GROUNDED EXPERTISE

Report on Geotechnical and Salinity Investigation

Proposed Industrial Development

3 Johnston Cresent, Horsley Park

Prepared for ESR Australia

Project 86826.09

20 September 2024

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

Signature		Date
Author	JSomerville	20 September 2024
Reviewer		20 September 2024

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Report on Geotechnical and Salinity Investigation
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1. Introduction

This report, prepared by Douglas Partners Pty Ltd (Douglas), presents the results of a geotechnical and salinity investigation undertaken for a proposed industrial development at 3 Johnston Cresent, Horsley Park (the site). The investigation was commissioned by David Mollerstrom of ESR Australia and was undertaken in accordance with Douglas' proposal 86826.09.P.001.Rev0 dated 4 July 2024.

It is understood that the proposed development includes the construction of two new warehouse buildings that will occupy most of the site, covering a total gross floor area (GFA) of 55,900 m^2. The buildings will be separated by loading docks and hardstand pavements and will include mezzanine and two storey office facilities. On-grade open and under-croft parking areas will be positioned along the northern side of Warehouse A and eastern side of Warehouse B. Perimeter landscaping is also proposed. Access to the site for light vehicles and trucks will be on the eastern side of the site directly from Johnston Cresent. The proposed site layout is shown on Drawing No. 14902_DA011 Issue 7, dated 27 August 2024, presented in Appendix B.

The investigation was carried out to provide information on the subsurface conditions for design and planning purposes and included the drilling of boreholes, cone penetration tests (CPTs), laboratory testing and engineering assessment. Details of the field work and comments relevant to design and construction practice as given herein.

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

2. Project SEARs

The Secretary's Environmental Assessment Requirements (SEARs), specifically Item 12 relating to ground and water conditions are addressed in the following report sections:

- Sections 7.1, 7.2, 9.1, 9.3 and 9.11 – Soil Erosion
- Sections 4.4, 7.1, 7.2 and 9.8 – Soil Salinity
- Section 4.3 – Acid Sulphate Soils
- Sections 6.2, 6.3 and 8.0 – Surface and Groundwater Impacts

3. Site Description

The site is located at 3 Johnston Cresent, Horsley Park (previously known as Lot 301 Johnston Cresent). Johnston Cresent borders the site on the northern, eastern and western sides with the southern side sharing a common boundary with an adjoining industrial site. The property occupies and area of approximately 8.7 hectares and is essentially rectangular with dimensions in the order of 443 m north to south and 196 m east to west. The site is a newly developed lot over a previous brick quarry and manufacturing plant.

The existing ground surface is relatively flat and unsealed and includes two small detention basins in its northern part. Existing ground surface levels fall gently to the north from typical reduced levels of RL83 to RL80, relative to Australian height datum (AHD). The site has been raised above the surrounding ground levels through the placement of controlled fill, which is supported by reinforced block retaining walls along the northern, eastern and western site boundaries. The retaining walls vary in height from approximately 3 m to 7.5 m. Land use on the adjoining lots is industrial on all sides.

4. Published Data

4.1 Geology

Reference to the Penrith 1:100,000 Geological Series Sheet indicates that the site is underlain by the Bringelly Shale formation which comprises shale, carbonaceous claystone, claystone, laminite, fine to medium-grained lithic sandstone, rare coal and tuff.

4.2 Soil Landscape

Reference to the Penrith 1:100,000 Soil landscape mapping indicates that the site is underlain by soils of the Blacktown group. The soil is described as shallow to moderately deep, red and brown podzolic soils on crests, upper slopes and well drained areas and yellow podzolic soils and soloths on lower slopes and areas of poor drainage.

The soils are generally moderately reactive, have low to very low fertility and have moderate erodibility.

This soil landscape generally occurs on gently undulating rises on the Wianamatta Shales, of which Bringelly Shale is a subgroup, with local relief of 10 – 30 m. Crests are broad and rounded with convex upper slopes grading into concave lower slopes. Rock outcrops are generally absent.

The extent of quarrying and subsequent earthworks on the site are likely to have removed or covered over a significant part of the natural soil profile.

4.3 Acid Sulfate Soils

The site is located within an area of no known acid sulphate soils.

4.4 Salinity

The site is located within an area identified as having a moderate salinity potential. The extent of quarrying and subsequent earthworks on the site are likely to have removed or covered over a significant part of the natural soil profile and thus the salinity potential would be based on the condition of the controlled fill placed on the site.

5. Previous Investigations

A previous investigation was undertaken by Douglas on the site in February 2023 following the completion of the bulk earthworks. The investigation included 24 CPTs on a relatively even spaced test grid (eight rows of three tests spread along the site from north to south). The CPTs extended to depths of between 3.6 m and 10.8 m. The work was undertaken for the property developer and the results were provided for information purposes as part of the property's pre-purchase due diligence documentation.

A review of the CPT results indicates that at the 24 CPT locations the thickness of the controlled fill placed on the site varies between 2.6 m and 10.4 m. These numbers are spot measurements at the CPT locations only.

From the bulk earthworks plan, provided as part of the pre-purchase due diligence documentation, it is apparent that the controlled fill thicknesses range between about 3 m and 14 m, indicating a reasonable correlation between the two data sets when considering that the deeper fill thicknesses indicated on the bulk earthworks plan relate to the controlled backfilling of a previous quarry pit that straddles the common boundary with the southern lot. Considering both data sets, it is estimated that the controlled fill thickness will be about 12 m deep below the southern warehouse and slightly deeper below the southern loading dock and hardstand.

The results of the CPTs indicate the fill is well compacted, which is supported by the earthworks report and accompanying summary of density tests included within the pre-purchase due diligence documentation.

Natural soils on the site are inferred from the CPT results to comprise clay and silty clay. Where present, they are between 0.4 m and 2.7 m thick. Experience suggests the soils are likely to be of medium and high plasticity.

The underlying rock surface was inferred in some of the CPTs and is possibly present from depths of between 4.8 m and 10.4 m, although this will increase further to the south where fill thicknesses are deeper. In such areas, the fill will directly overlie the rock surface due to previous quarrying activities.

6. Field Work

6.1 Field Work Methods

The field work for the current geotechnical and salinity investigation was conducted on 12 July 2024 and 16 July 2024 and included:

- Electronic scanning for buried services at the proposed test locations.
- CPTs at 15 locations (CPT101, CPT102 and CPT104 to CPT116) to refusal at depths of between 4.7 m and 14 m. During CPT testing, a ballasted truck-mounted test rig is used to push a 35 mm diameter instrumented cone-tipped probe into the soil using a hydraulic ram system. Continuous measurements are made of the end-bearing pressure on the cone tip and the friction on a 135 mm long sleeve located immediately behind the cone. The cone resistance and friction readings are displayed on a digit monitor and stored on a computer for subsequent plotting of results and interpretation. Further information on the test methods

and interpretation of CPT results is provided in the notes included with the results in Appendix C.

- Drilling of six boreholes (BH101 to BH106) using a track-mounted drilling rig. The boreholes were drilled with solid flight augers fitted with a tungsten carbide (TC) bit to a depth of approximately 5 m.
- Standard penetration tests (SPTs) were undertaken at regular depth intervals within each of the boreholes to determine the in-situ consistency of the subsurface soils encountered.
- Logging of the encountered subsurface conditions was undertaken by a geotechnical engineer who also collected samples of the soil profiles for subsequent laboratory testing.
- Sampling of soils and rock to assist in logging and to provide specimens for laboratory testing.

All test locations were backfilled with drilling spoil upon completion and were made safe. The ground surface levels at the CPT and borehole locations were measured relative to AHD using a differential global positioning system (dGPS) receiver, which is generally accurate to within ±0.2 m. Coordinates for each CPT and borehole location are with reference to Map Grid of Australia MGA2020, Zone 56 and have a similar accuracy. Coordinates and ground surface levels are recorded on the CPT plots and borehole logs included in Appendix C.

6.2 Field Work Results

The general sequency of subsurface materials encountered at the CPT and borehole locations are summarised in increasing depth order in Table 1.

Table 1: Summary of Subsurface Profile

Material	Depth Range to Top of Unit (m)	RL Range to Top of Unit (m AHD)	Thickness Range (m)	Description
Controlled Fill	0.0	79.7 – 83.3	3.2 – 13.8	All boreholes and CPTs encountered generally well compacted gravelly clay fill. The upper approximately 0.5 m appeared moderately compacted and contained a higher moisture content.
Residual Clay	3.2 – 13.8	71.3 – 79.4	0.5 – 4.0	Observed at eight CPT and one borehole locations. Generally consisting of very stiff to hard clay with some ironstone gravel.
Weathered Siltstone	4.3 – 12.3	68.4 – 77.5	N.O.	Encountered at all CPT locations (except for CPT116).

Notes: N.O. = not observed due to discontinuation of Boreholes and CPTs.

6.3 Groundwater

Groundwater was not encountered in any of the boreholes during auger drilling or after the withdrawal of the CPT rods. Groundwater monitoring wells were not installed during the investigation, as the site levels are raised above the surrounding ground surface levels on all sides of the site. Significant groundwater is unlikely to be encountered within the zone of influence of the development. It should be noted, however that groundwater levels and seepage flows can vary considerably with changes in climate and other factors, although such levels lie well below the site's surface level.

7. Laboratory Testing

7.1 Laboratory Methods

Geotechnical and chemical laboratory testing was carried out on selected representative soil samples collected during the field investigation. The following tests were undertaken:

- Six Atterberg limit tests to assess soil plasticity and reactivity.
- Six linear shrinkage tests to assess soil plasticity and reactivity.
- Six California bearing ratio (CBR) tests (Standard compaction, 4 day soak) for preliminary pavement design parameters.
- Fifteen aggressivity tests (chloride, sulphates, electrical conductivity ($EC_{1:5}$), and $pH_{1:5}$) for exposure classification.
- Fifteen salinity tests (electrical conductivity corrected for texture (EC_e) and textural classification.
- Fifteen exchangeable sodium percentage (ESP) tests to assess soil erosion potential.

7.2 Laboratory Results

Detailed laboratory test results are presented in Appendix D and are summarised in Table 2 to 4.

Table 2: Summary of Atterberg Limits, Shrink-Swell Index and CBR Test Results

Test Location	Depth (m)	Soil Description	LL (%)	PL (%)	PI (%)	Linear Shrinkage (%)	CBR (%)	Swell (%)
BH101	0.5-1.5	FILL/Gravelly CLAY	34	18	16	9.5	6	3.0
BH102	0.5-1.5	FILL/Gravelly CLAY	38	16	22	11.5	4.5	2.5
BH103	0.5-1.5	FILL/Gravelly CLAY	38	18	20	11.0	3.0	2.5
BH104	0.5-1.5	FILL/Gravelly CLAY	35	17	18	10.0	6	2.0
BH105	0.5-1.5	FILL/Gravelly CLAY	35	17	18	10.5	3.5	2.0
BH106	0.5-1.5	FILL/Gravelly CLAY	36	17	19	10.5	4.5	2.5

Where: LL = Liquid Limit PL = Plastic Limit PI = Plastic Index

Table 3: Summary of Chemical Test Results (Salinity Potential)

Test Location	Depth (m)	pHw (1:5)	Cl (mg/kg)	SO_4 (mg/kg)	EC (µS/cm)	Texture	ECe (dS/m)	Saline Class
BH101	0.4-0.5	9.1	230	130	390	9	3.5	Slightly Saline
BH101	2.5-2.95	8.5	170	190	320	7	2.2	Slightly Saline
BH101	4.0-4.45	9.4	130	120	330	7	2.3	Slightly Saline
BH102	0.4-0.5	8.3	240	310	420	7	2.9	Slightly Saline
BH102	2.5-2.95	8.3	370	270	480	7	3.4	Slightly Saline
BH102	4.0-4.45	7.7	290	130	290	7	2.1	Slightly Saline
BH103	0.4-0.5	8.3	210	260	460	7	3.2	Slightly Saline
BH103	2.5-2.95	7.1	250	150	280	7	<2	Non Saline
BH103	4.0-4.45	8.8	250	120	330	7	2.3	Slightly Saline
BH104	0.4-0.5	8.5	210	180	350	9	3.2	Slightly Saline
BH104	2.5-2.95	9.3	130	290	430	6	2.6	Slightly Saline
BH104	4.0-4.45	9.4	190	290	460	6	2.7	Slightly Saline
BH105	0.4-0.5	8.4	230	150	290	9	2.6	Slightly Saline
BH105	2.5-2.95	9.3	150	250	360	6	2.2	Slightly Saline
BH105	4.0-4.45	8.8	190	280	440	9	3.9	Slightly Saline

Where: pHw = pH in water Cl = Chloride SO_4 = Sulphate EC = Electrical Conductivity
Ece = Electrical Conductivity corrected for texture

Table 4: Summary of Chemical Test Results (Erosion Potential)

Test Location	Depth (m)	Exchangeable Sodium Percentage – ESP (%)	Sodicity Rating
BH101	0.4-0.5	13	Sodic
BH101	2.5-2.95	22	Highly Sodic
BH101	4.0-4.45	8	Sodic
BH102	0.4-0.5	8	Sodic
BH102	2.5-2.95	18	Highly Sodic
BH102	4.0-4.45	23	Highly Sodic
BH103	0.4-0.5	10	Sodic
BH103	2.5-2.95	29	Highly Sodic
BH103	4.0-4.45	25	Highly Sodic
BH104	0.4-0.5	17	Highly Sodic
BH104	2.5-2.95	14	Sodic
BH104	4.0-4.45	15	Sodic
BH105	0.4-0.5	27	Highly Sodic
BH105	2.5-2.95	22	Highly Sodic
BH105	4.0-4.45	16	Highly Sodic

8. Proposed Development

The master plan for the site indicates two new warehouse buildings with a total GFA of 55,900 m^2 within an industrial lot of approximately 8.7 hectares. The buildings will be separated by loading docks and hardstand pavements and will include mezzanine and two storey office facilities. On-grade open and under-croft parking areas will be positioned along the northern side of Warehouse A and the eastern side of Warehouse B. Perimeter landscaping is also proposed. Access to the site for light vehicles and trucks will be on the eastern side of the site directly from Johnston Crescent. The proposed site layout is shown on Drawing No. 14902_DA011 Issue 7, dated 27 August 2024, presented in Appendix B.

It is understood that the warehouses will include steel portal frames and internal columns that will be supported by pad footings founding at shallow depth within the controlled fill. Other structures will include concrete warehouse floor slabs and external pavements, short retaining walls along loading docks, inground services and isolated lighting and signage. No significant depths of excavation are proposed for the development.

The proposed finished floor levels for the warehouses and external pavements indicate minor cut and fill earthworks will be required to regrade the site. Cut depths and fill thicknesses of up to 2 m are anticipated. Service trenches may extend slightly deeper. Earthworks may necessitate minor additional perimeter retaining walls, or construction of landscaped batters.

9. Comments

9.1 Geotechnical Model

Based on the subsurface conditions encountered during the investigation, and considering those available from the due diligence documentation, it is apparent that the site is underlain by varying depths of fill ranging from 3.2 m to 12.3 m outside of the deep backfilled quarry pit and up to 13.8 m within the quarry pit near the southern lot boundary.

