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Our Ref: PSM4407-006L

2 November 2021

Project Manager
Archile Projects
606/50 Clarence St
SYDNEY NSW 2000
agoh@archile.com.au

Attention: Alan Goh

Dear Alan

RE: 311 SOUTH ST, MARSDEN PARK
RESULTS OF GEOTECHNICAL INVESTIGATION

1. Introduction

This letter presents the results of the geotechnical investigation undertaken by Pells Sullivan Meynink (PSM) for the proposed development at 311 South Street, Marsden Park. This work has been undertaken in accordance with the PSM proposal dated 13 August 2021 (Ref. PSM4407-004L).

PSM has previously completed a due diligence stage desktop review of geotechnical conditions for this site (ref. PSM4407-002L, dated 3 May 2021).

2. Background

We have been provided with, and reviewed, the following documents:

- Watson Young Site Plan (ref. 21259-DA03_P4, dated 9/09/2021)
- Costin Roe Consulting Bulk Earthworks and Cut/Fill Plan (ref. C014253.01-SSDA30_B, dated 15/09/2021).

Based on your email request and the documents above, we understand the following:

- The proposed site has an area of approximately 100 ha and currently comprises mainly vacant land with two maintained residential properties, a derelict property and several natural and/or man-made dams across the site. A high voltage transmission line passes across the western portion of the proposed site
- The proposed development is light industrial which comprises eight (8) warehouses including two-storey offices, hardstand areas, carparking, and landscaped areas
- Bulk earthworks will be required. The site primarily requires filling to bring it up to design level with fill depths up to 4.5 m. Localised cut will be required, typically less than 0.5 m but up to 3 m for a proposed bio retention basin.

Figure 1 presents a site locality plan of the proposed development.

3. Geotechnical Investigation

3.1 Fieldwork (20 September 2021)

The fieldwork was undertaken on 20 September 2021 under the full-time supervision of a PSM geotechnical engineer who undertook the following tasks:

- Directing service locating, excavation and reinstatement of test pits
- Preparing field logs of material encountered
- Undertaking DCP testing at some of the PSM test pit locations
- Collecting bulk soil samples for laboratory testing.

A total of ten (10) test pits were excavated and logged by PSM to depths of between 1.5 m to 3.0 m.

The test pits were excavated with an 8 tonne backhoe during our investigation. At the completion of the fieldwork, the test pits were backfilled with excavated spoil and lightly tamped with the excavator bucket.

Appendix A presents tabulated test pit logs including photographs of the PSM test pits and Appendix B presents the results of the Dynamic Cone Penetrometer (DCP) testing undertaken at seven of these test pit locations.

Selected site photographs from the geotechnical investigation are presented in Figures 2,3 and 4.

3.2 Geotechnical Laboratory Testing

3.2.1 California Bearing Ratio (CBR)

Three (3) bulk soil samples were recovered for CBR testing.

The following sample preparation was undertaken prior to CBR testing:

- Compact to 98% standard MDD, at optimum moisture content (OMC)
- Four (4) day-soaked sample; and
- 4.5 kg surcharge.

Table 1presents a summary of the CBR test results. The laboratory test results are included in Appendix C.

Table 1 – Summary of CBR Test Results

PSM TP ID	Depth (m)	Material Description	Soaked CBR (%)	OMC (%)	Standard Maximum Dry Density (t/m^3)	Swell (%)
TP02	0.5	CLAY	1.5*	23.6	1.59	3.5
TP06	0.5	CLAY trace gravel	1.5*	22.4	1.64	2.5
TP09	0.6	CLAY trace gravel	4.0*	20.7	1.67	2.0

Notes: * Indicates Soaked CBR value at 2.5 mm penetration

3.2.2 Shrink-Swell Index

Two (2) soil samples were recovered for shrink-swell index testing.

Table 2 presents a summary of the Shrink-Swell Index test results. The laboratory test results are included in Appendix D.

Table 2 – Summary of Shrink-Swell Index Test Results

PSM TP ID	Depth (m)	Material Description	Swell on Saturation (%)	Shrinkage (%)	Shrink Swell Index (%/pF)
TP03	1.0	Sandy CLAY	6.1	1.7	2.66
TP08	1.1	Sandy CLAY	1.1	2.4	1.63

3.2.3 Analytical Laboratory Testing

Five (5) disturbed soil samples were recovered for testing by a NATA accredited analytical laboratory. The following tests were undertaken on the disturbed soil samples:

- Cation Exchange Capacity (CEC) of calcium, magnesium, potassium and sodium
- Exchangeable sodium percentage
- Salinity (EC 1:5, one part soil to five parts water)
- Soil pH
- Chlorides
- Sulphates
- Resistivity.

Table 3 presents a summary of the results. The laboratory test results are included in Appendix E.

Table 3 - Analytical Laboratory Test Results

Sample ID	pH	Electrical Conductivity [µS/cm]	Saturated Resistivity [ohm.cm]	Moisture Content [%]	Chloride by discrete analyser [mg/kg]	Soluble Sulfate by icpaes [mg/kg]	Exchangeable Cations [meq/100g]					ESP [%]
							Ca	Mg	K	Na	CEC	
TP01 (0.8 m)	5.6	157	1030	16.9	190	40	0.2	8.0	0.3	3.1	12.3	26.7
TP02 (0.5 m)	4.8	290	750	18.1	340	70	2.1	8.9	0.4	3.7	15.5	24.7
TP03 (0.5 m)	5.5	94	1280	17	60	40	1.7	10.6	0.2	2.8	15.5	18.6
TP08 (0.5 m)	5.1	188	910	19.6	100	150	3.1	9.4	0.3	3.0	16.0	19.0
TP10 (1.1 m)	5.1	600	350	19.2	850	230	0.3	6.5	0.4	2.3	9.5	24.1

4. Site Conditions

4.1 Geological Setting

The 1:100,000 Penrith geological map (1991) indicates that that the site is underlain by Bringelly Shale of the Wianamatta Group (Rwb: Shale, carbonaceous claystone, claystone, laminate, fine to medium-grained lithic sandstone, rare coal and tuff).

The geological map also indicates that a diatreme (J_{v13}) comprising volcanic breccia and basalt is located in close proximity to the site.

Inset 1presents the site location with regards to the geological setting.

Inset 1: Penrith 1:100,000 geological map (site marked in red)

4.2 Surface Conditions

The site is bounded by South Street to the north, undeveloped grassed areas to the east, an old landfill to the southeast and a warehouse to the southwest.

At the time of the fieldwork, the following observations were made:

- The surface of the site comprised a typical rural setting with an occupied dwelling and associated sheds, grassed paddocks, gravel driveways, limited vegetation and several small dams
- The site had an undulating surface but generally sloped down to the southwest.

Inset 2 presents a recent aerial photograph of the site.

Inset 2: Nearmap Aerial Photograph of The Site Conditions On 7 August 2021

4.3 Subsurface Conditions

Table 4 shows the approximate depth to the top of the inferred geotechnical units encountered at the test pit locations. Table 5 presents the depth to the top of inferred geotechnical units in each test pit.

Table 4 – Summary of Inferred Subsurface Conditions Encountered In Test Pit Locations

Inferred Unit	Depth to top of inferred unit (m)	Material Description
TOPSOIL	0.0	Silty CLAY to Silty CLAY trace gravel; high plasticity, brown, soft to stiff; gravel sub-rounded to sub-angular up to 50 mm, dry to moist
FILL	0.2 – 0.4	CLAY to Gravelly CLAY; high plasticity, red, grey and brown, firm to very stiff; gravel sub-rounded to sub-angular up to 60 mm, dry to moist. Probably reworked natural.
NATURAL SOIL	0.5 – 1.2	CLAY to CLAY trace gravel; high plasticity, red, brown and grey, firm to hard; gravel sub-rounded to sub-angular up to 60 mm, moist to wet Sandy CLAY to Sandy CLAY with gravel; low to high plasticity, red, grey and brown, stiff to very stiff; sand fine grained; gravel sub-angular up to 60 mm, moist
BEDROCK	1.4 – 2.4	SHALE; red, grey and brown, extremely weathered to highly weathered, very low strength

Table 5 – Depth to Top Of Inferred Geotechnical Units Encountered In PSM Test Pits

BH ID	Depth to Top of Inferred Geotechnical Units (m) [1]				
	Topsoil	Fill	Natural soil	Bedrock	EOH [2]
TP01	0.00	0.40	1.10	1.70	1.80
TP02	0.00	0.30	1.20	1.40	1.50
TP03	0.00	0.30	0.70	2.40	3.00
TP04	0.00	0.20	0.70	1.50	2.00
TP05	0.00	NE	0.50	NE	3.00
TP06	0.00	0.20	0.70	1.50	2.20
TP07	0.00	0.30	0.80	1.80	2.20
TP08	0.00	0.30	0.70	1.40	1.50
TP09	0.00	0.30	0.80	1.50	1.80
TP10	0.00	0.20	0.70	2.00	3.00

1 NE = Not Encountered

2 EOH = End of Hole

4.4 Groundwater

Groundwater was not encountered during our investigation. No long term groundwater monitoring was undertaken.

