REPORT

Tonkin+Taylor

Northern Land Parcel - Ballarat West Employment Zone

Geotechnical Investigation and Pavement Design

Prepared for
Stantec Australia Pty Ltd
Prepared by
Tonkin & Taylor Pty Ltd
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1 Introduction

1.1 Engagement

Tonkin & Taylor Pty Ltd (T+T) has been engaged by Stantec Australia Pty Ltd (Stantec) to conduct a geotechnical investigation and pavement design for the Northern Land Parcel at the Ballarat West Employment Zone (BWEZ), Mitchell Park.

The work was commissioned by Stantec by returning a signed copy of T+T's contract terms via email dated 10 June 2022. The scope of work undertaken was consistent with T+T proposal 1018876-LOE-ENG-001.v4 dated 6 May 2022.

1.2 Project understanding

The Northern Land Parcel of the BWEZ is located within Lot A, Learmonth Road in Mitchell Park. Development Victoria is planning to develop the greenfield site into an industrial subdivision, as shown on the infrastructure plan[1] which is presented as Figure 1 in Appendix A.

We understand that geotechnical advice for the following components or aspects of the development is required:

- Pavement design for the road network within the subdivision including the connection with Sunraysia Drive;
- A retarding basin and associated drainage reserve, up to 1.5m below ground level (bgl);
- A sewer pump station in north corner at Sunraysia Drive, with an invert level of up to 7m bgl; and
- Reticulation sewers and stormwater drains within the subdivision, with invert levels no deeper than 5m bgl.

1.3 Objectives and scope of works

The objectives of the investigation were to provide comments and recommendations on the following:

- A summary of the sub-surface conditions encountered, including descriptions of the soil strata and, if encountered, the depth to groundwater, depth to seepage ingress and depth to rock and depth of fill;
- A summary and discussion of laboratory test results;
- Recommended design CBR value(s) for the road pavements;
- Recommended pavement structures and compositions based on provided traffic data;
- Advice on the geotechnical aspects of pavement construction;
- An assessment of excavation conditions for buried infrastructure and the drainage reserve, including temporary batter stability and trench support;
- A discussion on sewer and stormwater drain construction, including pipe embedment and trench backfill;
- Discussion on the geotechnical risks associated with the construction of the retarding basin, including dispersive soils and groundwater pressures; and

[1] Stantec (undated) Ballarat West Employment Zone Infrastructure Plan Stage 2. Drawing ref. 36266 CI-2-060-SK1 Rev D.

- An assessment of the suitability of in-situ soils for use as clay liner, including recommendations for the treatment of the in-situ soils if found to be dispersive.

2 Regional geology and hydrogeology

Based on published geological mapping[2] data, the site is underlain by the Newer Volcanics Group which typically comprises s high plasticity clays overlying weathered basalt rock.

Based on Visualising Victoria Groundwater (VVG)[3], the groundwater is generally expected to be within 5m bgl.

[2] Department of Jobs, Precincts and Regions (2022) Online 1:250,000 scale geological map (http://er-info.dpi.vic.gov.au/sd_weave/registered.htm). State Government of Victoria.
[3] Federation University Australia (2016) Visualising Victoria's Groundwater http://www.vvg.org.au/ Centre for eResearch and Digital Innovation, Federation University Australia.

3 Outline of the investigation

3.1 Field investigation

The fieldwork was undertaken in July and September 2022. Borehole drilling was undertaken on 19 and 20 July 2022, and test pitting and pavement dippings were carried out on 15 and 16 September 2022 as follows:

- Drilling 8 boreholes (designated BH01 to BH08) to depths of between 6m and 8m bgl.
- Excavating 1 pavement dipping (designated PD01) to a depth of 0.8m bgl.
- Excavating 15 test pits (designated TP01 to TP15) to depths ranging between 1.5m bgl and 3.5m bgl.
- Conducting Dynamic Cone Penetrometer (DCP) tests to a depth of 1.5m bgl, or prior refusal, adjacent to each borehole and test pit locations.

The pavement dippings and test pits were excavated using 4-ton excavator supplied and operated by Frys Earthmoving. The boreholes were drilled using a tracked drill rig supplied and operated by Urban Drilling and were advanced using a combination of solid auger and HQ3 diamond coring techniques.

All fieldwork was carried out under the direction and full-time supervision of an experienced T+T geotechnical engineer who was responsible for positioning the test locations, determining the extent of sampling, conducting in-situ tests, and logging the strata exposed in the boreholes, test pits and pavement dippings.

The site investigation was carried out in accordance with internal T+T quality, safety, and environmental management manuals and with reference to:

- AS1289 Methods of Testing of soils for Engineering Purposes.
- AS1726 - 2017 Geotechnical Site Investigations

The approximate test locations are shown on Figure 2 and Figure 3 in Appendix A. The coordinates were recorded using a handheld GPS device accurate to within five (±5) meters.

The engineering logs with an explanation of the terminology used in its preparation including the GPS coordinates are provided in Appendix B.

The material classification and logging were carried out in accordance with the attached explanatory notes. However, it should be noted that field classifications of materials are a subjective opinion of the site engineer and may differ in some respects from an interpretation derived from the laboratory test results.

3.2 Laboratory testing

The following laboratory testing on soil and rock samples were carried out at Chadwick Geotechnics NATA accredited laboratory.

- Subdivisional roads
  - 14 moisture content tests
  - 2 sieve analyses
  - 2 Atterberg limits tests
  - 3 laboratory 4-day soaked CBR tests

- Sewer pump station, reticulation sewers and stormwater drains
  - 3 Emerson Class Number tests
  - 8 Point Load Index Strength tests
- Drainage reserve:
  - 1 sieve analysis
  - 1 Atterberg limits test
  - 1 Emerson Class Number test
  - 1 Moyle and Burgess sedimentation test
  - 1 standard compaction
  - 1 permeability test on a remoulded sample, with or without gypsum treatment.

The results of the laboratory testing are summarised in in Section 4.4 whilst the test certificates are presented in Appendix C.

4 Results of the investigation

4.1 General site conditions

The site is generally flat with a slight rise towards the centre. The surface of the site has moderate grass cover with some shrubbery and a few trees present at the northeast side. A boggy area was found at the northeast side adjacent to Sunraysia Drive that is fed by a drain running from the eastern side into the northeast corner.

4.2 Subsurface conditions

Based on the subsurface conditions encountered in the investigative locations, the following generalised stratigraphy units are inferred.

- Unit 1 – Topsoil
- Unit 2 – Residual Clay
- Unit 3 – Weathered Basalt

It is possible that conditions elsewhere within the site are different from those identified in this report and on which our recommendations are based. Consequently, it is recommended that ground conditions be confirmed during construction by a suitably qualified and experienced geotechnical engineer or engineering geologist.

The description of each stratigraphy unit is provided below. For further details, reference should be made to the Engineering Logs presented in Appendix B together with an explanation of the terminology used in its preparation.

- **Unit 1 – Topsoil**

This unit was encountered up to a depth of 0.3m bgl at all the test locations. This unit comprised an upper layer of brown, dark brown, grey, grey mottled brown silt of low to medium and high plasticity with organic fibres. The silt layer was underlain in place by silty Gravel and moist to wet. DCP values typically ranging from 1 to 2 blows per 100 mm penetration at shallow depths and was assessed to be of soft to firm consistency.

- **Unit 2 – Residual Clay**

This unit was encountered immediately below Unit 1 to the termination depth of 1.5m bgl in the test pits, and to depths ranging between about 2.15m bgl and 6.45m bgl in the boreholes.

The unit comprised mainly brown, dark brown, mottled grey clay of high plasticity. The clay graded gravelly at depths near the interface with highly or less weathered basalt where refusal to drilling was encountered. The unit is moist and firm to stiff with DCP values typically ranging from 1 to 3 blows per 100 mm penetration at shallow depths and increasing with depth from 4 to 9 blows per 100 mm penetration indicating very stiff to hard consistency.

- **Unit 3 – Basalt Rock (Newer Volcanics Basalt)**

This unit was encountered in all the boreholes below Unit 2, except in BH02, to the termination depth ranging between 6m bgl and 8m bgl. The upper layer of 0.5 m thick or so was inferred (due to core loss) to be extremely weathered (EW) below which the basalt was less vesicular and typically highly weathered (HW) to slightly weathered (SW) and dark grey. Point Load Index (I_{50}) values for the tested rock samples generally ranged from 2.2 MPa to 8.6 MPa which indicates the rock to be of high and very high strength.

A summary of the subsurface conditions encountered in each of the area is presented in Sections 4.2.1 to 4.2.3.

4.2.1 Subdivisional roads (PD01, TP01 to TP11)

A summary of the subsurface conditions encountered in TP01 to TP11 and PD01 is presented in Table 4-1.

Table 4-1: Summary of subsurface conditions – Subdivisional roads

Unit	Depth to base of the unit in metres										
	TP01	TP02	TP03	TP04	TP05	TP06	TP07	TP08	TP09	TP10	TP11
1 Topsoil	0.2	0.2	0.2	0.3	0.25	0.15	0.3	0.25	0.2	0.3	0.3
2 Clay	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
3 Rock	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Termination depth (m)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

Where: NP = Not Penetrated

A pavement dipping excavated on the existing road encountered the following:

- Asphalt (40 mm thick) overlying about 260 mm thick gravelly sand; underlain by
- Spray seal layer(s) (30 mm thick) overlying about 270 mm thick cement treated crushed rock; over
- Sandy gravel with cobbles and boulders (possible fill).

4.2.2 Sewer pump station, reticulation sewers and stormwater drains (BH01 to BH08, TP12, TP13)

A summary of the subsurface conditions encountered in BH01 to BH08, TP12 and TP13 is presented in Table 4-2.

Table 4-2: Summary of subsurface conditions – Sewer pump station, reticulation sewers and stormwater drains

Unit	Depth to base of the unit in metres									
	BH01	BH02	BH03	BH04	BH05	BH06	BH07	BH08	TP12	TP13
1 Topsoil	0.3	0.1	0.1	0.2	0.2	0.1	0.2	0.1	0.3	0.25
2 Clay	6.0	4.5	4.5	4	2	2	3	3.5	3.5	1.8
3 Basalt (EW)	6.45	6.11	5	4.7	2.15	2.2	3.15	NE	NP	3.5
3 Basalt (HW-MW)	8.0	NP	6.5	6	6	6	6	6	NP	NP
Termination depth (m)	8.0	6.11	6.5	6	6	6	6	6	3.5	3.5

Where: NP = Not Penetrated; NE = Not Encountered

4.2.3 Drainage reserve including retarding basin (TP14, TP15)

The subsurface conditions encountered in TP14 and TP15 is presented in Table 4-3.

Table 4-3: Summary of subsurface conditions – Drainage reserve including retarding basin

Unit	Depth to base of the unit in metres	
	TP14	TP15
1 Topsoil	0.2	0.3
2 Clay	0.8 R	2.5
3 Rock	>0.8 - NP	NP
Termination depth (m)	0.8	2.5

Where: R = Refusal; NP = Not Penetrated

4.3 Groundwater

Standpipe piezometers were installed in boreholes BH01, BH04 and BH08 after the completion of drilling. The groundwater level was measured at a depth of 5m bgl in BH01 whilst no groundwater was encountered in BH04 and BH08.

During the return visit on 16 September 2022, the groundwater level was measured at a depth of 1m bgl in all the standpipes. This groundwater measurement is considered not reliable and may be effected by prior rain events. Further groundwater monitoring will be performed and the results will be updated in the final report.

4.4 Laboratory testing

Laboratory testing was undertaken at NATA accredited Chadwick Geotechnics (CG) laboratory. A summary of the test results is shown in **Error! Reference source not found.** to Table 4-7 and NATA laboratory test certificates are provided in Appendix C.

Table 4-4: Summary of soil classification test results

Test Location	Depth (m bgl)	Material Description	MC (%)	PI (%)	LL (%)	LS (%)	Percentage Passing (%)		
							Gravel	Sand	Fines
TP02	0.5 – 0.6	Clay	39	-	-	-	-	-	-
TP03	0.5 – 0.6	Clay	31.6	-	-	-	-	-	-
TP04	0.5 – 0.6	Clay	21.6	-	-	-	-	-	-
TP05	0.5 – 0.6	Clay	18.7	-	-	-	-	-	-
TP06	0.5 – 0.6	Clay	21.8	-	-	-	-	-	-
TP07	0.5 – 0.6	Clay	35.8	-	-	-	-	-	-
TP08	0.5 – 0.6	Clay	41.8	-	-	-	-	-	-
TP01	0.6 - 0.8	Clay	21.3	45	59	18.5	5	10	85
TP09	0.6 - 0.8	Clay	38.8	80	107	25	5	7	88
TP14	0.5 - 0.8	Gravelly Clay	24.6	43	64	17	38	10	52
TP10	0.5 – 0.6	Clay	24.5	-	-	-	-	-	-
TP11	0.5 – 0.6	Clay	39.1	-	-	-	-	-	-
TP12	0.5 – 0.6	Clay	17.5	-	-	-	-	-	-
TP13	0.5 – 0.6	Clay	39.7	-	-	-	-	-	-
TP15	0.5 – 0.6	Clay	37.8	-	-	-	-	-	-

Where: MC – Moisture Content; PI – Plasticity Index; LL – Liquid Limit; LS – Linear Shrinkage

Table 4-5: Summary of CBR test results

Test Location	Depth (m bgl)	Material Description	MDD (t/m^3)	OMC(%)	CBR (%)	Swell (%)
TP01	0.6 - 0.8	Clay	1.74	19	2.5	2
TP03	0.6 - 0.8	Clay	1.47	28	15	0
TP09	0.6 - 0.8	Clay	1.35	33	1	5.5

Where: MDD = Maximum Dry Density; OMC = Optimum Moisture Content

Table 4-6: Summary of dispersive and permeability test results

Test Location	Depth (m bgl)	Material Description	Emersion Class Number	Permeability (k) in m/sec	Moyle and Burgess Sedimentation
BH02	3 - 3.45	Clay	2	-	-
BH04	1.5 - 1.95	Clay	5	-	-
BH06	1.5 - 1.82	Clay	2	-	-
TP04	0.5 - 0.6	Clay	5	-	-
TP15	2 - 2.5	Clay	2	TBA*	TBA*

*Test is currently being undertaken and will be updated in the final report

Table 4-7: Summary of rock test results

Test Location	Material Description	Sample depth (m)	Test Type	Point Load Index, $Is_{(50)}$ (MPa)	Strength
BH01	Basalt	7.6 – 7.7	Axial	2.3	High
BH01	Basalt	7.7 – 7.9	Diametral	2.2	High
BH03	Basalt	6 – 6.3	Axial	5.8	Very high
BH03	Basalt	6.5 – 6.6	Diametral	6.7	Very high
BH04	Basalt	5 – 5.5	Diametral	8.6	Very high
BH06	Basalt	2.2 – 2.4	Axial	6.2	Very high
BH06	Basalt	3.8 - 4	Diametral	0.49	Medium
BH08	Basalt	4.7 - 5	Diametral	8.3	Very high

5 Conclusions and recommendations

5.1 Pavements

5.1.1 Subgrade design CBR

Based on our understanding, most of the pavements will be constructed to have a final surface level close to the existing ground surface. Considering this fact, the new pavements would be founded on residual clays. Results of laboratory testing indicated CBR values of 1%, 2.5% and 15% with swell of 5.5%, 2 and zero respectively.

DCP resistance ranged from 2 blows to 8 blows per 100 mm penetration. Based on the DCP results, in-situ CBR ranging from 4% to >15% is assessed.

Based on the results of the laboratory testing and T+T's previous experience with similar soils, a design subgrade CBR of 2% is considered appropriate, and the subgrade is considered as expansive.

Due to the expansive nature of on-site clays, in accordance with RC500.22, a minimum cover over expansive clay for pavements and a capping layer has been included in the design of pavements

Pavements founded in engineered fill depend on the CBR value of the fill materials. For pavements founded on fill constructed with site-won clays, a design subgrade CBR of 2% may be adopted. Any imported clay fill materials should also have a minimum Laboratory soaked CBR of 2%.

5.1.2 Design traffic loading

The traffic data used for the design of the pavement profiles was based on traffic movements presented in Preliminary Design Report[4] (PDR) provided by Stantec. The traffic loading provided in Figure 6 of PDR is presented in Table 5-1.

Table 5-1: Traffic data provided

AADT in vpd	Road name / Road Location	Pavement Type
3,100	Road 1 west of Road 2 Between Airport Road West Roundabout and Road 1 intersection	Type 1
1,950	Road 2	Type 2
500	Cul-de-sac (west of Road 1 & Airport Road west intersection) New left turn lane from Sunraysia Avenue	Type 3
3,100	Intersection of Road 1 and Road 2 Intersection of Road 1 and Airport Road West	Type 4
500	Road 1 between Road 2 and Sunraysia Drive Airport Road West (west of Road 1 & Airport Road west intersection)	Type 5
1,950	Roundabout approach – Road 2 intersection	Type 6

Where: AADT = Annual Average Daily Traffic (2 way); vpd = vehicles per day

Based on an email from Stantec [5], we understand that the traffic loading provided in the PDR would be reached at the completion of the proposed development (i.e., end of 10 years). Hence, the design traffic has been estimated as stated below for Road 1 and Road 2:

[4] Ballarat West Employment Zone (BWEZ) – Stage 2. Preliminary Design Report dated 15 February 2022.
[5] Email dated 27 September 2022. 11.56 AM from Peter Munzel of Stantec.

- For the first 10 years (0 to 10 years), no growth factor has been considered and the AADT value provided has been adopted.
- For the next 30 years (11 to 40 years), a growth factor of 1% has been adopted based on Table 12.2 of AGPT02-17.
- The proportion of heavy vehicles of 20 % has been adopted based on the PDR provided by Stantec. The load parameters of 2.3 Axle groups per heavy vehicle and 0.4 ESA per heavy vehicle have been adopted based on Table 12.2 of AGPT02-17
- Where AADT is <500 vpd, a growth factor of 1% as outlined in Table 12.2 of AGPT02-17 and a design life of 40 years has been adopted

(Note: A design of 40 years has been adopted as per Section 12.7.2 of IDM for Industrial Pavements)

A summary of the calculated design traffic loadings and the design parameters adopted in the assessment is presented in Table 5-2. If, in future, the anticipated traffic movements change, the pavement design options should be reviewed. A plan marked-up with the different types of pavements considered is presented on Figure 4 in Appendix A.

Table 5-2: Design traffic loading

Parameter	Type 1		Type 2		Type 3	Type 4	Type 5	Type 6
AADT (vpd) -2 way	3,100		1,950		500	3,100	500	1,950
Direction Factor (DF)	0.5		0.5		1*	0.5	0.5	0.5
LDF	1		1		1	1	1	1
Design speed (km/h)	40		40		10	10	40	10
Design period	0-10	11-40	0-10	11-40	0-40	Similar to Type 1	0-40	Similar to Type 2
Annua Growth Rate (%)	0	1	0	1	0		0	
Cumulative Growth Factor (CGF)	10	34.78	10	34.78	40		40	
Heavy Vehicles (HV)- %	20	20	20	20	20		20	
NHVAG (HVAG/HV)	2.3	2.3	2.3	2.3	2.3		2.3	
Cumulative HVAG (NDT)	$2.60x10^6$	$9.05 x10^6$	$1.64 x10^6$	$5.69 x10^6$	$3.3x10^6$		$3.3x10^6$	
ESA/HVAG	0.4		0.4		0.4	0.4	0.4	0.4
DESA	$4.66x10^6$		$2.93x10^6$		$1.34 x10^6$	$4.66x10^6$	$6.72x10^5$	$2.93x10^6$
Minimum cover^ (mm)	650		600		525	650	480	600

Where: vpd = vehicles per day; NHVAG = Average number of axle groups per heavy vehicle; HVAG = Heavy Vehicle Axle Group; ESA = Equivalent Standard Axle; DESA = Design traffic in Equivalent Standard Axle; NDT = Cumulative heavy vehicle axle groups in the design lane over the design period; LDF = Lane Distribution Factor

Notes:

* DF of 1 adopted for the intersection of Road 1 and Sunraysia Avenue in order to avoid longitudinal joints along east and west bound lanes of Road 1 near the intersection and ease of construction including new left turn lane.

^ Minimum cover over expansive clay as per RC500.22

5.1.3 Pavement design

Pavement structures and compositions have been developed for each of the pavement type in accordance with the following guides and code of practice:

- DoT[6] Code of Practice RC500.22 – *Selection and Design of Pavements and Surfacings.*
- Austroads Guide to Pavement Technology Part 2 (2012) – *Pavement Structural Design (AGPT02-12).*

All recommended pavement structures and compositions have been optimised using CIRCLY 6.0 software. CIRCLY output files have been presented in Appendix D.

The pavement profile design has been undertaken considering the following:

- A 15 mm construction tolerance has been added to the thickness of the structural course in deep strength asphalt pavements in compliance with the DoT requirement.
- A 190 mm asphalt layer has been maintained to match the standard kerb height.

5.1.4 Pavement compositions

Based on the estimated DESA and given that the roads would be subjected heavy vehicle traffic, a deep strength asphalt pavement is considered the most appropriate pavement structure for all pavement types within the development. The pavement structures and compositions are summarised in Table 5-3 to Table 5-8.