As part of Douglas' preliminary due diligence assessment, it was determined that the fill had been placed with appropriate geotechnical oversight and under a Level 1 inspection and testing programme, as outlined in AS3798-2007 Guidelines on Earthworks for Commercial and Residential Developments. Accordingly, the fill on 3 Johnston Cresent can be considered as 'controlled' and having a minimum specified degree of compaction equivalent to 98%, relative to Standard compaction. The filling is therefore well compacted.

Fill depths are generally variable across the site due in part to the increasing change in grade across the site boundary towards the north, but also due to irregular quarrying depths below the northern, eastern and southern parts of the lot. Reference should be made to the borehole logs and CPT plots for guidance on likely fill depths, as they are prone to rapid change over relatively short plan distances.

Below the fill is a discontinuous layer of probably moderate to high plasticity residual clay of between 0.5 m and 4 m in thickness, where present. Residual clay is only present outside of the previous quarried areas.

Underlying the clay is rock that is likely to comprise siltstone that forms part of the Bringelly Shale formation. The formation typically comprises siltstone and shale but is known to include 1 m to 2 m thick sandstone beds in the local area. The rock is initially extremely weathered grading to highly weathered and very low strength and then increasing to low strength within approximately 1 m to 2 m of the rock surface.

Depths and RLs to the top of each profile is shown in Table 5 and Table 6 below.

Table 5: Summary of Geotechnical Model - Boreholes

Material	Depth (m) and Reduced Level (m, AHD) To Top of Each Profile in Each Borehole					
	BH 101	BH102	BH103	BH104	BH105	BH106
Fill	(0) 80.8	(0) 81.1	(0) 81.2	(0) 83.0	(0) 83.0	(0) 82.0
Residual Clay	-	-	-	-	-	(4.3) 77.0
Extremely Weathered Siltstone	-	-	-	-	-	-

Where: - = Not encountered or not observed due to discontinuation of borehole

Table 6: Summary of Geotechnical Model - CPTs

Material	Depth (m) and Reduced Level (m, AHD) To Top of Each Profile in Each Borehole														
	CPT 101	CPT 102	CPT 104	CPT 105	CPT 106	CPT 107	CPT 108	CPT 109	CPT 110	CPT 111	CPT 112	CPT 113	CPT 114	CPT 115	CPT 116
Fill	(0) 83.0	(0) 82.6	(0) 81.9	(0) 81.4	(0) 80.8	(0) 79.7	(0) 80.3	(0) 80.7	(0) 79.8	(0) 80.0	(0) 80.3	(0) 80.8	(0) 81.3	(0) 81.7	(0) 83.3
Residual Clay	-	(3.2) 79.4	(4.8) 77.1	(3.8) 77.6	-	-	(4.2) 76.1	-	(8.4) 71.4	(4.0) 76.0	-	(8.2) 72.6	(10.0) 71.3	-	-
Extremely Weathered Siltstone	(13.8) 69.2	(5.1) 77.5	(5.4) 76.5	(4.3) 77.1	(6.3) 74.5	(7.8) 71.9	(5.1) 75.2	(12.3) 68.4	(8.9) 70.9	(8.0) 72.0	(5.9) 74.4	(8.7) 72.1	(11.4) 69.9	(10.1) 71.6	-

Where: - = Not encountered or not observed due to discontinuation of CPT

At some test locations the upper 0.2 m to 0.8 m was observed to be moderately compacted and contain a higher moisture content. This is likely due to ponding of water following rainfall and subsequent softening of the clay fill from exposure to weather since completion of the earthworks.

Construction on or within the underlying controlled fill, residual clays and siltstone bedrock should be relatively straightforward and significant groundwater is unlikely to be encountered during construction given the elevated site levels by comparison to surrounding ground levels and the relative shallow depths of excavation accompanying development construction.

The main geotechnical considerations that are considered to affect the design and construction of the proposed development at 3 Johnston Cresent include:

- Variation in fill depths across the site and the selection of appropriate footing types for different parts of the warehouse building.
- The effects of differential settlement due to variations in fill depths across the site and the provision of articulation or stiffened footing systems over and near rapid changes in fill thickness.
- The presence of high plasticity clay fill at or near the surface of the site following earthworks to achieve design surface levels.
- The importance of maintaining surface protections during and on completion of construction to avoid unnecessary soil erosion, although this is unlikely to be a concern given the vast site coverage by concrete pavements and floor slabs.

9.2 **Site Excavation Conditions**

It is understood that the proposed finished floor level of the warehouses is approximately RL 82.4 m AHD. The site will therefore require up to approximately 1.5 m of excavation in the south and approximately 1.5 m to 2 m of fill in the north to bulk earthworks levels of approximate RL 81.5 to RL 82 m AHD to accommodate the concrete floor slabs and external pavements. In addition, detailed excavations below bulk level will be required for pad footings and loading docks (approximately 0.5 m to 1 m depth) and the installation of services (approximately 1 m to 2 m depth). Accordingly:

- Excavation to bulk level will be within existing fill.
- Additional excavations for pad footings and loading docks will encounter controlled fill and possibly stiff and very stiff natural clays in the eastern part of Warehouse B.
- Excavations for services will predominantly encounter fill and possibly stiff and very stiff natural clays in the eastern part of Warehouse A and Warehouse B.

Excavation of the upper soil layers (natural or filled) should be readily achieved using conventional earthmoving equipment, such as tracked excavators and scrapers. Subject to the depth of excavation proposed, it is unlikely that ripping or hydraulic rock hammering will be required, accordingly there is unlikely to be any adverse effects from vibrations due to excavation work.

Excavation spoil is anticipated to be used as fill within the backfilling of temporary basins and raising of surface levels in the northern part of the site. All excess excavated material will need to be disposed of off-site in accordance with the provisions of the current legislation and guidelines, including the *Waste Classification Guidelines* (EPA, 2014).

9.3 Site Preparation

It is currently anticipated that the proposed warehouses will probably be supported by shallow spread footings founding on controlled fill or possibly natural silty clay of at least a stiff consistency. The preferred bearing stratum will depend on actual column loads, required bearing pressures and serviceability associated with total and differential settlements. External pavements will be supported by shallow subgrades formed mostly in fill and residual clay. In consideration of this, Douglas proposes the following site preparation measures:

- Remove all water from the temporary basins and discharge offsite.
- Remove all wet sediment from the base and sides of the basins and dispose offsite, or stockpile on site for later reuse as fill, if suitable once dry.
- Remove all softened (upper approximately 0.5 m) fill to expose an acceptable stripped surface and stockpile on site for later reuse as fill, if suitable once dry.
- Proof roll the exposed base of the basins and exposed stripped surface using a minimum 10 tonne smooth drum roller in non-vibration mode. The surfaces should be rolled a minimum of six times with the last two passes observed by an experienced geotechnical engineer to detect any soft or heaving areas. Remove any additional unsuitable soil identified during proof rolling.
- Compact the exposed base of the basins and approved stripped surfaces to a minimum dry density ratio of 98%, relative to Standard compaction, maintaining the moisture content to within 2% of Standard optimum moisture content (OMC).
- Commence bulk excavation of the site reusing suitable granular material as fill within the temporary basins backfill and the northern part of the site.
- Place suitable site won materials in maximum 300 mm thickness layers and compact to a minimum dry density ratio of 98%, relative to Standard compaction, maintaining the moisture content of the fill within 2% of Standard OMC.
- Place sufficient layers of fill to achieve design subgrade/foundation levels and compact as outlined above, increasing the minimum dry density ratio to 100%, relative to Standard compaction, within the upper 300 mm of the fill surface.

Geotechnical inspection and testing of the fill should be carried out in accordance with a Level 1 standard, as defined in AS3798-2007.

There is a potential for the presence of moderately to highly plastic and erodible fill soils at the site surface that may cause poor trafficability conditions when this material is exposed to wet weather. The use of a minimum 150 mm thick layer of strong, durable crushed rock fill or recycled concrete as a protective ‘running’ surface may allow ‘all-weather’ access to the site following wet weather and assist in erosion control.

9.4 Batter Slopes and Retaining Walls

During bulk excavation and earthworks, it is recommended that temporary batter slopes do not exceed 1H:1V (45 degrees) within the fill and natural clay soils for batters up to 4 m high. For permanent batters, a maximum grade of 2H:1V (26 degrees) is suggested, reducing to 3H:1V (18 degrees) if maintenance access is required (i.e. mowing, or similar).

It is unclear if retaining walls are proposed to form part of the site development beyond those required at the loading docks. If needed retaining walls may be designed based on an average unit weight of 20 kN/m^3 for controlled fill and natural clays, with a triangular earth pressure distribution calculated using an active earth pressure coefficient (K_a) value of 0.3 where some wall movement is acceptable or an 'at rest' earth pressure coefficient (K_o) value of 0.5 where wall movement is to be reduced. A coefficient of passive earth pressure (K_p) equal to 2.5 may be assumed within very stiff to hard clay and well compacted filling, to which a factor of safety must be applied in recognition of the fact that large movements are required to mobilise the full passive resistance.

The pressure distribution given above does not include hydrostatic pressure due to groundwater behind retaining walls, which should be included in the design unless adequate drainage is provided to prevent the build-up of hydrostatic pressures.

The design of batter slopes and retaining walls should account for surcharge loads, including storage of construction materials, adjacent pavements, access roads, buildings or similar. Design should also consider the effects of plant operating above the excavation and/or retaining wall during construction.

9.5 Footings

The results of the investigation have shown that the site is underlain by well compacted controlled fill with some residual clay soils and then weathered siltstone bedrock. Accordingly, it is anticipated that footings for the new warehouses will most likely comprise shallow pads founding within the upper 1 m of the controlled fill and possibly stiff and very stiff natural clays in the eastern part of Warehouse B. Alternatively, bored piles founding within the upper 1 m to 2 m of bedrock could be adopted, particularly in areas of deep fill, subject to column loads. The parameters listed in Table 7 are suggested for footing design.

Table 7: Suggested Footing Design Parameters

Soil/Rock Profile	End Bearing (kPa)		Shaft Adhesion (kPa)	
	Allowable	Ultimate	Allowable	Ultimate
Controlled Fill	150	500	15	20
Stiff / Very Stiff Clay	150	500	15	25
(Class V) Bedrock	700	3000	50	100
VLS (Class IV) Bedrock	1000	3500	100	150
LS (Class III) Bedrock	2000	6000	150	300

Notes: Values for Class V bedrock assume a minimum of 0.5 m penetration of the footing into rock. Values for Very Low Strength (VLS) and Low Strength (LS) rock are estimated. These rock conditions were not positively identified on the site.

To confirm the appropriateness of the adopted design footing parameters, it is recommended that all pad footing excavations bearing in soil are subjected to geotechnical inspection and dynamic cone penetrometer (DCP) testing during construction to verify that the listed allowable bearing pressures are available.

Shallow footings founding near excavations (service trenches or similar) must have all loads transferred below and influence line inclined upwards at 45 degrees commencing from the lowest and closest side of the excavation or trench base. Pad footings can be deepened to accommodate this load transfer or alternatively pile footing may be used. Footings founding above this line should be subject to specific geotechnical inspection during construction.

9.6 Settlements

On the basis that the site is prepared in accordance with the recommendations outlined in this report, it is anticipated that the resulting site conditions will provide an elastic settlement response below footings that is generally equal to or less than 1% of the minimum footing width. Differential settlements can be considered equal to approximately half that value. For areas of the site that contain controlled fill to depths of more than 5 m, additional creep settlements may be experienced over the life of the development. Elastic and creep settlements should be considered as cumulative.

Creep settlement occurs due to the self-weight of the fill resulting in constant high stresses that cause consolidation of lower fill layers. Creep settlements will continue for many years after the completion of the earthworks and they are directly related to the type of fill, depth of fill and the degree of compaction applied. Creep settlements can be expressed as:

$$\text{Creep Settlement} = C\alpha \times \text{filling thickness} \times \text{change in log time}$$

$C\alpha$ typically lies within the range of 0.3% to 0.5% for well compacted granular and clayey fill.

Important to the effects of creep settlement is the timing of fill placement and the change in thickness of fill across the site. From the due diligence assessment, it is known that the fill placement was completed more than one year ago. Accordingly, creep settlements occurring within the first log cycle of time (i.e. years 0 to 1) have already occurred. For a 50-year design life, ongoing creep settlements are likely to occur over 1.7 log cycles of time (i.e. years 1 to 10 and part portion of years 10 to 100).

The depth of fill identified during the investigation generally correlates with that shown on the CSR HP – Final Lot Fill Plan, Drawing No. 13044-FILL-01-1 dated 04 April 2023, presented in Appendix B. According to the Final Lot Fill Plan, the deepest fill underlying a warehouse will occur along the northern part of Warehouse A and will be in the order of 13 m to 14 m. Deep fill is also present along the southern boundary and eastern part of Warehouse B.

It is considered that creep settlements at the site can be based on an average $C\alpha$ of 0.35%. This results in an estimated creep settlement of approximately 32 mm per log cycle of time for the assumed maximum 14 m depth of fill. Table 8 provides estimates for the total creep settlements likely to occur for a 50-year development design period and a range of fill thicknesses.

Table 8: Estimates of Total Creep Settlement based on Cα = 0.35%

Fill Thickness (m)	Estimated Creep Settlement (mm) 50 Year Design Period
<5	Nil
6	6
8	18
10	30
12	42
14	54

It is important to note that any estimation of creep settlement is prone to a high degree of uncertainty. The estimates presented in Table 8 should be considered as having a potential variation of up to ±25%.

Differential settlements can be determined by calculating the difference in total creep settlements for any two given points of known fill thickness. Where fill depths change rapidly over short plan distances, differential settlements will be high. The greatest rapid change in fill depth occurs under the southern and south-western parts of Warehouse B, where differential settlements may be close to the total creep value.

To alleviate the effects of creep settlement on the structural design of buildings, floor slabs and to a lesser extent pavements, consideration could be given to stiffening footing and slab systems across site areas underlain by deep fill and the intervening fill depth transition zones.

9.7 Site Classification

The Australian Standard AS2870 *Residential Slabs and Footings* is applicable to residential dwellings and similar lightweight structures. Whilst not relevant to the specific structures proposed for this development, the characteristic ground surface movements provide useful information to designers of footing systems, slabs and pavements.

Materials testing undertaken on samples of the controlled fill within the site have identified low to medium plasticity silty clay and are considered representative of Class M to H1 soils, as defined in AS2870. Characteristic ground surface movements are therefore anticipated to be approximately 20 mm to 50 mm, hence it is considered that the site is best defined as Class H1.

9.8 Salinity

The NSW Salinity Potential map for Western Sydney indicates a moderate salinity potential category is relevant to the site. The extent of quarrying and subsequent earthworks on the site have removed or covered over most of the natural soil profile and thus the salinity potential should be based on the material properties of the controlled fill.

The results of electrical conductivity tests coupled with textural classification tests demonstrate that the materials used as controlled fill were predominantly slightly saline, except for one sample which returned a non-saline classification.