5. Discussion

5.1 Assessment of Analytical Laboratory Testing

5.1.1 Soil Chemistry

The laboratory test results summarised in Table 3 indicate the following:

- pH of the soil samples analysed was in the range of 4.8 to 5.6, with an average of 5.2
- The 1:5 soil to water extraction and subsequent electrical conductivity ($EC_{1:5}$) of the soil samples analysed to be in the range of 350 µS/cm to 1280 µS/cm
- Concentrations of chlorides in samples analysed was in the range of 60 mg/kg to 850 mg/kg
- Concentrations of soluble sulphate in samples analysed was in the range of 40 mg/kg to 230 mg/kg
- Cation Exchange Capacity (CEC) in samples analysed was in the range 9.5 meq/100g to 16.0 meq/100g
- Exchange Sodium Percentage (ESP) in samples analysed was in the range of 18.6 % to 26.7 %.

5.1.2 Salinity Assessment

Site Investigations for Urban Salinity (DLWC 2002) classify soil salinity based on electrical conductivity (EC_e). The method of conversion from $EC_{1:5}$ to EC_e (electrical conductivity of saturated extract) is based on DLWC (2002) and given by $EC_e = EC_{1:5} \times M$, where M is the multiplication factor based on "Soil Texture Group".

The "Soil Texture Group" of the samples tested were assessed during our investigation. The salinity classification for the soil samples that were tested are presented in Table 6.

Table 6 – Salinity Classification

SAMPLE ID	$EC_{1:5}$ (dS/m)	SOIL TYPE	M	EC_e (dS/m)	SALINITY CLASS
TP01 (0.8 m)	0.157	Medium Clay	7	1.099	Non-saline
TP02 (0.5 m)	0.290	Clay Loam	9	2.610	Slightly Saline
TP03 (0.5 m)	0.094	Clay Loam	9	0.846	Non-saline
TP08 (0.5 m)	0.188	Clay Loam	9	1.692	Non-saline
TP10 (1.1 m)	0.600	Medium Clay	7	4.200	Moderately-saline

It is assessed that the soils on site are classified as “non-saline to moderately saline”.

We have referred to Clause 4.8.2 of Australian Standard AS3600-2018 “Concrete Structures” and note that the assessed soil electrical conductivity (EC_e) is within the “A2” exposure classification.

5.2 Corrosivity / Aggressivity

Table 4.8.1 of AS3600-2018 “Concrete Structures” provides criteria for exposure classification for concrete in sulphate soils based on sulphates in soil and groundwater, and pH of soil. On the basis of the sulphate and pH testing completed we assess the exposure classification for concrete in sulphate soils to be “A2”.

Table 6.4.2(C) of Australian Standard AS2159:2009, Piling – Design and Installation provides criteria for exposure classification for concrete piles based on sulfates in the soil and groundwater, soil and groundwater pH, and chlorides in groundwater. On the basis of the soil sulfates and pH testing completed we assess the exposure classification for concrete piles in the soil to be mild.

Table 6.5.2(C) of Australian Standard AS2159:2009, Piling – Design and Installation provides criteria for exposure classification for steel piles based on resistivity, soil and groundwater pH, and chlorides in soil and groundwater. On the basis of the soil chlorides and pH testing completed we assess the exposure classification for steel piles in the soil to be moderate.

5.3 Sodicity

Sodicity provides a measure of the likely dispersion on wetting and to shrink/swell properties of a soil. Soil sodicity is classified based on the Exchangeable Sodium Percentage (ESP) which is the amount of exchangeable sodium as a percentage of the Cation Exchange Capacity (DLWC, 2002).

The Exchangeable Sodium Percentages calculated from these laboratory results, ranging from 18.6% to 26.7%, indicates that the soils on site are highly sodic when compared to criteria listed in “Site Investigations for Urban Salinity”, DLWC (2002).

6. Earthworks

A separate bulk earthworks specification has been prepared (ref. PSM4407-003S) in Appendix F. which sets out clearly the roles and responsibilities of the earthworks contractor and its Geotechnical Inspection and Testing Authority (GITA).

7. Interim Geotechnical Design Advice (IGDA)

7.1 General

The interim geotechnical design advice (IGDA) provided in the following sections has been prepared on the following basis:

- The earthworks will be undertaken in accordance with the PSM bulk earthworks specification PSM4407-003S.

As described in the specification, a round of plate load testing will be undertaken at the completion of the earthworks.

We note that desiccation and/or wetting up of the pad surface is possible should it be exposed to the elements for an extended period, particularly at completion of the bulk earthworks prior to the builder taking responsibility for the pad. To reduce the likelihood of this and preserve the pad condition we recommend the following should be considered following completion of the bulk earthworks:

- Placement of a sacrificial layer comprising road base or other equivalent material
- Grade the pad surface to reduce the extent and severity of standing water during and after weather events
- Minimise the time between the completion of earthworks and the builder commencing construction of the warehouse roof
- Limit vehicular and plant access until a roof has been installed.

Alternatively, the builder may have to undertake some surficial remediation if the pad is to comply with the requirements of this IGDA (i.e. comply with the PSM Specification) at the time of construction. It is PSM's opinion that it should be the builder's responsibility to maintain the condition of the pad after the handover date and accept the risk that comes with modifying excavation levels and weather. There should be a strict transfer of the risk. We recommend that building tenderers be required to indicate how they intend to manage this risk.

7.2 Site Classification

As the proposed development is of an industrial nature, it is outside the scope of AS2870-2011 "Residential slabs and footings". Notwithstanding this, we assess that, based on the natural clay soil on Site, and for fill placed in accordance with the PSM bulk earthworks Specification, the characteristic surface movement, y_s, would be in the range 40 to 60 mm and thus would classify the Site as Class H1. The civil and structural engineers should consider likely heave / settlement due to the effect of climatic factors in their designs.

We recommend that all structures and services be detailed such that they preclude any local wetting up or drying out of the subgrade after initial equilibrium is reached following construction of the slab and that the subgrade be within the PSM bulk earthworks Specification at the time of construction of the slab. We note that normal mounding or sagging away from the perimeter of covered areas will still occur and perimeters, or open joints, will still respond to environmental changes.

For effectively sealed areas away from the perimeter, the design should allow for the following:

- Differential mound movement, y_m = 25 mm. We note that this is not the total heave or settlement but the estimated local heave or settlement due to fill variability
- Tilts of up to approximately 1 in 300.

Mounds at perimeters or penetrations of slabs open to the environment can be taken to be as per AS2870-2011 for y_s = 55 mm.

7.3 Foundations

It is expected that the foundations used as part of the proposed development at the Site would typically include strip, pad, or other shallow footings.

Pad footings can be proportioned on the basis of an allowable bearing pressure (ABP) for centric vertical loads provided in Table 7. Further advice should be sought if the footings are located adjacent to a batter or wall.

We note that an allowable bearing pressure (ABP) is not a soil property. It depends on many factors such as the size of the footings, the embedment depth, the load direction and eccentricity, the stiffness of the footing, the adopted factor of safety (FOS), as well as the soil properties. As footings get bigger or deeper the capacity increases rapidly, and as the load gains eccentricity or becomes inclined, the capacity reduces rapidly.

Settlements in the NATURAL SOIL unit can be estimated using the elastic moduli provided in Table 7.