Table 5-3: Type 1 (Road 1) – Deep Strength Asphalt (CBR ≥ 2%, DESA 4.66x10^6)

Layer	Thickness (mm)	Description
Wearing Course	40	Size 14 mm Type H (Class 320 binder)
Intermediate Course(1)	75	Size 20 mm Type SI (Class 320 binder)
Base Course	75	Size 20 mm Type SI (Class 320 binder)
Upper subbase	120	Size 20 mm Class 3 Cement Treated Crushed Rock (~3% cement). Compacted to a minimum characteristic density ratio of 98% (Modified) Maximum Dry Density AS1289 5.2.1
Lower Subbase	100	Size 20mm Class 3 Crushed Rock (or Size 40mm Class 3 Crushed Rock). Compacted to a minimum characteristic density ratio of 98% (Modified) Maximum Dry Density AS1289 5.2.1
Capping layer	250	Type A Fill Material (Min CBR ≥7%, Swell ≤ 1.5%, Permeability ≤ 5 x 10^{-9} m/sec) Compacted to a minimum characteristic density ratio of 98% Standard Maximum Dry Density AS1289, 5.1.1
Total	**660**	Pavement thickness above subgrade

[6] Victorian Department of Transport (formerly VicRoads) Standard Specifications for Roadworks and Bridgeworks

Subgrade		Material as found, CLAY with design CBR 2%. Top 200 mm compacted to a minimum characteristic density ratio of 98% (Standard) Maximum Dry Density AS1289, 5.1.1 (not required if subgrade is stabilised)

Note: (1) Includes a 15 mm construction tolerance

Table 5-4: Type 2 (Road 2) – Deep Strength Asphalt (CBR ≥ 2%, DESA 2.93x10^6)

Layer	Thickness (mm)	Description
Wearing Course	40	Size 14 mm Type H (Class 320 binder)
Intermediate Course(1)	75	Size 20 mm Type SI (Class 320 binder)
Base Course	75	Size 20 mm Type SI (Class 320 binder)
Upper Subbase	100	Size 20 mm Class 3 Cement Treated Crushed Rock (~3% cement). Compacted to a minimum characteristic density ratio of 96% (Modified) Maximum Dry Density AS1289 5.2.1
Lower Subbase	100	Size 20mm Class 3 Crushed Rock (or Size 40mm Class 3 Crushed Rock). Compacted to a minimum characteristic density ratio of 98% (Modified) Maximum Dry Density AS1289 5.2.1
Capping layer	225	Type A Fill Material (Min CBR ≥7%, Swell ≤ 1.5%, Permeability ≤ 5 x 10^{-9} m/sec) Compacted to a minimum characteristic density ratio of 98% Standard Maximum Dry Density AS1289, 5.1.1
Total	**615**	Pavement thickness above subgrade
Subgrade		Material as found, CLAY with design CBR 2%. Top 200 mm compacted to a minimum characteristic density ratio of 98% (Standard) Maximum Dry Density AS1289, 5.1.1 (not required if subgrade is stabilised)

Note: (1) Includes a 15 mm construction tolerance

Table 5-5: Type 3 – Deep Strength Asphalt (CBR ≥ 2, DESA 1.34x10^6)

Layer	Thickness (mm)	Description
Wearing Course	40	Size 14 mm Type V (Class 320 binder)
Intermediate Course(1)	75	Size 20 mm Type SI (Class 320 binder)
Base Course	75	Size 20 mm Type SI (Class 320 binder)
Upper Subbase	100	Size 20 mm Class 3 Cement Treated Crushed Rock (~3% cement). Compacted to a minimum characteristic density ratio of 96% (Modified) Maximum Dry Density AS1289 5.2.1
Lower Subbase	100	Size 20mm Class 3 Crushed Rock (or Size 40mm Class 3 Crushed Rock). Compacted to a minimum characteristic density ratio of 98% (Modified) Maximum Dry Density AS1289 5.2.1
Capping layer	150	Type A Fill Material (Min CBR ≥7%, Swell ≤ 1.5%, Permeability ≤ 5 x 10^{-9} m/sec) Compacted to a minimum characteristic density ratio of 98% Standard Maximum Dry Density AS1289, 5.1.1
Total	**540**	Pavement thickness above subgrade
Subgrade		Material as found, CLAY with design CBR 2%. Top 200 mm compacted to a minimum characteristic density ratio of 98% (Standard) Maximum Dry Density AS1289, 5.1.1 (not required if subgrade is stabilised)

Notes:

(1) Includes a 15 mm construction tolerance.

Table 5-6: Type 4 – Deep Strength Asphalt (CBR ≥ 2%, DESA 4.66x10^6)

Layer	Thickness (mm)	Description
Wearing Course	40	Size 14 mm Type V (Class 320 binder)
Intermediate Course(1)	75	Size 20 mm Type SI (Class 320 binder)
Base Course	75	Size 20 mm Type SI (Class 320 binder)
Upper Subbase	140	Size 20 mm Class 3 Cement Treated Crushed Rock (~3% cement). Compacted to a minimum characteristic density ratio of 96% (Modified) Maximum Dry Density AS1289 5.2.1
Lower Subbase	130	Size 20mm Class 3 Crushed Rock (or Size 40mm Class 3 Crushed Rock). Compacted to a minimum characteristic density ratio of 98% (Modified) Maximum Dry Density AS1289 5.2.1
Capping layer	200	Type A Fill Material (Min CBR ≥7%, Swell ≤ 1.5%, Permeability ≤ 5 x 10^{-9} m/sec) Compacted to a minimum characteristic density ratio of 98% Standard Maximum Dry Density AS1289, 5.1.1
	660	Pavement thickness above subgrade
Subgrade		Material as found, CLAY with design CBR 2%. Top 200 mm compacted to a minimum characteristic density ratio of 98% (Standard) Maximum Dry Density AS1289, 5.1.1 (not required if subgrade is stabilised)

Note: (1) Includes a 15 mm construction tolerance

Table 5-7: Type 5 – Deep Strength Asphalt (CBR ≥ 2%, DESA 6.72x10^5)

Layer	Thickness (mm)	Description
Wearing Course	40	Size 14 mm Type H (Class 320 binder)
Intermediate Course(1)	75	Size 20 mm Type SI (Class 320 binder)
Base Course	75	Size 20 mm Type SI (Class 320 binder)
Upper Subbase	100	Size 20 mm Class 3 Cement Treated Crushed Rock (~3% cement). Compacted to a minimum characteristic density ratio of 96% (Modified) Maximum Dry Density AS1289 5.2.1
Lower Subbase	100	Size 20mm Class 3 Crushed Rock (or Size 40mm Class 3 Crushed Rock). Compacted to a minimum characteristic density ratio of 98% (Modified) Maximum Dry Density AS1289 5.2.1
Capping layer	150	Type A Fill Material (Min CBR ≥7%, Swell ≤ 1.5%, Permeability ≤ 5 x 10^{-9} m/sec) Compacted to a minimum characteristic density ratio of 98% Standard Maximum Dry Density AS1289, 5.1.1
Total	**540**	Pavement thickness above subgrade
Subgrade		Material as found, CLAY with design CBR 2%. Top 200 mm compacted to a minimum characteristic density ratio of 98% (Standard) Maximum Dry Density AS1289, 5.1.1 (not required if subgrade is stabilised)

Note: (1) Includes a 15 mm construction tolerance

Table 5-8: Type 6 – Deep Strength Asphalt (CBR ≥ 2%, DESA 2.93x10^6)

Layer	Thickness (mm)	Description
Wearing Course	40	Size 14 mm Type V (Class 320 binder)
Intermediate Course(1)	75	Size 20 mm Type SI (Class 320 binder)
Base Course	75	Size 20 mm Type SI (Class 320 binder)
Upper Subbase	120	Size 20 mm Class 3 Cement Treated Crushed Rock (~3% cement). Compacted to a minimum characteristic density ratio of 96% (Modified) Maximum Dry Density AS1289 5.2.1
Lower Subbase	100	Size 20mm Class 3 Crushed Rock (or Size 40mm Class 3 Crushed Rock). Compacted to a minimum characteristic density ratio of 98% (Modified) Maximum Dry Density AS1289 5.2.1
Capping layer	200	Type A Fill Material (Min CBR ≥7%, Swell ≤ 1.5%, Permeability ≤ 5 x 10^{-9} m/sec) Compacted to a minimum characteristic density ratio of 98% Standard Maximum Dry Density AS1289, 5.1.1
Total	**610**	Pavement thickness above subgrade
Subgrade		Material as found, CLAY with design CBR 2%. Top 200 mm compacted to a minimum characteristic density ratio of 98% (Standard) Maximum Dry Density AS1289, 5.1.1 (not required if subgrade is stabilised)

Where Type V, VP, HG or HP is recommended for use at intersections, it should commence at the start of the turn lane taper or a minimum of 80 m from the stop line or from where heavy vehicles are expected to commence braking, whichever is the greater distance and extend through the intersection and the first 30 m of the departure lanes.

5.1.5 Intersection of Road 1 and Sunraysia Drive

For the section of Road 1, pavement profile for Type 3 pavement presented in Table 5.5 may be adopted.

6 Pavement construction

6.1 Subgrade preparation

6.1.1 Weathered rock

Based on the depth to rock encountered in the boreholes and test pits, exposing rock within the road boxing out is unlikely.

However, where continuous rock is exposed at the subgrade level, the road formation should be over-excavated to ensure the rock is a minimum of 150mm below the design subgrade level. The rock surface should be cleared of loose material. The formation should be reinstated to the design subgrade level using a 20mm Class 3 crushed rock which should be compacted to a minimum density ratio of 98% Standard Maximum Dry Density at a moisture content between 2% dry and 2% wet of the optimum moisture content.

Where boulders and cobbles are exposed at subgrade level they should be removed, and the resulting cavities backfilled with clay having a minimum laboratory CBR value of 2.0%. The backfilled cavities can be compacted together with the remaining subgrade in accordance with the recommendations above.

6.1.2 Effects of weather

Previous experience with the silty and clayey soils as described within this report has shown that they are susceptible to severe loss of strength with an increase in moisture content that can occur during wetter times of the year or after heavy rainfall. Therefore, significant subgrade improvement may be required if construction is programmed during winter or heavy rainfall occurs during the construction period. Wetting up of clay soils can also create problems with the subgrade meeting proof rolling requirements. Previous experience, however, has shown that these materials if carefully treated or controlled can lead to the construction of roads exhibiting good performance.

While it would be preferable for construction to be programmed for the drier months, given the possibility wet weather during construction, the following actions are likely to prove beneficial.

- Shape and compact the formation to maximise surface water runoff and minimise the infiltration of water.
- Replace unsuitably wet materials with a suitable fill (lower subbase material) such as quarry rubble or soft rock to enable construction to proceed.
- After the formation has been prepared, construct the construction layer as soon as possible to protect the formation from adverse weather and to provide a platform suitable for construction vehicles.

Note: The suitability of any proposed fill for this purpose will require laboratory testing and/or have sufficient proven performance in practice.

6.1.3 Compaction

Subgrade soils should be compacted to a minimum dry density ratio of 98% of standard compaction at moisture contents of ±2.0% of standard optimum moisture content.

It is recommended that a subgrade inspection and testing (through Hilf rapid compaction tests and/or DCP tests) is undertaken at the boxing out stage of after in-situ stabilisation to assess the condition of the subgrade and to assess the need (if any) for further subgrade improvement unless in-situ stabilisation of the subgrade is to be undertaken.

6.1.4 Proof rolling

The construction layer is required to be proof rolled to confirm that the road formation is a uniform sound surface free of weak areas. Proof rolling should be conducted using a pneumatic-tyred roller loaded to 2.0 t/wheel and with a tyre pressure of 566kPa. Both the axle load and the tyre pressure must be confirmed prior to commencing proof rolling. The proof roller should be operated to provide two passes of all parts of the subgrade surface.

If a loaded truck is used as the proof roller it should be loaded to achieve 2.5t/wheel on the front axle and should have a tyre pressure not exceeding 700kPa. Both the axle load and the tyre pressure must be confirmed prior to commencing proof rolling.

Areas of the construction layer where there is visible rutting in excess of 10mm in depth or where "springiness" is observed, should be marked out and the soil in those areas removed and replaced with stronger and/or drier material compacted in accordance with the requirements of Section 5.1.3 above.

If the performance of the construction layer is to be assessed on the basis of deflection or movement then the observer should be observing the deflection at the wheel of the roller or, if a loaded truck is being used, at a point 200mm – 300mm offset from the front tyre of the truck in the direction at right angles to the direction of travel.

6.2 Subgrade improvement

6.2.1 Expansive clays

Given the laboratory results obtained on the cohesive subgrade material at this site, the underlying cohesive clay soils are expected to be highly expansive and therefore have the potential to shrink and swell with changes in moisture content.

The Austroads (2017) Guide to Pavement Technology Part 2 provides some advice on controlling the effects of volume changes in moderately expansive soils on pavements. A common technique used to reduce volume change involves the inclusion of a Select Fill capping layer above the expansive soil. This layer minimises the moisture ingress to the expansive soil and provides a minimum depth of cover over the expansive soils so that the effects of any volume change on the pavement are minimised. The inclusion of the capping layer also provides a working platform, allowing construction to proceed in adverse weather conditions.

The construction of the pavements should be completed as expeditiously as possible in order to reduce the period of exposure of the subgrade to:

- Warm to hot and windy weather which are the optimum drying conditions and drying of the expansive subgrade will result in cracking of the subgrade
- Wet weather conditions which will result in a sever loss of subgrade strength

The capping layer should be placed immediately after the formation is excavated and trimmed to the design subgrade level. Proof rolling should be conducted on the surface of the capping layer to avoid extending the time of exposure of the subgrade. The completion of the pavement should proceed immediately following an acceptable proof rolling response.

Further to the above, it is desirable that the subbase layer and the capping layer be extended a minimum 0.6m beyond the back of kerb and channel, except for arterial roads where it shall be ≥1.5m, to minimise moisture variation in the subgrade at the edge of the pavement.

The minimum depth of pavement over an expansive subgrade is determined in accordance with the DoT Code of Practice RC500.22, Figure 5.1. In order for the capping layer to be effective it is essential that the depth of sub-surface drains is above the base of the capping layer.

It is also important that any buried services should be installed such that they do not allow moisture to permeate or accumulate in the subgrade by bypassing the capping layer. This may require localised thickening of the capping layer so that the trench is encapsulated in capping layer materials or wrapped in an impermeable barrier so that moisture cannot migrate between the service trenches and the subgrade.

6.2.2 Limitation on planting and removal of vegetation

Where expansive soils are present in the road subgrades, trees in close proximity to the pavement can exacerbate swelling and shrinking movements associated with moisture variations in these soils. Additionally, the planting of large trees can result in root intrusion and disruption to the pavement subgrade. As both of these factors increase the risk of pavement cracking and roughness, the selection of trees and shrubs for planting alongside pavements needs to be carefully considered, along with adequate drainage, particularly in reactive clay sites to minimise the risk of premature damage to the pavement.

AS 2870-2011[7] considers the potential drying effects on building foundations of existing or proposed trees planted in the vicinity of the building. Conservatively, without consideration of species, leaf area or site environment, a minimum distance equal to the mature height of a tree or shrub may be used as an estimate of zone of influence of the tree or shrub. This should be doubled for rows or grouped plantings.

Furthermore, where trees are removed prior to or during construction the soil will be at an artificially low moisture content from which it will slowly recover but that recovery will be associated with higher-than-normal swelling movements. To counteract this extra swelling, deep soaking may be conducted in boreholes across the site, following removal of the trees and for a period thereafter of six to twelve months (based on normal rainfall) which may not be practical on many sites. When constructing pavements near mature trees, the possibility of the tree being removed or dying and the impact of that on soil moisture conditions and by extension on the performance of the pavement should be taken into account.

6.2.3 In-situ stabilisation

In view of the low soaked CBR value of the CLAY, economical pavement could be achieved by insitu stabilising the CLAY with lime than by designing a pavement over the natural silty clay.

No laboratory testing has been undertaken to determine the type or amount of additive to sufficiently increase the mechanical properties of the materials at this site. Previous experience with similar cohesive type soils (to that found at this site) indicated that 3% to 4% lime should be sufficient to increase the mechanical properties of the cohesive subgrade material at this site. The design subgrade CBR value depends on the effectiveness and depth of in-situ stabilisation.

Further laboratory testing could be undertaken to confirm the type and/or amount of additive to use. Alternatively, contractors and specialists in the field of stabilisation should be contacted to discuss their experience with similar ground conditions.

[7] Standards Australia (2011) Residential Slabs and Footings, Standards Australia, Sydney.

6.3 Drainage

Providing adequate surface and sub-surface drainage is essential for the proper functioning of a pavement. To improve the trafficability of the site and to minimise construction delays, adequate drainage of the site during construction should be provided. No pooling of water, either on natural or stripped surfaces within the boxed-out areas should be allowed.

6.3.1 Surface drainage

The pavements should be constructed with a minimum cross fall of 3% to ensure drainage of the asphalt surface.

Where catch or table drains are to be provided, careful consideration should be given to minimising the potential for water in the table drain to infiltrate the upper zone of the subgrade. This can be achieved by designing the drains to ensure that the water level remains at least 250 mm below subgrade level. Other factors that should be considered in designing the drains include flow velocity, shape, turn-off (discharge) areas and sediment control. Open drains such as catch drains and table drains should be regularly maintained to remove of any debris or sediment accumulation.

6.3.2 Subsurface drainage

The preferred subsurface drainage system is a 100mm diameter AGI, installed along both sides of the pavement and installed in accordance with DoT[8] Section 702 and include flushing points at the remote end from the outlet pit. The select fill capping layer is required to be extended beneath the subsurface drains in order to provide a minimum cover of 150mm from the underlying expansive subgrade which may require localised thickening of the subgrade layer.

Subsurface drains shall also be required at the interface of existing and new pavements where the new pavement material is likely to trap water within the adjacent existing materials. Subsurface drains should be installed on the high side of the new pavement. If the bottom of the new pavement is located within the subgrade such that it creates a sump, subsurface drainage should also be installed on the low side of the pavement.

6.4 Flexible pavement

6.4.1 Capping layer and construction layer

Material to be used as Capping Layer and Construction Layer must have following properties:

- Soaked CBR ≥ 7.0%;
- Swell of ≤ 1.5%;
- Liquid limit of less than 50%;
- Plasticity index (PI) of less than 25%;
- Hydraulic conductivity (k) of less than 5 x 10^{-9} m/s measured at OMC ±5%; and
- Weighted Plasticity Index (WPI) of less than 1200 (WPI = PI x % less than 0.425mm sieve).

Capping layer and Construction layer should be a minimum of 150mm thick or at least 2.5 times the maximum particle size in the layer. The layer should extend laterally to at least 0.6m beyond the back of the kerb and channel, except for arterial roads where it shall be ≥1.5m.

[8] VicRoads Standard Specifications for Roadworks and Bridgeworks

6.4.2 Granular layers

The sub-base crushed rock should comply with DoT Section 812 and should be placed and compacted in accordance with DoT Section 304 to the minimum density ratios specified in the pavement design tables. The use of recycled crushed concrete complying with DoT Sections 812 may be used in place of Class 3 and Class 4 crushed rock in subbase layers. The use of recycled crushed concrete materials is not recommended for base course layers.

The maximum thickness of any pavement base layer shall not exceed 150mm and the maximum thickness of any sub-base layer shall not exceed 200mm.

6.4.3 Cement Treated Crushed Rock (CTCR)

CTCR should comply with DoT Section 815 and should be placed and compacted in accordance with DoT Section 306 to the minimum density ratios specified in Section 5.14. Cement treated crushed concrete (CTCC) complying with VicRoads Sections 815 may be used in place of CTCR.

6.4.4 Tack Coat

Where lower layers of asphalt are left exposed for periods longer than 24 hours or are in dusty conditions, then the surface of the asphalt should be tack coated prior to placing the overlying asphalt layer. The tack coat should consist of an application of bitumen emulsion at a rate of 0.1l/m^2 to 0.2l/m^2 of residual bitumen.

6.4.5 Asphalt

Asphalt of the types recommended in the pavement design options should be manufactured in accordance with DoT Section 407 and should be registered with a General status a on the DoT Mix Register. Asphalt mixes should be supplied, placed, and compacted in accordance with DoT11 Section 407.

The roads should not be opened to traffic prior to completion of the asphalt wearing course where Type N asphalt is utilised in the pavement structure. If the road has to be opened to traffic between the placement of successive layers of asphalt it is recommended that further advice be sought.

The design thicknesses of asphalt layers make allowance for construction tolerances on the finish surface levels as stipulated in DoT Section 407.

7 Geotechnical comments and recommendations

7.1 Construction of sewer and stormwater drains

7.1.1 Construction methodology

We understand that the invert levels of the reticulation sewers and stormwater will be no deeper than 5m bgl. The construction of services could include one or more forms of construction. Shallow services (i.e., up to 1.0 – 1.5m bgl) could adopt trenching methods using unsupported excavations and safe batters. Deep services (i.e., deeper that 1.0 – 1.5m bgl) will require support via trench shields, shoring or retention systems.

Trenchless technology methods may be considered. The manholes and/or pits can be excavated by a topdown method to provide ground support and the boring to install the sewer/stormwater drains can be carried out using launching and receiving pits. If this option is to be considered, additional geotechnical engineering analysis should be undertaken, and further advice should be sought from the specialist contractors.

The following sections provide further details regarding different aspects of service construction.

7.1.2 Excavation conditions

Subsurface conditions encountered topsoil up to 0.3m bgl overlying residual clay ranging from 1.5m bgl to 6.45m bgl overlying weathered basalt rock.

Based on the subsurface profile at the site, excavations in soils are likely to be achieved using conventional mechanical equipment such as tracked excavators or a medium size bulldozer.

The excavations in rock will require the use of excavators fitted with hydraulic rock breakers or large bulldozers (Cat D6 or similar) fitted with a ripper blade..

7.1.3 Temporary groundwater control

Shallow excavations (i.e., up to 1m bgl) could encounter a seasonal perched water table during the wetter seasons of the year or after heavy/sustained rainfall. It is considered that perched water control will likely be achievable by means of a sump and pump system installed at lowest points of the excavation. Deeper excavation (i.e., more than 5m bgl) are expected to encounter the regional groundwater. It is recommended that the project planning allows for contingencies related to groundwater management and retention of trenches and excavations.

7.1.4 Temporary batter slopes

Worksafe Victoria recommends that excavations deeper than 1.5m should be battered, benched or shored to provide a safe working environment. For excavation depths exceeding 1.5m, it is recommended that excavations are shored or battered back to minimise the risk of collapse and debris spalling from the excavation sides.

The recommended temporary batter slopes are presented in Table 7-1.

Table 7-1: Recommended temporary batter slopes

Material	Temporary batters (< 2 weeks)
Unit 2 – Residual Clay	1V:1H, or flatter

Permanent unsupported batters are not anticipated at the site. Surcharge loading on the

unsupported slope should be eliminated within a distance from the crest equal to the height of the temporary cut.

Notwithstanding the above, it is recommended that the slopes are monitored at regular intervals to check for signs of instability throughout the construction period. This may be undertaken by placing a string line along the crest of the slope with pins installed at intervals beneath. Monitoring the offset distance of the pins from the string line can provide early indication of ground movement. Where this is observed, work should cease within the affected area and the advice of a suitably experienced and qualified geotechnical engineer sought.

When excavating trenches, it is recommended that the excavated spoil is stockpiled away from the trench walls at a minimum distance equal to the total depth of the trench, i.e., if a trench is 3m deep then the excavated material should be stockpiled at a minimum distance of 3m away from the trench walls.

In addition, for the duration of the works the trench should be protected from external water ingress by:

- Shaping the ground surface adjacent to the trench to cause water to flow away from the trench.
- Construction of temporary bunds around the edges of the trench sufficiently remote from the trench so as not to load the trench walls though close enough to minimise water ingress.
- Covering the top of the trench and the upper part of the trench walls with an impermeable membrane (geomembrane).

7.1.5 Temporary shoring

Temporary shoring, retention systems or trench boxes are recommended for deep excavations. These elements can be designed based on the parameters shown in Table 7-2.

Table 7-2: Geotechnical design parameters

Unit Number and Description	Unit Weight γ (kN/m^3)	Cohesion (kPa)		Effective Friction Angle ϕ' (deg)	Coefficients of Lateral Earth Pressure		
		Undrained Cu	Drained C'		Active (Ka)	At rest (K_0)	Passive (Kp)
Unit 2 – Residual Clay (Firm)	18	40	3	27	0.38	0.55	2.63
Unit 2 – Residual Clay (Stiff or better)	19	80	6	27	0.38	0.55	2.63
Unit 3 – Weathered Basalt	22	300	35	100	-	2.0	-

Where required, T+T can provide geotechnical engineering input for the design of temporary retention system.

7.1.6 Pipe embedment

As the sewer/stormwater invert level is expected to be within clay or weathered basalt and may be subject to groundwater inflows, it is recommended that a Type A or Type D embedment with geotextile wrap, in accordance with Melbourne Retail Water Agencies (MRWA) standards drawing MRWA-S-202 to be used for embedment layer.

7.1.7 Trench backfill

Backfilling of the trenches following installation of the sewer pipe work should be undertaken in accordance with the requirements of MRWA Specification 4.03-1 for non-trafficable areas. For trafficable areas, the backfill should be to the standards of the relevant Road Authority. If the Road Authority has not stipulated requirements for backfill then MRWA Specification 4.03-1 should be used.