For management of salinity risk, strategies are only required for salinity levels of moderately saline and higher and are therefore there is no need for a salinity management plan for this site.

9.9 Soil Aggressivity

Provided the soils analysed represent the broader soils present at the site, then the soil conditions can be considered as being non-aggressive to buried concrete and steel elements with reference to the laboratory test results listed in Table 3 (Section 6.2) and the guidelines given within Australian Standard AS2159 (2009).

9.10 Pavements

Based on the laboratory test results listed in Table 2 (Section 7.2), and subject to earthworks and the final condition of the soils within the upper 1 m of design subgrade level, the subgrades at this site can be assigned a design CBR value of 3%. To maintain this design value, or any other amended / alternative deign CBR value, it will be necessary to prepare the subgrade soils into a well compacted condition that is free of significant adverse long-term or differential settlements and / or deflection under service loading. Verification testing should also be conducted during construction to confirm that the design CBR value has been achieved post earthworks. The pavement designer should consider the following:

- The loads applied to the various pavements over their design life, including normal road vehicle pavements, commercial in-service truck loads and possibly construction machinery loads.
- The magnitude and frequency of load repetitions of the various vehicles using each pavement.
- The need to provide edge constraints to the pavement, particularly along the crest of batters, immediately behind retaining walls and along the edge of landscaped areas.
- The position and grading of subsurface drainage lines, particularly with reference to pavement edges and internal landscaped openings (where relevant).
- Pavement surface gradients and water flow to drainage lines. One-way cross falls may be beneficial, otherwise regularly spaced and centralised drainage collection pits should be installed.
- The backfilling and compaction of service trenches, particularly below heavily loaded pavements.
- The ability of any filled subgrade to carry the load of the pavement.

In addition, a regular long-term inspection and maintenance programme should be adopted by the operator of the pavement. The maintenance programme should be primarily aimed at limiting the amount of moisture infiltrating to the subgrade (e.g. inspecting drainage lines and repairing as required, maintaining construction joints and sealing or repairing cracks as they develop).

9.11 Drainage

Subsurface and subsoil drainage should be incorporated into the pavement and floor slab designs to prevent the ingress of moisture into the pavement and sub-floor working platform layers and any subsequent weakening of the pavement and subgrade layers. Drainage design should also consider standard practices for the control of surface and subsurface soil erosion.

10. **Limitations**

Douglas Partners Pty Ltd (Douglas) has prepared this report for this project at 3 Johnston Cresent, Horsley Park in line with Douglas' proposal 86826.09.P/001.Rev0 dated 4 July 2024 and acceptance received from David Mollerstrom of ESR Australia dated 6 July 2024. The work was carried out under Douglas' Engagement Terms. This report is provided for the exclusive use of ESR Australia for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of Douglas, does so entirely at its own risk and without recourse to Douglas for any loss or damage. In preparing this report Douglas has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

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

Appendix A

About this Report

About this Report

November 2023

Introduction

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

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

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

continued next page

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

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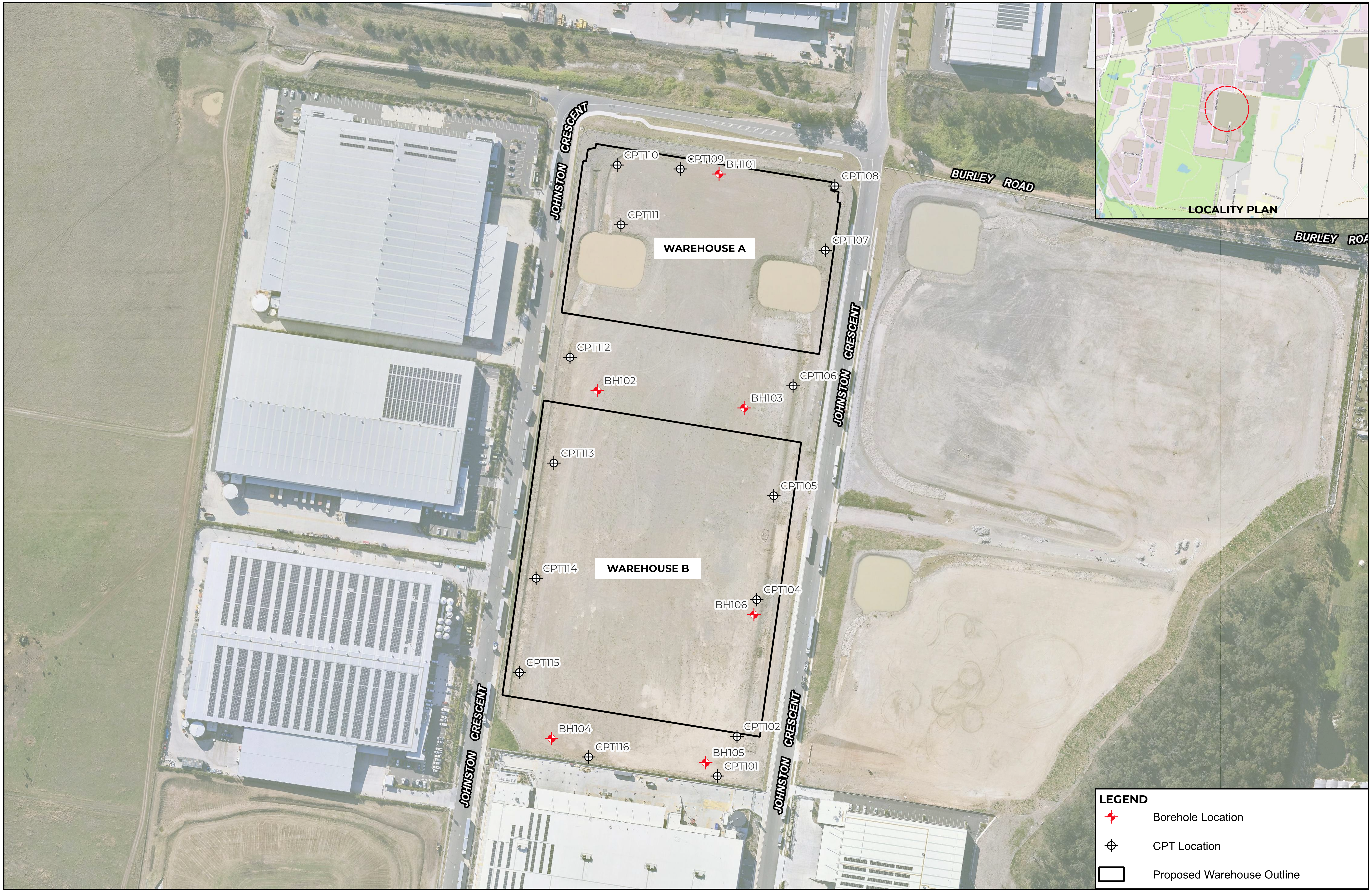
Appendix B

Drawings



REV	DESCRIPTION/COMMENT	DATE	DRAWN BY
0	INITIAL ISSUE	20.09.2024	EC

SCALE: 0 30 60 90 120 m
1:2500 @ A3

Douglas PARTNERS
OFFICE: SYDNEY
96-98 Hermitage Rd, West Ryde NSW 2114
(02)9809 0666

CLIENT:
ESR Australia

NOTE:
1: Basemap from Metromap (Dated 17.05.2024)
2: Warehouse Outlines from Nettletontribe, Reference 14092_DA0113, Issue 7 (Dated 27.08.2024)

COORDINATE REFERENCE SYSTEM: GDA2020 / MGA zone 56

PROJECT NAME:
Proposed Industrial Development

PROJECT ADDRESS:
3 Johnston Crescent, Horsley Park

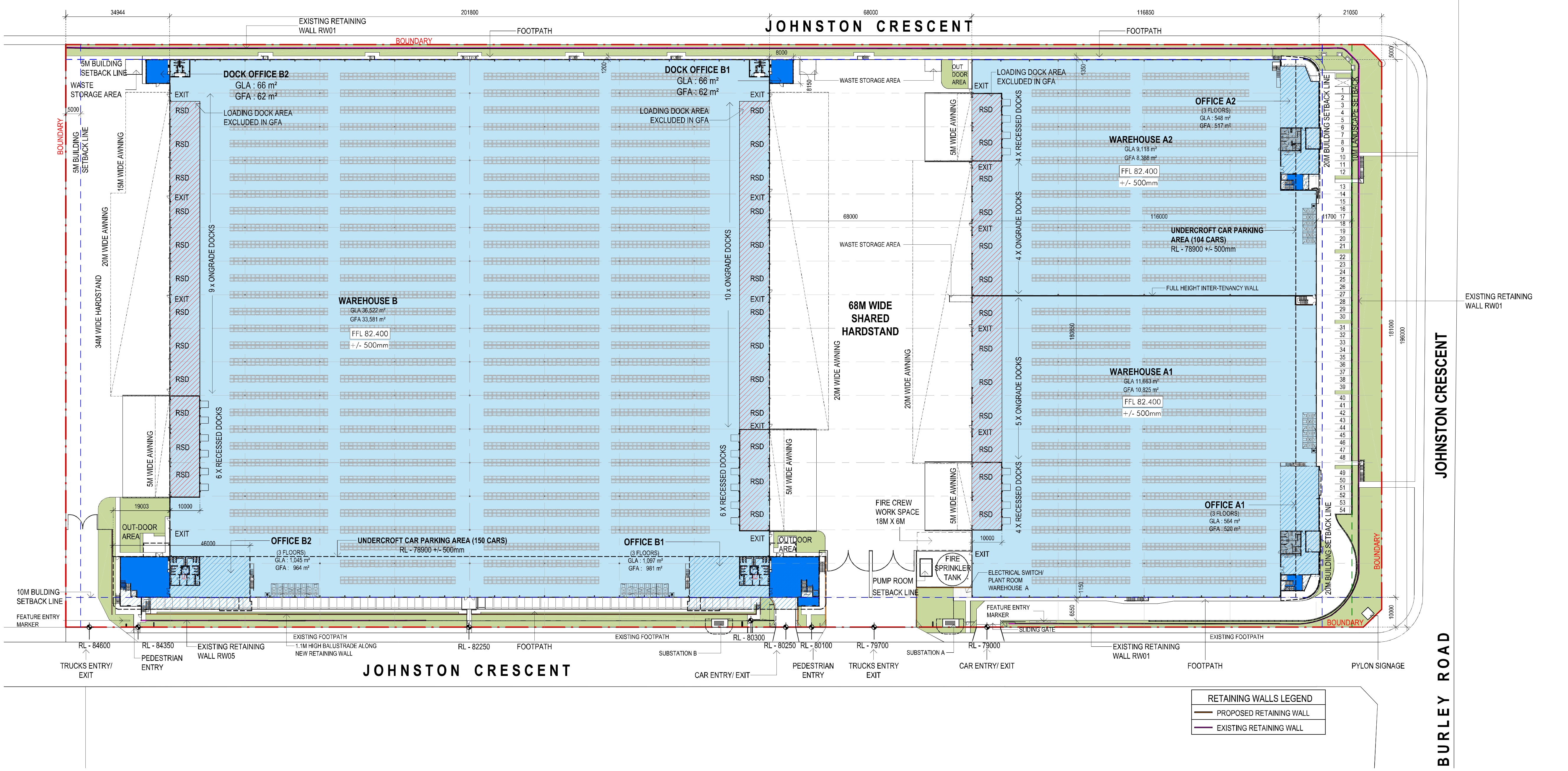
DRAWING TITLE:
Test Location Plan

PROJECT NO: **86826.09**
DRAWING NO: **1**
REVISION: **1**

DEVELOPMENT SUMMARY (GLA)	
SITE AREA	86,721 m²
TOTAL BUILDING AREA (GLA)	**60,689 m²**
SITE EFFICIENCY	70%
TOTAL WAREHOUSE AREA	57,303 m²
TOTAL OFFICES AREA	3,386 m²
BUILDING A	
WAREHOUSE A1	11,663 m²
OFFICE A1	564 m²
WAREHOUSE A2	9,118 m²
OFFICE A2	548 m²
TOTAL BUILDING AREA (GLA)	**21,893 m²**
BUILDING B	
WAREHOUSE B	36,522 m²
OFFICE B INCLUDING DOCK OFFICES INCLUDES AREAS OF BIKE STORAGE AND ELEC/ PLANT ROOMS	2,274 m²
TOTAL BUILDING AREA (GLA)	**38,796 m²**

DEVELOPMENT SUMMARY (GFA)	
TOTAL BUILDING AREA (GFA)	**55,900 m²**
FLOOR SPACE RATIO	0.64:1
TOTAL WAREHOUSE AREA EXCLUDING LOADING DOCK AREA	52,794 m²
TOTAL OFFICES AREA	3,106 m²
BUILDING A	
WAREHOUSE A1	10,825 m²
OFFICE A1	520 m²
WAREHOUSE A2	8,388 m²
OFFICE A2	517 m²
TOTAL BUILDING AREA (GFA)	**20,250 m²**
BUILDING B	
WAREHOUSE B	33,581 m²
OFFICE B INCLUDING DOCK OFFICES	2,069 m²
TOTAL BUILDING AREA (GFA)	**35,650 m²**

CAR PARKING PROVISIONS	
TOTAL CAR PARKING REQUIRED WH 1/300 M² (GFA) OFFICE 1/40 M² (GFA)	254 CARS
TOTAL CAR PARKING PROVIDED	254 CARS



1 DA_SITE PLAN
1 : 750

Client

ESR

Issue	Description	Date
7	ISSUED FOR DA	27.08.2024
6	ISSUED FOR DA	12.07.2024
5	REVISED GLA's	10.07.2024
4	ISSUED FOR SSDA	05.07.2024
3	ISSUED FOR SSDA	03.07.2024
2	ISSUED FOR COORDINATION	14.06.2024
1	DRAFT ISSUE	05.06.2024