When assessing the settlement of the shallow footings, the designer needs to consider the additional ground settlement due to the total building load on both shallow and deeper units. The differential settlement due to the building load shall also be assessed.

Foundation conditions at the proposed shallow pad footing locations should be inspected by a suitably qualified geotechnical engineer prior to the pouring of concrete.

Table 7 – Foundation Parameters of Inferred Geotechnical Units

Inferred Unit	Bulk Unit Weight (kN/m3)	Soil Effective Strength Parameters		Ultimate Bearing Pressure under Vertical Centric Loading [2] (kPa)	Allowable Bearing Pressure (ABP) under Vertical Centric Loading [3] (kPa)	Elastic Parameters	
		c' (kPa)	φ' (deg)			Long Term Youngs Modulus (MPa)	Poisson's Ratio
ENGINEERED FILL / NATURAL SOIL	18	0	30	420	150[1]	10	0.3
BEDROCK	22	N/A	N/A	3,000	700	100	0.25

1 Pad footings (for ABP of 150 kPa) should have a minimum horizontal dimension of 1 m and a minimum embedment depth of 0.5 m.

1 Ultimate values occur at large settlement (>5% of minimum footing).

2 ABP is an end bearing pressure to cause settlement of <1% of minimum footing.

7.4 Permanent and Temporary Slopes

The batter slope angles shown in Table 8 are recommended for the design of batters up to 3 m height and above the groundwater table, subject to the following recommendations:

1. The batters shall be protected from erosion.
2. Permanent batters shall be drained.
3. Temporary batters shall not be left unsupported for more than 1 month without further advice, and inspection by a geotechnical engineer should be undertaken following significant rain events.
4. Where loads are imposed or structures / services are located within on batter height of the crest of the batter, further advice should be sought.

Table 8 – Design Batter Slope Angles

Unit	Temporary	Permanent
SOIL UNITS, e.g. ENGINEEERED FILL, NATURAL SOIL	2H : 1V	2.5H : 1V
BEDROCK	1H : 1V	1.5H : 1V

Steeper batters may be possible subject to further advice, typically involving inspection during construction.

7.5 Retention

The selection of an appropriate retention system is a matter of design.

The design of these structures should be based on the following:

- Proposed wall geometry
- Effective soil strength parameters in Table 7
- Surcharge loads behind the retaining structure
- Water pressure (depending on the type of structure).

Note that design of retention systems may be based on either Ka or Ko earth pressures. Design using active earth pressures (Ka) provides the minimum lateral earth pressure that must be supported to avoid failure and requires a wall that can rotate or translate to allow the pressures to reduce to these values (vertical and lateral movements up to 2% of height may occur, typical movements will be much less).

Where the design is based on Ko pressures, construction should be carefully controlled to avoid unwanted effects. It should be noted that designing for Ko pressures does not, of itself, ensure that movement does not occur. Movements are controlled by the construction method, especially sequence.

Both surface and sub-surface drainage needs to be designed and constructed properly to prevent pore water pressures from building up behind the retaining walls or appropriate water pressures must be included in the design.

7.6 Slabs

The design of slabs on ENGINEERED FILL can be based on a subgrade with the following Young's moduli:

- Long term Young's modulus (E_{LT}) of 10 MPa
- Short term Young's modulus (E_{ST}) of 15 MPa.

We note that the environmental effects (e.g. drying or wetting up of the finished surface) affecting the land prior to development should be considered by the various designers of any development.

We note that the final bulk earthworks subgrade would require proof rolling and plate load testing to confirm the properties provided and may require some boxing out and refilling, etc.

7.7 Pavements

Three (3) CBR tests were undertaken on samples of the existing fill. The results (refer to Table 1) indicated a CBR of between 1.5% and 4%.

A CBR of 2% can be adopted for subgrade and fill formed in bulk earthworks placed in accordance with a PSM Specification.

Subgrade CBR for pavement design depends on the material at the finished subgrade levels.

We recommend that specific CBR testing be undertaken at subgrade level when pavement layouts are finalised. CBR testing shall be undertaken for any new imported material within the pavement subgrade (e.g., within 1 m below pavement).

Should you have any queries, please do not hesitate to contact the undersigned.

Yours Sincerely

BRYAN TAM
GEOTECHNICAL ENGINEER

AGUSTRIA SALIM
PRINCIPAL

Encl.

Figure 1	Locality Plan
Figures 2 to 4	Selected Site Photographs
Appendix A	Tabulated Test Pit Logs
Appendix B	DCP Results
Appendix C	CBR Results
Appendix D	Shrink Swell Index Results
Appendix E	Analytical Laboratory Testing Results
Appendix F	Bulk Earthworks Specification (PSM4407-003S)

Legend:

- Approximate site boundary
- Test pits completed on 20 September 2021

Note:

1. Aerial photo taken from Nearmap dated 7 August 2021

10 0 10 20 30 40m
1 : 2000 FULL SIZE A3

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Geotechnical Invevstigation

SITE LOCALITY PLAN

PSM4407-006L	FIGURE 1

Photo 1 - General site conditions near TP06 facing north (20/09/2021)

Photo 2 - General site conditions near TP10 facing south west (20/09/2021)

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Geotechnical Investigation

SELECTED SITE PHOTOGRAPHS (1 of 3)
20/09/2021

PSM4407-006L	FIGURE 2

Photo 3 - Backhoe setup on TP03 (20/09/2021)

Photo 4 - Cuttings from TP04 (20/09/2021)

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Geotechnical Investigation

SELECTED SITE PHOTOGRAPHS (2 of 3)
20/09/2021

PSM4407-006L	FIGURE 3

Photo 5 - Typical FILL unit encountered in TP02 (20/09/2021)

Photo 6 - Typical NATURAL SOIL unit encountered in TP10 (20/09/2021)

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311 South Street, Marsden Park

Geotechnical Investigation

SELECTED SITE PHOTOGRAPHS (3 of 3)

20/09/2021

PSM4407-006L	FIGURE 4

Appendix A
Tabulated Test Pit Logs

Test Pit ID	Approximate Depth (m)	Material Encountered	Notes
TP01	0 – 0.4 m	Silty CLAY; high plasticity, brown, stiff, moist, pp 220 – 370 kPa	Inferred Topsoil (Grassed area)
	0.4 – 1.1 m	CLAY; high plasticity, red and grey; firm, moist, pp 200 – 250 kPa At 0.8 m: becoming grey At 1.0 m: becoming stiff, pp 260 -350 kPa, rock fragments observed	Inferred Fill
	1.1 – 1.7 m	CLAY trace gravel; high plasticity, red, grey and brown; gravel sub-rounded to sub-angular up to 55 mm, stiff to very stiff, moist.	Inferred Natural
	1.7 – 1.8 m	SHALE; red grey and brown, extremely weathered, very low strength	Bedrock
	1.8 m	Test pit terminated at 1.8 m	Target Depth

Note: pp = pocket penetrometer

Test Pit ID	Approximate Depth (m)	Material Encountered	Notes
TP02	0 – 0.3 m	Silty CLAY; high plasticity, brown, stiff, moist, pp 360 – 490 kPa	Inferred Topsoil (Grassed area)
	0.3– 1.2 m	CLAY; high plasticity, red and grey, stiff, moist, pp 280 – 320 kPa At 0.5 m: becoming grey, firm, pp 200 – 250 kPa	Inferred Fill
	1.2 – 1.4 m	Sandy CLAY; high plasticity, red and grey, stiff; sand fine grained, moist	Inferred Natural
	1.4 – 1.5 m	SHALE; red and grey, extremely weathered, very low strength	Bedrock
	1.5 m	Test pit terminated at 1.5 m	Target Depth