7.1.7.1 Non-trafficable areas

The site derived clays may be used as backfill of sewer trenches located in non-trafficable areas. There is a risk that large clods of clay may make compaction of the backfill difficult and result in a permeable backfill which will be exhibit excessive swell–shrink movements. This risk can be controlled by:

- careful control of the moisture content to ensure it is within the recommended limits; and
- breaking up of all clods which are greater than 75mm in size prior to placement.

It is recommended that the backfill material is moisture conditioned prior to placement, to a moisture content between -3% and 3% wet of OMC, as determined by AS 1289.5.1.1 or AS 1289.5.7.1.

It is recommended that all backfill is placed in horizontal layers with a loose thickness no greater than 175 mm. The backfill should be compacted in accordance with the requirements of the MRWA 04-03.1 Backfill Specification (MRWA 04.03-1), to a minimum density ratio of 95% (AS 1289.5.1.1) in order to minimise the risk of future subsidence. However, some subsidence is inevitable in a compacted clay fill, due to the dissipation of pore pressures induced by the compaction process. In addition, heave or settlement can be expected during the life of the sewer due to seasonal changes in the fill moisture conditions.

In order to protect the pipe from damage during construction, a minimum depth of fill of 0.3 m should be placed over the pipe and compacted using manual compaction equipment. Alternatively, if mechanical compaction is to be used then the depth of fill over the pipe should be increased to 0.5 m. The initial backfill layer on the embedment zone may need to be manually compacted to ensure the pipe is not damaged due to excessive plant force or vibration.

The backfill should be placed and compacted evenly around access shafts and pits to avoid eccentric surcharge loading and differential settlement of the pipe.

7.1.8 Thrust blocks

Pressure mains will require thrust blocks or anchor blocks to transmit the pipe loads to the ground for which the available resistance is a function of the soil properties, and the depth and size of the thrust blocks. It is anticipated that the blocks will be constructed at depths up to 1.5m bgl and hence the available lateral resistance should consider the lateral earth pressures within the soil at this depth.

Standard drawing MRWA-W-200 provides a soil classification table which includes values for allowable horizontal bearing capacities. In accordance with the recommended values provided within MRWA-W-200, an allowable horizontal bearing pressure of 30 kPa and 50 kPa is recommended for firm and stiff (or better) clay, with a minimum depth to the centre point of the block of 1.0m bgl. Thrust blocks fully embedded within the rock shall be designed for an allowable horizontal bearing pressure of 200 kPa in accordance with MRWA-W-200.

Where thrust loads are expected to be permanent, then the design of the thrust blocks should consider the drained soil parameters (i.e., c', ϕ', Kp). Additional guidance on the design of thrust

blocks can be found in CIRIA Report 12818. The passive resistance of the soil can be assessed based on the parameters presented in Table 7-2.

7.2 Sewer pump station

We understand that the wet well will be installed at about 7m bgl. Subsurface conditions encountered topsoil up to 0.3m bgl overlying residual clay ranging from 1.8m bgl to 6m bgl overlying weathered basalt rock.

The method of installation of the proposed wet well was not known at the time of preparing this report. Based on our previous experience we assume that the wet well would comprise a precast circular wall and would be installed within a bored hole and the pump would be installed on pad footings (circular/square/rectangular). An allowable bearing capacity of 1000 kPa can be adopted for a footing with a minimum width of 1m on weathered basalt. Based on an allowable bearing capacity of 1000 kPa the long term (using drained modulus of elasticity) primary settlement at the centre of 2m diameter circular footing is estimated to be within 10 mm.

The footing design would need to consider a design hydraulic uplift pressure based on standing groundwater level that will be reported in the final report.

7.3 Construction of retarding basin

Subsurface conditions (test pits TP14 and TP15) encountered topsoil up to 0.3m bgl overlying residual clay ranging from 0.8m bgl to 2.5m bgl. TP14 reached refusal on weathered basalt at 0.8m bgl while TP15 was terminated at 2.5m bgl. Dispersion test carried out on a sample retrieved from TP15 within 2m bgl to 2.5m bgl provided Emerson Class Number of 2 that indicates the soil is dispersive.

As the on-site clay soils are dispersive, they would not be suitable for re-use as Embankment Fill Type 1 material unless treated with Gypsum at a sufficient rate to render them non-dispersive. Our experience suggests that adding 2% to 3% by weight of Gypsum should achieve a low or non-dispersive soil which retains a sufficiently low permeability to be suitable for use. Based on previous laboratory tests conducted on similar soils treated with 2% gypsum, the permeability is expected to be in the order of 10^{-10} m/sec that will be confirmed through current laboratory testing being undertaken and will be updated in the final report.

8 Applicability

This report has been prepared for the exclusive use of our client Stantec Australia Pty Ltd, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Recommendations and opinions in this report are based on data from discrete investigation locations. The nature and continuity of subsoil away from these locations are inferred but it must be appreciated that actual conditions could vary from the assumed model.

Tonkin & Taylor Pty Ltd
Environmental and Engineering Consultants

Report prepared by:

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Authorised for Tonkin & Taylor Pty Ltd by:

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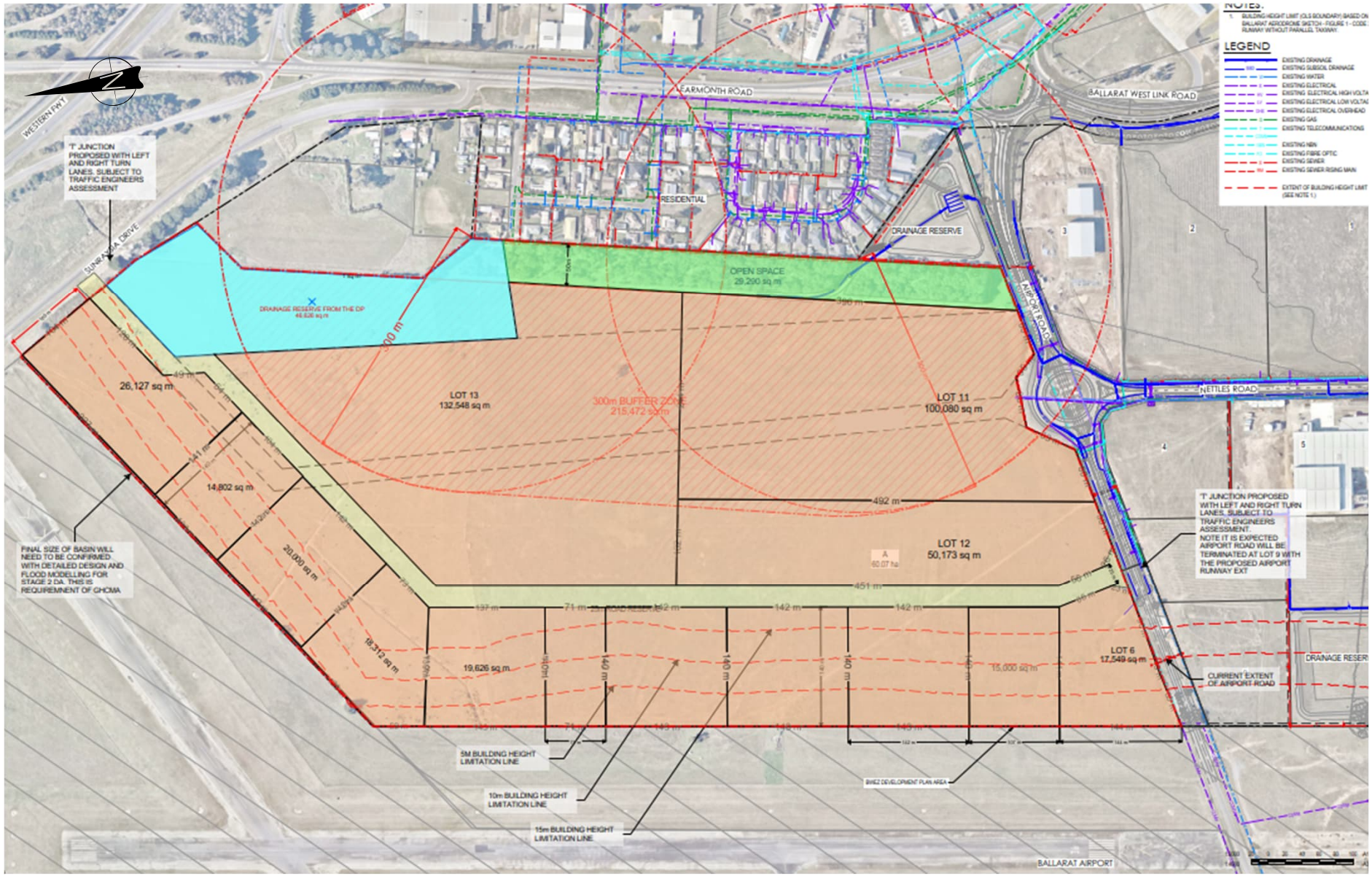
Elmar Kaltenbach
Project Director

Ganesh Manivannan
document2

Appendix A Site Plans



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DRAWN	SSE	Oct'22
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PROJECT No. 1018876.2000		

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NORTHERN LAND PARCEL

BALLARAT WEST EMPLOYMENT ZONE

Infrastructure Plan Showing Site Location

FIG. No. Figure 1

REV. 0

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APPROVED		DATE

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PROJECT: NORTHERN LAND PARCEL - BALLARAT WEST EMPLOYMENT ZONE

TITLE: GEOTECHNICAL INVESTIGATION TEST LOCATION PLAN

SCALE (A3)	FIG No.	REV
1:4000	Figure 2	1

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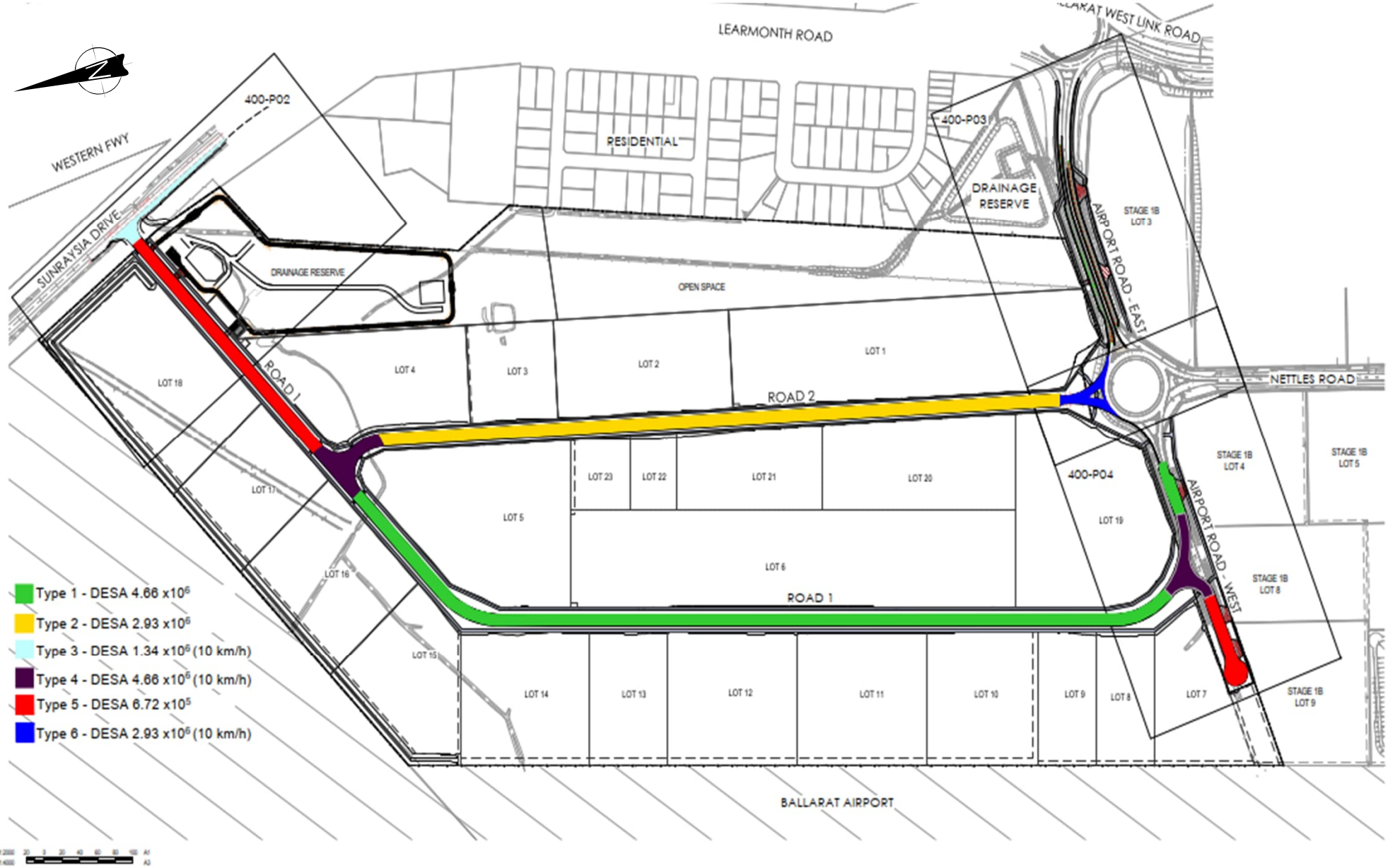
PROJECT: NORTHERN LAND PARCEL - BALLARAT WEST EMPLOYMENT ZONE

TITLE: GEOTECHNICAL INVESTIGATION TEST LOCATION PLAN

SCALE (A3)	FIG No.	REV
1:4000	Figure 3	1



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PROJECT No. 1018876.2000	FIG. No. Figure 4	REV. 0

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NORTHERN LAND PARCEL

BALLARAT WEST EMPLOYMENT ZONE

Plan showing extent of pavement types

Appendix B Engineering Logs

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Engineering log terminology

General

Soil and rock are described in terms of their engineering properties. Descriptions generally follow the "Description and Classification of Soils and Rocks for Geotechnical Purposes" system as given in AS1726 – 2017 Geotechnical Site Investigations.

Water

Water level on date shown

Water inflow

Water outflow

Drilling method/casing

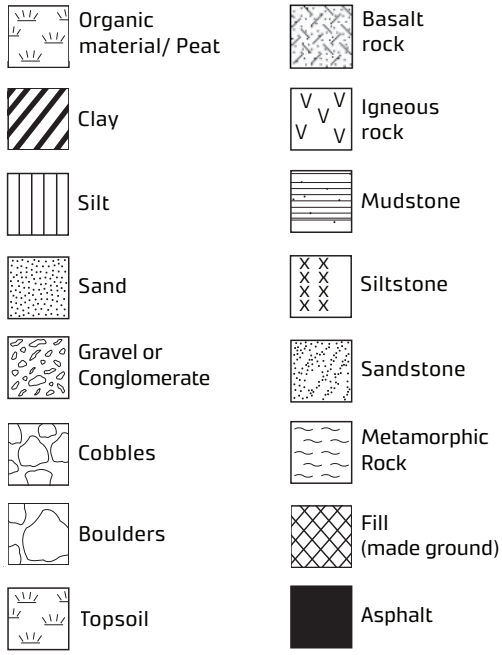
Common types:

SA	Solid auger
HOA	Hollow auger
NQ3	NQ triple tube coring
HQ3	HQ triple tube coring
SCD	Sonic Drilling
WB	Wash boring
AH	Air hammer
HA	Hand Auger
DP	Direct Push
ME	Mechanical Excavation

Graphic logs

The graphic log shows soil and rock types, significant defects and core loss.

Typical material symbols:



Tests

Field test(s) carried out

- **SPT(N):** Standard Penetration Test (uncorrected blow count for 300 mm)
- **DCP:** Dynamic Cone Penetrometer resistance (blows per 100 mm)
- **SV:** Shear Vane, undrained shear strength (kPa)
- **PP:** Pocket Penetrometer, gauge reading (kPa)

Laboratory test(s) carried out:

MC:	Moisture content (%)
LL:	Liquid limit (%)
PI:	Plasticity Index (%)
LS:	Linear shrinkage (%)
CBR:	California Bearing Ratio (%)
Swell:	CBR speciment swell (%) following soaking
PLI:	Point Load Index $Is_{(50)}$ (MPa)
PID:	Photoionization Detector (ppm)
UCS:	Uniaxial Compressive Strength (MPa)

Soil description

Moisture content

D	Dry, non-cohesive and free-running.
M	Moist, soil feels cool, darkened in colour. Soil tends to stick together.
W	Wet, soil feels cool, darkened in colour. Soil tends to stock together, free water forms when handling.

Consistency/ undrained shear strength

		C_u(kPa)
VS	Very soft	<=12
S	Soft	12 to 25
F	Firm	25 to 50
St	Stiff	50 to 100
VSt	Very stiff	100 to 200
H	Hard	> 200

Density index

VL	Very loose
L	Loose
MD	Medium dense
D	Dense
VD	Very dense

Proportional terms definition (Coarse soils)

Fraction	Term	% of soil mass	Example
Major	(UPPER CASE)	Major constituent	GRAVEL
Subordinate	(lower case)	> 12	Sandy
Minor	with ... trace ...	5-12 < 5	with sand trace sand

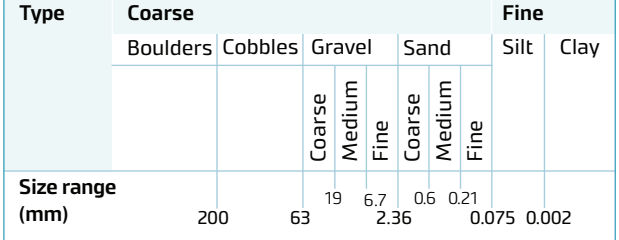
Proportional terms definition (Fine soils)

Fraction	Term	% of soil mass	Example
Major	(UPPER CASE)	Major constituent	CLAY
Subordinate	(lower case)	> 30	Sandy
Minor	with ... trace ...	30-15 < 15	with sand trace sand

Cementing

Uc	Uncemented, Clean grains exhibiting soil properties
Vwk	Very weakly cemented, Cement on some grains, collapsing feel under very light finger pressure
Wk	Weakly cemented: Cement on many grains, collapsing feel under finger pressure, breaks down to individual grains
Mwk	Moderately weakly cemented, Cement on most grains, breaks down to lumps under finger pressure, can crush to individual grains under knife blade
Mo	Moderately cemented, Cement on most grains, can break fragments off by hand and crush to small lumps
We	Well cemented, Practically all grains cemented together, cannot break fragments off by hand, dull sound under hammer
Vwe	Very well cemented, Most primary pores filled with cement, requires firm blow with hammer to break off fragments, rings when struck

Grain size criteria



Tonkin+Taylor

Engineering log terminology

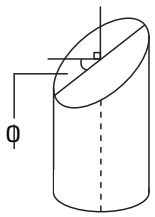
Rock description

Defect coding

Type
Angle (perpendicular to core axis)
Infilling description (as per soil description)

J 60˚, PL, SL, CV, STIFF GREEN CLAY

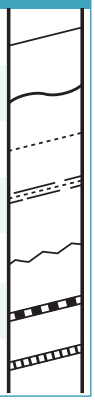
Infilling/coating type
Roughness
Shape



Defect Orientation: for vertical unoriented boreholes defect orientation is measured normal to core axis e.g horizontal = 0˚ (see diagram). For angled boreholes defect orientation is measured relative to core axis e.g parallel to core axis = 0˚.

Type - Signifcant defects

P	Parting
J	Joint
SS	Shear surface
SZ	Sheared seam/zone
CZ	Crushed seam/zone
IF	Infilled seam/zone
XD	Extremely weathered seam



Defect shape

PL	Planar
C	Curved
UN	Undulating
S	Stepped
IR	Irregular

Roughness of defect surface

VR	Very rough
R	Rough
SM	Smooth
PO	Polished
SL	Slickensided

Weathering

RS	Residual Soil
XW	Extremely weathered
DW	Distinctly weathered
HW	Highly weathered
MW	Moderately weathered
SW	Slightly weathered
FR	Fresh

Infillings and coatings

CN	Clean	No visible coating.
ST	Stained	No visible coating but surfaces are discoloured.
CV	Veneer	A visible coating of soil or mineral, too thin to measure, maybe patchy.
CT	Coating	A visible coating up to 1 mm thick.

RQD: Rock Quality Designation

Percentage of core run consisting of sound rock longer than 100 mm per core run.

TCR: Total Core Recovery

Expressed as percentage of the length of the core run recovered.