FOR SSDA

Key Plan

Project Name
HORSLEY LOGISTICS PARK STAGE 2

Project Address
3 JOHNSTON CRESCENT, HORSLEY PARK, NSW

Bar Scales
0 15000 37500

Drawing Title:
SITE PLAN

Author:	Checker:	Sheet Size:	Scale:
AB	MC	A1	1:750

Drawing Number: **14092_DA011**
Issue: **7**

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nettleton tribe partnership pty ltd ABN 58 161 683 122
117 Willoughby Road, Crows Nest, NSW 2065
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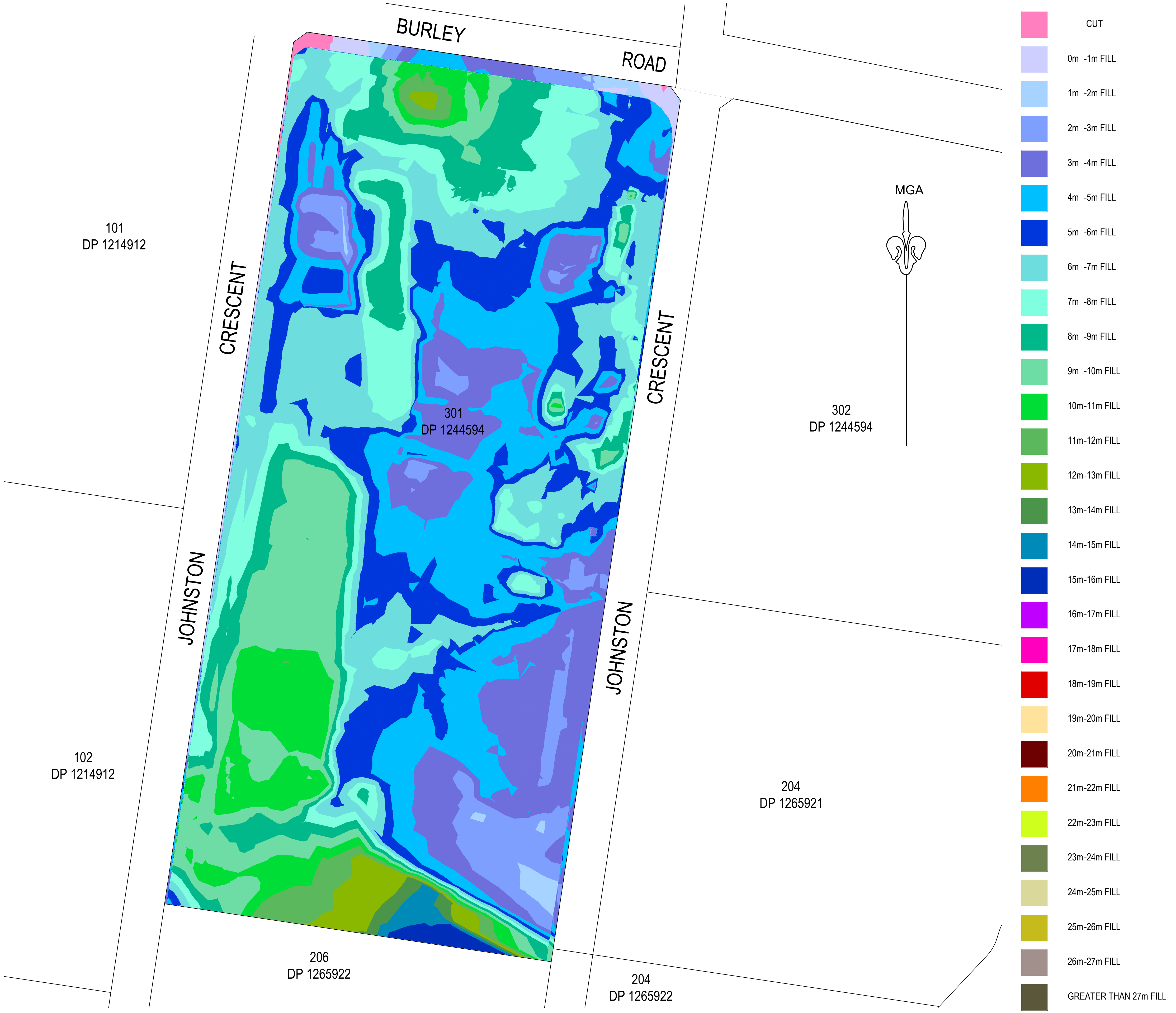

Total cut	-101.718m³
Total fill	558703.996m³
Total balance	558602.278m³

NOTES:

1. STRIP SURFACE LEVEL SURVEY BY FREEBURNS SURVEYORS PROVIDED ON 29/01/2023.
2. WAE SURFACE LEVEL SURVEYED ON 04/04/2023

		DESIGN	DRAWN	CHECK	APPD.	DATE	AMENDMENT DETAILS
FIRST ISSUE		AR	PW	KM	KM	15/03/2023	
AMENDMENTS	01	AR	PW	KM	KM	04/04/2023	

STATUS

AUTHORISED FOR ISSUE:
BY: KIM MURPHY
Registered Surveyor No.1677
SIGN: K. J. Murphy
DATE: 04/04/2023

SCALE
0 10 20 30 40 50 60 70 80
SCALE 1:1000 (A1) SCALE 1:2000 (A3)

CLIENT

calibre
 calibregroup.com

PROJECT
CSR HP - FINAL LOT FILL PLAN

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY, DO NOT SCALE. NOT FOR CONSTRUCTION UNLESS STAMPED BY CERTIFYING AUTHORITY

DRAWING TITLE
PLAN SHOWING DEPTHS OF FILL
CSR HP - FINAL

PROJECT No.	DRAWING No.	MILESTONE	REVISION
X13044-FILL	01		1

FILE: \\SYDNAS01.BROWNCAN.LOCAL\PROJECTS\X13\X13044 - CSR HORSLEY PARK\SURVEY\DRAWINGS\STG3A FILL PLAN\02_FINAL\X13044 - CSR HORSLEY PARK STG3A FILL PLAN FINAL A.DWG LAST SAVED BY:PENG WU

Appendix C

Field Work Results

Terminology, Symbols and Abbreviations

November 2023

Introduction to Terminology, Symbols and Abbreviations

Douglas Partners' reports, investigation logs, and other correspondence may use terminology which has quantitative or qualitative connotations. To remove ambiguity or uncertainty surrounding the use of such terms, the following sets of notes pages may be attached Douglas Partners' reports, depending on the work performed and conditions encountered:

- Soil Descriptions;
- Rock Descriptions; and
- Sampling, insitu testing, and drilling methodologies

In addition to these pages, the following notes generally apply to most documents.

Abbreviation Codes

Site conditions may also be presented in a number of different formats, such as investigation logs, field mapping, or as a written summary. In some of these formats textual or symbolic terminology may be presented using textual abbreviation codes or graphic symbols, and, where commonly used, these are listed alongside the terminology definition. For ease of identification in these note pages, textual codes are presented in these notes in the following style `XW`. Code usage conforms with the following guidelines:

- Textual codes are case insensitive, although herein they are generally presented in upper case; and
- Textual codes are contextual (i.e. the same or similar combinations of characters may be used in different contexts with different meanings (for example `PL` is used for plastic limit in the context of soil moisture condition, as well as in `PL(A)` for point load test result in the testing results column)).

Data Integrity Codes

Subsurface investigation data recorded by Douglas Partners is generally managed in a highly structured database environment, where records "span" between a top and bottom depth interval. Depth interval "gaps" between records are considered to introduce ambiguity, and, where appropriate, our practice guidelines may require contiguous data sets. Recording meaningful data is not always appropriate (for example assigning a "strength" to a concrete pavement) and the following codes may be used to maintain contiguity in such circumstances.

Term	Description	Abbreviation Code
Core loss	No core recovery	KL
Unknown	Information was not available to allow classification of the property. For example, when auguring in loose, saturated sand auger cuttings may not be returned.	UK
No data	Information required to allow classification of the property was not available. For example if drilling is commenced from the base of a hole predrilled by others	ND
Not Applicable	Derivation of the properties not appropriate or beyond the scope of the investigation. For example providing a description of the strength of a concrete pavement	NA

Graphic Symbols

Douglas Partners' logs contain a "graphic" column which provides a pictorial representation of the basic composition of the material. The symbols used are directly representing the material name stated in the adjacent "Description of Strata" column, and as such no specific graphic symbology legend has been provided in these notes.

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Introduction

All materials which are not considered to be "in-situ rock" are described in general accordance with the soil description model of AS 1726-2017 Part 6.1.3, and can be broken down into the following description structure:

classification | name | detailed description

(SC) Clayey SAND, trace silt; grey, fine to medium grained

The "classification" comprises a two character "group symbol" providing a general summary of dominant soil characteristics. The "name" summarises the particle sizes within the soil which most influence its behaviour. The detailed description presents more information about composition, condition, structure, and origin of the soil.

Classification, naming and description of soils require the relative proportion of particles of different sizes within the whole soil mixture to be considered.

Particle size designation and Behaviour Model

Solid particles within a soil are differentiated on the basis of size.

The engineering behaviour properties of a soil can subsequently be modelled to be either "fine grained" (also known as "cohesive" behaviour) or "coarse grained" ("non cohesive" behaviour), depending on the relative proportion of fine or coarse fractions in the soil mixture.

Particle Size Designation	Particle Size (mm)	Behaviour Model	
		Behaviour	**Approximate Dry Mass**
Boulder	>200	Excluded from particle behaviour model as "oversize"	
Cobble	63 - 200		
Gravel[1]	2.36 - 63	Coarse	>65%
Sand[1]	0.075 - 2.36		
Silt	0.002 - 0.075	Fine	>35%
Clay	<0.002		

[1] – refer grain size subdivision descriptions below

The behaviour model boundaries defined above are not precise, and the material behaviour should be assumed from the name given to the material (which considers the particle fraction which dominates the behaviour, refer "component proportions" below), rather than strict observance of the proportions of particle sizes. For example, if a material is named a "Sandy CLAY", this is indicative that the material exhibits fine grained behaviour, even if the dry mass of coarse grained material may exceed 65%.

Component proportions

The relative proportion of the dry mass of each particle size fraction is assessed to be a "primary", "secondary", or "minor" component of the soil mixture, depending on its influence over the soil behaviour.

Component Proportion Designation	Definition[1]	Relative Proportion	
		In Fine Grained Soil	**In Coarse Grained Soil**
Primary	The component (particle size designation, refer above) which dominates the engineering behaviour of the soil	The clay/silt component with the greater proportion	The sand/gravel component with the greater proportion
Secondary	Any component which is not the primary, but is significant to the engineering properties of the soil	Any component with greater than 30% proportion	Any granular component with greater than 30%; or Any fine component with greater than 12%
Minor[2]	Present in the soil, but not significant to its engineering properties	All other components	All other components

[1] As defined in AS1726-2017 6.1.4.4
[2] In the detailed material description, minor components are split into two further sub-categories. Refer "identification of minor components" below.

Composite Materials

In certain situations, a lithology description may describe more than one material, for example, collectively describing a layer of interbedded sand and clay. In such a scenario, the two materials would be described independently, with the names preceded or followed by a statement describing the arrangement by which the materials co-exist. For example, "INTERBEDDED Silty CLAY AND SAND".

Soil Descriptions

Classification

The soil classification comprises a two character group symbol. The first character identifies the primary component. The second character identifies either the grading or presence of fines in a coarse grained soil, or the plasticity in a fine grained soil. Refer AS1726-2017 6.1.6 for further clarification.

Soil Name

For most soils, the name is derived with the primary component included as the noun (in upper case), preceded by any secondary components stated in an adjective form. In this way, the soil name also describes the general composition and indicates the dominant behaviour of the material.

Component [1]	Prominence in Soil Name
Primary	Noun (eg "CLAY")
Secondary	Adjective modifier (eg "Sandy")
Minor	No influence

[1] – for determination of component proportions, refer component proportions on previous page

For materials which cannot be disaggregated, or which are not comprised of rock or mineral fragments, the names "ORGANIC MATTER" or "ARTIFICIAL MATERIAL" may be used, in accordance with AS1726-2017 Table 14.

Commercial or colloquial names are not used for the soil name where a component derived name is possible (for example "Gravelly SAND" rather than "CRACKER DUST").

Materials of "fill" or "topsoil" origin are generally assigned a name derived from the primary/secondary component (where appropriate). In log descriptions this is preceded by uppercase "FILL" or "TOPSOIL". Origin uncertainty is indicated in the description by the characters (?), with the degree of uncertainty described (using the terms "probably" or "possibly" in the origin column, or at the end of the description).

Identification of minor components

Minor components are identified in the soil description immediately following the soil name. The minor component fraction is usually preceded with a term indicating the relative proportion of the component.

Minor Component Proportion Term	Relative Proportion	
	In Fine Grained Soil	In Coarse Grained Soil
With	All fractions: 15-30%	Clay/silt: 5-12% sand/gravel: 15-30%
Trace	All fractions: 0-15%	Clay/silt: 0-5% sand/gravel: 0-15%

The terms "with" and "trace" generally apply only to gravel or fine particle fractions. Where cobbles/boulders are encountered in minor proportions (generally less than about 12%) the term "occasional" may be used. This term describes the sporadic distribution of the material within the confines of the investigation excavation only, and there may be considerable variation in proportion over a wider area which is difficult to factually characterise due to the relative size of the particles and the investigation methods.

Soil Composition

Plasticity

Descriptive Term	Laboratory liquid limit range	
	Silt	Clay
Non-plastic materials	Not applicable	Not applicable
Low plasticity	≤50	≤35
Medium plasticity	Not applicable	>35 and ≤50
High plasticity	>50	>50

Note, Plasticity descriptions generally describe the plasticity behaviour of the whole of the fine grained soil, not individual fine grained fractions.

Grain Size

Type		Particle size (mm)
Gravel	Coarse	19 - 63
	Medium	6.7 - 19
	Fine	2.36 – 6.7
Sand	Coarse	0.6 - 2.36
	Medium	0.21 - 0.6
	Fine	0.075 - 0.21

Grading

Grading Term	Particle size (mm)
Well	A good representation of all particle sizes
Poorly	An excess or deficiency of particular sizes within the specified range
Uniformly	Essentially of one size
Gap	A deficiency of a particular size or size range within the total range

Note, AS1726-2017 provides terminology for additional attributes not listed here.

Soil Descriptions

Soil Condition

Moisture

The moisture condition of soils is assessed relative to the plastic limit for fine grained soils, while for coarse grained soils it is assessed based on the appearance and feel of the material. The moisture condition of a material is considered to be independent of stratigraphy (although commonly these are related), and this data is presented in its own column on logs.

Applicability	Term	Tactile Assessment	Abbreviation code
Fine	Dry of plastic limit	Hard and friable or powdery	w<PL
	Near plastic limit	Can be moulded	w=PL
	Wet of plastic limit	Water residue remains on hands when handling	w>PL
	Near liquid limit	"oozes" when agitated	w=LL
	Wet of liquid limit	"oozes"	w>LL
Coarse	Dry	Non-cohesive and free running	D
	Moist	Feels cool, darkened in colour, particles may stick together	M
	Wet	Feels cool, darkened in colour, particles may stick together, free water forms when handling	W

The abbreviation code NDF, meaning "not-assessable due to drilling fluid use" may also be used.

Note, observations relating to free ground water or drilling fluids are provided independent of soil moisture condition.

Consistency/Density/Compaction/Cementation/Extremely Weathered Material

These concepts give an indication of how the material may respond to applied forces (when considered in conjunction with other attributes of the soil). This behaviour can vary independent of the composition of the material, and on logs these are described in an independent column and are generally mutually exclusive (i.e it is inappropriate to describe both consistency and compaction at the same time). The method by which the behaviour is described depends on the behaviour model and other characteristics of the soil as follows:

- In fine grained soils, the "consistency" describes the ease with which the soil can be remoulded, and is generally correlated against the materials undrained shear strength;
- In granular materials, the relative density describes how tightly packed the particles are, and is generally correlated against the density index;
- In anthropogenically modified materials, the compaction of the material is described qualitatively;
- In cemented soils (both natural and anthropogenic), the cemented "strength" is described qualitatively, relative to the difficulty with which the material is disaggregated; and
- In soils of extremely weathered material origin, the engineering behaviour may be governed by relic rock features, and expected behaviour needs to be assessed based the overall material description.

