic limit of composite samples.*

Sample	CBR (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index
CBR1 Composite (BH01, BH03 & BH05)	11	36	14	22
CBR2 Composite (BH02, BH04, BH06)	8	39	15	24

A design CBR of **8%** for the natural subgrade material may be adopted for the purpose of pavement thickness design, given adequate drainage provision.

5.11 Design Traffic Loading

No additional information was supplied by the client in regard to traffic loading of the proposed extension. It is assumed that traffic loading data has not seen an increase from the data supplied in McMahon report 5339. It is noted that the traffic loading estimates adopted in the previous report by McMahon were conservative and are considered appropriate for the proposed extension.

The following traffic data in Table 7 was supplied by Eric Kydd of Cardno (pers. comm August 2018) and was provided as a preliminary review for anticipated traffic volumes based on a site sketch plan provided by CJ Arms & Associates of the existing proposal for the aged care facility road network which included in the order of 133 dwellings. The new proposal with the new land extension has further reduced the number of lots to 118 with and aged care facility.

The following notes were added to the information in Table 7:

- *Red road type vpd conservatively assumes all lots to utilise boulevard roads*
- *Orange road type vpd varies however conservatively adopts the maximum vpd for this road type*
- *Waste collection vehicle size to be confirmed, up to 12.5m heavy rigid truck anticipated*
- *Bus/coach type to be confirmed, maximum 12.5m coach anticipated*
- *The anticipated traffic generation is based on case study data and RTA guide rates and are anticipated daily vehicle movements only.*

Table 7: *Supplied Traffic Loading Data*

Road Type	***Approx. Vehicle Movements Per Day***	***Heavy Vehicles Anticipated***
7 metre wide road pavement (north & south boulevard roads)	*266vpd*	*Waste truck, coach/bus*
5.5 metre wide road pavement	*62vpd*	*Waste truck*
4 metre wide road pavement	*20vpd*	*No heavy vehicles expected (in some instances, waste truck may access)*

Based on the above information, the following design traffic loading values are calculated, Table 8.

Table 8: *Estimated Traffic Loading (in ESA) of supplied design traffic loading data.*

Road Type	Approx. Vehicle Movements Per Day	Estimated Traffic Loading (ESA)
Local Access Road (7m wide)	266 vpd	$1.3x10^5$
Shareway (5.5m wide)	62 vpd	$2.0x10^4$
Shareway (4m wide)	20 vpd	$6.4x10^3$

It is assumed that the design life is 30 years and annual growth rate is 1%.

The *Wagga Wagga City Council Engineering Guidelines for Subdivisions and Development Standards* (2017) states that local access roads should be designed for a minimum design traffic loading of $2.0x10^5$ Equivalent Standard Axles (ESA) and access streets (shareway) to $1x10^{-5}$ for a minimum design life of 30 years. Based on previous experience with WWCC, the minimum design traffic loading for access streets has been increased from $2.0x10^5$ ESA to $2.5x10^5$ ESA.

As the provided design traffic loadings supplied by Eric Kydd of Cardno are less than the values provided by the *WWCC Engineering Guidelines for Subdivisions and Development Standards* (2017), the traffic loading values provided by Council have been used in determining pavement thickness.

5.12 Recommended Pavement Composition

Based on the above information and as per Austroads publication "Guide to Pavement Technology, Part 2: Pavement Structural Design", (2010), the following pavement compositions are recommended, Table 9.

Table 9: *Recommended Pavement Composition.*

Road	Design Traffic Loading (ESA)	Design CBR (%)	AC10 (mm)*	Base Course (mm)	Sub-base Course (mm)	Total (mm)
Access Road	$2.5x10^5$	8	40	130	150	280
Shareways	$1.0x10^5$	8	40	130	130	260

* Over single coat flush/primer seal

AC10 shall be lain over a single coat flush or primer seal. Base course material is to be DGB20 quality material. Sub-base course material shall be DGS40 or crushed sandstone or recycled aggregates with a 4-day laboratory soaked CBR greater than 30% (available locally). Pavement materials shall also meet any other relevant Council specifications.

The pavement depths are only valid if the subgrade and pavement materials are compacted to the following Minimum Dry Density Ratios (AS1289.5.4.1). Compaction of sub-base and base course layers should be in accordance with Table 10 below. Quality assurance testing of compacted materials should be undertaken by a NATA accredited laboratory at a frequency accordant with Council specifications outlined in the *WWCC Engineering Guidelines* (2017).

Table 10: *Compaction specifications*

Pavement Layer	Specification
Base Course	98% Modified
Sub-base Course	98% Modified
Subgrade	100% Standard

The pavement design assumes provision of adequate surface and sub-surface drainage of the pavement and adjacent areas. It is recommended that a sub-surface drainage system is installed, as directed by the designer and/or Council Engineers.

5.13 Geotechnical Design Parameters

The following table presents the recommended parameters for the design of the retaining walls and other structures.

Table 11: *Geotechnical Design Parameters.*

Material Description	Unit Weight (γ) kN/m^3	Angle of Internal Friction (ϕ) degree	Undrained Cohesion (C_u) kPa	Drained Cohesion (c') kPa
Organic Silts and Clays	17	22	-	-
Clayey Sands, sand-clay mixture	19	30	-	3
Inorganic Clays	18	26	100	5

Material Description	Coefficient of Active Earth Pressure (k_a)	Coefficient of Passive Earth Pressure (k_p)*	Shaft Adhesion / Skin Friction, kPa
Organic Silts and Clays	0.4	Ignore	-
Clayey Sands, sand-clay mixture	0.3	4.5	15.0
Inorganic Clays	0.35	3.5	50.0

*Note that coefficient of passive pressure (k_p) and shaft adhesion/skin friction values are ultimate values. Appropriate factor of safety values (2 for passive pressure and 2.5 or greater for shaft adhesion/skin friction) shall be used when calculating allowable values.