Field strength

		PLI (MPa)	UCS (MPa)	**Field guide** (50 mm diameter core)
VL	Very low	0.03 to 0.1	0.6 to 2	Crumbles with pick, can be peeled by knife
L	Low	0.1 to 0.3	2 to 6	150 mm piece may be broken by hand
M	Medium	0.3 to 1.0	6 to 20	150 mm piece may be broken by hand with difficulty
H	High	1 to 3	20 to 60	Core breaks after one blow with geological pick
VH	Very high	3 to 10	60 to 200	Core breaks after more than one blow with pick
EH	Extremely high	More than 10	More than 200	Core breaks after many blows with pick

BOREHOLE LOG

BOREHOLE No.: BH01

SHEET: 1 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.801076 (WGS84) -37.509086	METHOD: SA & HQ3	START DATE: 19/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 19/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: JCME
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Depth (m)
Newer Volcanic Group	*0.00m:* CLAY, grey-brown, high plasticity, moist, soft to firm. Root fibers to 0.1 m depth.	0
	0.30m: CLAY trace gravel, high plasticity; gravel, fine grained.	0.3
	0.42 - 0.60m: Very stiff	0.5
	0.60 - 1.10m: Very stiff - hard	1.0
	1.10 - 1.50m: Firm	1.5
	3.00m: CLAY trace sand and gravel, dark brown, high plasticity, very stiff; sand, fine to coarse grained; gravel, fine to medium grained.	3.0
		4.5

Rock Weathering: RS, XW, HW, MW, SW, DW

Rock Strength: VL, L, M, H, VH, EH

Sampling Method: SA

Core Recovery (%)

Testing: 5 5 5 N=10; 6 7 7 N=14; 8 8 10 N=18

DCP (Dynamic Cone Penetrometer): 2 2 1 2 3 5 9 9 10 10 11 6 3 2 3

RL (m)

Graphic Log

ROCK DEFECTS: Defect Log; Fracture Spacing (mm): 20, 60, 200, 600, 2000; RQD (%)

Description and Additional Observations:

0.00 - 0.20m: Topsoil - siltier

0.20 - 6.00m: Residual clay

Fluid Loss (%): 25, 50, 75

Water Level: 19/07/20

Casing

Installation

Core Box No

COMMENTS:

Hole Depth 8m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A

BOREHOLE LOG

BOREHOLE No.: BH01

SHEET: 2 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.801076 (WGS84) -37.509086	METHOD: SA & HQ3	START DATE: 19/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 19/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: JCME
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, grain size and type, colour, fabric, moisture, durability	Rock Weathering (RS, XW, HW, MW, SW, DW)	Rock Strength (VL, L, M, H, VH, EH)	Sampling Method	Core Recovery (%)	Testing	DCP (Dynamic Cone Penetrometer)	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (20, 60, 200, 600, 2000)	RQD (%)	Description and Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Newer Volcanic Group	[CONT] *3.00m:* CLAY trace sand and gravel, dark brown, high plasticity, very stiff; sand, fine to coarse grained; gravel, fine to medium grained.			SA	0			5.5											
	6.00m: NO CORE			HQ3	0	10 for 50mm **N>=50** Bouncing		6.0					0	*6.01 - 6.50m:* Probable extremely weathered rock *6.05 - 6.50m:* Drill bit clogging					
Newer Volcanic Group	*6.45m:* Dark grey, high strength, moderately weathered.			HQ3	100			6.5					10	*6.50 - 6.75m:* CZ *6.85 - 6.86m:* J, 0°, IR, R, *6.97 - 7.01m:* J, 45° *7.01 - 7.06m:* J, 45°, IR, R *7.13 - 7.14m:* J, 0°, IR, R *7.22 - 7.27m:* IF, 0°, IR, R *7.40 - 7.41m:* J, 0°, IR, R					
				HQ3	100			7.0											
	8m: END OF BOREHOLE							7.5					40						
								8.0											
								8.5											
								9.0											
								9.5											

COMMENTS:

Hole Depth 8m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A

BOREHOLE LOG

BOREHOLE No.: BH02

SHEET: 1 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.799470 (WGS84) -37.509701	METHOD: SA & HQ3	START DATE: 19/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 19/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: VTT
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, grain size and type, colour, fabric, moisture, durability)	Rock Weathering (RS, XW, HW, MW, SW, DW)	Rock Strength (VL, L, M, H, VH, EH)	Sampling Method	Core Recovery (%)	Testing	DCP (Dynamic Cone Penetrometer)	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (20, 60, 200, 600, 2000)	RQD (%)	Description and Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Newer Volcanic Group	*0.00m:* CLAY trace gravel, grey mottled brown, high plasticity, moist, firm to stiff; gravel, fine grained. Root zone to 0.1 m depth. *0.40 - 0.70m:* Very stiff *0.70 - 1.00m:* Hard *1.00 - 3.00m:* Very stiff			SA		3 5 7 **N=12**	2 3 3 3 6 8 12 15 14 18 9 6 6 7 7		0.5 1.0 1.5 2.0 2.5					*0.00 - 0.10m:* Topsoil - siltier *0.10 - 4.50m:* Residual clay					
	3.00m: CLAY with sand trace gravel, dark grey mottled brown, high plasticity, very stiff; sand, fine and coarse grained; gravel, fine and coarse grained.					7 8 10 **N=18**			3.0 3.5										
	4.50 - 6.00m: Hard					10 25 for 30mm **N>=50** Bouncing			4.0 4.5					*4.50 - 6.11m:* Probable extremely weathered		19/07/2022			

COMMENTS:

Hole Depth 6.11m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A

BOREHOLE LOG

BOREHOLE No.: BH02

SHEET: 2 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.799470 (WGS84) -37.509701	METHOD: SA & HQ3	START DATE: 19/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 19/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: VTT
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, grain size and type, colour, fabric, moisture, durability	Rock Weathering (RS, XW, HW, MW, SW, DW)	Rock Strength (VL, L, M, H, VH, EH)	Sampling Method	Core Recovery (%)	Testing	DCP (Dynamic Cone Penetrometer)	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (20, 60, 200, 600, 2000)	RQD (%)	Description and Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Newer Volcanic Group	[CONT] *3.00m:* CLAY with sand trace gravel, dark grey mottled brown, high plasticity, very stiff; sand, fine and coarse grained; gravel, fine and coarse grained.			SA	0	14 for 110mm **N>=50** Bouncing			5.5 6.0										
	6.11m: END OF BOREHOLE								6.5 7.0 7.5 8.0 8.5 9.0 9.5										

COMMENTS:

Hole Depth 6.11m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A

BOREHOLE LOG

BOREHOLE No.: BH03

SHEET: 1 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.8008552 (WGS84) -37.511065	METHOD: SA & HQ3	START DATE: 19/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 19/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: VTT
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, grain size and type, colour, fabric, moisture, durability	Rock Weathering (RS, XW, HW, MW, SW, DW)	Rock Strength (VL, L, M, H, VH, EH)	Sampling Method	Core Recovery (%)	Testing	DCP (Dynamic Cone Penetrometer)	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (20, 60, 200, 600, 2000)	RQD (%)	Description and Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Newer Volcanic Group	*0.00m:* CLAY with silt trace sand, grey mottled yellow, high plasticity; moist, sand, fine to coarse grained. Firm to stiff. Root zone to 0.1 m depth. *0.30 - 3.00m:* Very stiff			SA	0	5 5 6 **N=11**	2 3 4 6 5 6 6 9 8 5 5 6 6 5 5	0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5						*0.00 - 0.20m:* Topsoil - siltier *0.20 - 4.50m:* Residual clay					
	3.00m: CLAY trace sand, yellow mottled grey, high plasticity, moist, very stiff; sand, fine to coarse grained.					3 6 9 **N=15**													
	4.50m: Gravelly SAND with clay, brown, fine to coarse grained, moist, hard; gravel, fine to coarse grained. (Extremely weathered basalt).					25 for 25mm **N>=50** Bouncing								*4.50 - 5.00m:* Extremely weathered rock					

COMMENTS:

Hole Depth 6.5m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A

BOREHOLE LOG

BOREHOLE No.: BH03

SHEET: 2 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.8008552 (WGS84) -37.511065	METHOD: SA & HQ3	START DATE: 19/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 19/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: VTT
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, grain size and type, colour, fabric, moisture, durability	Rock Weathering (RS, XW, HW, MW, SW, DW)	Rock Strength (VL, L, M, H, VH, EH)	Sampling Method	Core Recovery (%)	Testing	DCP Dynamic Cone Penetrometer	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (20, 60, 200, 600, 2000)	RQD (%)	Description and Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Newer Volcanic Group	*5.00m:* BASALT, dark grey, high strength, slightly to moderately weathered.			HQ3	100				5.5				84	*5.27 - 5.29m:* J, 0°, IR, R, W *5.31 - 5.32m:* J, 0°, IR, R, W *5.60 - 5.65m:* J, 45°, IR, R, MW *5.85 - 5.91m:* J, 45°, IR, R, W *6.30 - 6.31m:* J, 0°, IR, R, W *6.32 - 6.33m:* J, 45°, IR, R, MW *6.43 - 6.46m:* J, 45°, IR, R, W					
	6.5m: END OF BOREHOLE								6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5										

COMMENTS:

Hole Depth 6.5m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A

BOREHOLE LOG

BOREHOLE No.: BH04

SHEET: 1 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.797157 (WGS84) -37.511080	METHOD: SA & HQ3	START DATE: 19/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 19/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: VTT
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, grain size and type, colour, fabric, moisture, durability)	Rock Weathering (RS, XW, HW, MW, SW, DW)	Rock Strength (VL, L, M, H, VH, EH)	Sampling Method	Core Recovery (%)	Testing	DCP (Dynamic Cone Penetrometer)	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (20, 60, 200, 600, 2000)	RQD (%)	Description and Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Newer Volcanic Group	*0.00m:* CLAY, brown, high plasticity, moist, firm to stiff. Root zone to 0.2 m depth.						3 4 3 3 3 4 3 3 3 3 3 2 2 3 4 4		0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5					*0.00 - 0.20m:* Topsoil - siltier *0.20 - 4.00m:* Residual clay					
	1.50m: CLAY with silt trace sand, brown, high plasticity, moist, very stiff; sand, fine to coarse grained.			SA	0	3 3 6 **N=9**												
	3.00 - 4.00m: Hard					15 15 for 100mm **N>=50** Bouncing												
	4.00m: Gravelly SAND, brown grey, fine to coarse grained, moist, medium dense to dense; gravel, fine to coarse grained. Extremely weathered.													*4.00 - 4.70m:* Extremely weathered rock					
	4.50m: NO CORE																		
	4.73m: BASALT, dark grey, high strength, slightly to moderately weathered.			HQ3									44	*4.73 - 4.92m:* CZ					

COMMENTS:

Hole Depth 6m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A

BOREHOLE LOG

BOREHOLE No.: BH04

SHEET: 2 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.797157 (WGS84) -37.511080	METHOD: SA & HQ3	START DATE: 19/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 19/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: VTT
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, grain size and type, colour, fabric, moisture, durability	Rock Weathering (RS, XW, HW, MW, SW, DW)	Rock Strength (VL, L, M, H, VH, EH)	Sampling Method	Core Recovery (%)	Testing	DCP Dynamic Cone Penetrometer	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (20, 60, 200, 600, >2000)	RQD (%)	Description and Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Newer Volcanic Group	[CONT] *4.73m:* BASALT, dark grey, high strength, slightly to moderately weathered.			HQ3	84			5.5					44	*5.42 - 5.43m:* J, 0°, IR, R, MN *5.52 - 5.60m:* J, 0°, IR, R, N *5.68 - 5.69m:* J, 0°, IR, R, MN *5.88 - 5.90m:* J, 0°, IR, R, W					
	6m: END OF BOREHOLE							6.0											
									6.5										
									7.0										
									7.5										
									8.0										
									8.5										
									9.0										
									9.5										

COMMENTS:

Hole Depth 6m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A

BOREHOLE LOG

BOREHOLE No.: BH05

SHEET: 1 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.798348 (WGS84) -37.512368	METHOD: SA & HQ3	START DATE: 20/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 20/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: VTT
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	DCP	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description and Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, grain size and type, colour, fabric, moisture, durability	RS XW HW MW SW DW	VL L M H VH EH				Dynamic Cone Penetrometer					20 60 200 600 2000			25 50 75				
Newer Volcanic Group	*0.00m:* CLAY with silt, brown-red, medium to high plasticity, moist, firm to stiff. Root zone to 0.2 m depth.						1 2 3 3 6 8 11 13 20		0.5					*0.00 - 0.20m:* Topsoil - siltier *0.20 - 2.00m:* Residual clay					
	0.50 - 0.90m: Hard																		
	0.90m: CLAY with silt, yellow mottled grey, high plasticity, dry, hard.			SA	0				1.0										
	1.50m: CLAY with silt, red-brown, high plasticity, moist, hard.					4 8 20 for 100mm **N>=50** Bouncing			1.5										
	2.00m: CORE LOSS.								2.0					*2.00 - 2.15m:* Probable extremely weathered rock					
	2.15m: Dark grey, high strength, slightly to moderately weathered, slightly altered.			HQ3	93				2.5				82	*2.34 - 2.37m:* J, 45°, IR, R, MW *2.43 - 2.47m:* J, 45°, IR, R, MW *2.55 - 2.56m:* J, 0°, IR, R, MN						
									3.0										
									3.5					*3.31 - 3.32m:* J, 5°, IR, R, MW *3.32 - 3.33m:* J, 5°, IR, R, MW *3.50 - 3.51m:* J, 5°, IR, R *3.51 - 3.55m:* J, 45°, IR, R, MN						
				HQ3	100				4.0				19	*3.60 - 3.80m:* J, 70°, IR, R, MN *3.60 - 3.90m:* J, 90°, IR, R, MN *3.80 - 3.90m:* J, 70°, IR, R, MN *3.90 - 4.26m:* CZ *4.26 - 4.37m:* J, 60°, IR, R, MN *4.38 - 4.60m:* CZ *4.66 - 4.72m:* J, 45°, IR, R, N						
									4.5										

COMMENTS:

Hole Depth 6m

BOREHOLE LOG

BOREHOLE No.: BH05

SHEET: 2 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.798348 (WGS84) -37.512368	METHOD: SA & HQ3	START DATE: 20/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 20/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: VTT
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, grain size and type, colour, fabric, moisture, durability	Rock Weathering (RS, XW, HW, MW, SW, DW)	Rock Strength (VL, L, M, H, VH, EH)	Sampling Method	Core Recovery (%)	Testing	DCP Dynamic Cone Penetrometer	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (20, 60, 200, 600, 2000)	RQD (%)	Description and Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Newer Volcanic Group	[CONT] *2.15m:* Dark grey, high strength, slightly to moderately weathered, slightly altered.			HQ3	90				5.5				0	*4.95 - 4.98m:* J, 45°, IR, R, W *5.00 - 5.20m:* CZ *5.20 - 5.24m:* J, 45°, IR, R, MN *5.24 - 5.28m:* J, 0°, IR, R, MN *5.29 - 5.34m:* J, 70°, IR, R, MW *5.36 - 5.43m:* J, 70°, IR, R, MN *5.46 - 5.50m:* CZ					
				HQ3	100								72	*5.68 - 5.69m:* J, 0°, IR, R, W *5.69 - 5.87m:* CZ					
	6m: END OF BOREHOLE								6.0										

COMMENTS:

Hole Depth 6m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A

BOREHOLE LOG

BOREHOLE No.: BH06

SHEET: 1 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.795086 (WGS84) -37.513166	METHOD: SA & HQ3	START DATE: 20/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 20/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: VTT
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, grain size and type, colour, fabric, moisture, durability
Newer Volcanic Group	*0.00m:* CLAY trace sand and gravel, brown-grey, high plasticity, moist, firm to stiff; sand, fine to medium grained; gravel, fine and coarse grained. Root zone to 0.1 m depth. *0.40 - 1.00m:* Stiff to very stiff *1.20 - 1.80m:* Hard
Newer Volcanic Group	*1.80m:* CLAY trace sand and gravel, brown, dry, very stiff; sand, fine and coarse grained; gravel, fine and coarse grained. *2.00m:* NO CORE
Newer Volcanic Group	*2.16m:* BASALT, dark grey, slightly vesicular, low strength, moderately to highly weathered.
Newer Volcanic Group	*3.63m:* NO CORE *3.81m:* BASALT, dark grey, slightly vesicular, low strength, moderately to highly weathered.

Rock Weathering: RS, XW, HW, MW, SW, DW

Rock Strength: VL, L, M, H, VH, EH

Sampling Method: SA; HQ3; HQ3

Core Recovery (%): 0; 89; 76

Testing: 2 5 for 130mm **N>=50** Bouncing

DCP (Dynamic Cone Penetrometer): 2, 5, 4, 3, 6, 7, 6, 4, 4, 3, 2, 2, 10, 10, 10

RL (m) / Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

Graphic Log

ROCK DEFECTS

Defect Log

Fracture Spacing (mm): 20, 60, 200, 600, 2000

RQD (%): 31; 29

Description and Additional Observations

0.00 - 0.10m: Topsoil - siltier

0.10 - 1.50m: Residual clay

1.50 - 2.16m: Extremely weathered rock

2.29 - 2.37m: J, 45°, IR, R, W

2.33 - 2.39m: J, 45°, IR, R, W

2.39 - 2.61m: J, 80°, IR, R, W

2.50 - 2.60m: CZ,

2.73 - 2.77m: J, 45°, IR, R, MN

2.80 - 2.88m: J, 45°, IR, R, MN

2.83 - 2.84m: J, 0°, IR, R, MN

2.83 - 2.85m: J, 20°, IR, R, MN

2.87 - 2.89m: J, 20°, IR, R, MN

3.00 - 3.10m: CZ

3.14 - 3.15m: J, 10°, IR, R, MN

3.18 - 3.20m: J, 10°, IR, R, MN

3.23 - 3.26m: J, 30°, IR, R, W

3.26 - 3.50m: DD

3.50 - 3.61m: CZ

3.84 - 3.86m: J, 45°, IR, R, MW

4.00 - 4.01m: J, 45°, IR, R, MN

4.23 - 4.26m: J, 10°, IR, R, W

4.26 - 4.47m: CZ

4.54 - 4.56m: J, 0°, IR, R, W

4.62 - 4.66m: J, 0°, IR, R, W

4.77 - 4.82m: CZ

4.86 - 4.89m: J, 45°, IR, R, W

Fluid Loss (%): 25, 50, 75

Water Level

Casing

Installation

Core Box No

COMMENTS:

Hole Depth 6m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A

BOREHOLE LOG

BOREHOLE No.: BH06

SHEET: 2 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.795086 (WGS84) -37.513166	METHOD: SA & HQ3	START DATE: 20/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 20/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: VTT
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, grain size and type, colour, fabric, moisture, durability	Rock Weathering (RS, XW, HW, MW, SW, DW)	Rock Strength (VL, L, M, H, VH, EH)	Sampling Method	Core Recovery (%)	Testing	DCP Dynamic Cone Penetrometer	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (20, 60, 200, 600, 2000)	RQD (%)	Description and Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Newer Volcanic Group	*4.95m:* NO CORE *5.10m:* BASALT, dark grey, moderately vesicular, low to medium strength, slightly to moderately weathered *5.30 - 5.60m:* extremely to highly weathered			HQ3	92				5.5				23	*5.10 - 5.25m:* CZ *5.34 - 5.37m:* J, 45°, IR, R, W *5.37 - 5.65m:* CZ *5.86 - 5.88m:* J, 10°, IR, R, MW					
	6m: END OF BOREHOLE								6.0										
									6.5										
									7.0										
									7.5										
									8.0										
									8.5										
									9.0										
									9.5										

COMMENTS:

Hole Depth 6m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A

BOREHOLE LOG

BOREHOLE No.: BH07

SHEET: 1 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.799011 (WGS84) -37.514974	METHOD: SA & HQ3	START DATE: 20/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 20/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: VTT
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, grain size and type, colour, fabric, moisture, durability	Rock Weathering (RS, XW, HW, MW, SW, DW)	Rock Strength (VL, L, M, H, VH, EH)	Sampling Method	Core Recovery (%)	Testing	DCP (Dynamic Cone Penetrometer)	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (20, 60, 200, 600, 2000)	RQD (%)	Description and Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Newer Volcanic Group	*0.00m:* CLAY trace sand, brown motteld grey, high plasticity, wet, soft to firm; sand, fine grained. Root zone to 0.2 m depth. *0.45 - 1.20m:* Very stiff to hard			SA	0	2 2 3 **N=5**	2 2 3 2 7 8 8 8 13 9 10 10 2 2 2		0.5 1.0 1.5 2.0 2.5 3.0					*0.00 - 0.20m:* Topsoil - siltier *0.20 - 3.00m:* Residual clay					
	1.20m: CLAY, brown grey, high plasticity, moist, firm to stiff.																		
	3.00m: NO CORE					10 for 60mm **N>=50** Bouncing													
Newer Volcanic Group	*3.15m:* BASALT, brown, mottled yellow, highly to extremely weathered.													*3.15 - 3.25m:* IF, Gravelly clay *3.25 - 3.38m:* CZ					
	3.42m: BASALT, dark grey, moderately vesicular, medium to high strength, moderately weathered.			HQ3	88				3.5 4.0				42	*3.44 - 3.49m:* J, 45°, IR, R, MN *3.46 - 3.60m:* J, 70°, IR, R, MN *3.50 - 3.63m:* J, 70°, IR, R, N *3.65 - 3.72m:* J, 45°, IR, R, MN *3.84 - 3.90m:* J, 45°, IR, R, MN *4.00 - 4.02m:* IF, W, Clay seam					
	4.30m: NO CORE																		
	4.50m: BASALT, dark grey, moderately vesicular, low strength, highly weathered.			HQ3	71				4.5				14	*4.60 - 4.67m:* CZ *4.71 - 4.72m:* J, 0°, IR, R, N *4.72 - 4.79m:* J, 80°, IR, R, MN *4.80 - 4.90m:* CZ					

COMMENTS:

Hole Depth 6m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A

BOREHOLE LOG

BOREHOLE No.: BH07

SHEET: 2 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.799011 (WGS84) -37.514974	METHOD: SA & HQ3	START DATE: 20/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 20/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: VTT
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, grain size and type, colour, fabric, moisture, durability	Rock Weathering (RS, XW, HW, MW, SW, DW)	Rock Strength (VL, L, M, H, VH, EH)	Sampling Method	Core Recovery (%)	Testing	DCP Dynamic Cone Penetrometer	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	ROCK DEFECTS: Fracture Spacing (mm) (20, 60, 200, 600, 2000)	ROCK DEFECTS: RQD (%)	ROCK DEFECTS: Description and Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Newer Volcanic Group	*5.00m:* NO CORE *5.10m:* BASALT, dark grey, moderately vesicular, low strength, moderately to highly weathered.			HQ3	90			5.5	6.0				11	*4.90 - 5.00m:* IF, Clay seam *5.13 - 5.19m:* J, 45°, IR, R-SM, W *5.22 - 5.32m:* CZ *5.32 - 5.50m:* IF, Clay seam *5.50 - 5.60m:* CZ *5.60 - 5.70m:* J, 45°, IR, R, N *5.65 - 5.79m:* J, 90°, IR, R, MN *5.75 - 5.77m:* J, 90°, IR, R, MN *5.78 - 5.80m:* IF, Clay seam *5.91 - 6.00m:* IF, Clay seam					
	6m: END OF BOREHOLE								6.5 7.0 7.5 8.0 8.5 9.0 9.5										

COMMENTS:

Hole Depth 6m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A

BOREHOLE LOG

BOREHOLE No.: BH08

SHEET: 1 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.794495 (WGS84) -37.516730	METHOD: SA & HQ3	START DATE: 20/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 20/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: VTT
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, grain size and type, colour, fabric, moisture, durability)	Rock Weathering (RS, XW, HW, MW, SW, DW)	Rock Strength (VL, L, M, H, VH, EH)	Sampling Method	Core Recovery (%)	Testing	DCP (Dynamic Cone Penetrometer)	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (20, 60, 200, 600, 2000)	RQD (%)	Description and Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Newer Volcanic Group	*0.00m:* CLAY with silt trace sand and gravel, high plasticity, dry to moist, firm to stiff; sand, fine and coarse grained; gravel, fine and coarse grained. Root zone to 0.1 m depth. *0.30 - 1.50m:* Very stiff to hard			SA	0	7, 9, 10 **N=19**	1, 2, 4, 6, 8, 8, 8, 9, 10, 9, 9, 8, 10, 6, 6		0.5, 1.0, 1.5, 2.0, 2.5, 3.0					*0.00 - 0.10m:* Topsoil - siltier *0.10 - 3.50m:* Residual clay					
						4, 5, 8 **N=13**													
	1.50m: CLAY with silt trace sand and gravel, brown mottled grey, dry to moist, very stiff; sand, fine and coarse grained; gravel, fine and coarse grained.																		
	3.50m: NO CORE								3.5										
Newer Volcanic Group	*3.57m:* BASALT, dark grey, slightly vesicular, high to very high strength, fresh to slightly weathered.			HQ3	95				4.0, 4.5				72	*3.66 - 3.82m:* J, 90°, IR, R, MW *4.36 - 4.40m:* J, 45°, IR, R, MW *4.42 - 4.48m:* IF, 45°, IR, R, MW, clay seam *4.67 - 4.68m:* J, 0°, IR, R, MW *4.79 - 4.80m:* J, 0°, IR, R, W					

COMMENTS:

Hole Depth 6m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A

BOREHOLE LOG

BOREHOLE No.: BH08

SHEET: 2 OF 2

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.794495 (WGS84) -37.516730	METHOD: SA & HQ3	START DATE: 20/07/2022
	EQUIPMENT: Hanjin DB8	FINISH DATE: 20/07/2022
R.L.:	TECHNICIAN: Reece & Adam	LOGGED BY: VTT
DATUM:	CONTRACTOR: Urban Drilling	CHECKED BY: SSE