Quantitative engineering performance of these materials may be determined by laboratory testing or estimated by correlated field tests (for example penetration or shear vane testing). In some cases, performance may be assessed by tactile or other subjective methods, in which case investigation logs will show the estimated value enclosed in round brackets, for example (VS).

Consistency (fine grained soils)

Consistency Term	Tactile Assessment	Undrained Shear Strength (kPa)	Abbreviation Code
Very soft	Extrudes between fingers when squeezed	<12	VS
Soft	Mouldable with light finger pressure	>12 - ≤25	S
Firm	Mouldable with strong finger pressure	>25 - ≤50	F
Stiff	Cannot be moulded by fingers	>50 - ≤100	St
Very stiff	Indented by thumbnail	>100 - ≤200	VSt
Hard	Indented by thumbnail with difficulty	>200	H
Friable	Easily crumbled or broken into small pieces by hand	-	Fr

Relative Density (coarse grained soils)

Relative Density Term	Density Index	Abbreviation Code
Very loose	<15	VL
Loose	>15 - ≤35	L
Medium dense	>35 - ≤65	MD
Dense	>65 - ≤85	D
Very dense	>85	VD

Note, tactile assessment of relative density is difficult, and generally requires penetration testing, hence a tactile assessment guide is not provided.

Soil Descriptions

Compaction (anthropogenically modified soil)

Compaction Term	Abbreviation Code
Well compacted	WC
Poorly compacted	PC
Moderately compacted	MC
Variably compacted	VC

Cementation (natural and anthropogenic)

Cementation Term	Abbreviation Code
Moderately cemented	MOD
Weakly cemented	WEK

Extremely Weathered Material

AS1726-2017 considers weathered material to be soil if the unconfined compressive strength is less than 0.6 MPa (i.e. less than very low strength rock). These materials may be identified as "extremely weathered material" in reports and by the abbreviation code XWM on log sheets. This identification is not correlated to any specific qualitative or quantitative behaviour, and the engineering properties of this material must therefore be assessed according to engineering principles with reference to any relic rock structure, fabric, or texture described in the description.

Soil Origin

Term	Description	Abbreviation Code
Residual	Derived from in-situ weathering of the underlying rock	RS
Extremely weathered material	Formed from in-situ weathering of geological formations. Has strength of less than 'very low' as per as1726 but retains the structure or fabric of the parent rock.	XWM
Alluvial	Deposited by streams and rivers	ALV
Fluvial	Deposited by channel fill and overbank (natural levee, crevasse splay or flood basin)	FLV
Estuarine	Deposited in coastal estuaries	EST
Marine	Deposited in a marine environment	MAR
Lacustrine	Deposited in freshwater lakes	LAC
Aeolian	Carried and deposited by wind	AEO
Colluvial	Soil and rock debris transported down slopes by gravity	COL
Slopewash	Thin layers of soil and rock debris gradually and slowly deposited by gravity and possibly water	SW
Topsoil	Mantle of surface soil, often with high levels of organic material	TOP
Fill	Any material which has been moved by man	FILL
Littoral	Deposited on the lake or seashore	LIT
Unidentifiable	Not able to be identified	UID

Cobbles and Boulders

The presence of particles considered to be "oversize" may be described using one of the following strategies:

- Oversize encountered in a minor proportion (when considered relative to the wider area) are noted in the soil description; or
- Where a significant proportion of oversize is encountered, the cobbles/boulders are described independent of the soil description, in a similar manner to composite soils (described above) but qualified with "MIXTURE OF".

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Rock Strength

Rock strength is defined by the unconfined compressive strength, and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index $I_{s(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

Strength Term	Unconfined Compressive Strength (MPa)	Point Load Index[1] $I_{s(50)}$ MPa	Abbreviation Code
Very low	0.6 - 2	0.03 - 0.1	VL
Low	2 - 6	0.1 - 0.3	L
Medium	6 - 20	0.3 - 1.0	M
High	20 - 60	1 - 3	H
Very high	60 - 200	3 - 10	VH
Extremely high	>200	>10	EH

[1] Rock strength classification is based on UCS. The UCS to $I_{s(50)}$ ratio varies significantly for different rock types and specific ratios may be required for each site. The point load Index ranges shown above are as suggested in AS1726 and should not be relied upon without supporting evidence.

The following abbreviation codes are used for soil layers or seams of material "within rock" but for which the equivalent UCS strength is less than 0.6 MPa.

Scenario	Abbreviation Code
The material encountered has an equivalent UCS strength of less than 0.6 MPa, and therefore is considered to be soil (as per Note 1 of Table 20 of AS 1726-2017). The properties of the material encountered over this interval are described in the "Description of Strata" and soil properties columns.	SOIL
The material encountered has an equivalent UCS strength of less than 0.6 MPa, and therefore is considered to be soil (as per Note 1 of Table 20 of AS 1726-2017). The prominence of the material is such that it can be considered to be a seam (as defined in Table 22 of AS1726-2017) and the properties of the material are described in the defect column.	SEAM

Degree of Weathering

The degree of weathering of rock is classified as follows:

Weathering Term	Description	Abbreviation Code
Residual Soil[1]	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.	RS
Extremely weathered[1]	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible	XW
Highly weathered	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching or may be decreased due to deposition of weathering products in pores.	HW
Moderately weathered	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable but shows little or no change of strength from fresh rock.	MW
Slightly weathered	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.	SW
Fresh	No signs of decomposition or staining.	FR
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.	DW

[1] The parent rock type, of which the residual/extremely weathered material is a derivative, will be stated in the description (where discernible).

Rock Descriptions

Degree of Alteration

The degree of alteration of the rock material (physical or chemical changes caused by hot gasses or liquids at depth) is classified as follows:

Term	Description	Abbreviation Code
Extremely altered	Material is altered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.	XA
Highly altered	The whole of the rock material is discoloured, usually by staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is changed by alteration. Some primary minerals are altered to clay minerals. Porosity may be increased by leaching or may be decreased due to precipitation of secondary materials in pores.	HA
Moderately altered	The whole of the rock material is discoloured, usually by staining or bleaching to the extent that the colour of the original rock is not recognisable but shows little or no change of strength from fresh rock.	MA
Slightly altered	Rock is slightly discoloured but shows little or no change of strength from fresh rock	SA
Note: If HA and MA cannot be differentiated use DA (see below)		
Distinctly altered	Rock strength usually changed by alteration. The rock may be highly discoloured, usually by staining or bleaching. Porosity may be increased by leaching or may be decreased due to precipitation of secondary minerals in pores.	DA

Degree of Fracturing

The following descriptive classification apply to the spacing of natural occurring fractures in the rock mass. It includes bedding plane partings, joints and other defects, but excludes drilling breaks. These terms are generally not required on investigation logs where fracture spacing is presented as a histogram, and where used are presented in an unabbreviated format.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD }\% = \frac{\text{cumulative length of 'sound' core sections} > 100\text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or stronger. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e., drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

These terms may be used to describe the spacing of bedding partings in sedimentary rocks. Where used, these terms are generally presented in an unabbreviated format

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Rock Descriptions

Defect Descriptions

Defect Type

Term	Abbreviation Code
Bedding plane	B
Cleavage	CL
Crushed seam	CS
Crushed zone	CZ
Drilling break	DB
Decomposed seam	DS
Drill lift	DL
Extremely Weathered seam	EW
Fault	F
Fracture	FC
Fragmented	FG
Handling break	HB
Infilled seam	IS
Joint	JT
Lamination	LAM
Shear seam	SS
Shear zone	SZ
Vein	VN
Mechanical break	MB
Parting	P
Sheared Surface	S

Rock Defect Orientation

Term	Abbreviation Code
Horizontal	H
Vertical	V
Sub-horizontal	SH
Sub-vertical	SV

Rock Defect Coating

Term	Abbreviation Code
Clean	CN
Coating	CT
Healed	HE
Infilled	INF
Stained	SN
Tight	TI
Veneer	VNR

Rock Defect Infill

Term	Abbreviation Code
Calcite	CA
Carbonaceous	CBS
Clay	CLAY
Iron oxide	FE
Manganese	MN
Pyrite	Py
Secondary material	MS
Silt	M
Quartz	Qz
Unidentified material	MU

Rock Defect Shape/Planarity

Term	Abbreviation Code
Curved	CU
Discontinuous	DIS
Irregular	IR
Planar	PR
Stepped	ST
Undulating	UN

Rock Defect Roughness

Term	Abbreviation Code
Polished	PO
Rough	RF
Smooth	SM
Slickensided	SL
Very rough	VR

Defect Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

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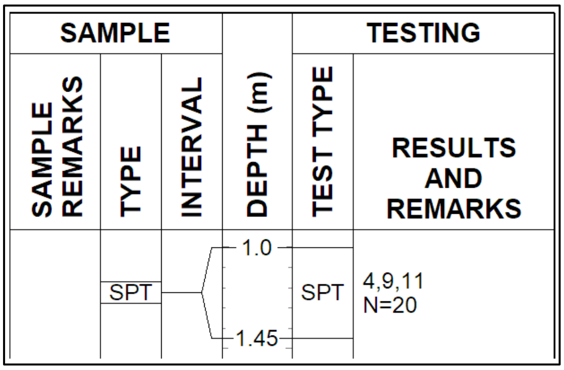
Sampling and Testing

A record of samples retained, and field testing performed is usually shown on a Douglas Partners' log with samples appearing to the left of a depth scale, and selected field and laboratory testing (including results, where relevant) appearing to the right of the scale, as illustrated below:



Sampling

The type or intended purpose for which a sample was taken is indicated by the following abbreviation codes.

Sample Type	Code
Auger sample	A
Acid Sulfate sample	ASS
Bulk sample	B
Core sample	C
Disturbed sample	D
Environmental sample	ES
Gas sample	G
Piston sample	P
Sample from SPT test	SPT
Undisturbed tube sample	U[1]
Water sample	W
Material Sample	MT
Core sample for unconfined compressive strength testing	UCS

[1] – numeric suffixes indicate tube diameter/width in mm

The above codes only indicate that a sample was retained, and not that testing was scheduled or performed.

Field and Laboratory Testing

A record that field and laboratory testing was performed is indicated by the following abbreviation codes.

Test Type	Code
Pocket penetrometer (kPa)	PP
Photo ionisation detector (ppm)	PID
Standard Penetration Test x/y =*x* blows for *y* mm penetration HB = hammer bouncing HW = fell under weight of hammer	SPT
Shear vane (kPa)	V
Unconfined compressive strength, (MPa)	UCS

Field and laboratory testing (continued)

Test Type	Code
Point load test, (MPa), axial (A), diametric (D), irregular (I)	PLT(_)
Dynamic cone penetrometer, followed by blow count penetration increment in mm (cone tip, generally in accordance with AS1289.6.3.2)	DCP/150
Perth sand penetrometer, followed by blow count penetration increment in mm (flat tip, generally in accordance with AS1289.6.3.3)	PSP/150

Groundwater Observations

▷	seepage/inflow
▽	standing or observed water level
NFGWO	no free groundwater observed
OBS	observations obscured by drilling fluids

Drilling or Excavation Methods/Tools

The drilling/excavation methods used to perform the investigation may be shown either in a dedicated column down the left-hand edge of the log, or stated in the log footer. In some circumstances abbreviation codes may be used.

Method	Abbreviation Code
Direct Push	DP
Solid flight auger. Suffixes: /T = tungsten carbide tip, /V = v-shaped tip	AD[1]
Air Track	AT
Diatube	DT[1]
Hand auger	HA[1]
Hand tools (unspecified)	HAND
Existing exposure	X
Hollow flight auger	HSA[1]
HQ coring	HQ3
HMLC series coring	HMLC
NMLC series coring	NMLC
NQ coring	NQ3
PQ coring	PQ3
Predrilled	PD
Push tube	PT[1]
Ripping tyne/ripper	R
Rock roller	RR[1]
Rock breaker/hydraulic hammer	EH
Sonic drilling	SON[1]
Mud/blade bucket	MB[1]
Toothed bucket	TB[1]
Vibrocore	VC[1]
Vacuum excavation	VE
Wash bore (unspecified bit type)	WB[1]

[1] – numeric suffixes indicate tool diameter/width in mm

Cone Penetration Testing

November 2023

Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

- Cone tip resistance q_c
- Sleeve friction f_s
- Inclination (from vertical) i
- Depth below ground z

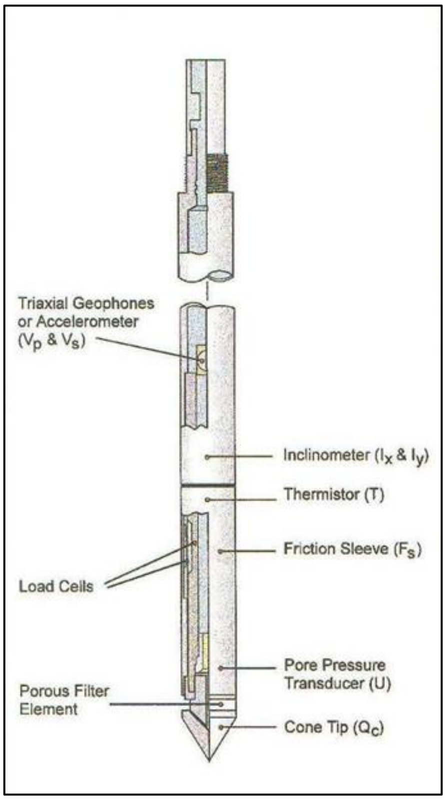


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.

Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Type	Measures
Standard	Basic parameters (qc, fs, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (□) plus basic parameters
Seismic	Shear wave velocity (Vs), compression wave velocity (Vp), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration testing

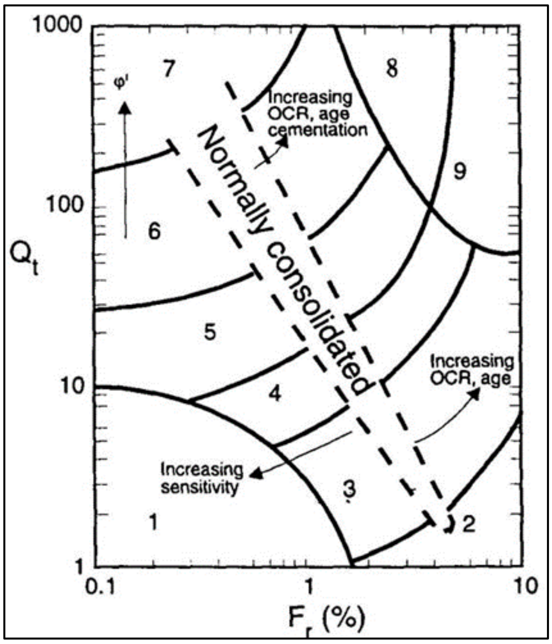


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation.