Bored piers, if used to support retaining walls and/or other structures can be founded in bedrock (socketed at least 0.3m in extremely weathered Ordovician metasediment) and can be designed for an allowable end bearing capacity of 500kPa. Shaft adhesion can be taken as 50kPa. However, shaft adhesion shall be used only if the piers are socketed at least 2 times the diameter in bedrock.

For calculating the uplift/overturning resistance the top 1m of the shaft adhesion/skin friction shall be neglected.

5.14 Earthworks Suitability

Unsuitable Material

Unsuitable material was found as follows:

- Topsoil containing organic matter was identified on site at varying depths. It is recommended that where present, organic topsoils are removed from site to a depth at which suitable material is encountered.
- Root affected soils from trees currently present on site must be grubbed and removed to a suitable depth at which natural unaffected materials are encountered, suitable materials as described below in 'structural fill' should be compacted as per the recommendations set out in section 7.

While this report identifies some unsuitable fill materials, there is the possibility of other unsuitable materials being uncovered on site upon commencement of earthworks. If any deleterious or unsuitable materials or conditions are discovered in situ upon commencement of earthworks, the material should be removed from site and replaced with suitable structural fill with a CBR equal to or greater than the specified design CBR. The replacement fill materials should also comply with AS1289 5.1.1, 5.4.1, 5.7.1 or to relevant Council specifications

Structural Fill

Residual natural soils are the only materials on site that have been positively identified as being suitable for use as structural fill (CBR >8).

- The laboratory CBR values vary from 8% to 11%.
- DCP values (site specific) vary in the upper 600 mm where the pavement is expected to be located. As previously stated, changes in moisture regime occur across the site and it is recommended that where excavation occurs, and poor soil moisture conditions are encountered, soil moisture conditioning be carried out on subgrade materials prior to any construction works being carried out.

Based on the above considerations, an appropriate CBR value of 8 may be adopted as the minimum requirement for any imported structural fill materials. Furthermore, RTA Q3071 provides specifications for select fill materials. It is recommended that any imported fill material be of similar quality to that specified in RMS Q3071 for select fill materials to be used as structural fill.

6.0 Site Preparation and Earthworks

New fill for the preparation of pavement subgrade should be placed, compacted and tested to an engineering specification in general accordance with recommendations outlined in AS3798-2007, 'Guidelines on Earthworks for Commercial and Residential Developments' or to Council specification. The following general procedure is recommended as a guide for site preparation and the placement of controlled fill:

- Remove existing topsoil, uncontrolled fill, vegetation, root affected or other potentially deleterious materials from proposed fill area;
- Earthworks are ideally carried out in dry weather conditions;
- Provisions are made for effective surface water diversion away from outside the pavement works site;
- It is possible that site preparation could expose wet subgrade material, particularly if excavation is carried out after a prolonged period of rainfall. Trafficability in the low to medium plasticity clay material for wheeled vehicles can be expected to be slightly difficult during and following rainfall. If material wets up during construction, it should be scarified, dried and re-compacted;
- The exposed natural soils should then be scarified to a depth of about 200mm, moisture conditioned to within ±2% of Standard Optimum Moisture Content (SOMC) and then re-compacted to a standard maximum dry density (SMDD) of 100% in accordance with AS1289 5.1.1, 5.4.1 or 5.7.1 or to Council specifications;
- Any soft or weak areas identified during the compaction process that do not respond to further compaction should be removed and replaced with suitable site materials in layers not exceeding 250mm thickness and should be compacted to the above criteria.
- If required, the subgrade should be stabilised as recommended; and
- Subsequent layers of fill should be placed in uniform layers as specified, moisture conditioned and compacted to a minimum of 98% MMDD for base and sub-base and select fill or to council specification. The compacted layers are to be tested by a relevant NATA accredited facility.

The backfilling of the service trenches should be undertaken carefully. The bedding materials and materials immediately around the services should be placed and compacted as per AS3798 or other relevant standards. The general backfill above the pipe should be compacted to the following criteria:

- When backfilling service trenches with sand or aggregate, compaction to a density index of at least 70% should be used;
- When backfilling service trenches the cohesive materials (e.g. clays, sandy clays) should be moisture conditioned to within ±2% of standard optimum moisture content and then compacted to a minimum dry density of 95% standard in accordance with AS1289 5.1.1, 5.4.1 or 5.7.1;
- The earthworks at the site should be inspected and tested as per the requirements of AS3798-2007 and should be carried out during dry weather conditions; and
- Provision should be made for effective diversion of surface water from outside the site. The surface runoff from the site should be treated to remove sediments before discharge.

7.0 Notes relating to results

Groundwater

A standing groundwater level of 5.5mbgl was observed within Borehole 16 during fieldwork. Groundwater was not present at any other of the investigated locations at the time of the investigation. A groundwater table or seepage may be present at other times and fluctuations in groundwater levels and seepage could occur due to rainfall, changes in seasonal conditions and other factors.

Bore hole / test pit logging

The information supplied in the log sheets is based on visual and tactile assessment based on field conditions at the time of testing. The log sheets can include inferred data based on the experience of the geotechnician as well as factual data from in situ testing.