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, grain size and type, colour, fabric, moisture, durability	Rock Weathering (RS, XW, HW, MW, SW, DW)	Rock Strength (VL, L, M, H, VH, EH)	Sampling Method	Core Recovery (%)	Testing	DCP Dynamic Cone Penetrometer	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	ROCK DEFECTS: Fracture Spacing (mm) (20, 60, 200, 600, 2000)	ROCK DEFECTS: RQD (%)	ROCK DEFECTS: Description and Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Newer Volcanic Group	[CONT] *3.57m:* BASALT, dark grey, slightly vesicular, high to very high strength, fresh to slightly weathered.			HQ3	100			5.5	6.0		....		96	*5.92 - 5.93m:* J, 0°, IR, R, MN *5.94 - 6.00m:* IF, 45°, IR, R, W, Clayed seam					
	6m: END OF BOREHOLE								6.5 7.0 7.5 8.0 8.5 9.0 9.5										

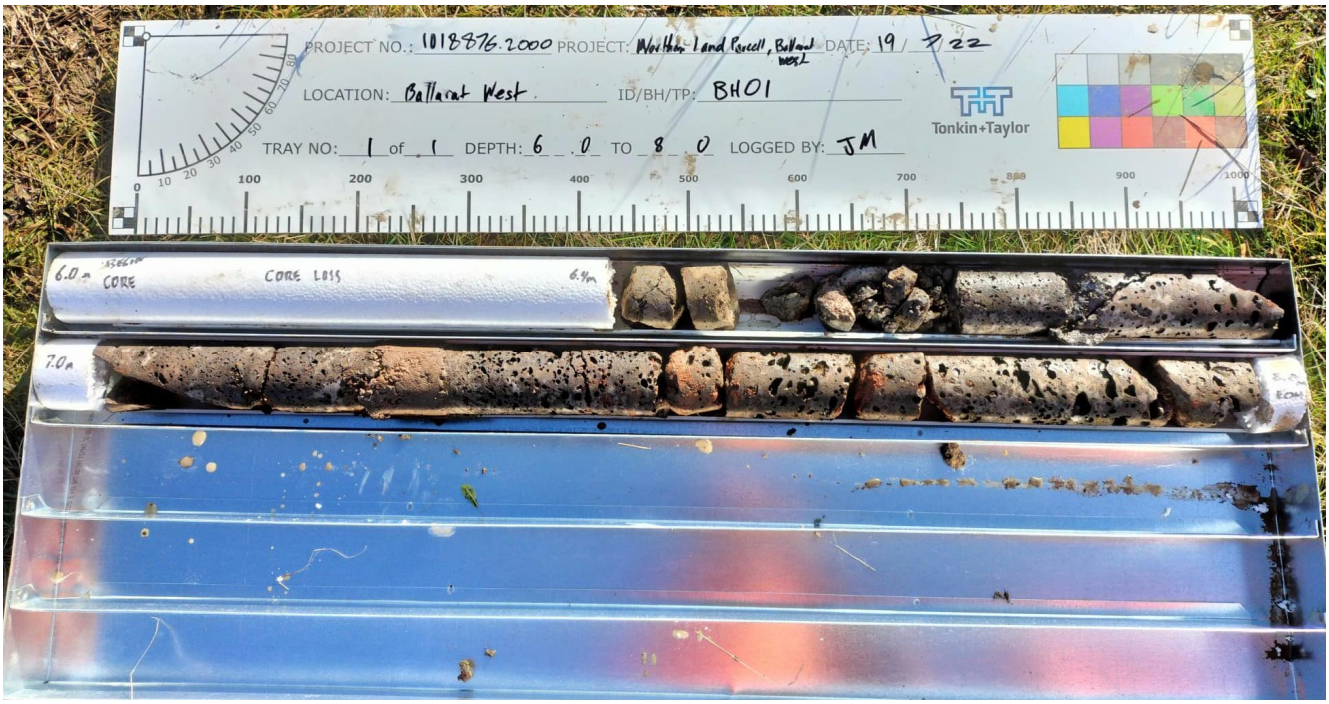
COMMENTS:

Hole Depth 6m

Scale 1:25

These logs are to be read in conjunction with the full Tonkin & Taylor report

Rev.: A



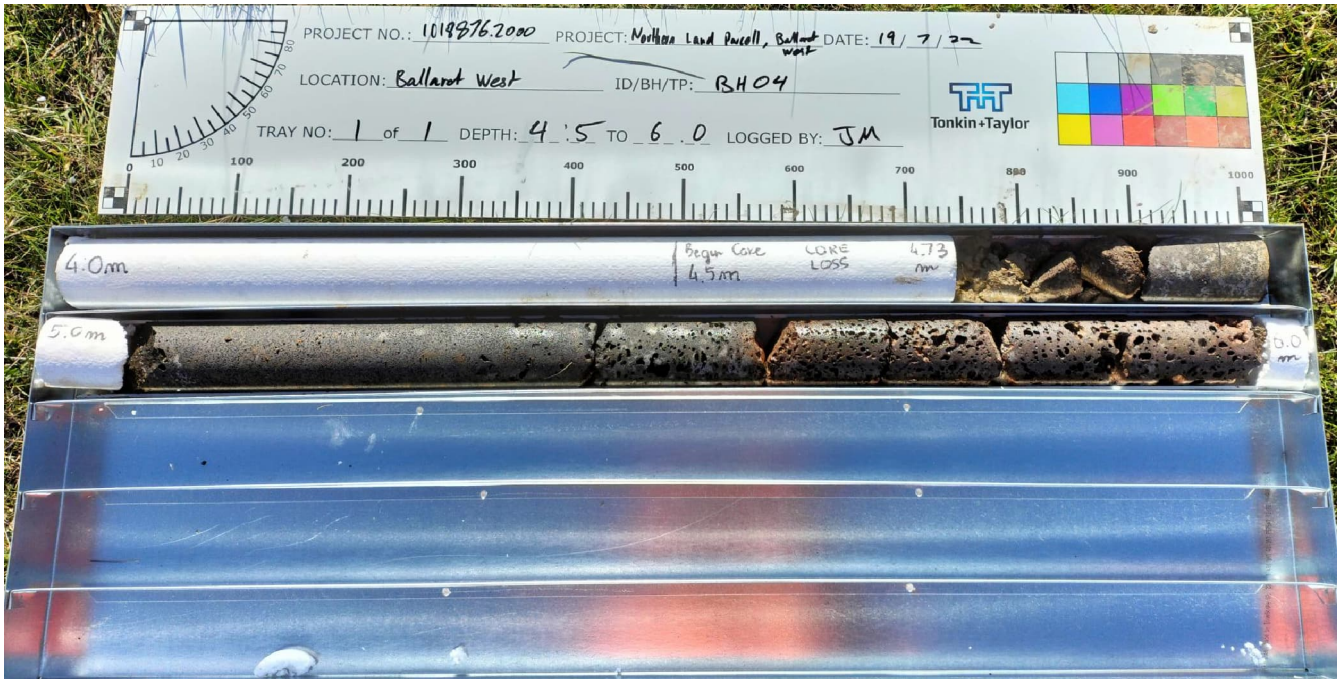
Borehole BH01 – Depth 6 m to 8 m

Borehole BH03 – Depth 5.0 m to 6.5 m

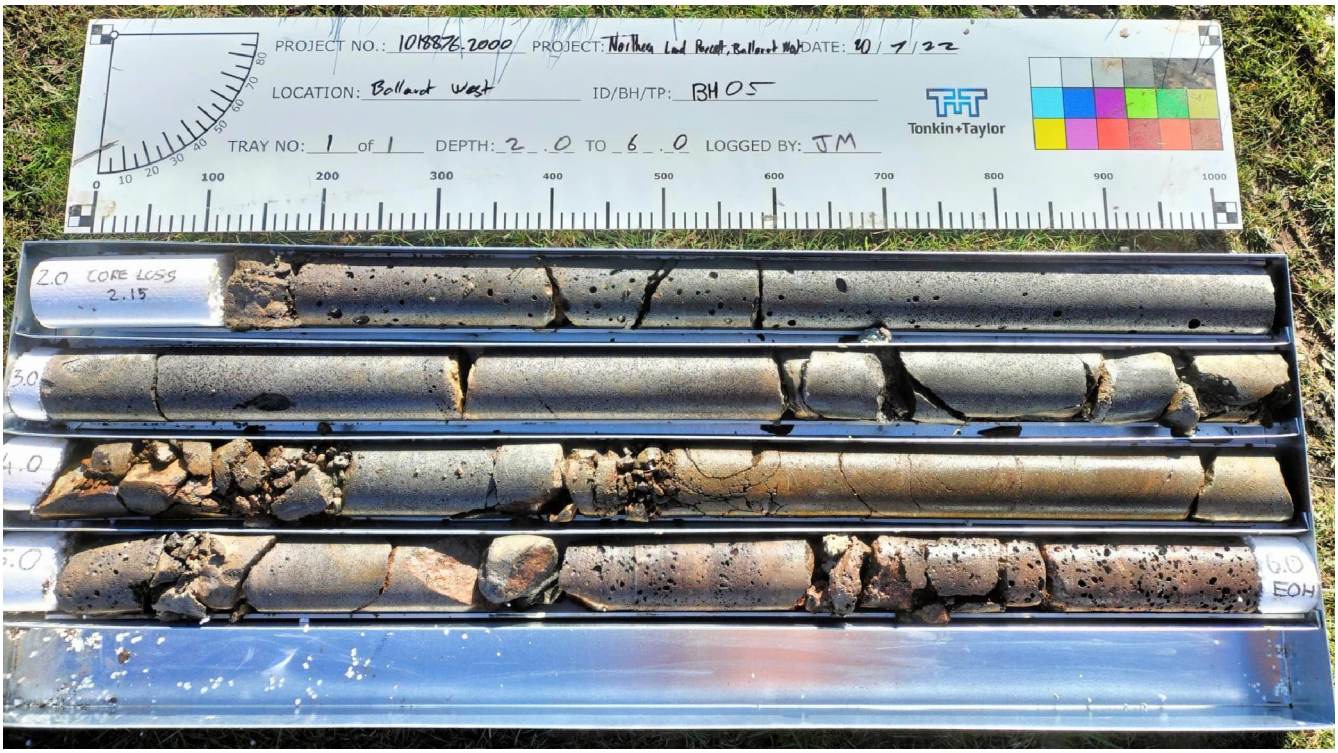
Notes:
1. Aerial image sourced from....(Size 8)

Tonkin+Taylor www.tonkintaylor.co.nz	DRAWN	SSE	10/22
	DRAFTING CHECKED		
	APPROVED		
	FILE : PPT FILE		
	APPROX. SCALE (AT A4 SIZE) NOT TO SCALE		
	PROJECT No. 1018876.2000	FIG. No. Figure	REV. 0

STANTEC AUSTRALIA PTY LTD
BALLARAT WEST EMPLOYMENT ZONE
NORTHERN LAND PARCEL
Core Photographs



Borehole BH04 – Depth 4.5 m to 6.0 m

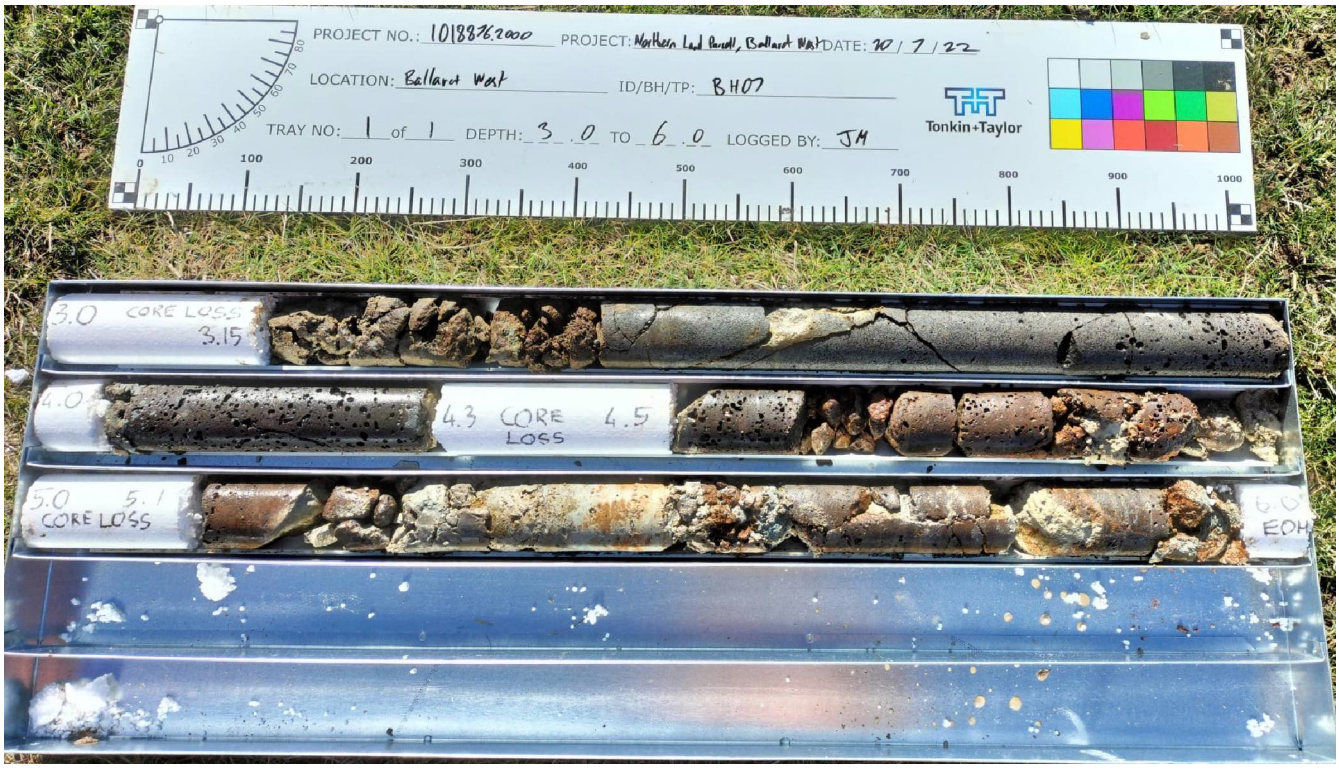


Borehole BH05 – Depth 2.0 m to 6.0 m

Tonkin+Taylor www.tonkintaylor.co.nz	DRAWN	SSE	10/22
	DRAFTING CHECKED		
	APPROVED		
	FILE : PPT FILE		
	APPROX. SCALE (AT A4 SIZE) NOT TO SCALE		
	PROJECT No. 1018876.2000	FIG. No. Figure	REV. 0

STANTEC AUSTRALIA PTY LTD
BALLARAT WEST EMPLOYMENT ZONE
NORTHERN LAND PARCEL
Core Photographs

Borehole BH06 – Depth 2.0 m to 6.0 m



Borehole BH07 – Depth 3.0 m to 6.0 m

Tonkin+Taylor www.tonkintaylor.co.nz	DRAWN	SSE	10/22
	DRAFTING CHECKED		
	APPROVED		
	FILE : PPT FILE		
	APPROX. SCALE (AT A4 SIZE) NOT TO SCALE		
	PROJECT No. 1018876.2000	FIG. No. Figure	REV. 0

STANTEC AUSTRALIA PTY LTD
BALLARAT WEST EMPLOYMENT ZONE
NORTHERN LAND PARCEL
Core Photographs

Borehole BH08 – Depth 3.0 m to 6.0 m

Tonkin+Taylor www.tonkintaylor.co.nz	DRAWN	SSE	10/22
	DRAFTING CHECKED		
	APPROVED		
	FILE : PPT FILE		
	APPROX. SCALE (AT A4 SIZE) NOT TO SCALE		
	PROJECT No. 1018876.2000	FIG. No. Figure	REV. 0

STANTEC AUSTRALIA PTY LTD
BALLARAT WEST EMPLOYMENT ZONE
NORTHERN LAND PARCEL
Core Photographs

EXCAVATION LOG

INVESTIGATION Id.:

PD01

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.802842 (WGS84) -37.517979	EXPOSURE METHOD: ME	START DATE: 15/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 15/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
ME	Groundwater Not Encountered 15/09/2022	Pavement			*0.00m:* Asphalt .	D			0.25				*0.33 - 0.6m:* Rock Breaker
		Fill			*0.04m:* Gravelly SAND, pale brown, dry; sand, sub-angular to angular; gravel, sub-angular to angular.				0.50				
		Pavement			*0.30m:* Spray seal.				0.75				
		Fill			*0.33m:* Sandy GRAVEL, cement treated, grey, dry.				1.00				
					0.60m: Sandy GRAVEL with cobbles and boulders, grey, dry; gravel, sub-rounded to sub-angular.				1.25				
					0.8m: Effective refusal				1.50				
									1.75				

SKETCH / PHOTO:

COMMENTS: Movement on asphalt surface, pavement dip abandoned

Hole Depth 0.8m

Scale 1:17

Rev.: A

Tonkin+Taylor

EXCAVATION LOG

INVESTIGATION Id.:

TP01

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.801900 (WGS84) -37.508454	EXPOSURE METHOD: ME	START DATE: 16/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 16/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
ME	Groundwater Not Encountered 16/09/2022	Newer Volcanic Group		ML	*0.00m:* SILT, grey, low plasticity, wet, firm.	W	F-St		0			0	*0.0 - 0.2m:* Topsoil
				CH	*0.20m:* CLAY trace gravel, brown mottled grey, high plasticity, moist, firm to stiff.	M	St-VSt		0.25			2	
												1	*0.2 - 1.5m:* Residual clay
									0.50	*SV* 145/- kPa		2	
												4	
												3	
					0.60m: Very stiff to hard.		VSt-H					5	
									0.75			6	
												7	
												8	
									1.00	*SV* 161/- kPa		9	
												8	
									1.25			10	
												9	
												9	
					1.5m: END OF INVESTIGATION				1.50	*SV* 153/- kPa			
									1.75				

SKETCH / PHOTO:

COMMENTS:

Hole Depth 1.5m

Scale 1:17

Rev.: A

EXCAVATION LOG

INVESTIGATION Id.:

TP02

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.800049 (WGS84) -37.509462	EXPOSURE METHOD: ME	START DATE: 16/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 16/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
ME	Groundwater Not Encountered 16/09/2022	Newer Volcanic Group		MH	*0.00m:* SILT, brown, low plasticity, moist, soft.	M	S		0			0	*0.0 - 0.2m:* Topsoil
				GM	*0.15m:* Silty GRAVEL, grey, wet, medium dense.	W			0.25			1	*0.2 - 1.5m:* Residual clay
				CH	*0.20m:* CLAY trace gravel, brown mottled grey, high plasticity, moist, firm to stiff.	M	F-St		0.50	*SV* 153/- kPa		1	
					0.60m: Stiff to very stiff.		St-VSt		0.75			2	
									1.00	*SV* 145/- kPa		3	
									1.25			2	
					1.5m: END OF INVESTIGATION				1.50	*SV* 129/- kPa		5	
									1.75			6	
												7	
												6	
												8	
												6	
												9	
												7	
												8	

SKETCH / PHOTO:

COMMENTS:

Hole Depth 1.5m

Scale 1:17

Rev.: A

EXCAVATION LOG

INVESTIGATION Id.:

TP03

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.799413 (WGS84) -37.511207	EXPOSURE METHOD: ME	START DATE: 16/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 16/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
ME	Groundwater Not Encountered 16/09/2022	Newer Volcanic Group		MH	*0.00m:* SILT, brown, high plasticity, moist, firm to stiff.	M	F-St		0.25			1	*0.0 - 0.2m:* Topsoil
												2	
				CH	*0.20m:* CLAY trace sand and gravel, brown, high plasticity, moist, stiff to very stiff.		St-VSt					4	*0.2 - 1.5m:* Residual clay
									0.50	*SV* 153/- kPa		6	
												6	
												5	
		Neerim Volcanic Group			*0.60m:* Very stiff to hard.		VSt-H		0.75			6	
												7	
												8	
									1.00			10	
												9	
									1.25			8	
												9	
									1.50			8	
					1.5m: END OF INVESTIGATION					*SV* 148/- kPa		8	
									1.75				

SKETCH / PHOTO:

COMMENTS:

Hole Depth 1.5m

Scale 1:17

Rev.: A

EXCAVATION LOG

INVESTIGATION Id.:

TP04

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.799320 (WGS84) -37.51266	EXPOSURE METHOD: ME	START DATE: 15/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 15/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
ME	15/09/2022	Newer Volcanic Group		MH	*0.00m:* SILT, brown, high plasticity, moist, firm.	M	F		0.25			1	*0.0 - 0.3m:* Topsoil
				GM	*0.10m:* Silty GRAVEL, grey, wet, very loose.	W	VL					1	
				CH	*0.30m:* Gravelly CLAY with sand, brown mottled red, high plasticity, moist, firm to stiff.	M	F-St		0.50			3	*0.3 - 1.5m:* Residual clay
					0.60m: Very stiff to hard.		VSt-H		0.75			3	
												4	
									1.00			6	
												6	
									1.25			6	
												7	
									1.50			6	
					1.5m: END OF INVESTIGATION							8	
									1.75			9	
												7	
												8	

SKETCH / PHOTO:

COMMENTS:

Hole Depth 1.5m

Scale 1:17

Rev.: A

EXCAVATION LOG

INVESTIGATION Id.:

TP05

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.799178 (WGS84) -37.514015	EXPOSURE METHOD: ME	START DATE: 15/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 15/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: VTT
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
ME	Groundwater Not Encountered 15/09/2022	Newer Volcanic Group		MH	*0.00m:* SILT, grey, high plasticity, wet, soft.	W	S		0			0	*0.0 - 0.25m:* Topsoil
				GM	*0.10m:* Silty GRAVEL, grey, wet, medium dense.				1			1	
				CH	*0.25m:* Gravelly CLAY, brown, high plasticity, moist, firm to stiff.	M	F-St		0.25 2			2	*0.25 - 1.5m:* Residual clay
									3			2	
									0.50 3	*SV* 0/- kPa		3	
									4			3	
									0.75 4			4	
									5			3	
					1.00m: Very stiff.		VSt		1.00 5	*SV* 0/- kPa		5	
									6			6	
									1.25 5			5	
									5			5	
					1.5m: END OF INVESTIGATION				1.50 6	*SV* 0/- kPa		6	
									1.75				

SKETCH / PHOTO:

COMMENTS:

Hole Depth 1.5m

Scale 1:17

Rev.: A

EXCAVATION LOG

INVESTIGATION Id.:

TP06

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.798981 (WGS84) -37.516606	EXPOSURE METHOD: ME	START DATE: 15/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 15/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
ME	Groundwater Not Encountered 15/09/2022	Newer Volcanic Group		MH	*0.00m:* SILT, grey, high plasticity, moist, firm.	M	F		0			1	*0.0 - 0.15m:* Topsoil
				CH	*0.15m:* CLAY trace gravel, brown mottled grey, high plasticity, moist, firm to stiff.		F-St		0.25			1	*0.15 - 1.5m:* Residual clay
												2	
									0.50	*SV* 129/- kPa		3	
												3	
					0.60m: Stiff to very stiff.		St-VSt					4	
									0.75			5	
												6	
									1.00	*SV* 147/- kPa		7	
												6	
									1.25			6	
												7	
									1.50			6	
					1.5m: END OF INVESTIGATION					*SV* 143/- kPa		6	
									1.75				

SKETCH / PHOTO:

COMMENTS:

Hole Depth 1.5m

Scale 1:17

Rev.: A

EXCAVATION LOG

INVESTIGATION Id.:

TP07

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.798444 (WGS84) -37.510392	EXPOSURE METHOD: ME	START DATE: 16/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 16/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
ME	Groundwater Not Encountered 16/09/2022	Newer Volcanic Group		MH	*0.00m:* SILT, brown, high plasticity, saturated, firm.	M	F		0.25			1	*0.0 - 0.3m:* Topsoil
				GM	*0.15m:* Silty GRAVEL trace sand, grey, wet, medium dense.	W	VL					2	
				CH	*0.30m:* CLAY trace gravel, brown mottled grey, high plasticity, moist, stiff to very stiff.	M	St-Vst		0.50	*SV* 158/- kPa		3	
									0.75			4	*0.3 - 1.5m:* Residual clay
									1.00	*SV* 142/- kPa		5	
									1.25			6	
					1.5m: END OF INVESTIGATION				1.50	*SV* 129/- kPa		7	
									1.75			6	

SKETCH / PHOTO:

COMMENTS:

Hole Depth 1.5m

Scale 1:17

Rev.: A

EXCAVATION LOG

INVESTIGATION Id.:

TP08

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.797050 (WGS84) -37.512155	EXPOSURE METHOD: ME	START DATE: 15/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 15/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
ME	Groundwater Not Encountered 15/09/2022	Newer Volcanic Group		MH	*0.00m:* SILT with gravel, dark grey, high plasticity, wet, soft.	W	S		0.00			2	*0.0 - 0.25m:* Topsoil
				ML	*0.10m:* Gravelly SILT trace sand, grey, non-plastic, wet, very soft.		VS					3	
				CH	*0.25m:* CLAY trace gravel and boulders, brown, high plasticity, moist, stiff to very stiff.	M	St		0.25			3	*0.25 - 1.5m:* Residual clay
									0.50	*SV* UTP		5	
												4	
					0.80m: Very stiff to hard.		VSt-H		0.75			5	
												7	
									1.00	*SV* UTP		6	
												6	
												9	
									1.25			9	
												8	
												7	
					1.5m: END OF INVESTIGATION				1.50	*SV* UTP			
									1.75				

SKETCH / PHOTO:

COMMENTS:

Hole Depth 1.5m

Scale 1:17

Rev.: A

EXCAVATION LOG

INVESTIGATION Id.:

TP09

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.796745 (WGS84) -37.513974	EXPOSURE METHOD: ME	START DATE: 15/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 15/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
				MH	*0.00m:* SILT, dark brown, high plasticity, wet, soft to firm.	W	S-F					2	*0.0 - 0.2m:* Topsoil
												3	
				CH	*0.20m:* CLAY trace sand and gravel, brown, high plasticity, moist, stiff to very stiff.	M	St-VSt		0.25			2	*0.2 - 1.5m:* Residual clay
												4	
												6	
									0.50	*SV* 193/- kPa		6	
												5	
									0.75			6	
					0.80m: Very stiff to hard.		VSt-H					8	
												9	
									1.00	*SV* 177/- kPa		7	
												8	
									1.25			9	
												9	
	Groundwater Not Encountered 15/09/2022	Newer Volcanic Group										11	
					1.5m: END OF INVESTIGATION				1.50	*SV* UTP			
									1.75				

SKETCH / PHOTO:

COMMENTS:

Hole Depth 1.5m

Scale 1:17

Rev.: A

EXCAVATION LOG

INVESTIGATION Id.:

TP10

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.796393 (WGS84) -37.515757	EXPOSURE METHOD: ME	START DATE: 15/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 15/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
ME	Groundwater Not Encountered 15/09/2022	Newer Volcanic Group		MH	*0.00m:* SILT, pale grey, high plasticity, wet, soft.	W	S		0.25			1 1 3	*0.0 - 0.3m:* Topsoil
				CH	*0.30m:* CLAY trace cobbles and boulders, brown mottled grey, high plasticity, moist, stiff to very stiff.	M	St-VSt		0.50	*SV* 145/- kPa		3 5 4	*0.3 - 1.5m:* Residual clay
					0.75m: Very stiff.		VSt		0.75			6 7 8	
									1.00	*SV* 164/- kPa		8 6 6	
									1.25			7 7	
					1.5m: END OF INVESTIGATION				1.50	*SV* 176/- kPa			
									1.75				

SKETCH / PHOTO:

COMMENTS:

Hole Depth 1.5m

Scale 1:17

Rev.: A

EXCAVATION LOG

INVESTIGATION Id.:

TP11

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.796122 (WGS84) -37.517602	EXPOSURE METHOD: ME	START DATE: 15/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 15/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
ME	Groundwater Not Encountered 15/09/2022	Newer Volcanic Group		MH	*0.00m:* SILT, pale grey, high plasticity, wet, soft.	W	S		0.25			1 2 3	*0.0 - 0.3m:* Topsoil
				CH	*0.30m:* CLAY, brown mottled grey, high plasticity, moist, stiff to very stiff.	M	St-VSt		0.50	*SV* 158/97 kPa		3 6 6	*0.3 - 1.5m:* Residual clay
					0.70m: Very stiff to hard.		VSt-H		0.75			8 9 10	
									1.00	*SV* 156/97 kPa		10 8 9	
									1.25			8 10	
					1.5m: END OF INVESTIGATION				1.50	*SV* 155/93 kPa		12	
									1.75				

SKETCH / PHOTO:

COMMENTS:

Hole Depth 1.5m

Scale 1:17

Rev.: A

EXCAVATION LOG

INVESTIGATION Id.:

TP12

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.794292 (WGS84) -37.5179653128654	EXPOSURE METHOD: ME	START DATE: 15/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 15/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
ME	Groundwater Not Encountered 15/09/2022	Newer Volcanic Group		MH	*0.00m:* SILT, pale grey, high plasticity, wet, soft.	W	S		0			2 2 3	*0.0 - 0.3m:* Topsoil
				CH	*0.30m:* CLAY with gravel trace sand, brown mottled grey, high plasticity, moist, stiff to very stiff.	M	St-VSt		0.5	*SV* 177/- kPa		3 4 5 6 6 6	*0.3 - 3.5m:* Residual clay
					1.00m: Very stiff to hard.		VSt-H		1.0	*SV* 174/- kPa		7 8 8	
									1.5	*SV* 180/- kPa		7 8 8	
									2.0	*SV* 185/- kPa			
									2.5	*SV* 193/- kPa			
									3.0				
					3.5m: END OF INVESTIGATION				3.5				

SKETCH / PHOTO:

COMMENTS:

Hole Depth 3.5m

Scale 1:33

Rev.: A

EXCAVATION LOG

INVESTIGATION Id.:

TP13

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.800571 (WGS84) -37.51345	EXPOSURE METHOD: ME	START DATE: 16/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 16/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
ME	Groundwater Not Encountered 16/09/2022	Newer Volcanic Group		MH	*0.00m:* SILT, brown, high plasticity, wet, soft to firm.	W	F		0			1	*0.0 - 0.25m:* Topsoil
				CH	*0.25m:* CLAY with gravel trace sand and boulders, brown, high plasticity, moist, stiff.	M	St		0.5	*SV* 161/- kPa		2	*0.25 - 1.8m:* Residual clay
									1.0	*SV* 137/- kPa		2	
					1.30m: Very stiff to hard.		VSt-H		1.5	*SV* 145/- kPa		4	
				CH	*1.80m:* COBBLE & CLAY trace boulders, high plasticity clay, brown, moist, very stiff. (Cobbles in clay matrix).				2.0	*SV* 142/- kPa		5	*1.8 - 3.5m:* Extremely Weathered Basalt
									2.5			6	
									3.0			6	
					3.5m: END OF INVESTIGATION				3.5			5	
												7	
												6	
												6	
												7	
												8	
												10	
												8	

SKETCH / PHOTO:

COMMENTS:

Hole Depth 3.5m

Scale 1:33

Rev.: A

EXCAVATION LOG

INVESTIGATION Id.:

TP14

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.801343 (WGS84) -37.510801	EXPOSURE METHOD: ME	START DATE: 16/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 16/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
				MH	*0.00m:* SILT, brown, high plasticity, moist, firm to stiff.	M	F-St					3	*0.0 - 0.2m:* Topsoil
												3	
ME	Groundwater Not Encountered 16/09/2022	Newer Volcanic Group		CH	*0.20m:* CLAY with gravel trace sand, brown mottled yellow, high plasticity, moist, stiff to very stiff.		St-VSt		0.25			4	*0.2 - 0.8m:* Residual clay
									0.50	*SV* 161/- kPa		5	
												6	
												8	
					0.60m: Very stiff to hard.		VSt-H					10	
									0.75				*0.7m:* DCP refusal
					0.8m: Refusal on HW Basalt				1.00				
									1.25				
									1.50				
									1.75				

SKETCH / PHOTO:

COMMENTS:

Hole Depth 0.8m

Scale 1:17

Rev.: A

EXCAVATION LOG

INVESTIGATION Id.:

TP15

Hole Location: Ballarat West

SHEET: 1 OF 1

PROJECT: Northern Land Parcel, Ballarat West	LOCATION: Ballarat West	JOB No.: 1018876.2000
CO-ORDINATES: 143.8016314 (WGS84) -37.509424	EXPOSURE METHOD: ME	START DATE: 16/09/2022
	EQUIPMENT: 4t Excavator	FINISH DATE: 16/09/2022
R.L.:	OPERATOR: Frys Earthmoving	LOGGED BY: JCME
DATUM:	DIMENSIONS:	CHECKED BY: SSE

GEOLOGICAL | TESTING

METHOD	WATER	UNIT	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE	CONSISTENCY / RELATIVE DENSITY	RL (m)	DEPTH (m)	SAMPLES TESTS	SAMPLES	DCP Dynamic Cone Penetrometer	ADDITIONAL COMMENTS
ME	Groundwater Not Encountered 16/09/2022	Newer Volcanic Group		MH	*0.00m:* SILT, grey, high plasticity, wet, soft.	W	S		0.5			0 1 1	*0.0 - 0.3m:* Topsoil
				CH	*0.30m:* CLAY trace sand and gravel, brown mottled yellow, high plasticity, moist, stiff to very stiff.	M	St-VSt		1.0 1.5 2.0			1 2 3 5 6 7 8 8 6 7 7 7	*0.3 - 2.5m:* Residual clay
					2.5m: END OF INVESTIGATION				2.5 3.0 3.5				

SKETCH / PHOTO:

COMMENTS:

Hole Depth 2.5m

Scale 1:33

Rev.: A

Appendix C Laboratory Test Certificates

Head Office
25 Metcalf Drive
DANDENONG SOUTH VIC 3175

Ph: +61 3 8796 7900
Fax: +61 3 8796 7944

CHADWICK GEOTECHNICS

MOISTURE CONTENT REPORT

Customer: Tonkin & Taylor (Aus) Pty Limited
Work Order No: **W22DS01898**
Customer Address: Level 3, 99 Conventry Street, South Melbourne VIC
Report Date: 18/10/22
Project: Northern Land Parcel, Ballarat West
CG Job No: 1018876.2000
Location: -
Test Method: AS 1289 2.1.1
Customer Order No.: -

Testing performed and reported at our Dandenong South Laboratory 12712

Sample No.:	S22DS-07548	S22DS-07549	S22DS-07550	S22DS-07551	S22DS-07552	S22DS-07553	S22DS-07554	S22DS-07555	S22DS-07556	S22DS-07557
ID No.:	-	-	-	-	-	-	-	-	-	-
Lot No.:	-	-	-	-	-	-	-	-	-	-
Date Sampled:	16/09/2022	16/09/2022	16/09/2022	15/09/2022	15/09/2022	15/09/2022	16/09/2022	15/09/2022	15/09/2022	16/09/2022
Time Sampled:	-	-	-	-	-	-	-	-	-	-
Date Tested:	26/09/2022	26/09/2022	26/09/2022	26/09/2022	26/09/2022	26/09/2022	26/09/2022	26/09/2022	26/09/2022	26/09/2022
Material Source:	In-Situ	In-Situ	In-Situ	In-Situ	In-Situ	In-Situ	In-Situ	In-Situ	In-Situ	In-Situ
Material Description:	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
To Be Used As:	Material Analysis	Material Analysis	Material Analysis	Material Analysis	Material Analysis	Material Analysis	Material Analysis	Material Analysis	Material Analysis	Material Analysis
Sample Location :	TP01 0.5 - 0.6m	TP02 0.5 - 0.6m	TP03 0.5 - 0.6m	TP04 0.5 - 0.6m	TP05 0.5 - 0.6m	TP06 0.5 - 0.6m	TP07 0.5 - 0.6m	TP08 0.5 - 0.6m	TP09 0.5 - 0.6m	TP10 0.5 - 0.6m
Layer Depth (mm):	-	-	-	-	-	-	-	-	-	-
Test Depth (mm):	-	-	-	-	-	-	-	-	-	-
Sampling Method:	As Supplied	As Supplied	As Supplied	As Supplied	As Supplied	As Supplied	As Supplied	As Supplied	As Supplied	As Supplied
Moisture Content (%):	**25.0**	**39.0**	**31.6**	**21.6**	**18.7**	**21.8**	**35.8**	**41.8**	**37.8**	**24.5**

Remarks:

ilac-MRA NATA Accreditation No. 12719

Accredited for compliance with ISO/IEC 17025 - Testing
Accreditation No. 12719
Corporate Site No. 12712

APPROVED SIGNATORY

M.Longfield

Form No.: **CG.319.004**

Issue Date: 1/05/2021

Head Office
25 Metcalf Drive
DANDENONG SOUTH VIC 3175

Ph: +61 3 8796 7900
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CHADWICK GEOTECHNICS

MOISTURE CONTENT REPORT

Customer: Tonkin & Taylor (Aus) Pty Limited
Work Order No: **W22DS01898**
Customer Address: Level 3, 99 Conventry Street, South Melbourne VIC
Report Date: 18/10/22
Project: Northern Land Parcel, Ballarat West
CG Job No: 1018876.2000
Location: -
Test Method: AS 1289 2.1.1
Customer Order No.: -

Testing performed and reported at our Dandenong South Laboratory 12712

Sample No.:	S22DS-07558	S22DS-07559	S22DS-07561	S22DS-07562						
ID No.:	-	-	-	-	-					
Lot No.:	-	-	-	-	-					
Date Sampled:	16/09/2022	16/09/2022	16/09/2022	15/09/2022	15/09/2022					
Time Sampled:	-	-	-	-	-					
Date Tested:	26/09/2022	26/09/2022	26/09/2022	26/09/2022						
Material Source:	In-Situ	In-Situ	In-Situ	In-Situ	In-Situ					
Material Description:	Clay	Clay	Clay	Clay	Clay					
To Be Used As:	Material Analysis	Material Analysis	Material Analysis	Material Analysis	Material Analysis					
Sample Location :	TP11 0.5 - 0.6m	TP12 0.5 - 0.6m	TP13 0.5 - 0.6m	TP14 0.5 - 0.6m	TP15 0.5 - 0.6m					
Layer Depth (mm):	-	-	-	-	-					
Test Depth (mm):	-	-	-	-	-					
Sampling Method:	As Supplied	As Supplied	As Supplied	As Supplied	As Supplied					
Moisture Content (%):	**39.1**	**17.5**	**39.7**	**37.8**						

Remarks:

ilac-MRA NATA Accreditation No. 12719

Accredited for compliance with ISO/IEC 17025 - Testing
Accreditation No. 12719
Corporate Site No. 12712

APPROVED SIGNATORY

M.Longfield

Form No.: **CG.319.004**

Issue Date: 1/05/2021

CHADWICK GEOTECHNICS

Dandenong South
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DANDENONG SOUTH, VIC 3175

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Report No: MAT:S22DS-07563/1
Issue No: 1

Material Test Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 13/10/2022

Sample Details

Sample Location	TP01, 0.6 - 0.8m
Field Sample ID	1
Date Sampled	16/09/2022
Source	In-Situ
Material	CH CLAY, trace gravel, trace sand, brown, high plasticity
Specification	AS Grading
Sampling Method	Submitted by client
Sample ID	S22DS-07563

Other Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	21.3	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	18.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.2	59	
Plastic Limit (%)	AS 1289.3.2.1	14	
Plasticity Index (%)	AS 1289.3.3.1	45	
Date Tested		29/09/2022	

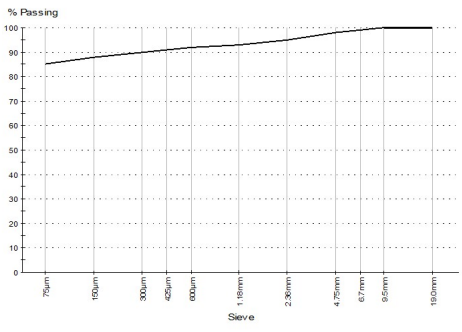
Particle Size Distribution

Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 27/09/2022

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	
9.5mm	100	
6.7mm	99	
4.75mm	98	
2.36mm	95	
1.18mm	93	
600µm	92	
425µm	91	
300µm	90	
150µm	88	
75µm	85	

Chart



Comments

N/A

CHADWICK GEOTECHNICS

Dandenong South
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DANDENONG SOUTH, VIC 3175

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Report No: MAT:S22DS-07565/1
Issue No: 1

Material Test Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 14/10/2022

Sample Details

Sample Location	TP09, 0.6 - 0.8m
Field Sample ID	3
Date Sampled	15/09/2022
Source	In-Situ
Material	CH; CLAY, trace gravel, trace sand, brown, high plasticity
Specification	AS Grading
Sampling Method	Submitted by client
Sample ID	S22DS-07565

Other Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	38.8	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	25.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.2	107	
Plastic Limit (%)	AS 1289.3.2.1	27	
Plasticity Index (%)	AS 1289.3.3.1	80	
Date Tested		29/09/2022	

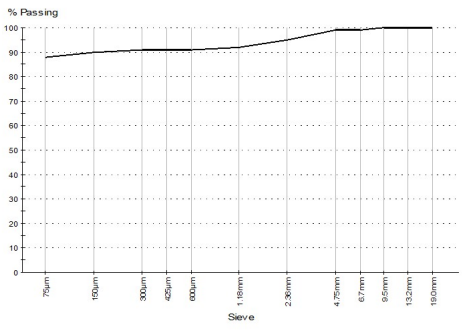
Particle Size Distribution

Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 27/09/2022

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	
13.2mm	100	
9.5mm	100	
6.7mm	99	
4.75mm	99	
2.36mm	95	
1.18mm	92	
600µm	91	
425µm	91	
300µm	91	
150µm	90	
75µm	88	

Chart



Comments

N/A

CHADWICK GEOTECHNICS

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Report No: MAT:S22DS-07566/1
Issue No: 1

Material Test Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 14/10/2022

Sample Details

Sample Location	TP14, 0.5 - 0.8m
Field Sample ID	4
Date Sampled	16/09/2022
Source	In-Situ
Material	CH; Gravelly CLAY trace sand, brown, high plasticity
Specification	AS Grading
Sampling Method	Submitted by client
Sample ID	S22DS-07566

Other Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	24.6	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	17.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.2	64	
Plastic Limit (%)	AS 1289.3.2.1	21	
Plasticity Index (%)	AS 1289.3.3.1	43	
Date Tested		29/09/2022	
Emerson Class Number	AS 1289.3.8.1 - 2017	5	
Soil Description			
Type of Water		Distilled	
Date Tested		27/09/2022	

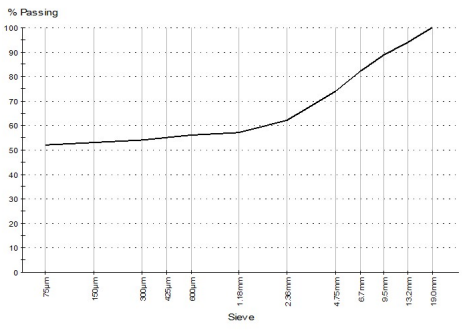
Particle Size Distribution

Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 27/09/2022

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	
13.2mm	94	
9.5mm	89	
6.7mm	82	
4.75mm	74	
2.36mm	62	
1.18mm	57	
600µm	56	
425µm	55	
300µm	54	
150µm	53	
75µm	52	

Chart



Comments

N/A

CHADWICK GEOTECHNICS

Dandenong South
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Report No: MAT:S22DS-07567/1
Issue No: 1

Material Test Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 14/10/2022

Sample Details

Sample Location	BH02, 3 - 3.45m
Field Sample ID	5
Date Sampled	19/07/2022
Source	In-Situ
Material	Clay
Specification	
Sampling Method	Submitted by client
Sample ID	S22DS-07567

Other Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1 - 2017	2	
Soil Description			
Type of Water		Distilled	
Date Tested		27/09/2022	

Particle Size Distribution

Chart

Comments

N/A

CHADWICK GEOTECHNICS

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Report No: MAT:S22DS-07568/1
Issue No: 1

Material Test Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 14/10/2022

Sample Details

Sample Location	BH04, 1.5 - 1.95m
Field Sample ID	6
Date Sampled	19/07/2022
Source	In-Situ
Material	Clay
Specification	
Sampling Method	Submitted by client
Sample ID	S22DS-07568

Other Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1 - 2017	5	
Soil Description			
Type of Water		Distilled	
Date Tested		27/09/2022	

Particle Size Distribution

Chart

Comments

N/A

CHADWICK GEOTECHNICS

Dandenong South
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Report No: MAT:S22DS-07569/1
Issue No: 1

Material Test Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 14/10/2022

Sample Details

Sample Location	BH06, 1.5 - 1.82m
Field Sample ID	7
Date Sampled	20/07/2022
Source	In-Situ
Material	Clay
Specification	
Sampling Method	Submitted by client
Sample ID	S22DS-07569

Other Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1 - 2017	2	
Soil Description			
Type of Water		Distilled	
Date Tested		27/09/2022	

Particle Size Distribution

Chart

Comments

N/A

CHADWICK GEOTECHNICS

Dandenong South
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Report No: MAT:S22DS-07921/1
Issue No: 1

Material Test Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 14/10/2022

Sample Details

Sample Location	TP04, 0.5 - 0.6m
Field Sample ID	8
Date Sampled	15/09/2022
Source	In-Situ
Material	Clay
Specification	
Sampling Method	Submitted by client
Sample ID	S22DS-07921

Other Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1 - 2017	5	
Soil Description			
Type of Water		Distilled	
Date Tested		7/10/2022	

Particle Size Distribution

Chart

Comments

N/A

CHADWICK GEOTECHNICS

Dandenong South
ACN 143 009 330
25 Metcalf Street
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Report No: MAT:S22DS-07922/1
Issue No: 1

Material Test Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 14/10/2022

Sample Details

Sample Location	TP15, 2 - 2.5m
Field Sample ID	9
Date Sampled	16/09/2022
Source	In-Situ
Material	Clay
Specification	
Sampling Method	Submitted by client
Sample ID	S22DS-07922

Other Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1 - 2017	2	
Soil Description			
Type of Water		Distilled	
Date Tested		7/10/2022	

Particle Size Distribution

Chart

Comments

N/A

Dandenong South
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Fax: +61 3 9706 9431