Test Pit ID	Approximate Depth (m)	Material Encountered	Notes
TP03	0 – 0.3 m	Silty CLAY; high plasticity, dark brown, firm, moist, pp 160 kPa	Inferred Topsoil (Grassed area)
	0.3 – 0.7 m	CLAY trace gravel; high plasticity, red, grey and brown, firm; gravel sub-rounded to sub-angular up to 30 mm, moist, pp 210 – 280 kPa	Inferred Fill
	0.7 – 1.1 m	Sandy CLAY; medium plasticity, red, grey and brown, stiff; sand fine grained, moist, pp 270 – 370 kPa	Inferred Natural
	1.1 – 1.7 m	Sandy CLAY with gravel; low to medium plasticity, red and grey, very stiff; sand fine grained; gravel sub-angular up to 60 mm, moist	-
	1.7 – 2.4 m	CLAY trace gravel: high plasticity, red and grey, very stiff to hard; gravel sub-angular up to 60 mm, moist	-
	2.4 – 3.0 m	SHALE; red, grey and brown, extremely weathered, very low strength	Bedrock
	3.0 m	Test pit terminated at 3.0 m	Target Depth

Test Pit ID	Approximate Depth (m)	Material Encountered	Notes
TP04	0 – 0.2 m	Silty CLAY; high plasticity, brown, firm, moist, pp 170 – 230 kPa	Inferred Topsoil (Grassed area)
	0.2 – 0.7 m	CLAY trace gravel; high plasticity, grey and brown, firm to stiff; gravel sub-angular up to 30 mm, moist, pp 170 – 350 kPa	Inferred Fill
	0.7 – 1.5 m	CLAY; high plasticity, grey, firm to stiff, moist to wet, pp 100 – 300 kPa At 1.2 m: becoming red and grey, very stiff, shale fragments up to 40 mm observed	Inferred Natural
	1.5 – 2.0 m	SHALE; red and grey, extremely weathered, very low strength	Bedrock
	2.0 m	Test pit terminated at 2.0 m	Target Depth

Test Pit ID	Approximate Depth (m)	Material Encountered	Notes
TP05	0 – 0.5 m	Silty CLAY trace gravel; high plasticity, soft to firm plasticity; gravel sub-rounded to sub-angular up to 55 mm, moist, pp 30 – 190 kPa	Inferred Topsoil (Grassed area)
	0.5 – 3.0 m	CLAY; high plasticity, red and grey, firm, wet, pp 120 – 200 kPa At 1.0 m: becoming stiff At 1.6 m: rock fragments observed At 2.0 m: becoming very stiff, pp 340 – 380 kPa	Inferred Natural
	3.0 m	Test pit terminated at 3.0 m	Target Depth

Test Pit ID	Approximate Depth (m)	Material Encountered	Notes
TP06	0 – 0.2 m	Silty CLAY; high plasticity, brown, firm, moist, pp 160 – 300 kPa	Inferred Topsoil (Grassed area)
	0.2 – 0.7 m	CLAY trace gravel; high plasticity, grey and brown, firm; gravel sub-angular up to 30 mm, moist, pp 90 – 180 kPa	Inferred Fill
	0.7 – 1.2 m	CLAY; high plasticity, pale grey, firm to stiff, moist, 160 – 170 kPa	Inferred Natural
	1.2 – 1.5 m	Sandy CLAY; red, grey and brown, high plasticity, stiff to very stiff; sand fine grained, moist, pp 210 – 460 kPa	-
	1.5 – 2.2 m	SHALE; red and grey, extremely weathered, very low strength	Bedrock
	2.2 m	Test pit terminated at 2.2 m	Target Depth

Test Pit ID	Approximate Depth (m)	Material Encountered	Notes
TP07	0 – 0.3 m	Silty CLAY; high plasticity, brown, firm, dry, pp 330 kPa	Inferred Topsoil (Grassed area)
	0.3 – 0.8 m	CLAY trace gravel; high plasticity, red, grey and brown, firm to stiff; gravel sub-rounded to sub-angular up to 30 mm, moist, pp 310 - 410 kPa	Inferred Fill
	0.8 – 1.8 m	CLAY; high plasticity, red and grey, firm to stiff, moist, 150 – 280 kPa At 1.0m: stiff to very stiff, rock fragments encountered and increasing in size with depth	Inferred Natural
	1.8 – 2.2 m	SHALE; red, grey and brown, extremely weathered, very low strength	Bedrock
	2.2 m	Test pit terminated at 2.2 m	Target Depth

Test Pit ID	Approximate Depth (m)	Material Encountered	Notes
TP08	0 – 0.3 m	Silty CLAY; high plasticity, brown, firm, moist, pp 200 – 250 kPa, with rootlets	Inferred Topsoil (Grassed area)
	0.3 – 0.7 m	CLAY trace gravel; high plasticity, grey and brown, firm; gravel sub-angular up to 40 mm, dry, pp 150 - 260 kPa	Inferred Fill
	0.7 – 1.0 m	CLAY; high plasticity, red, grey and brown, firm to stiff	Inferred Natural
	1.0 – 1.4 m	Sandy CLAY; low to medium plasticity, grey and brown, stiff; sand fine grained	-
	1.4 – 1.5 m	SHALE; red, grey and brown, extremely weathered, very low strength	Bedrock
	1.5 m	Test pit terminated at 1.5 m	Target Depth

Test Pit ID	Approximate Depth (m)	Material Encountered	Notes
TP09	0 – 0.3 m	Silty CLAY; high plasticity, brown, firm, moist, pp 50 – 180 kPa	Inferred Topsoil (Grassed area)
	0.3 – 0.8 m	CLAY trace gravel; high plasticity, grey and brown, firm to stiff; gravel sub-angular up to 15mm, moist, pp 260 – 330 kPa	Inferred Fill
	0.8 – 1.5 m	CLAY; high plasticity, grey and brown, stiff to very stiff, moist to wet, pp 200 – 250 kPa At 1.0 m: rock fragments observed At 1.2 m: becoming red, grey and brown	Inferred Natural
	1.5 – 1.8 m	SHALE; red and grey, extremely weathered, very low strength	Bedrock
	1.8 m	Test pit terminated at 1.8 m	Target Depth

Test Pit ID	Approximate Depth (m)	Material Encountered	Notes
TP10	0 – 0.2 m	Silty CLAY trace gravel; high plasticity, brown, firm to stiff; gravel sub-angular up to 30 mm, dry, pp 300 – 400 kPa	Inferred Topsoil (Grassed area)
	0.2 – 0.7 m	Gravelly CLAY; high plasticity, red and brown, stiff to very stiff; gravel sub-angular up to 60 mm, pp 290 – 440 kPa	Inferred Fill
	0.7 – 2.0 m	CLAY; high plasticity, red and grey, stiff to very stiff, moist At 1.0 m: pp 290 – 300 kPa At 1.5 m: pp 300 – 370 kPa At 1.7 m: rock fragments encountered	Inferred Natural
	2.0 – 3.0 m	SHALE; red and grey, extremely weathered, very low strength	Bedrock
	3.0 m	Test pit terminated at 0.4 m	Target Depth

Appendix B
DCP Results

DYNAMIC CONE PENETROMETER TEST RESULTS

Job No.	PSM4407	**Sheet**	1 **of** 2
Project	311 South Street, Marsden Park	**Date**	20-Sep-21

Test Method	*AS 1289.6.3.2. - 1997 Methods of Testing Soils for Engineering Purposes - 9 kg Dynamic Cone Penetrometer Test*	Drop Height	*510 mm*
		Hammer Mass	*9 kg*
Tested by	*BT/WW*	Tip Type	*CONICAL*

Test Depth	***DCP***	***DCP***	***DCP***	***DCP***	***DCP***	***DCP***
LOCATION	02	03	04	05	07	08
0.10	4	4	4	5	3	5
0.20	4	4	2	4	3	5
0.30	4	2	2	4	4	4
0.40	4	2	2	3	3	6
0.50	3	2	2	2	4	3
0.60	3	1	2	1	4	3
0.70	3	3	2	1	3	12
0.80	2	3	3	2	2	6
0.90	2	5	2	1	1	4
1.00	2	10	1	2	3	3
1.10	4	17	2	3	4	6 R
1.20	4	17	4	2	4	
1.30	7	14	4	4	8	
1.40	3 R	12	7	3	9	
1.50		8	6	3	13	
1.60		10	17	4	19	
1.70		8	16	5	15	
1.80		9	13	6	9	
1.90		13	14 R	5	16	
2.00		10 R		7	14 R	
2.10				14		
2.20				16		
2.30				22		
2.40				20		
2.50				22		
2.60				19		
2.70				20		
2.80				21		
2.90				23		
3.00				25 R		
3.10						
3.20						
3.30						
3.40						
3.50						
3.60						
3.70						
3.80						
3.90						
4.00						