Log Column		Symbol	Definition
Soil Origin		TOPSOIL	Mantle of surface and/or near-surface soil often but not always defined by high levels of organic material, both dead and living. Remnant topsoils are topsoils that subsequently been buried by other transported soils. Roots of trees may extend significantly into otherwise unaltered soil and the presence of roots is not a sufficient reason for describing a material as topsoil.
		FILL	Any material which has been placed by anthropogenic processes
		Alluvial	Deposited by streams and rivers
		Colluvial	Soil and rock debris transported down slope by gravity, with or without the assistance of flowing water and generally deposited in gullies or at the base of slopes. Colluvium is often used to refer to thicker deposits such as those formed from landslides, whereas the term 'slopewash' may be used for thinner and more widespread deposits that accumulate gradually over longer geological timeframes.
		Extremely weathered material	Formed directly from in situ weathering of geological formations. Although this material is of soil strength, it retains the structure and/or fabric of the parent rock material.
		Residual	Formed directly from in situ weathering of geological formations. These soils no longer retain any visible structure or fabric of the parent soil or rock material
Class (AS1726-2017)	Coarse grained soils	GW	Gravel and gravel-sand mixtures, little to no fines
		GP	Gravel and gravel-sand mixtures, little to no fines, uniform gravels
		GM	Gravel-silt mixtures and gravel-sand-silt mixtures
		GC	Gravel-clay mixtures and gravel-sand-clay mixtures
		SW	Sand and gravel-sand mixtures, little to no fines
		SP	Sand and gravel-sand mixtures, little to no fines
		SM	Sand-silt mixtures
		SC	Sand-clay mixtures
	Fine grained soils	ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity
		CL, CI	Inorganic clays of low to medium plasticity, gravelly clay, sandy clay
		OL	Organic silt
		MH	Inorganic silt
		CH	Inorganic clays of high plasticity
		OH	Organic clay of medium to high plasticity, organic silt
		Pt	Peat, highly organic soil
Soil Name/ Description		SAND	Coarse grained soil
		SILT	Fine grained soil – low dry strength, low wet toughness and dilatancy
		CLAY	Fine grained soil – high dry strength, high wet toughness and plasticity
Grain Size		Coarse	>2mm
		Medium	0.06 – 2mm
		Fine	<0.06mm
Moisture		D	Dry
		T	Moderately Moist
		M	Moist
		W	Wet
Plasticity		Non-plastic	Not applicable
		Low	Only slight pressure is required to roll the thread of soil near the plastic limit. The thread and lump are weak and soft. The dry specimen crumbles into powder with some finger pressure.
		Medium	Medium pressure is required to roll the thread of soil to near the plastic limit. The thread and lump have medium stiffness. The dry specimen breaks into pieces or crumbles with considerable finger pressure.
		High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness. The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Consistency		Very Soft (VS)	Exudes between fingers when squeezed in hand
		Soft (S)	Can be moulded by light finger pressure
		Firm (F)	Can be moulded by strong finger pressure
		Stiff (St)	Cannot be moulded by fingers
		Very Stiff (VSt)	Can be indented by thumb nail
		Hard (H)	Can be indented by thumb nail with difficulty
		Friable (Fr)	Can be easily crumbled or broken into small pieces by hand

8.0 Disclaimer

The information contained in this report has been extracted from field and laboratory sources believed to be reliable and accurate. DM McMahon Pty Ltd will not assume any responsibility for the misinterpretation of information supplied in this report. The accuracy and reliability of recommendations identified in this report need to be evaluated with due care according to individual circumstances. It should be noted that the recommendations and findings in this report are based solely upon the said site location and the ground level conditions at the time of testing. The results of the said investigations undertaken are an overall representation of the conditions encountered. The properties of the soil within the location may change due to variations in ground conditions outside of the tested area. The author has no control or liability over site variability that may warrant further investigation that may lead to significant design changes.

9.0 Reference

Chen X.Y. and McKane D.J., 1997, Soil Landscapes of the Wagga Wagga 1:100,000 Sheet map and report, Department of Land and Water Conservation, Sydney

Geeves GW, Craze B and Hamilton GJ 2007a. Soil physical properties. In 'Soils – their properties and management'. 3rd edn. (Eds Charman PEV and Murphy BW) pp. 168-191 Oxford University Press Melbourne.

Geology information: Copyright Commonwealth of Australia (MDBC) 1999

Hazelton, P., and Murphy, B., 2007. Interpreting Soil Test Results, What do All the Numbers Mean? NSW Dept Natural Resources.

Roads and Maritime Services, Test Method T106 - Coarse particle distribution of road construction materials (By dry sieving), Oct 2012

Roads and Maritime Services, Test Method T107 - Fine particle size distribution of road construction materials, Oct 2012

Roads and Maritime Services, QA Specification R3071, Selected Materials in Formation 2013

Standards Australia AS 1289.5.1.1:2017 - Determination of the dry density/moisture content relation of a soil using standard compactive effort

Standards Australia AS 1289.5.4.1:2007 - Compaction Control Test - Dry density ratio, moisture variation and moisture ratio

Standards Australia AS 1289.5.7.1:2006 - Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method)

Standards Australia AS 1289.6.1.1:2014 - Determination of the California Bearing Ratio of a soil - Standard laboratory method for a remoulded specimen

Standards Australia AS 1289.6.3.2:1997 - Determination of the penetration resistance of a soil - 9kg dynamic cone penetrometer test

Standards Australia AS 1726:2017 - Geotechnical Site Investigations

Standards Australia AS 2870:2011 - Residential Slabs and Footings

Standards Australia AS 3798:2007 - Guidelines on earthworks for commercial and residential developments

Wagga Wagga City Council Engineering Guidelines for Subdivisions and Development Standards, Version 2, June 2017. Accessed 1 Aug 2018 <https://www.wagga.nsw.gov.au/__data/assets/pdf_file/0005/73715/ENGINEERINGSTANDARDS_WEBFINAL-with-designs.pdf>

10.0 Attachments

Attachment	Details
A. Bore logs	2 page
B. DCP report	1 page
C. Laboratory reports 6705	4 pages
D. CIRCLY analysis output	2 pages

McMahon EARTH SCIENCE

DOCUMENT ATTACHMENTS

REPORT 6705

DM McMahon Pty Ltd
6 Jones Street, (PO Box 6118)
Wagga Wagga NSW 2650

t (02) 6931 0510
www.dmmcmahon.com.au

Attachment A : *Bore logs*

McMahon EARTH SCIENCE

AS1726:2017 Bore Log Page _1_ of _1_

Job No:	6705	**Landform:**	Simple Slope
Client:	Croft	**Slope:**	Gently Inclined
Site:	121 Fernleigh Rd, Turvey Park NSW 2650	**Vegetation/Surface:**	Grass
Date:	26/02/2020	**Logged By:**	LN