Report No: MDD:S22DS-07563
Issue No: 1

Maximum Dry Density Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

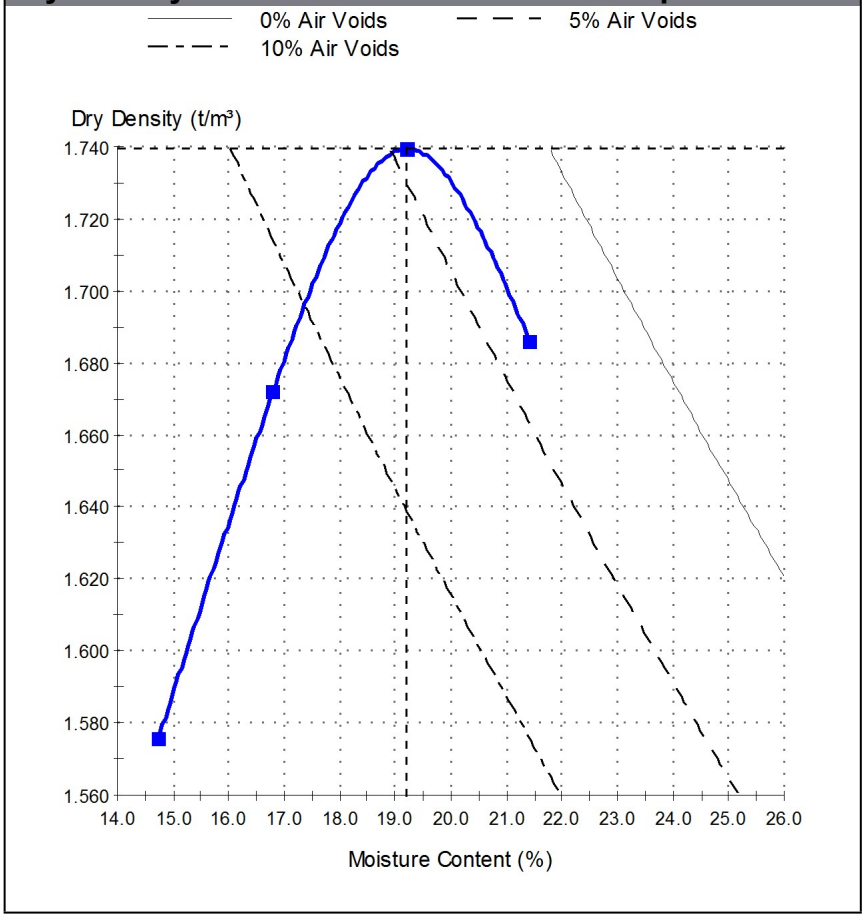
Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 13/10/2022

Sample Details

Location:
Sample ID: S22DS-07563
Sampling Method: Submitted by client
Source: In-Situ
Specification: AS Grading
Location: TP01, 0.6 - 0.8m
Date Tested: 30/09/2022
Date Sampled: 16/09/2022
Material: CH CLAY, trace gravel, trace sand, brown, high plasticity

Dry Density - Moisture Content Relationship



Test Results

AS 1289.5.1.1 - 2017

Standard MDD (t/m³):	**1.74**
Standard OMC (%):	**19.0**
Retained Sieve (mm):	19.0
Oversize Material (%):	0
Curing Time (h):	97
LL Method:	Visual / Tactile

Comments

CHADWICK GEOTECHNICS

Dandenong South
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25 Metcalf Street
DANDENONG SOUTH, VIC 3175

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Report No: MDD:S22DS-07564
Issue No: 1

Maximum Dry Density Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

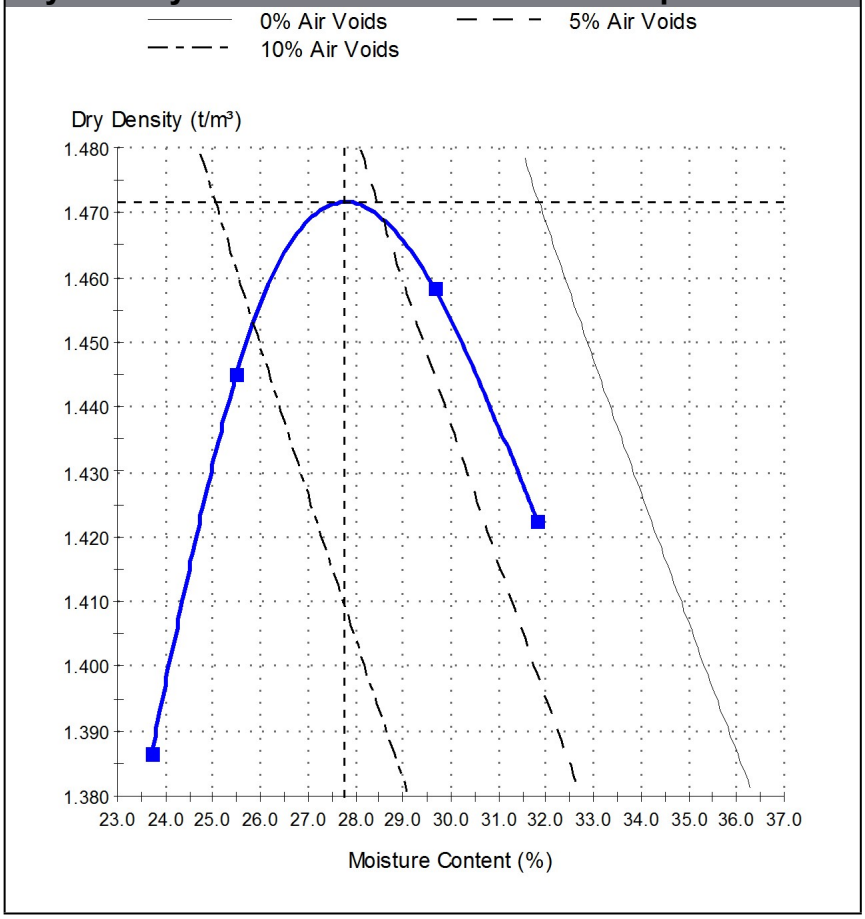
Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 13/10/2022

Sample Details

Location:
Sample ID: S22DS-07564
Sampling Method: Submitted by client
Source: In-Situ
Specification:
Location: TP03, 0.6 - 0.8m
Date Tested: 30/09/2022
Date Sampled: 16/09/2022
Material: Clay

Dry Density - Moisture Content Relationship



Test Results

AS 1289.5.1.1 - 2017

Standard MDD (t/m³):	**1.47**
Standard OMC (%):	**28.0**
Retained Sieve (mm):	19.0
Oversize Material (%):	0
Curing Time (h):	96
LL Method:	Visual / Tactile

Comments

Dandenong South
ACN 143 009 330
25 Metcalf Street
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Fax: +61 3 9706 9431

Report No: MDD:S22DS-07565
Issue No: 1

Maximum Dry Density Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

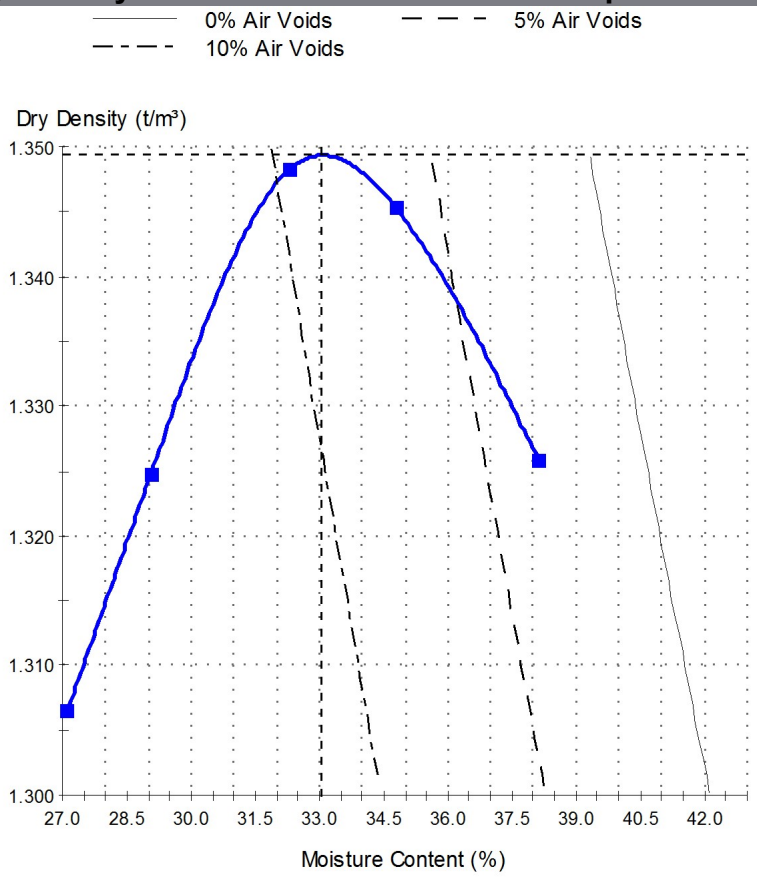
Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 14/10/2022

Sample Details

Location:
Sample ID: S22DS-07565
Sampling Method: Submitted by client
Source: In-Situ
Specification: AS Grading
Location: TP09, 0.6 - 0.8m
Date Tested: 30/09/2022
Date Sampled: 15/09/2022
Material: CH; CLAY, trace gravel, trace sand, brown, high plasticity

Dry Density - Moisture Content Relationship



Test Results

AS 1289.5.1.1 - 2017

Standard MDD (t/m³):	**1.35**
Standard OMC (%):	**33.0**
Retained Sieve (mm):	19.0
Oversize Material (%):	0
Curing Time (h):	98
LL Method:	Visual / Tactile

Comments

CHADWICK GEOTECHNICS

Dandenong South
ACN 143 009 330
25 Metcalf Street
DANDENONG SOUTH, VIC 3175

Ph: + 61 3 8796 7900
Fax: +61 3 9706 9431

Report No: CBR:S22DS-07564
Issue No: 1

California Bearing Ratio Test Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

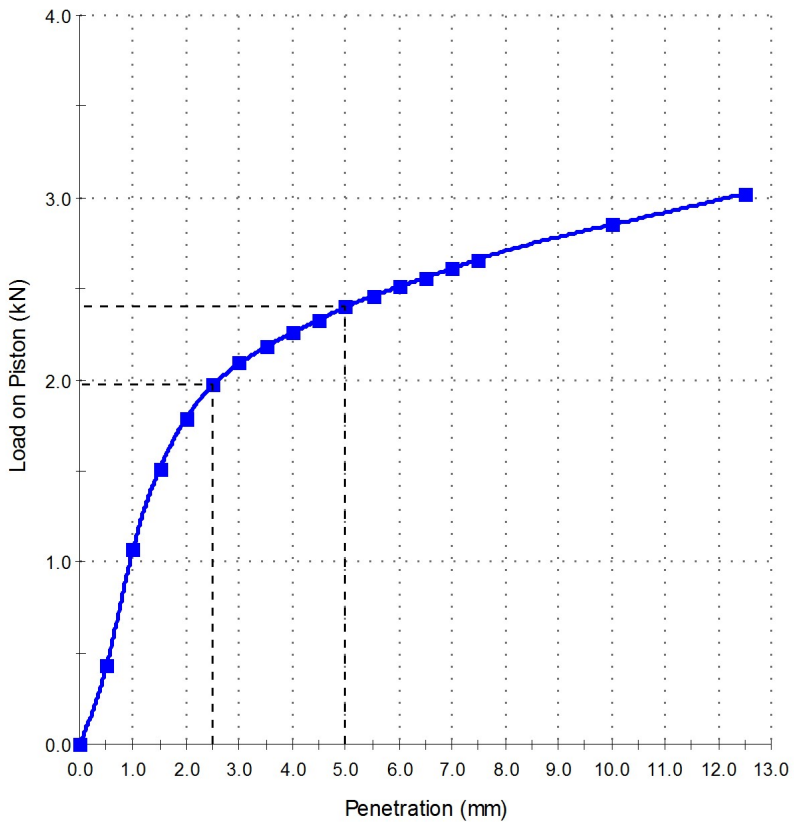
Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 13/10/2022

Sample Details

Sample ID:	S22DS-07564	**Date Sampled:**	16/09/2022
Sampled By:	Client	**Sampling Method:**	Submitted by client
Source:	In-Situ	**Material:**	Clay
Location:			
Location:	TP03, 0.6 - 0.8m	**Date Tested:**	10/10/2022

Load vs Penetration



Test Results

AS 1289.6.1.1 - 2017

CBR at 2.5mm (%):	**15**
Dry Density before Soaking (t/m³):	1.45
Density Ratio before Soaking (%):	98.5
Moisture Content before Soaking (%):	27.0
Moisture Ratio before Soaking (%):	97.5
Dry Density after Soaking (t/m³):	1.45
Density Ratio after Soaking (%):	98.5
Swell (%):	0.0
Moisture Content of Top 30mm (%):	29.1
Compaction Hammer Used:	Standard AS 1289.5.1.1
MDD (t/m³):	1.47
OMC (%):	27.8
Surcharge Mass (kg):	4.50
Period of Soaking (Days):	4
Retained on 19 mm Sieve (%):	0
CBR Moisture Content Method:	AS 1289.2.1.1
Sample Curing Time (h):	49

Comments

Dandenong South
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25 Metcalf Street
DANDENONG SOUTH, VIC 3175

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Report No: CBR:S22DS-07563
Issue No: 1

California Bearing Ratio Test Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

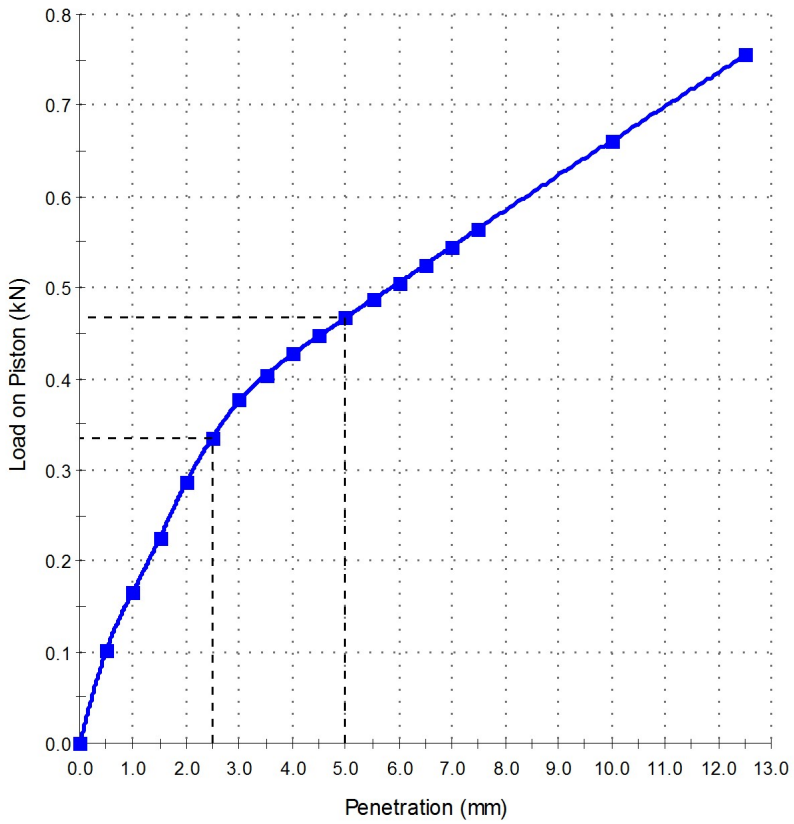
Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 13/10/2022

Sample Details

Sample ID:	S22DS-07563	**Date Sampled:**	16/09/2022
Sampled By:	Client	**Sampling Method:**	Submitted by client
Source:	In-Situ	**Material:**	CH CLAY, trace gravel, trace sand, brown, high plasticity
Location:			
Location:	TP01, 0.6 - 0.8m	**Date Tested:**	10/10/2022

Load vs Penetration



Test Results

AS 1289.6.1.1 - 2017

CBR at 2.5mm (%):	**2.5**
Dry Density before Soaking (t/m³):	1.69
Density Ratio before Soaking (%):	97.5
Moisture Content before Soaking (%):	19.2
Moisture Ratio before Soaking (%):	100.0
Dry Density after Soaking (t/m³):	1.66
Density Ratio after Soaking (%):	95.5
Swell (%):	2.0
Moisture Content of Top 30mm (%):	24.7
Compaction Hammer Used:	Standard AS 1289.5.1.1
MDD (t/m³):	1.74
OMC (%):	19.2
Surcharge Mass (kg):	4.50
Period of Soaking (Days):	4
Retained on 19 mm Sieve (%):	0
CBR Moisture Content Method:	AS 1289.2.1.1
Sample Curing Time (h):	240
Plasticity Determination Method:	AS 1289.3.1.2

Comments

CHADWICK GEOTECHNICS

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Report No: CBR:S22DS-07565
Issue No: 1

California Bearing Ratio Test Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

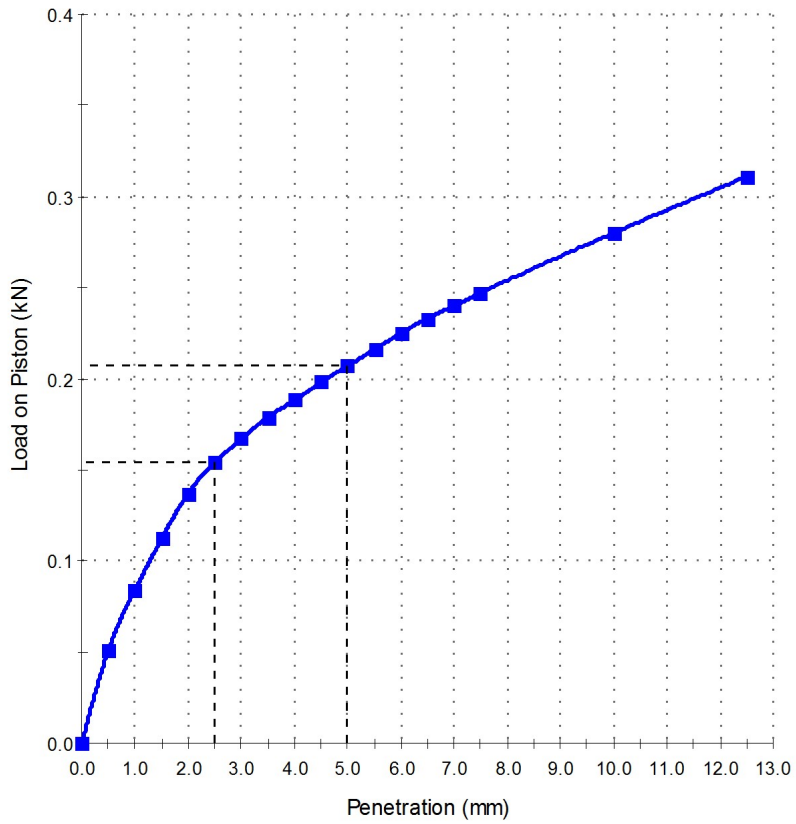
PRELIMINARY REPORT

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 14/10/2022

Sample Details

Sample ID:	S22DS-07565	**Date Sampled:**	15/09/2022
Sampled By:	Client	**Sampling Method:**	Submitted by client
Source:	In-Situ	**Material:**	CH; CLAY, trace gravel, trace sand, brown, high plasticity
Location:			
Location:	TP09, 0.6 - 0.8m	**Date Tested:**	14/10/2022

Load vs Penetration



Test Results

AS 1289.6.1.1 - 2017

CBR at 2.5mm (%):	**1.0**
Dry Density before Soaking (t/m³):	1.31
Density Ratio before Soaking (%):	97.0
Moisture Content before Soaking (%):	33.5
Moisture Ratio before Soaking (%):	101.5
Dry Density after Soaking (t/m³):	1.24
Density Ratio after Soaking (%):	91.5
Swell (%):	5.5
Moisture Content of Top 30mm (%):	
Compaction Hammer Used:	Standard AS 1289.5.1.1
MDD (t/m³):	1.35
OMC (%):	33.1
Surcharge Mass (kg):	4.50
Period of Soaking (Days):	4
Retained on 19 mm Sieve (%):	0
CBR Moisture Content Method:	AS 1289.2.1.1
Sample Curing Time (h):	
Plasticity Determination Method:	AS 1289.3.1.2

Comments

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Report No: RS:W22DS01932
Issue No: 1

Rock Strength Test Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 14/10/2022

Testing Details

Work Date: 29/09/2022
Field Test Procedures: AS 4133.4.1 - 2007
Sampling Method: Submitted by client

Sample Results

Sample ID	Field Sample ID	Location	Depth	Rock Type	Moisture Condition	Storage History
S22DS-07692	1	BH01	from 7.60 to 7.70 m	basalt	Wet	Core Tray
S22DS-07693	2	BH01	from 7.70 to 7.90 m	basalt	Wet	Core Tray
S22DS-07694	3	BH03	from 6.00 to 6.30 m	basalt	Wet	Core Tray
S22DS-07695	4	BH03	from 6.50 to 6.60 m	basalt	Wet	Core Tray
S22DS-07696	5	BH04	from 5.00 to 5.50 m	basalt	Wet	Core Tray
S22DS-07697	6	BH06	from 2.20 to 2.40 m	basalt	Wet	Core Tray

Specimen Results

Sample ID	Type	Load (kN)	Is (MPa)	Is(50) (MPa)	Failure Mode	Type	Load (kN)	Is (MPa)	Is(50) (MPa)	Failure Mode	Mean Is(50) (MPa)	Ia(50) (MPa)
S22DS-07692	Core - Diametral					Core - Axial	7.04	2.2	2.3	substance		
S22DS-07693	Core - Diametral	5.39	2.2	2.2	substance	Core - Axial						
S22DS-07694	Core - Diametral					Core - Axial	20.00	5.3	5.8	substance		
S22DS-07695	Core - Diametral	21.00	6.2	6.7	substance	Core - Axial						
S22DS-07696	Core - Diametral	27.93	8.0	8.6	substance	Core - Axial						
S22DS-07697	Core - Diametral					Core - Axial	20.00	5.8	6.2	substance		

Comments

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Report No: RS:W22DS01932
Issue No: 1

Rock Strength Test Report

Client: Tonkin & Taylor (Aus) Pty Limited
Address: Level 3, 99 Coventry Street
SOUTH MELBOURNE VIC 3006
Project: Northern Land Parcel, Ballarat West
Project No.: 1018876.2000
Order No.: **CG Request No.:**
TRN: **Lot No.:**

Accredited for compliance with ISO/IEC 17025 – Testing

Accreditation Number: 12719
Site Number: 12712
Approved Signatory: J. Lamont (Dandenong Laboratory Manager)
Date of Issue: 14/10/2022

Testing Details

Work Date: 29/09/2022
Field Test Procedures: AS 4133.4.1 - 2007
Sampling Method: Submitted by client

Sample Results

Sample ID	Field Sample ID	Location	Depth	Rock Type	Moisture Condition	Storage History
S22DS-07698	7	BH06	from 3.80 to 4.00 m	basalt	Wet	Core Tray
S22DS-07699	8	BH08	from 4.70 to 5.00 m	basalt	Wet	Core Tray

Specimen Results

Sample ID	Type	Load (kN)	Is (MPa)	Is(50) (MPa)	Failure Mode	Type	Load (kN)	Is (MPa)	Is(50) (MPa)	Failure Mode	Mean Is(50) (MPa)	Ia(50) (MPa)
S22DS-07698	Core - Diametral	1.62	0.45	0.49	defect	Core - Axial						
S22DS-07699	Core - Diametral	26.00	7.7	8.3	substance	Core - Axial						