Comments: R - Refusal

DYNAMIC CONE PENETROMETER TEST RESULTS

Job No.	PSM4407	**Sheet**	2 **of** 2
Project	311 South Street, Marsden Park	**Date**	20-Sep-21

Test Method	*AS 1289.6.3.2. - 1997 Methods of Testing Soils for Engineering Purposes - 9 kg Dynamic Cone Penetrometer Test*	Drop Height	*510 mm*
		Hammer Mass	*9 kg*
Tested by	*BT/WW*	Tip Type	*CONICAL*

Test Depth	***DCP***	***DCP***	***DCP***	***DCP***	***DCP***	***DCP***
LOCATION	09					
0.10	2					
0.20	3					
0.30	1					
0.40	2					
0.50	2					
0.60	2					
0.70	2					
0.80	2					
0.90	3					
1.00	4					
1.10	8					
1.20	9					
1.30	8					
1.40	17					
1.50	21					
1.60	16 R					
1.70						
1.80						
1.90						
2.00						
2.10						
2.20						
2.30						
2.40						
2.50						
2.60						
2.70						
2.80						
2.90						
3.00						
3.10						
3.20						
3.30						
3.40						
3.50						
3.60						
3.70						
3.80						
3.90						
4.00						

Comments: R - Refusal

Appendix C
CBR Results

115 Wicks Road
Macquarie Park, NSW 2113
PO Box 976
North Ryde, Bc 1670
Telephone: 02 9888 5000
Facsimile: 02 9888 5001

SOIL TEST SERVICES

ABN 43 002 145 173

FOUR DAY SOAKED CALIFORNIA BEARING RATIO TEST REPORT

Client: Pells Sullivan Meynink
PSM Job No.: PSM4407

Report No.: L4687E - 2
Report Date: 5/10/2021

TESTPIT NUMBER	TP 2	TP 6	TP 9
DEPTH (m)	0.5	0.5	0.6
Surcharge (kg)	4.5	4.5	4.5
Maximum Dry Density (t/m^3)	1.59 STD	1.64 STD	1.67 STD
Optimum Moisture Content (%)	23.6	22.4	20.7
Moulded Dry Density (t/m^3)	1.55	1.61	1.63
Sample Density Ratio (%)	98	98	98
Sample Moisture Ratio (%)	101	100	101
Moisture Contents			
Insitu (%)	24.3	29.5	26.7
Moulded (%)	23.8	22.4	21.0
After soaking and			
After Test, Top 30mm(%)	32.8	36.4	31.4
Remaining Depth (%)	24.9	23.3	25.6
Material Retained on 19mm Sieve (%)	0	0	0
Swell (%)	3.5	2.5	2.0
C.B.R. value: @2.5mm penetration	1.5	1.5	4.0

NOTES: Sampled and supplied by client. Samples tested as received.

- Refer to appropriate Test Pit logs for soil descriptions
- Test Methods : AS 1289 6.1.1, 5.1.1 & 2.1.1.
- Date of receipt of sample: 21/09/2021.
- TP 6 & TP 9 dried back prior to testing as the samples were too saturated.

NATA

NATA Accredited Laboratory Number:1327

05/10/2021
Authorised Signature / Date
(D. Treweek)

Appendix D
Shrink Swell Index Results

115 Wicks Road
Macquarie Park, NSW 2113
PO Box 976
North Ryde, Bc 1670
Telephone: 02 9888 5000
Facsimile: 02 9888 5001

SOIL TEST SERVICES

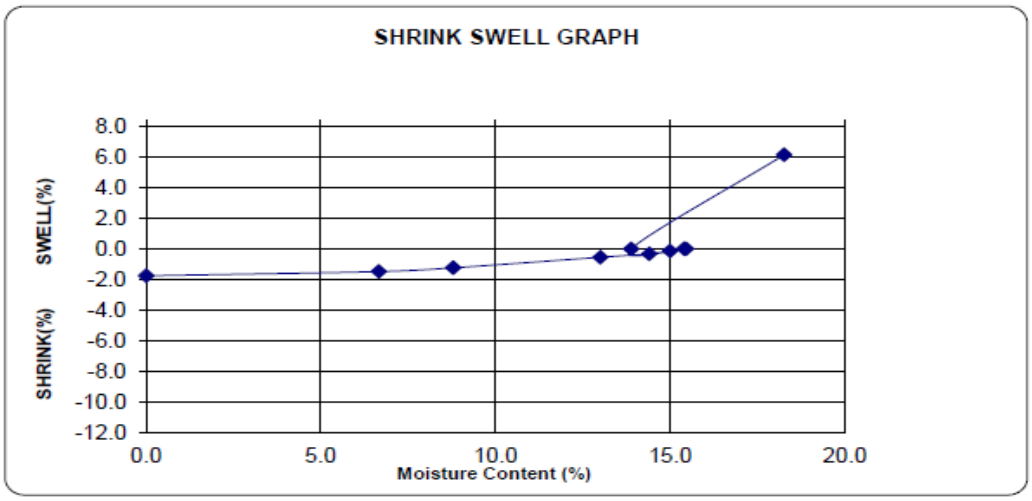
ABN 43 002 145 173

SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

Client: Pells Sullivan Meynink
PSM Job No.: PSM4407

Report No.: L4687E - 1
Report Date: 5/10/2021
Page 1 of 2

Testpit No.: 3		Depth: 1.0m			
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH			
BEFORE TEST	AFTER TEST	BEFORE	TEST	AFTER	TEST
13.9%	18.3%	>600	kPa	>450	kPa
LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION			SWELL ON SATURATION	SHRINKAGE
0	-0.8%			6.1%	1.7%



SHRINK SWELL INDEX
2.66 %/pF

Notes: Sampled and supplied by client. Sample tested as received.
- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Inert Inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 21/09/2021.

NATA

NATA Accredited Laboratory Number:1327

05/10/2021
Authorised Signature / Date
(D. Treweek)

115 Wicks Road
Macquarie Park, NSW 2113
PO Box 976
North Ryde, Bc 1670
Telephone: 02 9888 5000
Facsimile: 02 9888 5001

SOIL TEST SERVICES

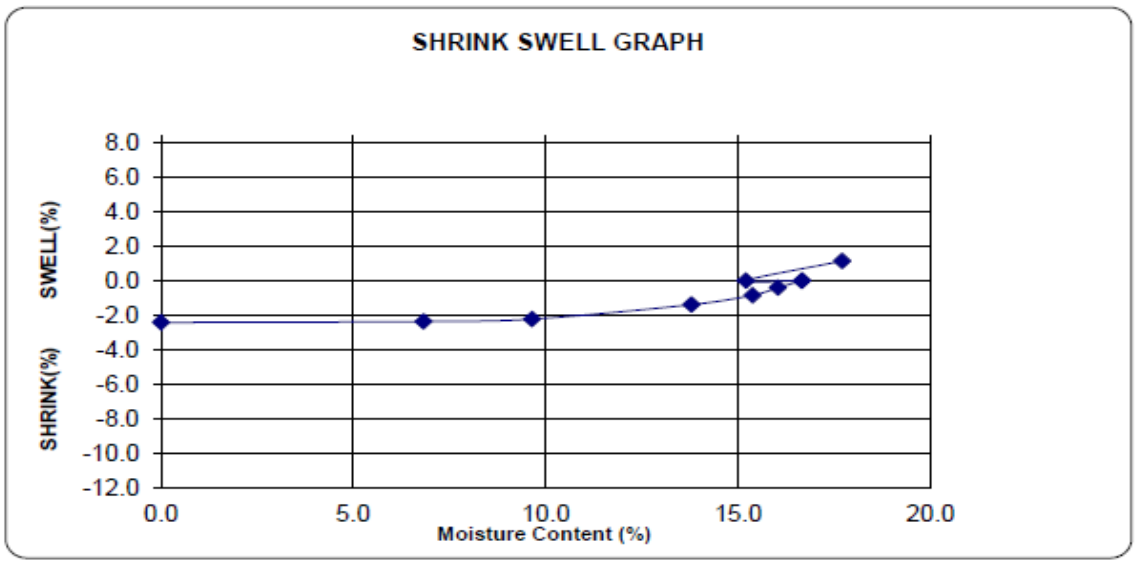
ABN 43 002 145 173

SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

Client: Pells Sullivan Meynink
PSM Job No.: PSM4407

Report No.: L4687E - 1
Report Date: 5/10/2021
Page 2 of 2

Testpit No.: 8		Depth: 1.1m			
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH			
BEFORE TEST	AFTER TEST	BEFORE TEST		AFTER TEST	
15.2%	17.7%	>600	kPa	430	kPa
LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION		SWELL ON SATURATION	SHRINKAGE	
25	-1.5%		1.1%	2.4%	



SHRINK SWELL INDEX
1.63 %/pF

Notes: Sampled and supplied by client. Sample tested as received.
- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Inert Inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 21/09/2021.