Sheet: 'Geotech Field Sheet_rev2'

Sampling Method: AS1289.1.2.1-1998: cl. [ ] 6.5.1 - Hand Excavated [ ] 6.5.2 - Hand Auger [X] 6.5.3 - Power Auger [ ] 6.5.4 - Machine Excavated Other:_____

Site Identity	Sample	Co-ordinates MGA GDA94 z55	Depth to Top of Layer (m)	Depth to Bottom of Layer (m)	Classification (AS1726:2017 Table 9 & 10)	Soil Name (BLOCK LETTERS)	Grain Size (Fine / Coarse)	Primary Colour	Mottle Colour	Plasticity	Consistency (Cohesive soils)	Relative Density (Non-cohesive)	Moisture	Soil Origin	Comments (Coarse Fragments, Size, %, Structure (Zoning, Defects, Cementing etc.))
BH01		531747 E	0.0	0.1	OH	Silty CLAY	F	RB	Nil	L	F	*	D	TOPSOIL	
	CBR1	6112478 S	0.1	0.6	SC	Sandy CLAY	F/C	RB	Nil	L-M	F	*	D	Residual	CBR Sampled from 0.3m to 1.0m
	1/2		0.6	1.5	CH	CLAY	F/C	RY	Nil	M-H	ST	*	D	Residual	with trace fine sands
BH02		531688 E	0.0	0.1	OH	Silty CLAY	F	RB	Nil	L	F	*	D	TOPSOIL	
	CBR2	6112501 S	0.1	0.5	CI	Silty Sandy CLAY	F/C	RB	Nil	L-M	F	*	D	Residual	CBR Sampled from 0.3m to 1.0m
	2/2		0.5	1.5	CH	CLAY	F/C	RY	Nil	M-H	ST	*	D	Residual	with trace fine sands
BH03		531737 E	0.0	0.1	OH	Silty CLAY	F	RB	Nil	L	F	*	D	TOPSOIL	
	CBR1	6112405 S	0.1	0.8	CI	Silty Sandy CLAY	F/C	RB	Nil	L-M	F	*	D	Residual	CBR Sampled from 0.3m to 1.0m
	3/2		0.8	1.5	CH	CLAY	F/C	RY	Nil	M-H	ST	*	D	Residual	with trace fine sands
BH04		531669 E	0.0	0.1	OH	Silty CLAY	F	RB	Nil	L	F	*	D	TOPSOIL	
	CBR2	6112418 S	0.1	0.6	CI	Silty Sandy CLAY	F/C	RB	Nil	L-M	F	*	D	Residual	CBR Sampled from 0.3m to 1.0m
	4/2		0.6	1.5	CH	CLAY	F/C	RY	Nil	M-H	ST	*	D	Residual	with trace fine sands
BH05		531740 E	0.0	0.1	OH	Silty CLAY	F	RB	Nil	L	F	*	D	TOPSOIL	
	CBR1	6112352 S	0.1	0.8	CI	Silty Sandy CLAY	F/C	RB	Nil	L-M	F	*	D	Residual	CBR Sampled from 0.3m to 1.0m
	5/2		0.8	1.1	CH	CLAY	F/C	RY	Nil	L-M	ST	*	D	Residual	Quartz 5% with fine sands
			1.1	1.5	SC	Sandy CLAY	F/C	-Y	Nil	M-H	VST	*	D	EWM	Ordovician Metasediment derived
BH06		531689 E	0.0	0.1	OH	Silty CLAY	F	RB	Nil	L	F	*	D	TOPSOIL	
	CBR2	6112356 S	0.1	0.7	CI	Silty Sandy CLAY	F/C	RB	Nil	L-M	F	*	D	Residual	CBR Sampled from 0.3m to 1.0m
	6/2		0.7	1.5	CH	CLAY	F/C	RY	Nil	M-H	ST	*	D	Residual	with trace fine sands

ENVIRONMENTAL WELL BH02

PROJECT NUMBER 6705	**DRILLING COMPANY** McMahon Earth Science	**COORDINATES**
PROJECT NAME	**DRILLER** Mr. David McMahon	**COORD SYS** MGA94 z55H
CLIENT Croft Developments Pty Ltd	**DRILLLERS LICENCE** DL1770	**SURFACE ELEVATION** ~197.2m
ADDRESS 121 Fernleigh Road, Turvey Park	**DRILLING METHOD** Augering Solid Flight	**WELL TOC** 6.0m
ADDRESS NSW 2650	**TOTAL DEPTH** 6m	**LOGGED BY** AR & LN
DRILLING DATE 26/02/2020	**DIAMETER** 100mm	**CHECKED BY** A. Rudd

COMPLETION 26/02/2020	**CASING** uPVC -50mm Class 12	**SCREEN** uPVC -50mm Class 12 Slotted

COMMENTS North west corner of proposed lot 87. Piezo installed to existing ground height. Elevation has been approximated from survey data.

Depth (m)	Elevation (m)	Samples	Is Analysed?	Water	Piezometer Installation	Graphic Log	Classification (AS1726:2017)	Material Description	Moisture	Consistency
0	197	6705/2.1	LS		Piezo		OL	TOPSOIL: Dark brown silty clay, organic, dry, firm consistency.	D	F
							CI	SILTY SANDY CLAY: Colluvial, reddish brown, low plasticity, firm consistency, Dry.		
0.5	196.5	6705/CBR	CBR					SANDY CLAY: Residual, reddish yellow, low to moderate plasticity, stiff consistency, Dry.		ST
1		6705-1.0m	pH & EC							
	196									
1.5								SANDY CLAY: Residual, yellow, low to moderate plasticity, very stiff consistency, Dry.		VST
	195.5									
2		6705-2.0m	pH & EC				CH	CLAY: Residual, yellow, low to moderate plasticity, stiff consistency, moderately moist. traces of silt and fine sand present. Minor white mottling from chemically weathered parent material. No structure or fabric of parent material corestones present.	T	ST
	195									
2.5										
	194.5							SILTY CLAY: Residual brownish yellow, low to moderate plasticity, stiff consistency, moderately moist. Coarse fragments of Ordovician Metasedimentary rocks present (5-10%) up to 20mm. Silt present on surface of chemically weathered coarse fragments and throughout. White mottling present from completely weathered OM, presents as saprolite.		
3		6705-3.0m	pH & EC							
	194									
3.5										
	193.5									
4		6705-4.0m	pH & EC					SILTY CLAY: Residual, brownish red, low to moderate plasticity, stiff consistency, moderately moist to 5.5m, wet from 5.5 to termination depth of 6.0m. Residual material derived from Ordovician Metasedimentary parent material		
	193									
4.5										
	192.5									
5		6705-5.0m	pH & EC							
	192									
5.5									W	VF
	191.5			▽						
6		6705-6.0m	pH & EC							
	191							Termination at target depth: 6.0 m		