Comments

Appendix D CIRCLY Output Files

CIRCLY - Version 6.0 (12 February 2020)

Job Title: 1018876.2000 - BWEZ (Stage 2)

Damage Factor Calculation

Assumed number of damage pulses per movement:
Combined pulse for gear (i.e. ignore NROWS)

Traffic Spectrum Details:

Load No.	Load ID	Movements
1	ESA750-Full	4.66E+06

Details of Load Groups:

Load No.	Load ID	Load Category	Load Type	Radius	Pressure/ Ref. stress	Exponent
1	ESA750-Full	ESA750-Full	Vertical Force	92.1	0.75	0.00

Load Locations:

Location No.	Load ID	Gear No.	X	Y	Scaling Factor	Theta
1	ESA750-Full	1	-165.0	0.0	1.00E+00	0.00
2	ESA750-Full	1	165.0	0.0	1.00E+00	0.00
3	ESA750-Full	1	1635.0	0.0	1.00E+00	0.00
4	ESA750-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: BWEZ-1 Title: Road 1 (Type 1) CBR2%

Layer No.	Lower i/face	Material ID	Isotropy	Modulus (or Ev)	P.Ratio (or vvh)	F	Eh	vh
1	rough	14H-40	Iso.	3.00E+03	0.40			
2	rough	20SI_40	Iso.	3.10E+03	0.40			
3	rough	20SI_40	Iso.	3.10E+03	0.40			
4	rough	Cem500A	Aniso.	5.00E+02	0.35	3.70E+02	2.50E+02	0.35
5	rough	Gran_120	Aniso.	1.20E+02	0.35	8.89E+01	6.00E+01	0.35
6	rough	subsltCBR7	Aniso.	7.00E+01	0.45	4.83E+01	3.50E+01	0.45
7	rough	Sub_CBR2	Aniso.	2.00E+01	0.45	1.38E+01	1.00E+01	0.45

Performance Relationships:

Layer No.	Location	Material ID	Component	Perform. Constant	Perform. Exponent	Traffic Multiplier
1	bottom	14H-40	ETH	0.003870	5.000	1.100
2	bottom	20SI_40	ETH	0.003820	5.000	1.100
3	bottom	20SI_40	ETH	0.003820	5.000	1.100
6	top	subsltCBR7	EZZ	0.009300	7.000	1.600
7	top	Sub_CBR2	EZZ	0.009300	7.000	1.600

Reliability Factors:
Project Reliability: Austroads 90%

Layer No.	Reliability Factor	Material Type
1	1.50	Asphalt
2	1.50	Asphalt
3	1.50	Asphalt
6	1.00	Subgrade (Selected Material)
7	1.00	Subgrade (Austroads 2004)

Details of Layers to be sublayered:
Layer no. 5: Austroads (2004) sublayering
Layer no. 6: Austroads (2004) sublayering

Results:

Layer No.	Thickness	Material ID	Load ID	Critical Strain	CDF
1	40.00	14H-40	ESA750-Full	3.22E-05	5.13E-31
2	60.00	20SI_40	ESA750-Full	-3.76E-05	3.17E-04
3	75.00	20SI_40	ESA750-Full	-1.87E-04	9.66E-01
4	120.00	Cem500A	n/a	n/a	n/a
5	100.00	Gran_120	n/a	n/a	n/a
6	250.00	subsltCBR7	ESA750-Full	4.39E-04	3.90E-03
7	0.00	Sub_CBR2	ESA750-Full	5.93E-04	3.21E-02

CIRCLY - Version 6.0 (12 February 2020)

Job Title: 1018876.2000 - BWEZ (Stage 2)

Damage Factor Calculation

Assumed number of damage pulses per movement:
Combined pulse for gear (i.e. ignore NROWS)

Traffic Spectrum Details:

Load No.	Load ID	Movements
1	ESA750-Full	2.93E+06

Details of Load Groups:

Load No.	Load ID	Load Category	Load Type	Radius	Pressure/ Ref. stress	Exponent
1	ESA750-Full	ESA750-Full	Vertical Force	92.1	0.75	0.00

Load Locations:

Location No.	Load ID	Gear No.	X	Y	Scaling Factor	Theta
1	ESA750-Full	1	-165.0	0.0	1.00E+00	0.00
2	ESA750-Full	1	165.0	0.0	1.00E+00	0.00
3	ESA750-Full	1	1635.0	0.0	1.00E+00	0.00
4	ESA750-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: BWEZ-2 Title: Road 2 (Type 2) CBR2%

Layer No.	Lower i/face	Material ID	Isotropy	Modulus (or Ev)	P.Ratio (or vvh)	F	Eh	vh
1	rough	14H_40	Iso.	2.80E+03	0.40			
2	rough	20SI_40	Iso.	3.10E+03	0.40			
3	rough	20SI_40	Iso.	3.10E+03	0.40			
4	rough	Cem500A	Aniso.	5.00E+02	0.35	3.70E+02	2.50E+02	0.35
5	rough	Gran_120	Aniso.	1.20E+02	0.35	8.89E+01	6.00E+01	0.35
6	rough	subsltCBR7	Aniso.	7.00E+01	0.45	4.83E+01	3.50E+01	0.45
7	rough	Sub_CBR2	Aniso.	2.00E+01	0.45	1.38E+01	1.00E+01	0.45

Performance Relationships:

Layer No.	Location	Material ID	Component	Perform. Constant	Perform. Exponent	Traffic Multiplier
1	bottom	14H_40	ETH	0.004000	5.000	1.100
2	bottom	20SI_40	ETH	0.003820	5.000	1.100
3	bottom	20SI_40	ETH	0.003820	5.000	1.100
6	top	subsltCBR7	EZZ	0.009300	7.000	1.600
7	top	Sub_CBR2	EZZ	0.009300	7.000	1.600

Reliability Factors:
Project Reliability: Austroads 90%

Layer No.	Reliability Factor	Material Type
1	1.50	Asphalt
2	1.50	Asphalt
3	1.50	Asphalt
6	1.00	Subgrade (Selected Material)
7	1.00	Subgrade (Austroads 2004)

Details of Layers to be sublayered:
Layer no. 5: Austroads (2004) sublayering
Layer no. 6: Austroads (2004) sublayering

Results:

Layer No.	Thickness	Material ID	Load ID	Critical Strain	CDF
1	40.00	14H_40	ESA750-Full	1.92E-05	3.22E-31
2	60.00	20SI_40	ESA750-Full	-5.30E-05	1.11E-03
3	75.00	20SI_40	ESA750-Full	-2.06E-04	9.76E-01
4	100.00	Cem500A	n/a	n/a	n/a
5	100.00	Gran_120	n/a	n/a	n/a
6	225.00	subsltCBR7	ESA750-Full	4.86E-04	5.01E-03
7	0.00	Sub_CBR2	ESA750-Full	6.47E-04	3.68E-02

CIRCLY - Version 6.0 (12 February 2020)

Job Title: 1018876.2000 - BWEZ (Stage 2)

Damage Factor Calculation

Assumed number of damage pulses per movement:
Combined pulse for gear (i.e. ignore NROWS)

Traffic Spectrum Details:

Load No.	Load ID	Movements
1	ESA750-Full	1.34E+06

Details of Load Groups:

Load No.	Load ID	Load Category	Load Type	Radius	Pressure/ Ref. stress	Exponent
1	ESA750-Full	ESA750-Full	Vertical Force	92.1	0.75	0.00

Load Locations:

Location No.	Load ID	Gear No.	X	Y	Scaling Factor	Theta
1	ESA750-Full	1	-165.0	0.0	1.00E+00	0.00
2	ESA750-Full	1	165.0	0.0	1.00E+00	0.00
3	ESA750-Full	1	1635.0	0.0	1.00E+00	0.00
4	ESA750-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: BWEZ-3 Title: Type 3; CBR2%

Layer No.	Lower i/face	Material ID	Isotropy	Modulus (or Ev)	P.Ratio (or vvh)	F	Eh	vh
1	rough	14H_10	Iso.	1.70E+03	0.40			
2	rough	20SI_10	Iso.	1.80E+03	0.40			
3	rough	20SI_10	Iso.	1.80E+03	0.40			
4	rough	Cem500A	Aniso.	5.00E+02	0.35	3.70E+02	2.50E+02	0.35
5	rough	Gran_120	Aniso.	1.20E+02	0.35	8.89E+01	6.00E+01	0.35
6	rough	subsltCBR7	Aniso.	7.00E+01	0.45	4.83E+01	3.50E+01	0.45
7	rough	Sub_CBR2	Aniso.	2.00E+01	0.45	1.38E+01	1.00E+01	0.45

Performance Relationships:

Layer No.	Location	Material ID	Component	Perform. Constant	Perform. Exponent	Traffic Multiplier
1	bottom	14H_10	ETH	0.004790	5.000	1.100
2	bottom	20SI_10	ETH	0.004650	5.000	1.100
3	bottom	20SI_10	ETH	0.004650	5.000	1.100
6	top	subsltCBR7	EZZ	0.009300	7.000	1.600
7	top	Sub_CBR2	EZZ	0.009300	7.000	1.600

Reliability Factors:
Project Reliability: Austroads 90%

Layer No.	Reliability Factor	Material Type
1	1.50	Asphalt
2	1.50	Asphalt
3	1.50	Asphalt
6	1.00	Subgrade (Selected Material)
7	1.00	Subgrade (Austroads 2004)

Details of Layers to be sublayered:
Layer no. 5: Austroads (2004) sublayering
Layer no. 6: Austroads (2004) sublayering

Results:

Layer No.	Thickness	Material ID	Load ID	Critical Strain	CDF
1	40.00	14H_10	ESA750-Full	-4.49E-06	7.12E-10
2	60.00	20SI_10	ESA750-Full	-8.51E-05	2.01E-03
3	75.00	20SI_10	ESA750-Full	-2.75E-04	7.13E-01
4	100.00	Cem500A	n/a	n/a	n/a
5	100.00	Gran_120	n/a	n/a	n/a
6	150.00	subsltCBR7	ESA750-Full	7.12E-04	3.30E-02
7	0.00	Sub_CBR2	ESA750-Full	8.44E-04	1.09E-01

CIRCLY - Version 6.0 (12 February 2020)

Job Title: 1018876.2000 - BWEZ (Stage 2)

Damage Factor Calculation

Assumed number of damage pulses per movement:
Combined pulse for gear (i.e. ignore NROWS)

Traffic Spectrum Details:

Load No.	Load ID	Movements
1	ESA750-Full	1.34E+06

Details of Load Groups:

Load No.	Load ID	Load Category	Load Type	Radius	Pressure/ Ref. stress	Exponent
1	ESA750-Full	ESA750-Full	Vertical Force	92.1	0.75	0.00

Load Locations:

Location No.	Load ID	Gear No.	X	Y	Scaling Factor	Theta
1	ESA750-Full	1	-165.0	0.0	1.00E+00	0.00
2	ESA750-Full	1	165.0	0.0	1.00E+00	0.00
3	ESA750-Full	1	1635.0	0.0	1.00E+00	0.00
4	ESA750-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: BWEZ-3 Title: Type 3; CBR2%

Layer No.	Lower i/face	Material ID	Isotropy	Modulus (or Ev)	P.Ratio (or vvh)	F	Eh	vh
1	rough	14V_10	Iso.	1.60E+03	0.40			
2	rough	20SI_10	Iso.	1.80E+03	0.40			
3	rough	20SI_10	Iso.	1.80E+03	0.40			
4	rough	Cem500A	Aniso.	5.00E+02	0.35	3.70E+02	2.50E+02	0.35
5	rough	Gran_120	Aniso.	1.20E+02	0.35	8.89E+01	6.00E+01	0.35
6	rough	subsltCBR7	Aniso.	7.00E+01	0.45	4.83E+01	3.50E+01	0.45
7	rough	Sub_CBR2	Aniso.	2.00E+01	0.45	1.38E+01	1.00E+01	0.45

Performance Relationships:

Layer No.	Location	Material ID	Component	Perform. Constant	Perform. Exponent	Traffic Multiplier
1	bottom	14V_10	ETH	0.004680	5.000	1.100
2	bottom	20SI_10	ETH	0.004650	5.000	1.100
3	bottom	20SI_10	ETH	0.004650	5.000	1.100
6	top	subsltCBR7	EZZ	0.009300	7.000	1.600
7	top	Sub_CBR2	EZZ	0.009300	7.000	1.600

Reliability Factors:
Project Reliability: Austroads 90%

Layer No.	Reliability Factor	Material Type
1	1.50	Asphalt
2	1.50	Asphalt
3	1.50	Asphalt
6	1.00	Subgrade (Selected Material)
7	1.00	Subgrade (Austroads 2004)

Details of Layers to be sublayered:
Layer no. 5: Austroads (2004) sublayering
Layer no. 6: Austroads (2004) sublayering

Results:

Layer No.	Thickness	Material ID	Load ID	Critical Strain	CDF
1	40.00	14V_10	ESA750-Full	2.24E-05	1.47E-31
2	60.00	20SI_10	ESA750-Full	-8.02E-05	1.50E-03
3	75.00	20SI_10	ESA750-Full	-2.76E-04	7.19E-01
4	100.00	Cem500A	n/a	n/a	n/a
5	100.00	Gran_120	n/a	n/a	n/a
6	150.00	subsltCBR7	ESA750-Full	7.18E-04	3.50E-02
7	0.00	Sub_CBR2	ESA750-Full	8.50E-04	1.15E-01

CIRCLY - Version 6.0 (12 February 2020)

Job Title: 1018876.2000 - BWEZ (Stage 2)

Damage Factor Calculation

Assumed number of damage pulses per movement:
Combined pulse for gear (i.e. ignore NROWS)

Traffic Spectrum Details:

Load No.	Load ID	Movements
1	ESA750-Full	6.72E+05

Details of Load Groups:

Load No.	Load ID	Load Category	Load Type	Radius	Pressure/ Ref. stress	Exponent
1	ESA750-Full	ESA750-Full	Vertical Force	92.1	0.75	0.00

Load Locations:

Location No.	Load ID	Gear No.	X	Y	Scaling Factor	Theta
1	ESA750-Full	1	-165.0	0.0	1.00E+00	0.00
2	ESA750-Full	1	165.0	0.0	1.00E+00	0.00
3	ESA750-Full	1	1635.0	0.0	1.00E+00	0.00
4	ESA750-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: BWEZ-5 Title: Type 5; CBR2%

Layer No.	Lower i/face	Material ID	Isotropy	Modulus (or Ev)	P.Ratio (or vvh)	F	Eh	vh
1	rough	14H-40	Iso.	3.00E+03	0.40			
2	rough	20SI_40	Iso.	3.10E+03	0.40			
3	rough	20SI_40	Iso.	3.10E+03	0.40			
4	rough	Cem500A	Aniso.	5.00E+02	0.35	3.70E+02	2.50E+02	0.35
5	rough	Gran_120	Aniso.	1.20E+02	0.35	8.89E+01	6.00E+01	0.35
6	rough	subsltCBR7	Aniso.	7.00E+01	0.45	4.83E+01	3.50E+01	0.45
7	rough	Sub_CBR2	Aniso.	2.00E+01	0.45	1.38E+01	1.00E+01	0.45

Performance Relationships:

Layer No.	Location	Material ID	Component	Perform. Constant	Perform. Exponent	Traffic Multiplier
1	bottom	14H-40	ETH	0.003870	5.000	1.100
2	bottom	20SI_40	ETH	0.003820	5.000	1.100
3	bottom	20SI_40	ETH	0.003820	5.000	1.100
6	top	subsltCBR7	EZZ	0.009300	7.000	1.600
7	top	Sub_CBR2	EZZ	0.009300	7.000	1.600

Reliability Factors:
Project Reliability: Austroads 90%

Layer No.	Reliability Factor	Material Type
1	1.50	Asphalt
2	1.50	Asphalt
3	1.50	Asphalt
6	1.00	Subgrade (Selected Material)
7	1.00	Subgrade (Austroads 2004)

Details of Layers to be sublayered:
Layer no. 5: Austroads (2004) sublayering
Layer no. 6: Austroads (2004) sublayering

Results:

Layer No.	Thickness	Material ID	Load ID	Critical Strain	CDF
1	40.00	14H-40	ESA750-Full	3.78E-05	7.39E-32
2	60.00	20SI_40	ESA750-Full	-4.19E-05	7.78E-05
3	75.00	20SI_40	ESA750-Full	-2.12E-04	2.59E-01
4	100.00	Cem500A	n/a	n/a	n/a
5	100.00	Gran_120	n/a	n/a	n/a
6	150.00	subsltCBR7	ESA750-Full	5.71E-04	3.52E-03
7	0.00	Sub_CBR2	ESA750-Full	7.01E-04	1.49E-02

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Job Title: 1018876.2000 - BWEZ (Stage 2)

Damage Factor Calculation

Assumed number of damage pulses per movement:
Combined pulse for gear (i.e. ignore NROWS)

Traffic Spectrum Details:

Load No.	Load ID	Movements
1	ESA750-Full	4.66E+06

Details of Load Groups:

Load No.	Load ID	Load Category	Load Type	Radius	Pressure/ Ref. stress	Exponent
1	ESA750-Full	ESA750-Full	Vertical Force	92.1	0.75	0.00

Load Locations:

Location No.	Load ID	Gear No.	X	Y	Scaling Factor	Theta
1	ESA750-Full	1	-165.0	0.0	1.00E+00	0.00
2	ESA750-Full	1	165.0	0.0	1.00E+00	0.00
3	ESA750-Full	1	1635.0	0.0	1.00E+00	0.00
4	ESA750-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: BWEZ-4 Title: Type 4; CBR2%

Layer No.	Lower i/face	Material ID	Isotropy	Modulus (or Ev)	P.Ratio (or vvh)	F	Eh	vh
1	rough	14V_10	Iso.	1.60E+03	0.40			
2	rough	20SI_10	Iso.	1.80E+03	0.40			
3	rough	20SI_10	Iso.	1.80E+03	0.40			
4	rough	Cem500A	Aniso.	5.00E+02	0.35	3.70E+02	2.50E+02	0.35
5	rough	Gran_120	Aniso.	1.20E+02	0.35	8.89E+01	6.00E+01	0.35
6	rough	subsltCBR7	Aniso.	7.00E+01	0.45	4.83E+01	3.50E+01	0.45
7	rough	Sub_CBR2	Aniso.	2.00E+01	0.45	1.38E+01	1.00E+01	0.45

Performance Relationships:

Layer No.	Location	Material ID	Component	Perform. Constant	Perform. Exponent	Traffic Multiplier
1	bottom	14V_10	ETH	0.004680	5.000	1.100
2	bottom	20SI_10	ETH	0.004650	5.000	1.100
3	bottom	20SI_10	ETH	0.004650	5.000	1.100
6	top	subsltCBR7	EZZ	0.009300	7.000	1.600
7	top	Sub_CBR2	EZZ	0.009300	7.000	1.600

Reliability Factors:
Project Reliability: Austroads 90%

Layer No.	Reliability Factor	Material Type
1	1.50	Asphalt
2	1.50	Asphalt
3	1.50	Asphalt
6	1.00	Subgrade (Selected Material)
7	1.00	Subgrade (Austroads 2004)

Details of Layers to be sublayered:
Layer no. 5: Austroads (2004) sublayering
Layer no. 6: Austroads (2004) sublayering

Results:

Layer No.	Thickness	Material ID	Load ID	Critical Strain	CDF
1	40.00	14V_10	ESA750-Full	9.52E-06	5.13E-31
2	60.00	20SI_10	ESA750-Full	-7.24E-05	3.13E-03
3	75.00	20SI_10	ESA750-Full	-2.26E-04	9.33E-01
4	140.00	Cem500A	n/a	n/a	n/a
5	130.00	Gran_120	n/a	n/a	n/a
6	200.00	subsltCBR7	ESA750-Full	5.51E-04	1.91E-02
7	0.00	Sub_CBR2	ESA750-Full	6.75E-04	7.87E-02

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Job Title: 1018876.2000 - BWEZ (Stage 2)

Damage Factor Calculation

Assumed number of damage pulses per movement:
Combined pulse for gear (i.e. ignore NROWS)

Traffic Spectrum Details:

Load No.	Load ID	Movements
1	ESA750-Full	2.93E+06

Details of Load Groups:

Load No.	Load ID	Load Category	Load Type	Radius	Pressure/ Ref. stress	Exponent
1	ESA750-Full	ESA750-Full	Vertical Force	92.1	0.75	0.00

Load Locations:

Location No.	Load ID	Gear No.	X	Y	Scaling Factor	Theta
1	ESA750-Full	1	-165.0	0.0	1.00E+00	0.00
2	ESA750-Full	1	165.0	0.0	1.00E+00	0.00
3	ESA750-Full	1	1635.0	0.0	1.00E+00	0.00
4	ESA750-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: BWEZ-6 Title: Type 6; CBR2%

Layer No.	Lower i/face	Material ID	Isotropy	Modulus (or Ev)	P.Ratio (or vvh)	F	Eh	vh
1	rough	14V_10	Iso.	1.60E+03	0.40			
2	rough	20SI_10	Iso.	1.80E+03	0.40			
3	rough	20SI_10	Iso.	1.80E+03	0.40			
4	rough	Cem500A	Aniso.	5.00E+02	0.35	3.70E+02	2.50E+02	0.35
5	rough	Gran_120	Aniso.	1.20E+02	0.35	8.89E+01	6.00E+01	0.35
6	rough	subsltCBR7	Aniso.	7.00E+01	0.45	4.83E+01	3.50E+01	0.45
7	rough	Sub_CBR2	Aniso.	2.00E+01	0.45	1.38E+01	1.00E+01	0.45

Performance Relationships:

Layer No.	Location	Material ID	Component	Perform. Constant	Perform. Exponent	Traffic Multiplier
1	bottom	14V_10	ETH	0.004680	5.000	1.100
2	bottom	20SI_10	ETH	0.004650	5.000	1.100
3	bottom	20SI_10	ETH	0.004650	5.000	1.100
6	top	subsltCBR7	EZZ	0.009300	7.000	1.600
7	top	Sub_CBR2	EZZ	0.009300	7.000	1.600

Reliability Factors:
Project Reliability: Austroads 90%

Layer No.	Reliability Factor	Material Type
1	1.50	Asphalt
2	1.50	Asphalt
3	1.50	Asphalt
6	1.00	Subgrade (Selected Material)
7	1.00	Subgrade (Austroads 2004)

Details of Layers to be sublayered:
Layer no. 5: Austroads (2004) sublayering
Layer no. 6: Austroads (2004) sublayering

Results:

Layer No.	Thickness	Material ID	Load ID	Critical Strain	CDF
1	40.00	14V_10	ESA750-Full	1.52E-05	3.22E-31
2	60.00	20SI_10	ESA750-Full	-7.57E-05	2.46E-03
3	75.00	20SI_10	ESA750-Full	-2.48E-04	9.19E-01
4	120.00	Cem500A	n/a	n/a	n/a
5	100.00	Gran_120	n/a	n/a	n/a
6	200.00	subsltCBR7	ESA750-Full	6.05E-04	2.32E-02
7	0.00	Sub_CBR2	ESA750-Full	7.46E-04	1.00E-01

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