The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G0. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

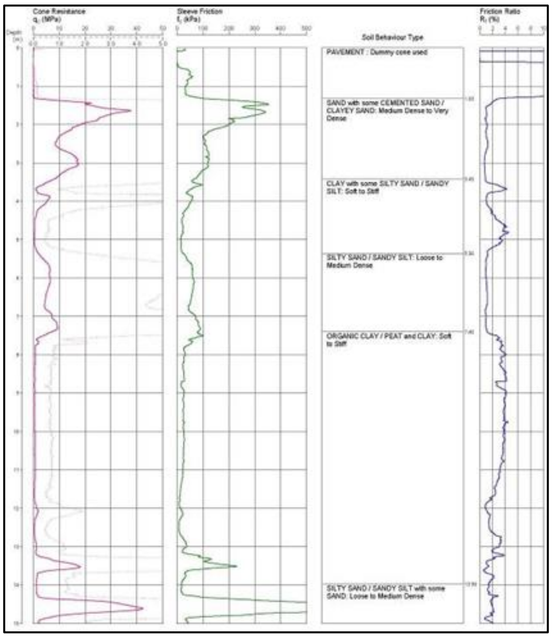


Figure 4: Sample Cone Plot

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BOREHOLE LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: Johnston Crescent, Horsley Park, NSW

SURFACE LEVEL: 80.8 AHD
COORDINATE: E:298637.3, N:6254805.1
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH101
PROJECT No: 86826.09
DATE: 12/07/24
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
12/07/24 NFGWO		0.00	FILL / Gravelly CLAY, with silt: brown; medium plasticity; fine to coarse, siltstone and sandstone gravel; trace brick fragments.		FILL	WC	w<PL		A	0.00–0.10	0.10		
									A	0.40–0.50	0.40, 0.50		
	80												
		1							B	0.90–1.50	0.90, 1.00	SPT	6,15,12 N=27
									A	1.00 (approx.)	1.50		
	79	2									2		
	78											SPT	3,12,14 N=26
		3									3		
	77	4									4	SPT	7,9,9 N=18
	76	5.00	Borehole discontinued at 5.00m depth. Target depth reached.										

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

PLANT: Bobcat
OPERATOR: Ground Test (CS)
LOGGED: JM
METHOD: AD/T to 5.0 m
CASING: Uncased
REMARKS: No free groundwater observed whilst augering.

Refer to explanatory notes for symbol and abbreviation definitions

BOREHOLE LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: Johnston Crescent, Horsley Park, NSW

SURFACE LEVEL: 81.1 AHD
COORDINATE: E:298552.5, N:6254654.4
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH102
PROJECT No: 86826.09
DATE: 12/07/24
SHEET: 1 of 1

Groundwater	RL (m)	Depth (m)	Description of Strata	Graphic	Origin(#)	Consis.(*) / Density(*)	Moisture	Remarks	Sample Type	Interval / Depth (m)	Test Type	Results and Remarks
12/07/24 NFGWO	81	0.00–5.00	FILL / Gravelly CLAY: brown; medium plasticity; fine to coarse, siltstone and sandstone gravel; trace brick fragments.		FILL	MC (0.00–2.50); WC (2.50–5.00)	w=PL (0.00–0.80); w<PL (0.80–5.00)		A	0.10		
									A	0.40–0.50		
	80	1							B	0.50–1.50		
									A	0.90–1.00	SPT	6,5,8 N=13
	79	2										
											SPT	5,11,13 N=24
	78	3										
	77	4									SPT	12,11,10 N=21
		5.00	Borehole discontinued at 5.00m depth. Target depth reached.									

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

PLANT: Bobcat
METHOD: AD/T to 5.0 m
REMARKS: No free groundwater observed whilst augering.

OPERATOR: Ground Test (CS)

LOGGED: JM
CASING: Uncased

Refer to explanatory notes for symbol and abbreviation definitions

BOREHOLE LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: Johnston Crescent, Horsley Park, NSW

SURFACE LEVEL: 81.2 AHD
COORDINATE: E:298654.8, N:6254642.3
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH103
PROJECT No: 86826.09
DATE: 12/07/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED									SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
12/07/24 NFGWO	81	0.00	FILL / Gravelly CLAY: brown; medium plasticity; fine to coarse, siltstone and sandstone gravel; trace brick fragments.		FILL	MC	w=PL		A		0.10		
							w<PL		A		0.40–0.50		
	80	1							B		0.90–1.50		
									A		1.00	SPT	3,5,6 N=11
	79	2											
											2.50	SPT	3,6,8 N=14
	78	3											
	77	4				WC					4.00	SPT	7,8,9 N=17
		5.00	Borehole discontinued at 5.00m depth. Target depth reached.										

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

PLANT: Bobcat
METHOD: AD/T to 5.0 m
REMARKS: No free groundwater observed whilst augering.

OPERATOR: Ground Test (CS)

LOGGED: JM
CASING: Uncased

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

BOREHOLE LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: Johnston Crescent, Horsley Park, NSW

SURFACE LEVEL: 83.0 AHD
COORDINATE: E:298520.8, N:6254412.2
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH104
PROJECT No: 86826.09
DATE: 12/07/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED								SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
12/07/24 NFGWO			FILL / Gravelly CLAY, with silt: brown; fine to coarse, siltstone and sandstone gravel; trace brick fragments.		FILL	WC	w<PL		A		0.10		
									A		0.40 – 0.50		
	82	1							B		0.90 – 1.50	SPT	10,8,17 N=25
									A		1.00 – 1.50		
	81	2											
	80	3										SPT	14,14,9 N=23
	79	4										SPT	5,11,12 N=23
		5	Borehole discontinued at 5.00m depth. Target depth reached.										

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

PLANT: Bobcat
OPERATOR: Ground Test (CS)
LOGGED: JM
METHOD: AD/T to 5.0 m
CASING: Uncased
REMARKS: No free groundwater observed whilst augering.

Refer to explanatory notes for symbol and abbreviation definitions

BOREHOLE LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: Johnston Crescent, Horsley Park, NSW

SURFACE LEVEL: 83.0 AHD
COORDINATE: E:298628.0, N:6254395.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°

LOCATION ID: BH105
PROJECT No: 86826.09
DATE: 12/07/24
SHEET: 1 of 1

GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN(#)	CONSIS.(*) / DENSITY.(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
12/07/24 NFGWO			FILL / Gravelly CLAY, with silt: brown; medium plasticity; fine to coarse, siltstone and sandstone gravel; trace brick fragments.		FILL	WC	w<PL		A		0.10		
									A		0.40 – 0.50		
	82	1							B		0.90 – 1.50		
											1.00	SPT	7,10,10 N=20
									A		1.50		
	81	2									2		
												SPT	3,13,12 N=25
	80	3									3		
	79	4									4	SPT	8,21,16 N=37
	78		Borehole discontinued at 5.00m depth. Target depth reached.										

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

PLANT: Bobcat
METHOD: AD/T to 5.0 m
REMARKS: No free groundwater observed whilst augering.

OPERATOR: Ground Test (CS)

LOGGED: JM
CASING: Uncased

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

BOREHOLE LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: Johnston Crescent, Horsley Park, NSW
SURFACE LEVEL: 82.0 AHD
COORDINATE: E:298661.6, N:6254498.5
DATUM/GRID: MGA2020 Zone 56
DIP/AZIMUTH: 90°/---°
LOCATION ID: BH106
PROJECT No: 86826.09
DATE: 12/07/24
SHEET: 1 of 1

Groundwater	RL (m)	Depth (m)	Description of Strata	Graphic	Origin(#)	Consis.(*) / Density(*)	Moisture	Sample Remarks	Sample Type	Sample Depth (m)	Test Type	Results and Remarks
12/07/24 NFGWO		0.00	FILL / Gravelly CLAY: brown; medium plasticity; fine to coarse, siltstone and sandstone gravel; trace brick fragments.		FILL		MC (to ~2.5 m); w<PL; WC		A	0.10		
									A	0.40–0.50		
	81	1							B	0.90–1.50		
											SPT (1.00)	4,6,9 N=15
									A	1.00–1.50		
	80	2										
											SPT	6,19,14 N=33
	79	3										
	78	4									SPT	6,5,7 N=12
		4.30	CLAY (CI-CH), trace gravel: mottled pale grey and red; medium to high plasticity; fine, ironstone gravel.		RS	St						
	77	5.00	Borehole discontinued at 5.00m depth. Target depth reached.									

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

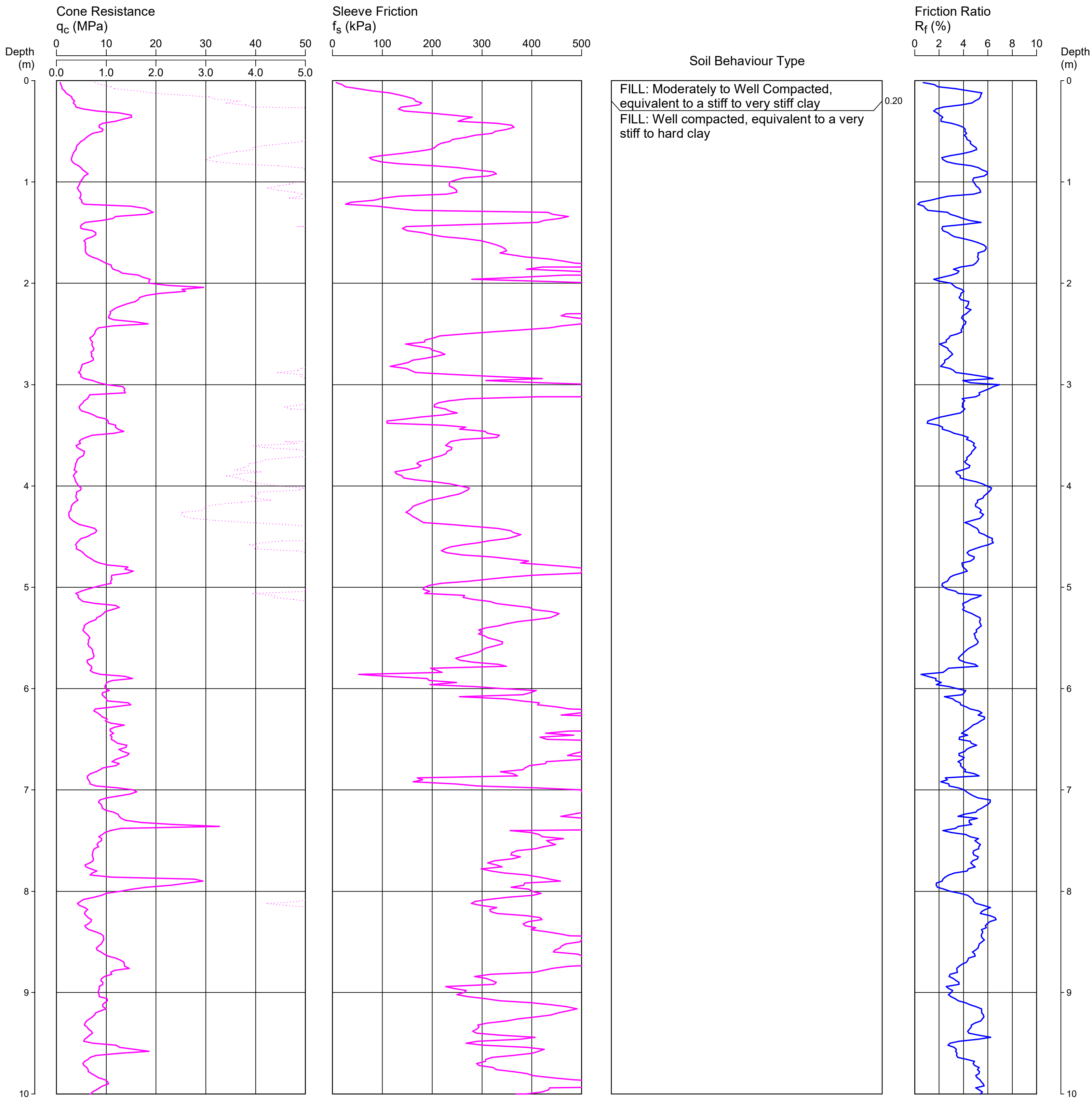
PLANT: Bobcat
OPERATOR: Ground Test (CS)
LOGGED: JM
METHOD: AD/T to 5.0 m
CASING: Uncased
REMARKS: No free groundwater observed whilst augering.

Refer to explanatory notes for symbol and abbreviation definitions

Douglas PARTNERS

CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA	**LOCATION:** LOT 301 JOHNSTON CRES, HORSLEY PARK	**CPT101** Page 1 of 2
PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT	**REDUCED LEVEL:** 83.0	**DATE** 12/07/2024
	COORDINATES: 298636.1E 6254386.2N MGA2020	**PROJECT No:** 86826.09



REMARKS: TEST DISCONTINUED DUE TO BENDING ON FILLING
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT101.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: LOT 301 JOHNSTON CRES, HORSLEY PARK

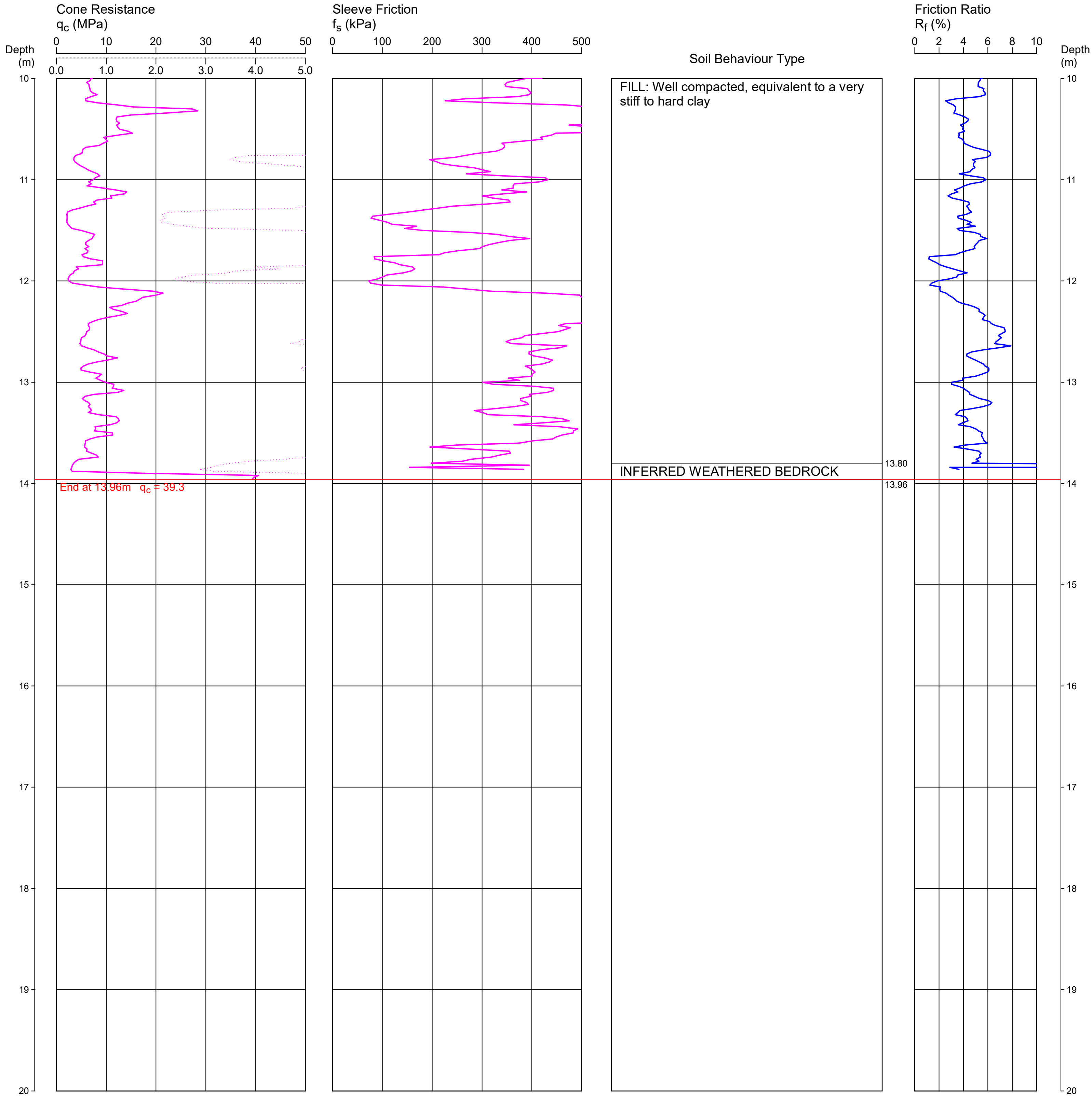
REDUCED LEVEL: 83.0

COORDINATES: 298636.1E 6254386.2N MGA2020

CPT101

DATE 12/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO BENDING ON FILLING
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT101.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: LOT 301 JOHNSTON CRES, HORSLEY PARK