Disclaimer This bore log is intended for environmental not geotechnical purposes.

produced by ESlog.ESdat.net on 28 Feb 2020

Attachment B : *DCP report*

DM McMahon Pty Ltd
PO Box 6118
WAGGA WAGGA NSW 2650
Ph: 0269 310 510

PAGE: 1
OF: 1
DATE TESTED: 26/02/2020
TESTED BY: LN
DATE SUBMITTED: 26/02/2020
SUBMITTED BY: LN
SPECIFICATIONS: *

TEST REPORT

Dynamic Cone Penetrometer

AS TEST METHOD AS 1289.6.3.2

CLIENT: Croft Developments Pty Ltd
JOB DESCRIPTION: Geotechnical Investigation
LOCATION: 121 Fernleigh Rd, Turvey Park NSW 2650

JOB NO.: 6705

Test Number:	1	2	3	4	5	6	*	*
Moisture Condition:	Dry	Dry	Dry	Dry	Dry	Dry	*	*
Depth Below FL(mm):	0	0	0	0	0	0	*	*
Location:	BH01	BH02	BH03	BH04	BH05	BH06	*	*
Penetration (mm)	Blows /100mm	Blows /100mm	Blows /100mm	Blows /100mm	Blows /100mm	Blows /100mm	Blows /100mm	Blows /100mm
100	9	12	9	14	15	13	*	*
200	10	15	15	15	16	10	*	*
300	15	17	18	18	17	12	*	*
400	16	18	19	19	18	14	*	*
500	18	19	20	21	19	16	*	*
600	25+	20	19	25+	25+	18	*	*
700	End	21	25+	End	End	20	*	*
800	*	23	End	*	*	23	*	*
900	*	End	*	*	*	End	*	*
1000	*	*	*	*	*	*	*	*
1100	*	*	*	*	*	*	*	*
1200	*	*	*	*	*	*	*	*
1300	*	*	*	*	*	*	*	*
1400	*	*	*	*	*	*	*	*
1500	*	*	*	*	*	*	*	*
1600	*	*	*	*	*	*	*	*
1700	*	*	*	*	*	*	*	*
1800	*	*	*	*	*	*	*	*
1900	*	*	*	*	*	*	*	*
2000	*	*	*	*	*	*	*	*
2100	*	*	*	*	*	*	*	*
2200	*	*	*	*	*	*	*	*
2300	*	*	*	*	*	*	*	*
2400	*	*	*	*	*	*	*	*
2500	*	*	*	*	*	*	*	*

NATA ACCREDITED FOR TECHNICAL COMPETENCE
Number: 3349

Accredited for compliance with ISO/IEC 17025 - Testing. The results of the tests included in this document are traceable to Australian/National Standards. This document shall not be reproduced except in full.

Remarks:

APPROVED SIGNATORY: A. Rudd

DATE: 28/02/2020

Attachment C : *Laboratory reports 6705*

DM McMahon Pty Ltd
PO Box 6118
WAGGA WAGGA NSW 2650
Ph: 0269 310 510

DATE SAMPLED: 26/2/20
SAMPLED BY: LN
DATE SUBMITTED: 6/03/2020
SUBMITTED BY: LN
NO OF SAMPLES: 2
SAMPLING METHOD: AS1289.1.2.1
CLAUSE: 6.5.3
SPECIFICATIONS: *
PREP. METHOD: AS1289.6.1.1:2014
DATE OF LAB TESTING: 27/02/20 - 06/03/20
JOB NO.: 6705

TEST REPORT

CALIFORNIA BEARING RATIO OF SOILS AND GRAVELS
RMS TEST METHOD T117 & AS 1289 6.1.1

CLIENT: Croft Developments Pty Ltd
JOB DESCRIPTION: 121 Fernleigh Rd, Turvey Park NSW 2650