NATA

NATA Accredited Laboratory Number:1327

05/10/2021
Authorised Signature / Date
(D. Treweek)

Appendix E
Analytical Laboratory Testing Results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2133999**	Page	: 1 of 3
Client	: **PELLS SULLIVAN MEYNINK T/A PSM Admin PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: BRYAN TAM	Contact	: Customer Services ES
Address	: G3, 56 DELHI ROAD NORTH RYDE NSW, AUSTRALIA 2113	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: PSM4407	Date Samples Received	: 20-Sep-2021 17:45
Order number	: ----	Date Analysis Commenced	: 21-Sep-2021
C-O-C number	: ----	Issue Date	: 29-Sep-2021 18:16
Sampler	: BRYAN TAM		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 5		
No. of samples analysed	: 5		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Dian Dao	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA032 (Saturated Paste EC): NATA accreditation does not cover the performance of this service.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).
- ALS is not NATA accredited for the calculation of saturated resistivity in a soil.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	TP01-0.8m	TP02-0.5m	TP03-0.5m	TP08-0.5m	TP10-1.1m
			Sampling date / time	20-Sep-2021 00:00	20-Sep-2021 00:00	20-Sep-2021 00:00	20-Sep-2021 00:00	20-Sep-2021 00:00
Compound	CAS Number	LOR	Unit	ES2133999-001	ES2133999-002	ES2133999-003	ES2133999-004	ES2133999-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	5.6	4.8	5.5	5.1	5.1
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	157	290	94	188	600
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	16.9	18.1	17.0	19.6	19.2
EA084: Saturated Resistivity								
Resistivity at 25°C	----	10	ohm cm	1030	750	1280	910	350
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.2	2.1	1.7	3.1	----
Exchangeable Magnesium	----	0.1	meq/100g	8.0	8.9	10.6	9.4	----
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.4	0.2	0.3	----
Exchangeable Sodium	----	0.1	meq/100g	3.1	3.7	2.8	3.0	----
Cation Exchange Capacity	----	0.1	meq/100g	12.3	15.5	15.5	16.0	----
Exchangeable Sodium Percent	----	0.1	%	26.7	24.7	18.6	19.0	----
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	----	----	----	0.3
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	----	6.5
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	----	0.4
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	----	2.3
Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	----	9.5
Exchangeable Sodium Percent	----	0.1	%	----	----	----	----	24.1
ED040S: Soluble Major Anions								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	40	70	40	150	230
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	190	340	60	100	850

Appendix F
Bulk Earthworks Specification (PSM4407-003S)

311 South St Marsden Park BEW Strategy

Bulk Earthworks Specification Filling, Cutting and Testing

PSM4407-003S 22 April 2021

PSM Consult Pty Limited ABN 47 134 739 496

www.psm.com.au

Table of Contents

List of Appendices

1. Scope

This specification details the requirements for the bulk earthworks to be undertaken at 311 South Street, Marsden Park. The area where this specification is applicable is shown in Figure 1. This includes areas where material is filled to bulk earthworks level (BEL) within the site.

Fill placed in accordance with this specification is denoted as Engineered Fill.

This specification does not address any environmental, contamination or erosion issues with respect to the fill material.

There is a HOLD POINT on placing fill in Section 2.4 of this specification.

2. Filling Works

2.1 Subgrade Preparation

The condition of the subgrade should be assessed immediately prior to the commencement of filling.

All Engineered Fill is to be placed on one of the following materials:

1. Bedrock.
2. Natural insitu material of at least stiff consistency.
3. Engineered compacted fill placed in accordance with this or other approved specifications for which the Geotechnical Inspection and Testing Authority (GITA) has a Level 1 certificate certifying compliance with that approved specification AND of at least stiff consistency.
4. Existing fill and other materials as approved by PSM.

Proof rolling shall only be undertaken under the direction of PSM. PSM may also direct a bridging layer of Engineered Fill be placed and compacted to a Dry or Hilf Density Ratio (Standard Compaction) of between 95% and 102%. Any such layer shall be a Lot under Clause 5.3.

The GITA should satisfy itself that the subgrade has not been desiccated, affected by rain or disturbed. If the GITA cannot so satisfy itself, then the subgrade should be moisture conditioned and compacted to be in accordance with Clauses 2.5 and 2.6 of this specification.

Engineered Fill shall be placed only on subgrade approved by the GITA as being in accordance with this specification.

2.2 Base Geometry and Permanent Batters

The slope of any buried batter shall be less than 2H:1V unless otherwise directed by PSM.

The contractor shall remove or flatten any geometrical obstructions (e.g. protrusions or holes) such that subsequent Engineered Fill can be placed to achieve the requirements of this specification.

Engineered Fill shall be placed only on areas where the base geometry has been approved by the GITA.

Permanent batters in fill shall be built by overfilling then cut back to the final slopes as shown in the bulk earthworks drawings, e.g. 2H:1V, or other method as approved by PSM.

2.3 Material

2.3.1 Imported Fill

Imported Engineered Fill is to conform to one of the following definitions:

1. "Virgin excavated natural material" (**VENM**) as defined by the Protection of the Environment Operations Act 1997 No 156, Schedule 1, on Page 209:

   "Virgin excavated natural material (e.g. clay, gravel, sand, soil and rock) that is not mixed with any other waste and that:

a. *has been excavated from areas that are not contaminated, as a result of industrial, commercial, mining or agricultural activities, with manufactured chemicals and that does not contain sulphide ores or soils, or.*

b. *consists of excavated natural materials that meet such criteria as may be approved by the EPA".*

2. "Excavated natural material" (**ENM**) as defined under Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014:

"Excavated natural material is naturally occurring rock and soil (including but not limited to materials such as sandstone, shale, clay and soil) that has:

a. *been excavated from the ground, and.*

b. *contains at least 98% (by weight) natural material, and.*

c. *does not meet the definition of Virgin Excavated Natural Material in the Act.*

Excavated Natural Material does not include material that has been located in a hotspot; that has been processed; or that contains asbestos, Acid Sulphate Soils (ASS), Potential Acid Sulphate soils (PASS) or sulfidic ores."

2.3.2 Site Won Material

Site won material shall comprise material won from excavations on site including natural and existing fill. Material needs to satisfy Clause 2.3.3

2.3.3 All Fill

The Engineered Fill shall be approved by the GITA as suitable for use in a structural fill.

Engineered Fill shall not comprise unsuitable material as defined by Clause 4.3 of AS3798-2007 "Guidelines on earthworks for commercial and residential developments" as:

a. *"organic soils, such as many topsoils, severely root-affected subsoils and peat.*

b. *materials contaminated through past site usage which may contain toxic substances or soluble compounds harmful to water supply or agriculture.*

c. *materials containing substances which can be dissolved or leached out in the presence of moisture (e.g.: gypsum), or which undergo volume change or loss of strength when disturbed and exposed to moisture (e.g.: some shales and sandstones), unless these matters are specifically addressed in the design.*

d. *silts, or materials that have the deleterious engineering properties of silt.*

e. *other materials with properties that are unsuitable for the forming of structural fill, and.*

f. *fill that contains wood, metal, plastic, boulders or other deleterious material, in sufficient proportions to affect the required performance of the fill."*

The GITA shall assess that the proportion of deleterious material in each Lot is not greater than 1% by weight. Deleterious material is defined by Table 3015.3 of the RTA QA Specification 3051 (Edition 5 June 1998) as:

"Type III: Rubber, Plastic, Bitumen, Paper, Cloth, Paint, Wood and Other Vegetable Matter".