REDUCED LEVEL: 82.6

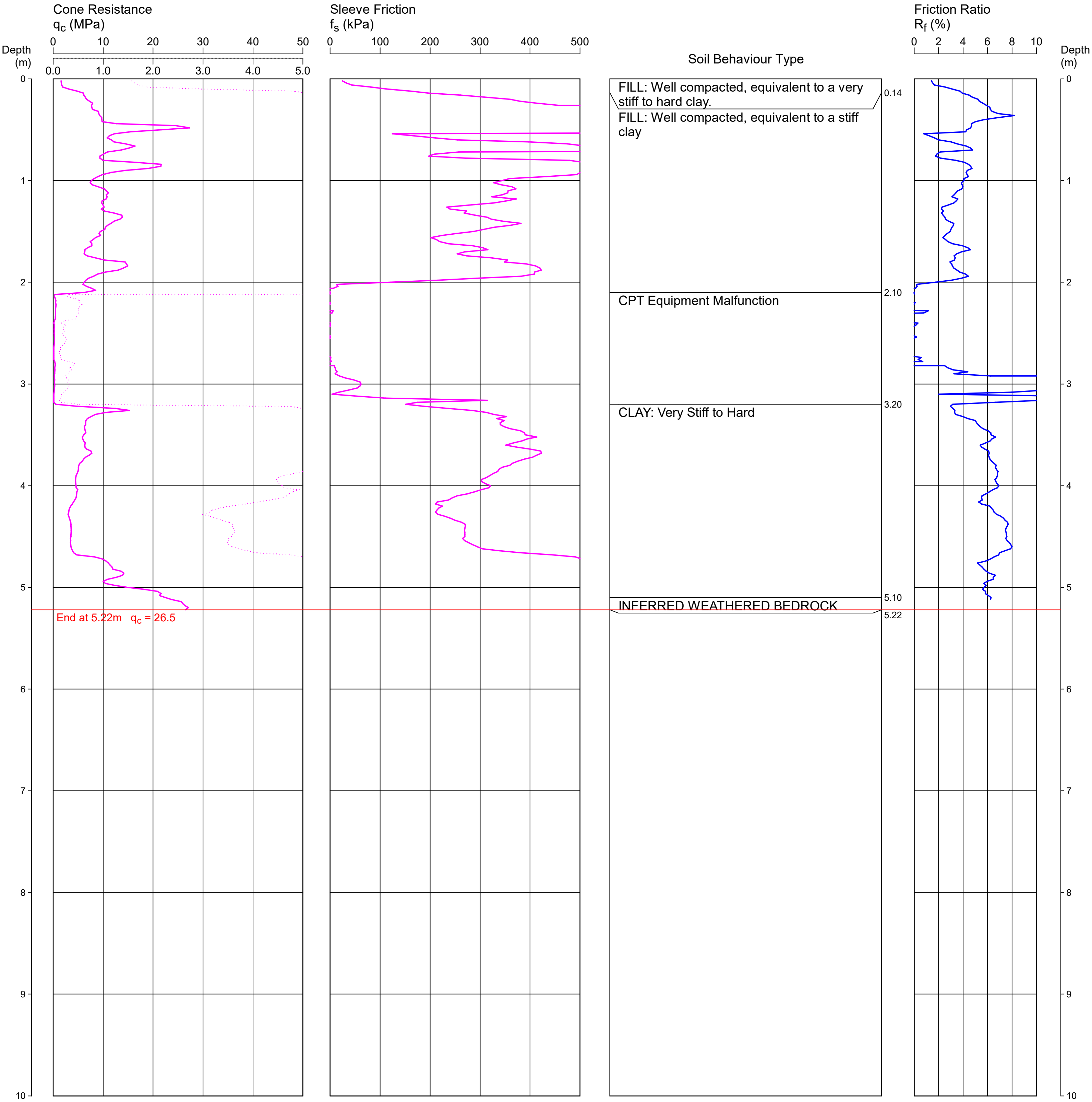
COORDINATES: 298649.8E 6254413.7N MGA2020

CPT102

Page 1 of 1

DATE 12/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON (or NEAR) INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT102.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: LOT 301 JOHNSTON CRES, HORSLEY PARK

REDUCED LEVEL: 81.9

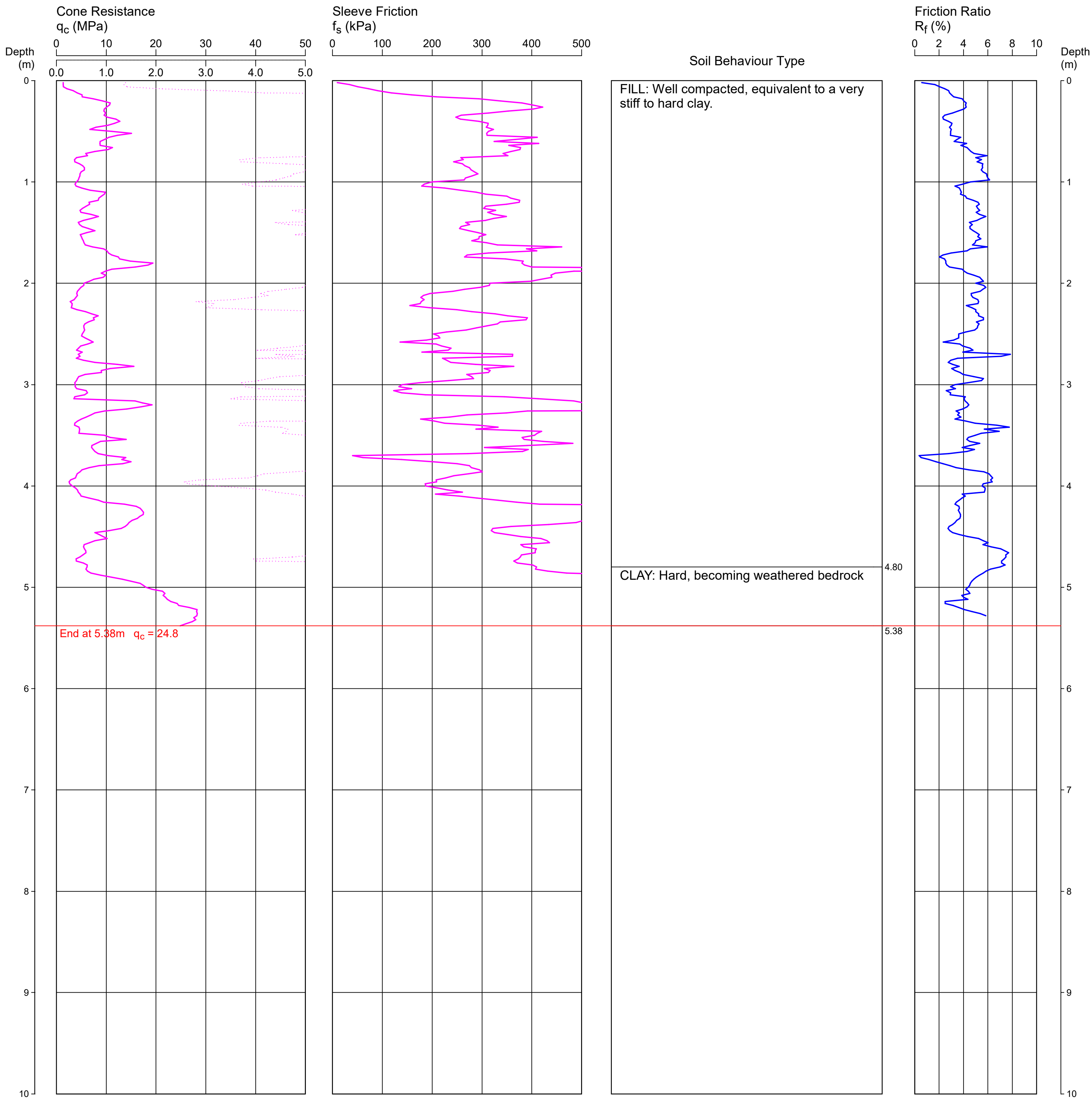
COORDINATES: 298663.5E 6254508.9N MGA2020

CPT104

Page 1 of 1

DATE 12/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON (or NEAR) INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT104.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: LOT 301 JOHNSTON CRES, HORSLEY PARK

REDUCED LEVEL: 81.4

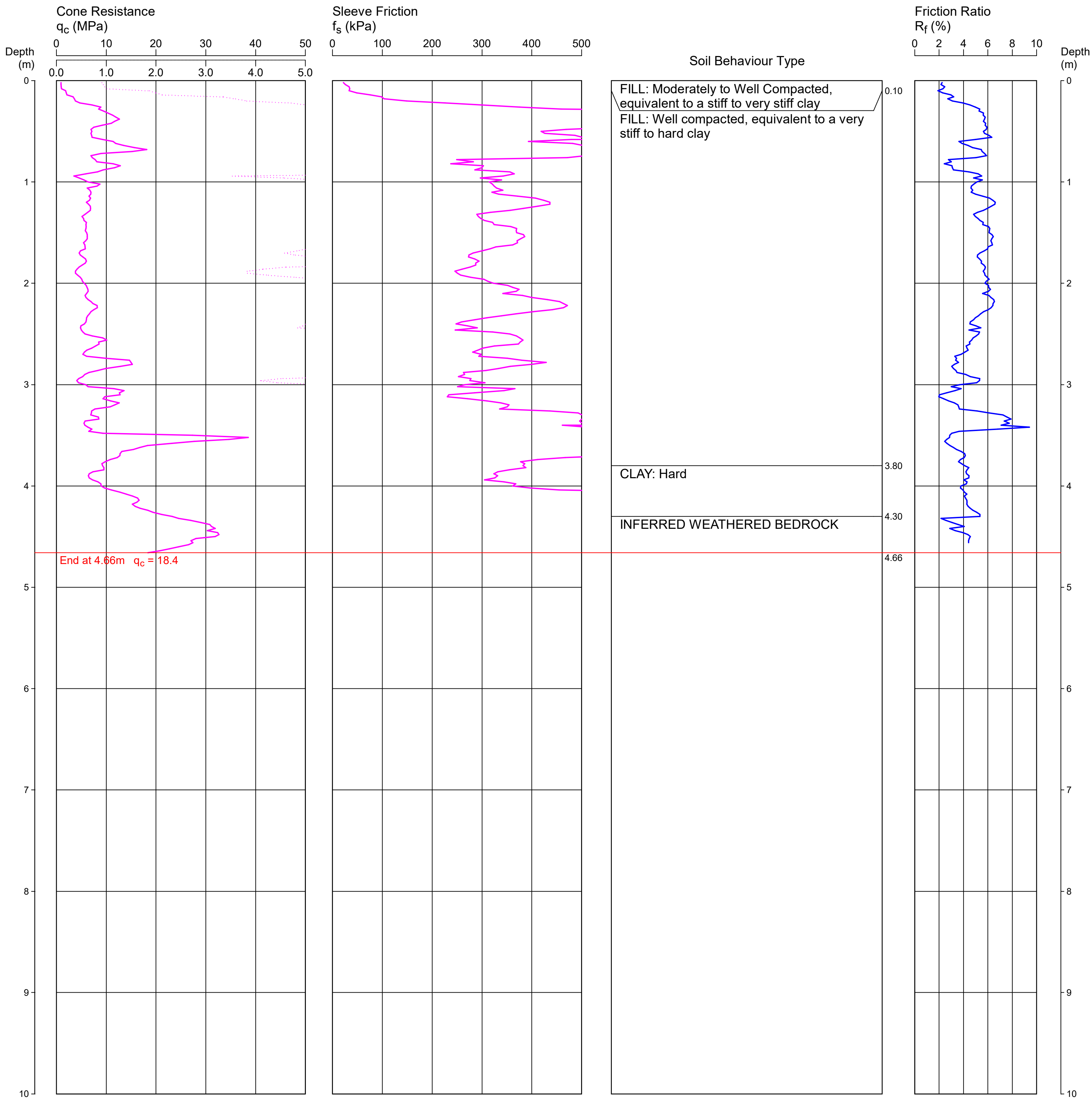
COORDINATES: 298675.4E 6254581.2N MGA2020

CPT105

Page 1 of 1

DATE 12/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO BENDING ON (or NEAR) INFERRED WEATHERED
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT105B.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: JOHNSTON CRESCENT, HORSLEY PARK