MATERIAL SOURCE: in situ
PROPOSED USE: Pavement Design
MATERIAL TYPE: Soil

SAMPLE NUMBER:		1	2	*	*	*	*
SITE:		BH 1, 3 & 5	BH 2, 4 & 6	*	*	*	*
SAMPLE DEPTH (m):		0.3-1.0	0.3-1.0	*	*	*	*
ADDITIVE IF STABLISED:		*	*	*	*	*	*
AMOUNT OF ADDITIVE:		*	*	*	*	*	*
TYPE OF COMPACTION (Standard or Modified):		Standard	Standard	*	*	*	*
MATERIAL RETAINED ON THE 19.0mm SIEVE (%):		0	0	*	*	*	*
OVERSIZED MATERIAL +53mm (%):		0	0	*	*	*	*
OPTIMUM MOISTURE CONTENT (%):		18.7	18.4	*	*	*	*
RMS T111 MAXIMUM DRY DENSITY (t/m^3):		1.68	1.76	*	*	*	*
DRY DENSITY	AT MOULDING (t/m^3):	1.71	1.72	*	*	*	*
	AFTER SOAK (t/m^3):	1.70	1.70	*	*	*	*
RMS T120 MOISTURE	AT MOULDING (%):	19.3	18.9	*	*	*	*
	AFTER SOAK (%):	19.6	19.9	*	*	*	*
	TOP 30mm (%):	19.5	19.6	*	*	*	*
ABSORPTION (%):		0.4	1.0	*	*	*	*
SWELL (%):		0.96	1.19	*	*	*	*
CBR OBTAINED FROM PENETRATION (mm):		2.5	2.5	*	*	*	*
CALIFORNIA BEARING RATIO (%):		**11**	**8**	*	*	*	*
NUMBER OF DAYS SOAKING:		4	4	*	*	*	*
SPECIFIED LABORATORY DENSITY RATIO (%):		*	*	*	*	*	*
ACTUAL LABORATORY DENSITY RATIO (%):		102	98	*	*	*	*
SPECIFIED LABORATORY MOISTURE RATIO (%):		*	*	*	*	*	*
ACTUAL LABORATORY MOISTURE RATIO (%):		103	102	*	*	*	*
AS1289.3.1.2	LIQUID LIMIT (%):	36	39	*	*	*	*
AS1289.3.2.1	PLASTIC LIMIT (%):	14	15	*	*	*	*
AS1289.3.3.1	PLASTICITY INDEX (%):	22	24	*	*	*	*
T113	LINEAR SHRINKAGE (%):	*	*	*	*	*	*
AS1289.3.8.1	EMERSON AGGREGATE TEST:	*	*	*	*	*	*
T120	FIELD MOISTURE CONTENT (%):	12.0	11.4	*	*	*	*

LDR Target = (99%-101% RMS & AS)
LMR Target = (97%-102% RMS & 95%-105% AS)

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Number: 3349

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APPROVED SIGNATORY: DM McMahon

DATE: 6/03/2020

DM McMahon Pty Ltd
PO Box 6118
WAGGA WAGGA NSW 2650
Ph: 0269 310 510

DATE SAMPLED: 26/02/2020
SAMPLED BY: LN
DATE SUBMITTED: 6/03/2020
SUBMITTED BY: LN
NO OF SAMPLES: 12
SAMPLING METHOD: AS1289.1.2.1
CLAUSE: 6.5.3
SPECIFICATIONS: *
PREP. METHOD: p/test method
DATE OF LAB TESTING: 6/03 - 20/03/2020
JOB NO.: 6705

TEST REPORT

PAVEMENT MATERIALS, FILLS, SUBGRADE AND SOILS

CLIENT: Croft Developments Pty Ltd
JOB DESCRIPTION: 121 Fernleigh Road, Turvey Park NSW 2650
Geotechnical Investigation

MATERIAL SOURCE: In situ
PROPOSED USE: Design/Investigation
MATERIAL TYPE: Soil

		SAMPLE NUMBER:			6705-1/1	6705-1/2	6705-2/1	6705-2/2	6705-3/1
		SITE OR CHAINAGE (m):			BH01	BH01	BH02	BH02	BH03
		DEPTHS BETWEEN WHICH SAMPLES TAKEN (m):			0.3	1.0	0.3	1.0	0.3
		SPECIFIED LIMITS LISTED BELOW FOR:	*	*	*	*	*	*	*
TESTS		PRETREATMENT:	*	*	*	*	*	*	*
T106		PASS 75.0mm SIEVE %	*	*	*	*	*	*	*
		PASS 53.0mm SIEVE %	*	*	*	*	*	*	*
		PASS 37.5mm SIEVE %	*	*	*	*	*	*	*
		PASS 26.5mm SIEVE %	*	*	*	*	*	*	*
		PASS 19.0mm SIEVE %	*	*	*	*	*	*	*
		PASS 13.2mm SIEVE %	*	*	*	*	*	*	*
		PASS 9.50mm SIEVE %	*	*	*	*	*	*	*
		PASS 6.70mm SIEVE %	*	*	*	*	*	*	*
		PASS 4.75mm SIEVE %	*	*	*	*	*	*	*
		PASS 2.36mm SIEVE %	*	*	*	*	*	*	*
T107	-2.36mm	PASS 425µm SIEVE %	*	*	*	*	*	*	*
		PASS 75µm SIEVE %	*	*	*	*	*	*	*
		LESS THAN 13.5µm %	*	*	*	*	*	*	*
		OBSERVATIONS	*	*	*	*	*	*	*
RATIOS	A -	PASS 425µm %	*	*	*	*	*	*	*
	B -	PASS 75/425 µm %	*	*	*	*	*	*	*
	C -	BELOW 13.5/75µm %	*	*	*	*	*	*	*
AS1289.3.1.2		LIQUID LIMIT %	*	*	*	36	*	38	*
AS1289.3.2.1		PLASTIC LIMIT %	*	*	*	15	*	15	*
AS1289.3.3.1		PLASTICITY INDEX %	*	*	*	21	*	23	*
T113		LINEAR SHRINKAGE %	*	*	6.0	8.0	5.0	9.5	5.0
T111		MAX. DRY DENSITY t/m³	*	*	*	*	*	*	*
		OPTIMUM MOISTURE CONTENT %	*	*	*	*	*	*	*
AS1289.3.8.1		EMERSON AGGREGATE TEST	*	*	*	*	*	*	*
T120		FIELD MOISTURE CONTENT %	*	*	*	*	*	*	*

NATA
ACCREDITED FOR TECHNICAL COMPETENCE
Number: 3349

Accredited for compliance with ISO/IEC 17025 - Testing. The results of the tests included in this document are traceable to Australian/National Standards. This document shall not be reproduced except in full.