If the GITA is not able to visually assess the above criterion, the GITA shall arrange appropriate testing.

All Engineered Fill particles shall be able to be incorporated within a single layer. Further, less than 30% of particles shall be retained on the 37.5 mm sieve.

Engineered Fill shall be able to be tested in accordance with the Standard Compaction method (AS1289.5.4.1) or Hilf test method (AS1289.5.7.1). These methods require less than 20% retained on the 37.5 mm sieve. Where between 20% and 30% of particles are retained on the 37.5 mm sieve the above test methods shall still be adopted and test reports annotated appropriately.

These requirements should be met by the material after placement and compaction.

Only material approved by the GITA shall be placed as Engineered Fill.

2.4 Fill Zonation and Placement

HOLD POINT	
Process Held	Placement of Fill
Submission detail	The Contractor / GITA submit to PSM a Weekly Certificate as defined in Clause 6.2.1 of this specification for the earthworks completed to the previous Saturday no later than 5 pm of the subsequent Wednesday.
Release of Hold Point	PSM to confirm receipt of Weekly Certificate and recommend release of Hold Point if initial assessment of the Weekly Certificate indicates it complies with requirements of this specification. The contract superintendent should then release the Hold Point if it considers appropriate.

Engineered Fill shall be placed in accordance with the following requirements:

1. In near horizontal, laterally extensive layers of uniform material and thickness, deposited systematically across the work area as determined by the GITA.
2. The compacted thickness of each layer shall be equal to or less than 300 mm.

Engineered Fill shall only be placed on subgrade in accordance with this specification and approved by the GITA.

2.5 Compaction

Engineered Fill shall be placed and compacted to a Dry or Hilf Density Ratios (Standard Compaction) of between 98% and 102%.

The insitu density shall be measured over the full depth of each layer placed.

2.6 Moisture Control

The placement moisture variation or Hilf moisture variation shall be controlled to be between 2% dry of optimum and 2% wet of optimum.

Placement moisture content of the Engineered Fill shall be measured.

3. Cutting

3.1 Subgrade Condition

The subgrade is to comprise one of the following materials:

3. Bedrock.
4. Natural insitu material of at least stiff consistency.
5. Existing fill and other materials as approved by PSM.

Proof rolling shall only be undertaken under the direction of PSM.

The GITA should satisfy itself that the subgrade has not been desiccated, affected by rain or disturbed. If the GITA cannot so satisfy itself, then the subgrade should be excavated and filled to the BEL in accordance with this specification.

4. Survey

4.1 Filling Areas

The survey requirements are as follows:

1. Any approved subgrade shall be surveyed prior to first filling such that subgrade levels are established to within ± 0.1 m. The area subject to approval shall be assessed and shown on a plan drawing to an accuracy of at least +/- 5 m in plan.
2. The Lot boundaries shall be assessed and shown on a plan drawing to an accuracy of at least +/- 5 m in plan.
3. The location of the field density tests shall be assessed and shown on the Lot boundary plan drawing to an accuracy of at least +/-5 m in plan.
4. The elevation of the field density tests shall be surveyed to an accuracy of +/-0.05 m.

The plan drawing shall show at the boundaries of the site and other identifiable site features, so as to allow the location of the lots and the test to be recoverable.

4.2 Cutting Areas

Any approved subgrade for cut areas shall be surveyed such that subgrade levels are established to within ± 0.1 m.

5. Inspection and Testing

5.1 Role of the GITA

The Geotechnical Inspection and Testing Authority (GITA) shall be contracted to document and certify that the works undertaken by the contractor has been completed in accordance with the relevant design and specifications.

5.2 Level 1 Control

The GITA shall adopt Level 1 responsibility as described in Section 8.2 of AS 3798-2007 "Guidelines on earthworks for commercial and residential developments":

> *"The primary objective of Level 1 Inspection and Testing is for the geotechnical inspection and testing authority (GITA) to be able to express an opinion on the compliance of the work. The GITA is responsible for ensuring that the inspection and testing are sufficient for this purpose.*
>
> *The geotechnical inspection and testing authority need to have competent personnel on site at all times while earthwork operations are undertaken. Such operations include:*
>
> - *Completion of removal of topsoil*
> - *Placing of imported or cut material*
> - *Compaction and adding/removal of moisture*
> - *Trenching and backfilling*
> - *Test rolling*
> - *Testing.*
>
> *The superintendent should agree a suitable inspection and testing plan prior to commencement of the works.*
>
> *On completion of the earthworks, the GITA will usually be required to provide a report setting out the inspections, sampling and testing it has carried out, and the locations and results thereof. Unless very unusual conditions apply, the GITA should also be able to express an opinion that the works (as far as it has been able to determine) comply with the requirements of the specification and drawings."*

For this particular contract, Level 1 responsibility includes:

1. Lot testing as per Clause 5.3 of this specification.
2. A frequency of compaction testing not less than that specified in Clause 5.4 of this specification.
3. The GITA documenting and reporting its activity in the terms required by Clause 6 of this specification.
4. The GITA undertaking adequate inspections and testing to comply with the above requirements and to be able to certify the fill in the terms required by Clause 6 of this specification.

5.3 Lot Testing

This specification requires lot testing to be undertaken.

A Lot is defined as a single layer of Engineered Fill consisting of uniform material which has undergone similar treatment.

Lot testing comprises the following:

1. A Lot shall be identified by the Contractor or the GITA with a Lot Number and presented for testing.
2. A Lot shall be deemed to be in accordance with the specification if all the tests undertaken within the Lot are in accordance with the specification, i.e. "a none to fail basis".
3. If any one test undertaken within a Lot fails, the whole of the Lot shall be reworked and retested.

Any portion of the placed Engineered Fill must be part of a single lot and all Lots will require approval by the GITA.

5.4 Testing Frequency (Compaction Testing)

The frequency of compaction testing for each lot shall not be less than the greater of:

1. For lot less than 50 m^3.
    a. 1 test per lot.
2. For lot between 50 m^3 and 100 m^3.
    a. 2 tests per lot.
3. For lot greater than 100 m^3.
    a. 1 test per 500 m^3 of material placed.
    b. 3 tests per lot.

A laboratory moisture content test shall be undertaken for each field density test.

5.5 Proof Rolling and Plate Load Testing

Proof rolling, together with minor boxing out and refilling, of the upper surface of the bulk earthworks will be undertaken as directed by PSM. The plant to be adopted depends upon the design loads adopted by the structural engineers for each section of the site. Any remediation of soft spots identified during proof rolling shall be undertaken in accordance with this Specification (Cl 2.5 and 2.6).

Plate load testing shall be undertaken at the direction of PSM at the following stages:

1. At final bulk earthworks level (BEL). Expected test frequency is approximately a day of testing for each building pad.

The contractor is to make a suitable reaction (e.g. 20 tonne excavator) available for the tests.

5.6 Inspection and Testing

The GITA shall at least undertake the following tasks:

Cut areas

1. Identify the subgrade as one of the three (3) subgrade types listed in Clause 3.1 of this specification and assess that the subgrade condition of cut areas is in accordance with the subgrade condition requirements of Clause 3.1 of this specification. If the cut subgrade has been approved by PSM, the GITA will be required to reference the approval in its weekly report.
2. Should Engineered Fill be required to fill overcut areas, assess that filling has been placed in accordance with this specification.

Fill areas

3. For fill areas, identify the subgrade as one of the four (4) subgrade types listed in Clause 2.1 of this specification and assess that the subgrade condition of any area prior to placement of fill material is in

accordance with the subgrade preparation requirements of Clause 2.1 of this specification. For the following subgrade types, GITA needs to include / refer to PSM approval in its weekly report:

a. Existing fill and other materials as approved by PSM.