All samples are oven dried and dry sieved preparation unless otherwise stated

APPROVED SIGNATORY: A. Rudd DATE: 20/04/2020

DM McMahon Pty Ltd
PO Box 6118
WAGGA WAGGA NSW 2650
Ph: 0269 310 510

DATE SAMPLED: 26/02/2020
SAMPLED BY: LN
DATE SUBMITTED: 6/03/2020
SUBMITTED BY: LN
NO OF SAMPLES: 12
SAMPLING METHOD: AS1289.1.2.1
CLAUSE: 6.5.3
SPECIFICATIONS: *
PREP. METHOD: p/test method
DATE OF LAB TESTING: 6/03 - 20/03/2020
JOB NO.: 6705

TEST REPORT

PAVEMENT MATERIALS, FILLS, SUBGRADE AND SOILS

CLIENT: Croft Developments Pty Ltd
JOB DESCRIPTION: 121 Fernleigh Road, Turvey Park NSW 2650
Geotechnical Investigation

MATERIAL SOURCE: In situ
PROPOSED USE: Design/Investigation
MATERIAL TYPE: Soil

		SAMPLE NUMBER:			6705-3/2	6705-4/1	6705-4/2	6705-5/1	6705-5/2
		SITE OR CHAINAGE (m):			BH03	BH04	BH04	BH05	BH05
		DEPTHS BETWEEN WHICH SAMPLES TAKEN (m):			1.0	0.3	1.0	0.3	1.0
		SPECIFIED LIMITS LISTED BELOW FOR:	*	*	*	*	*	*	*
TESTS		PRETREATMENT:	*	*	*	*	*	*	*
T106		PASS 75.0mm SIEVE %	*	*	100	*	100	*	*
		PASS 53.0mm SIEVE %	*	*	100	*	100	*	*
		PASS 37.5mm SIEVE %	*	*	100	*	100	*	*
		PASS 26.5mm SIEVE %	*	*	100	*	100	*	*
		PASS 19.0mm SIEVE %	*	*	100	*	100	*	*
		PASS 13.2mm SIEVE %	*	*	100	*	100	*	*
		PASS 9.50mm SIEVE %	*	*	100	*	100	*	*
		PASS 6.70mm SIEVE %	*	*	99	*	100	*	*
		PASS 4.75mm SIEVE %	*	*	96	*	85	*	*
		PASS 2.36mm SIEVE %	*	*	70	*	42	*	*
T107	-2.36mm	PASS 425µm SIEVE %	*	*	67	*	40	*	*
		PASS 75µm SIEVE %	*	*	60	*	36	*	*
		LESS THAN 13.5µm %	*	*	38	*	25	*	*
		OBSERVATIONS	*	*	*	*	*	*	*
RATIOS	A -	PASS 425µm %	*	*	*	*	*	*	*
	B -	PASS 75/425 µm %	*	*	*	*	*	*	*
	C -	BELOW 13.5/75µm %	*	*	*	*	*	*	*
AS1289.3.1.2		LIQUID LIMIT %	*	*	31	*	34	*	42
AS1289.3.2.1		PLASTIC LIMIT %	*	*	11	*	13	*	18
AS1289.3.3.1		PLASTICITY INDEX %	*	*	20	*	21	*	24
T113		LINEAR SHRINKAGE %	*	*	8.0	3.5	9.0	5.0	10.0
T111		MAX. DRY DENSITY t/m³	*	*	*	*	*	*	*
		OPTIMUM MOISTURE CONTENT %	*	*	*	*	*	*	*
AS1289.3.8.1		EMERSON AGGREGATE TEST	*	*	*	*	*	*	*
T120		FIELD MOISTURE CONTENT %	*	*	*	*	*	*	*

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Number: 3349

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All samples are oven dried and dry sieved preparation unless otherwise stated

APPROVED SIGNATORY: A. Rudd DATE: 20/04/2020

DM McMahon Pty Ltd
PO Box 6118
WAGGA WAGGA NSW 2650
Ph: 0269 310 510

DATE SAMPLED: 26/02/2020
SAMPLED BY: LN
DATE SUBMITTED: 6/03/2020
SUBMITTED BY: LN
NO OF SAMPLES: 12
SAMPLING METHOD: AS1289.1.2.1
CLAUSE: 6.5.3
SPECIFICATIONS: *
PREP. METHOD: p/test method
DATE OF LAB TESTING: 6/03 - 20/03/2020
JOB NO.: 6705

TEST REPORT

PAVEMENT MATERIALS, FILLS, SUBGRADE AND SOILS

CLIENT: Croft Developments Pty Ltd
JOB DESCRIPTION: 121 Fernleigh Road, Turvey Park NSW 2650
Geotechnical Investigation

MATERIAL SOURCE: In situ
PROPOSED USE: Design/Investigation
MATERIAL TYPE: Soil

		SAMPLE NUMBER:			6705-6/1	6705-6/2	*	*	*
		SITE OR CHAINAGE (m):			BH06	BH06	*	*	*
		DEPTHS BETWEEN WHICH SAMPLES TAKEN (m):			0.3	1.0	*	*	*
		SPECIFIED LIMITS LISTED BELOW FOR:	*	*	*	*	*	*	*
TESTS		PRETREATMENT:	*	*	*	*	*	*	*
T106		PASS 75.0mm SIEVE %	*	*	*	*	*	*	*
		PASS 53.0mm SIEVE %	*	*	*	*	*	*	*
		PASS 37.5mm SIEVE %	*	*	*	*	*	*	*
		PASS 26.5mm SIEVE %	*	*	*	*	*	*	*
		PASS 19.0mm SIEVE %	*	*	*	*	*	*	*
		PASS 13.2mm SIEVE %	*	*	*	*	*	*	*
		PASS 9.50mm SIEVE %	*	*	*	*	*	*	*
		PASS 6.70mm SIEVE %	*	*	*	*	*	*	*
		PASS 4.75mm SIEVE %	*	*	*	*	*	*	*
		PASS 2.36mm SIEVE %	*	*	*	*	*	*	*
T107	-2.36mm	PASS 425µm SIEVE %	*	*	*	*	*	*	*
		PASS 75µm SIEVE %	*	*	*	*	*	*	*
		LESS THAN 13.5µm %	*	*	*	*	*	*	*
		OBSERVATIONS	*	*	*	*	*	*	*
RATIOS	A -	PASS 425µm %	*	*	*	*	*	*	*
	B -	PASS 75/425 µm %	*	*	*	*	*	*	*
	C -	BELOW 13.5/75µm %	*	*	*	*	*	*	*
AS1289.3.1.2		LIQUID LIMIT %	*	*	*	42	*	*	*
AS1289.3.2.1		PLASTIC LIMIT %	*	*	*	16	*	*	*
AS1289.3.3.1		PLASTICITY INDEX %	*	*	*	26	*	*	*
T113		LINEAR SHRINKAGE %	*	*	4.0	10.0	*	*	*
T111		MAX. DRY DENSITY t/m³	*	*	*	*	*	*	*
		OPTIMUM MOISTURE CONTENT %	*	*	*	*	*	*	*
AS1289.3.8.1		EMERSON AGGREGATE TEST	*	*	*	*	*	*	*
T120		FIELD MOISTURE CONTENT %	*	*	*	*	*	*	*

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APPROVED SIGNATORY: A. Rudd

DATE: 20/04/2020

Attachment D : *CIRCLY analysis output*

CIRCLY Version 5.0u (8 April 2013)

Job Title: Community Aged Care Facility

Road Type : Access Road

Damage Factor Calculation

Assumed number of damage pulses per movement:
One pulse per axle (i.e. use NROWS)

Traffic Spectrum Details:

ID: 2.5e5 Title: 2.5e5

Load No.	Load ID	Movements
1	ESA75-Full	2.50E+05

Details of Load Groups:

Load No.	Load ID	Load Category	Load Type	Radius	Pressure/ Ref. stress	Exponent
1	ESA75-Full	SA750-Full	Vertical Force	92.1	0.75	0.00

Load Locations:

Location No.	Load ID	Gear No.	X	Y	Scaling Factor	Theta
1	ESA75-Full	1	-165.0	0.0	1.00E+00	0.00
2	ESA75-Full	1	165.0	0.0	1.00E+00	0.00
3	ESA75-Full	1	1635.0	0.0	1.00E+00	0.00
4	ESA75-Full	1	1965.0	0.0	1.00E+00	0.00

Layout of result points on horizontal plane:
Xmin: 0 Xmax: 165 Xdel: 165
Y: 0

Details of Layered System:

ID: 14325-1-1 Title: 14325-1-1 Access Road - Flexible Pavement

Layer No.	Lower i/face	Material ID	Isotropy	Modulus (or Ev)	P.Ratio (or vvh)	F	Eh	vh
1	rough	Gran_350	Aniso.	3.50E+02	0.35	2.60E+02	1.75E+02	0.35
2	rough	Gran_200	Aniso.	2.00E+02	0.35	1.50E+02	1.00E+02	0.35
3	rough	Sub_CBR8	Aniso.	8.00E+01	0.45	5.52E+01	4.00E+01	0.45

Performance Relationships:

Layer No.	Location	Performance ID	Component	Perform. Constant	Perform. Exponent	Traffic Multiplier
3	top	Sub_2004	EZZ	0.009300	7.000	1.600

Reliability Factors: Not Used.

Details of Layers to be sublayered:
Layer no. 1: Austroads (2004) sublayering
Layer no. 2: Austroads (2004) sublayering

Results:

Layer No.	Thickness	Material ID	Load ID	Critical Strain	CDF
1	130.00	Gran_350		n/a	n/a
2	150.00	Gran_200		n/a	n/a
3	0.00	Sub_CBR8	ESA75-Full	1.31E-03	4.31E-01

CIRCLY Version 5.0u (8 April 2013)

Job Title: Community Aged Care Facility

Road Type : Shareways

Damage Factor Calculation

Assumed number of damage pulses per movement:
One pulse per axle (i.e. use NROWS)

Traffic Spectrum Details:

ID: 1E5 Title: 1E5

Load No.	Load ID	Movements
1	ESA75-Full	1.00E+05

Details of Load Groups:

Load No.	Load ID	Load Category	Load Type	Radius	Pressure/ Ref. stress	Exponent
1	ESA75-Full	SA750-Full	Vertical Force	92.1	0.75	0.00

Load Locations:

Location No.	Load ID	Gear No.	X	Y	Scaling Factor	Theta
1	ESA75-Full	1	-165.0	0.0	1.00E+00	0.00
2	ESA75-Full	1	165.0	0.0	1.00E+00	0.00
3	ESA75-Full	1	1635.0	0.0	1.00E+00	0.00
4	ESA75-Full	1	1965.0	0.0	1.00E+00	0.00

Layout of result points on horizontal plane:
Xmin: 0 Xmax: 165 Xdel: 165
Y: 0

Details of Layered System:

ID: 14325-1-2 Title: 14325-1-2 Shareways - Flexible Pavement

Layer No.	Lower i/face	Material ID	Isotropy	Modulus (or Ev)	P.Ratio (or vvh)	F	Eh	vh
1	rough	Gran_350	Aniso.	3.50E+02	0.35	2.60E+02	1.75E+02	0.35
2	rough	Gran_200	Aniso.	2.00E+02	0.35	1.50E+02	1.00E+02	0.35
3	rough	Sub_CBR8	Aniso.	8.00E+01	0.45	5.52E+01	4.00E+01	0.45

Performance Relationships:

Layer No.	Location	Performance ID	Component	Perform. Constant	Perform. Exponent	Traffic Multiplier
3	top	Sub_2004	EZZ	0.009300	7.000	1.600

Reliability Factors: Not Used.

Details of Layers to be sublayered:
Layer no. 1: Austroads (2004) sublayering
Layer no. 2: Austroads (2004) sublayering

Results:

Layer No.	Thickness	Material ID	Load ID	Critical Strain	CDF
1	130.00	Gran_350		n/a	n/a
2	140.00	Gran_200		n/a	n/a
3	0.00	Sub_CBR8	ESA75-Full	1.38E-03	2.55E-01