4. Assess that the base geometry of any area prior to placement of fill material is in accordance with the base geometry requirements of Clause 2.2 of this specification.
5. For each Lot, identify the material as either Site Won or Imported fill as defined in Clause 2.3 of this specification and assess that the material placed is in accordance with the fill material requirements of Clause 2.3 of this Specification.
6. Assess the proportion of deleterious material is in accordance with the requirements of Clause 2.3.3 of this Specification.
7. Assess that the Engineered Fill has been placed in accordance with the requirements for fill zonation and placement of Clause 2.4 of this specification.
8. Assess that each Lot as presented for approval by the contractor is in accordance with the requirements for Lot definition of Clause 5.3 of this specification.
9. Ensure that the survey requirements in Clause 5 of this specification have been completed.
10. Estimate the approximate volume of Engineered Fill placed in each Lot presented for approval.
11. Conduct Lot testing in accordance with the construction control testing requirements of Clauses 5.3 and 5.4 of this specification.
12. Assess that the compaction of each Lot is in accordance with the requirements of Clause 2.5 of this specification. The GITA shall select a depth of insitu density tests that allows the density of the full layer to be assessed.
13. Assess that the moisture variation of each Lot is in accordance with the requirements for moisture control in Clause 2.6 of this specification.
14. Conduct material property testing in accordance with the material testing requirements in this specification.

6. Reporting and Certification

6.1 Reporting

The GITA shall produce at least the following reports:

1. *VENM / ENM Validation Reports*. Such a report shall transmit the VENM or ENM validation certificates for the fill imported to site.
2. *Subgrade Approval Reports* (a sample is attached). Such a report shall:
   – Document assessments undertaken for tasks 1 and task 3 of Clause 5.6 including reporting the subgrade type
   – Document the subgrade survey that has been undertaken
   – Approve or reject the subgrade condition and base geometry for filling, based on tasks 3 and 4 of Clause 5.6
   – Approve or reject the subgrade condition for cut areas based on task 1.
3. *Lot Approval Reports* (a sample is attached). Such a report shall:
   – Document assessments, testing and survey undertaken for tasks 3 to 14 of Clause 5.6
   – Report material identification undertaken for task 5 of Clause 5.6
   – Report the assessed proportion of deleterious material for task 6 of Clause 5.6
   – Report the results of testing undertaken for task 11 of Clause 5.6
   – Approve or reject lots based on tasks 12 and 13 of Clause 5.6.
4. Material Testing Reports. Such a report shall:
   – Report the results of material property testing undertaken for task 14 of Clause 5.6.
5. *Daily Reports* (a sample is attached). Such a report shall be completed daily and shall:

- Document time spent on site by the GITA personnel
- List subgrade assessments and approvals undertaken each day with reference to relevant Subgrade Approval Report(s)
- List Lots presented, accepted and approved or rejected each day, with reference to relevant Lot Approval Report(s)
- List survey undertaken each day as for task 9 of Clause 5.6 and not already documented in the Subgrade or Lot Approval Reports
- Document other relevant activities undertaken on site that day (site instructions, breakdowns, compaction equipment used, etc.).

6.2 Certification

6.2.1 Weekly Certificate

The GITA shall produce a Weekly Certificate for any week in which earthworks are undertaken in accordance with this specification. The Weekly Certificate will cover all works from the previous Weekly Certificate until the end of work on a Saturday.

The Weekly Certificate shall transmit the following:

- Copy or reference to the complete specification document(s)
- Subgrade Approval Reports
- Lot Approval Reports
- Material property testing reports
- Daily Reports
- Survey of subgrade geometry prior to filling or in cut areas
- Plan survey drawing showing lot boundaries and location of density tests
- Survey documenting filling undertaken to date and showing location of testing
- Provide an Excel spreadsheet presenting the results of the week's acceptance testing completed by the GITA.

And certify that:

"All the earthworks undertaken and the subgrade condition in the cut areas [in the stated period] are documented in the above reports and have been undertaken in accordance with the Specification (Ref. PSM4407-003S Rev XX dated XXX)."

6.2.2 Interim or Final Filling Certificate

At the completion of the bulk earthworks, or as requested by the Client, the GITA shall provide an Interim or Final Filling Certificate which shall:

1. Transmit a reference list of the Weekly Certificates.
2. Provide an Excel spreadsheet presenting the results of all the acceptance testing completed by the GITA.
3. Certify that *"All the earthworks undertaken and the subgrade condition in the cut areas [in the stated period] are documented in the above reports and have been undertaken in accordance with the Specification (Ref. PSM4407-003S Rev XX dated XXX)."*

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Appendix A
Figure 1

— Approximate Site Boundary

20 0 20 40 60 80m

1 : 4000 FULL SIZE A3

Dexus
311 South St
Marsden Park

Approximate Site Location

PSM4407-003S	FIGURE 1

Appendix B
Subgrade Approval Report

GEOTECHNICAL INSPECTION AND TESTING AUTHORITY

NATA accreditation number

SUBGRADE APPROVAL REPORT

Client:	Contractor:
Job number:	Report number:
Project:	Technician:

Subgrade areas assessed:

Area ID	Date	Approximate extent	Subgrade description	Geometry summary	Specification reference	Compliance (Pass/Fail)	Survey reference	Approved (Yes/No)

COMMENTS:

Signed: Date:

Appendix C
Lot Approval Report

GEOTECHNICAL INSPECTION AND TESTING AUTHORITY

NATA accreditation number

LOT APPROVAL REPORT

Client:	Report number:
Job number:	Report date:
Project:	Technician:
Contractor:	Test methods:

LOT ID:			**Sheet**	**of**
Retest (Yes/No)			Original test report number:	
Specification reference				
Location:				
Lot boundary survey reference/location:				
Materials description:	*(MATERIAL TYPE, colour, minor components, maximum particle size)*			
Material identification:	*(Identify the material as defined in Clause 2.3.1, Clause 2.3.2 or Clause 2.3.3 of the Specification)*			
Deleterious material assessment:	*(Report proportion of deleterious material)*			
Layer thickness:				
Accepted as Lot: (Yes/No)			Date:	
Approximate volume (m3)			Number of tests required:	

Test ID No.				
Test soil description				
Date tested:				
Grid reference				
Surveyed test locations (RL,E,N)				
Test depth (mm)				
Max size (mm)				
% Oversize material (wet)				
Field wet density (t/m^3)				
Field moisture content (%)				
PWCD (t/m^3)				
Compactive effort				
Moisture variation (%)				
HILF density ratio (%)				
TEST (Pass/Fail)				

LOT APPROVAL	(Pass/Fail)	Signed:	Date:

Appendix D
Daily Report

GEOTECHNICAL INSPECTION AND TESTING AUTHORITY

NATA accreditation number

DAILY REPORT

Client:	Report number:
Job number:	Report date:
Project:	
Location:	Level of testing: Level 1
Contractor	Technician:
Time on site:	
Time off site:	

1. Subgrade Approval

Areas ID	Subgrade Approval Report No:	Comments

2. Lot Approval

Lot ID	Lot Approval Report No:	Comments

3. Survey

Type of survey	Survey undertaken by:	Reference

4. Instructions received on site

5. Instructions given on site

COMMENTS:

Signed: Date:

Appendix E
Certification Letter (Sample Only)

Our Ref:

Date:

Addressed to: Earthwork Contractor

Attention: Earthwork Contractor Representative

Dear

RE: SAMPLE INTERIM (OR FINAL) FILLING CERTIFICATE
INDUSTRIAL DEVELOPMENT, BULK EARTHWORKS
CERTIFICATION OF EARTHWORKS
BETWEEN [DATE OF COMMENCEMENT] AND [DATE OF COMPLETION]

In the period between [date start] and [date finish] the contractor has undertaken earthworks in areas XXX and XXX.

During the above period:

- The GITA has prepared the following Subgrade Approval Reports:

1. Subgrade Approval Report No 1
2. ……

- The GITA has prepared the following Lot Approval Reports:

1. Lot Approval Report No 1
2. ……

- The GITA has prepared the following Daily Reports:

1. Daily Report No 1……
2. ……

- The following subgrade survey was undertaken:

1. Subgrade Survey reference……
2. ……

- The following weekly survey was undertaken:

1. Weekly survey of week ending …….reference……..
2. ……

Copies of all the above documents are attached.

The GITA certifies that all the earthworks undertaken in the above stated period are documented in the above reports and have been undertaken in accordance with the Specifications (ref. PSM4407-003S, dated XXX) a copy of which is attached, with the exception of:

1. List outstanding issues (not approved subgrade, lots, unsuitable material, failed tests etc.)
2. ……..

Signed

GITA