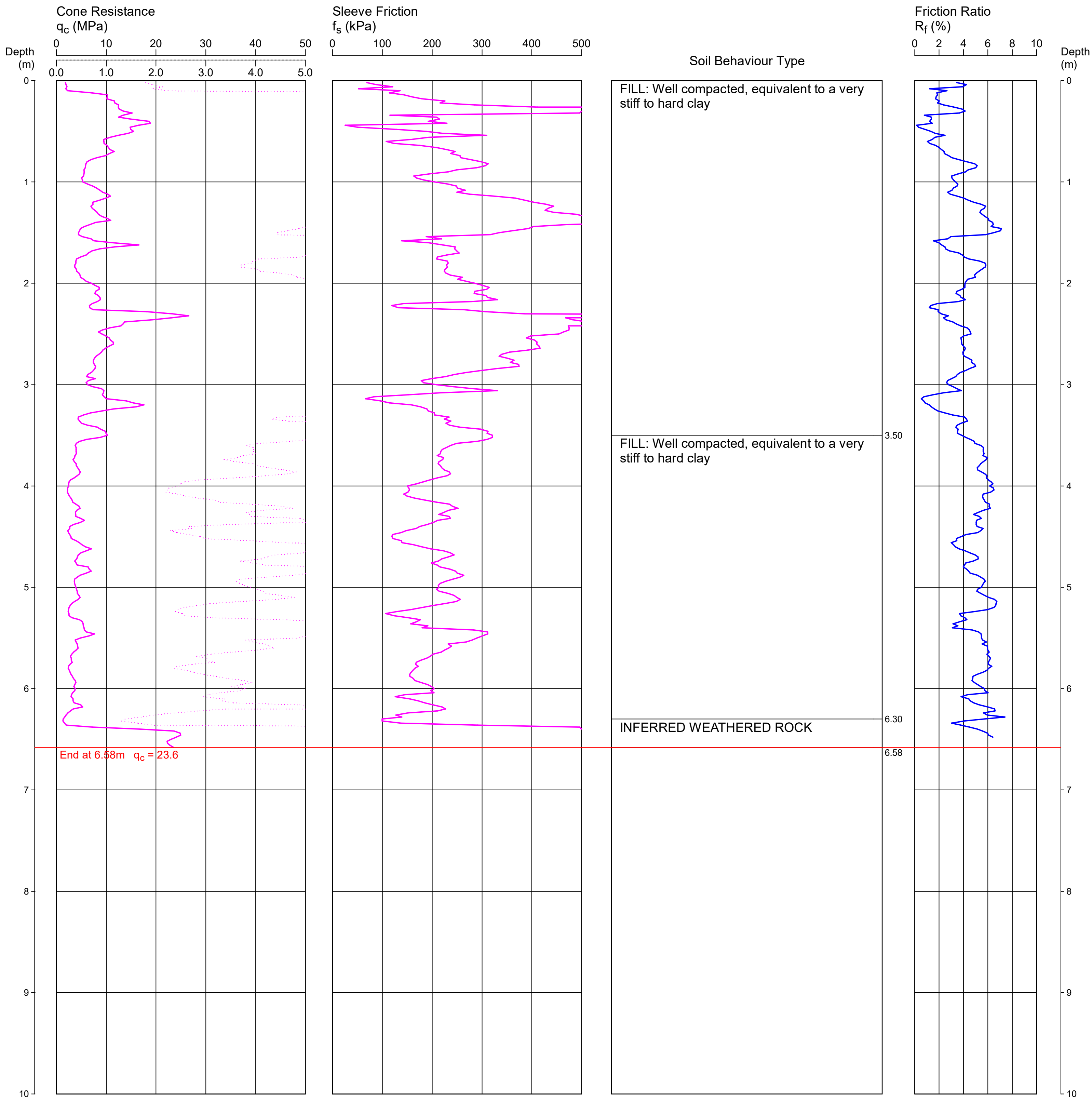
REDUCED LEVEL: 80.8

COORDINATES: 298688.8E 6254657.7N MGA2020

CPT106

DATE 16/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO BENDING NEAR INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT106.CP5
Cone ID: 190722 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: JOHNSTON CRESCENT, HORSLEY PARK

REDUCED LEVEL: 79.7

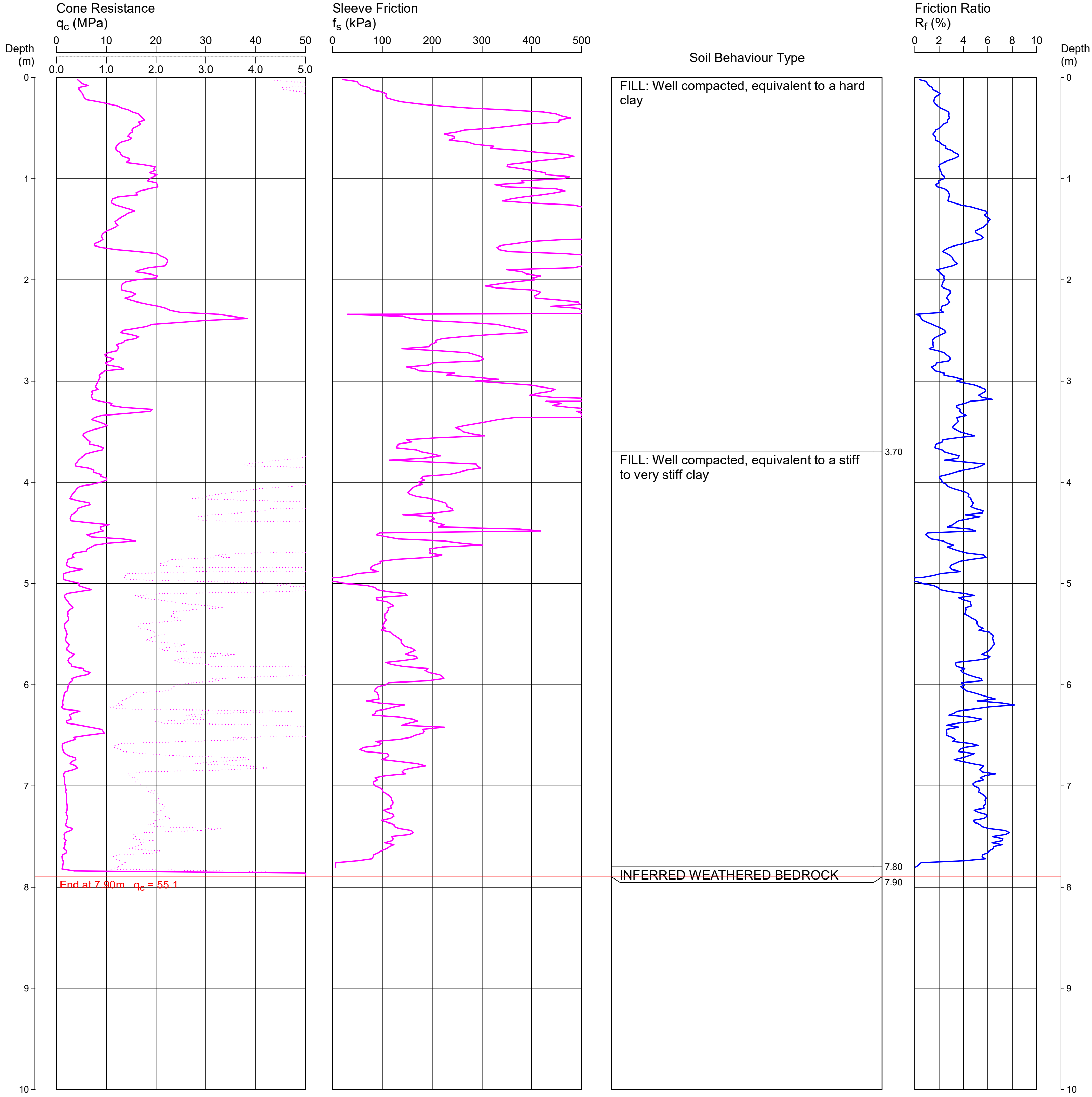
COORDINATES: 298711.2E 6254752.1N MGA2020

CPT107

Page 1 of 1

DATE 16/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT107A.CP5
Cone ID: 190722 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: JOHNSTON CRESCENT, HORSLEY PARK

REDUCED LEVEL: 80.3

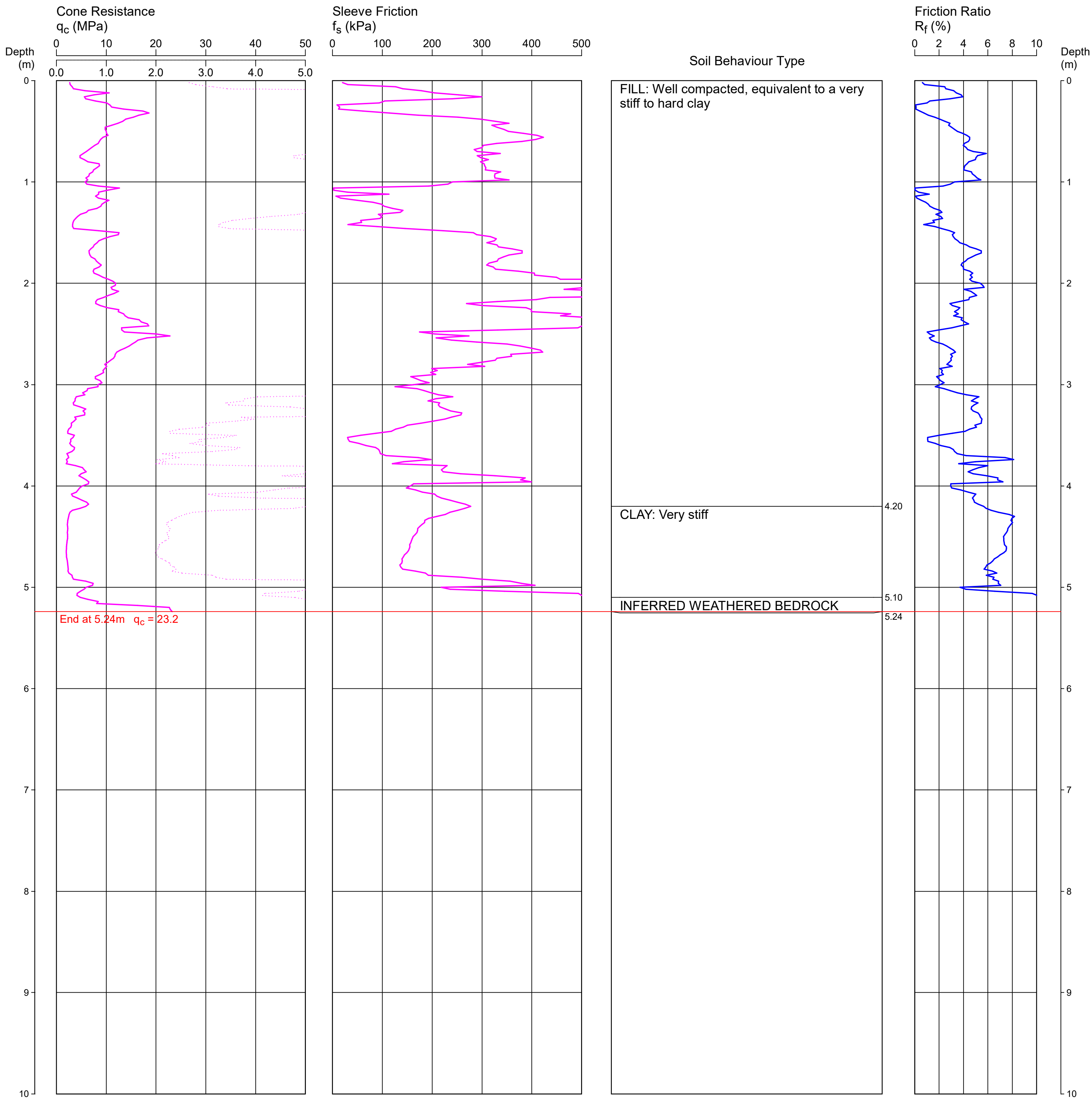
COORDINATES: 298717.9E 6254796.8N MGA2020

CPT108

Page 1 of 1

DATE 16/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO BENDING NEAR INFERRED WEATHERED ROCK
HOLE COLLAPSED AT 3.6M AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT108.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: JOHNSTON CRESCENT, HORSLEY PARK

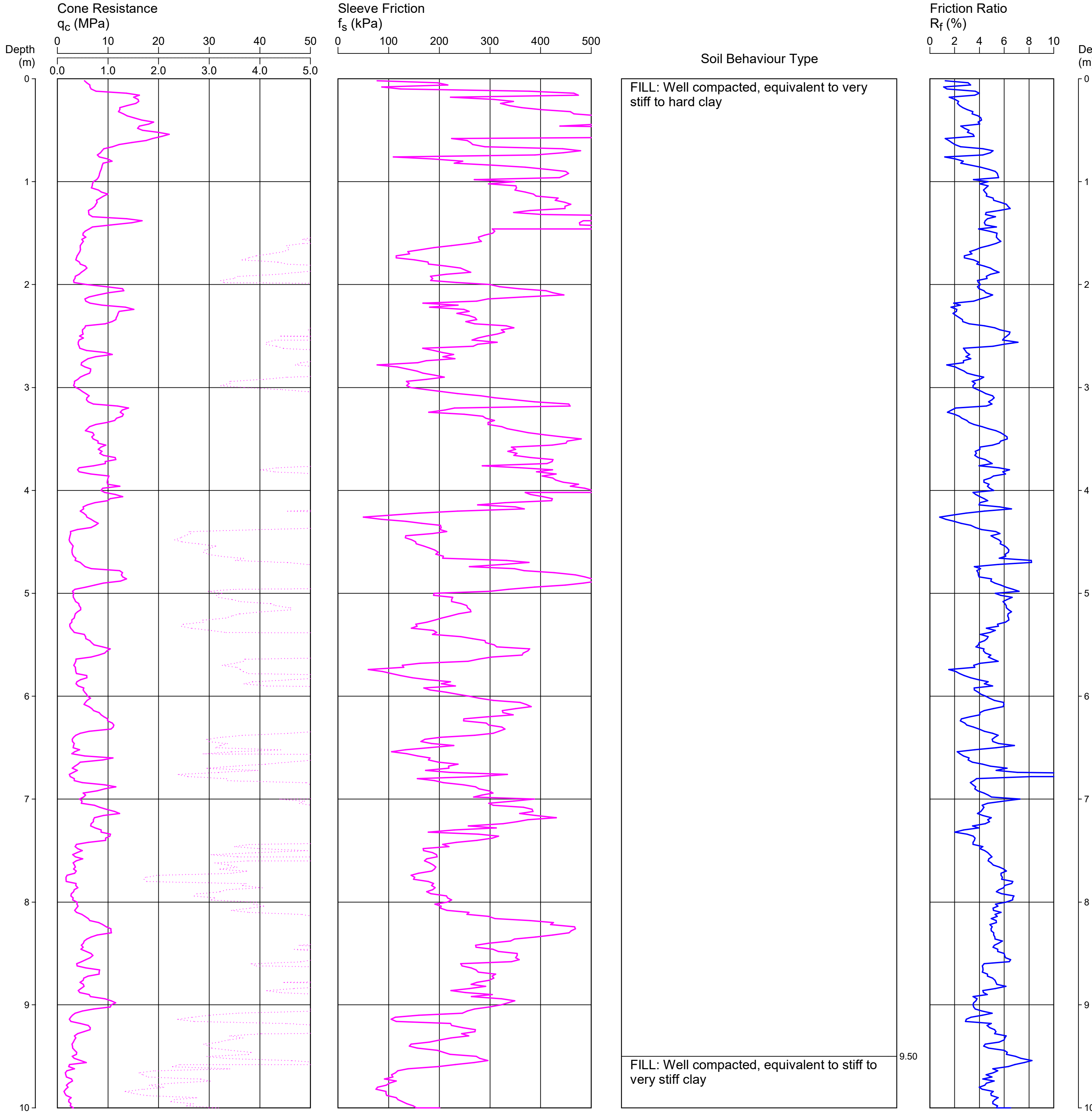
REDUCED LEVEL: 80.7

COORDINATES: 298610.3E 6254808.6N MGA2020

CPT109

DATE 16/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO BENDING NEAR INFERRED WEATHERED ROCK
HOLE COLLAPSED AT 9.5M AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT109A.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: JOHNSTON CRESCENT, HORSLEY PARK

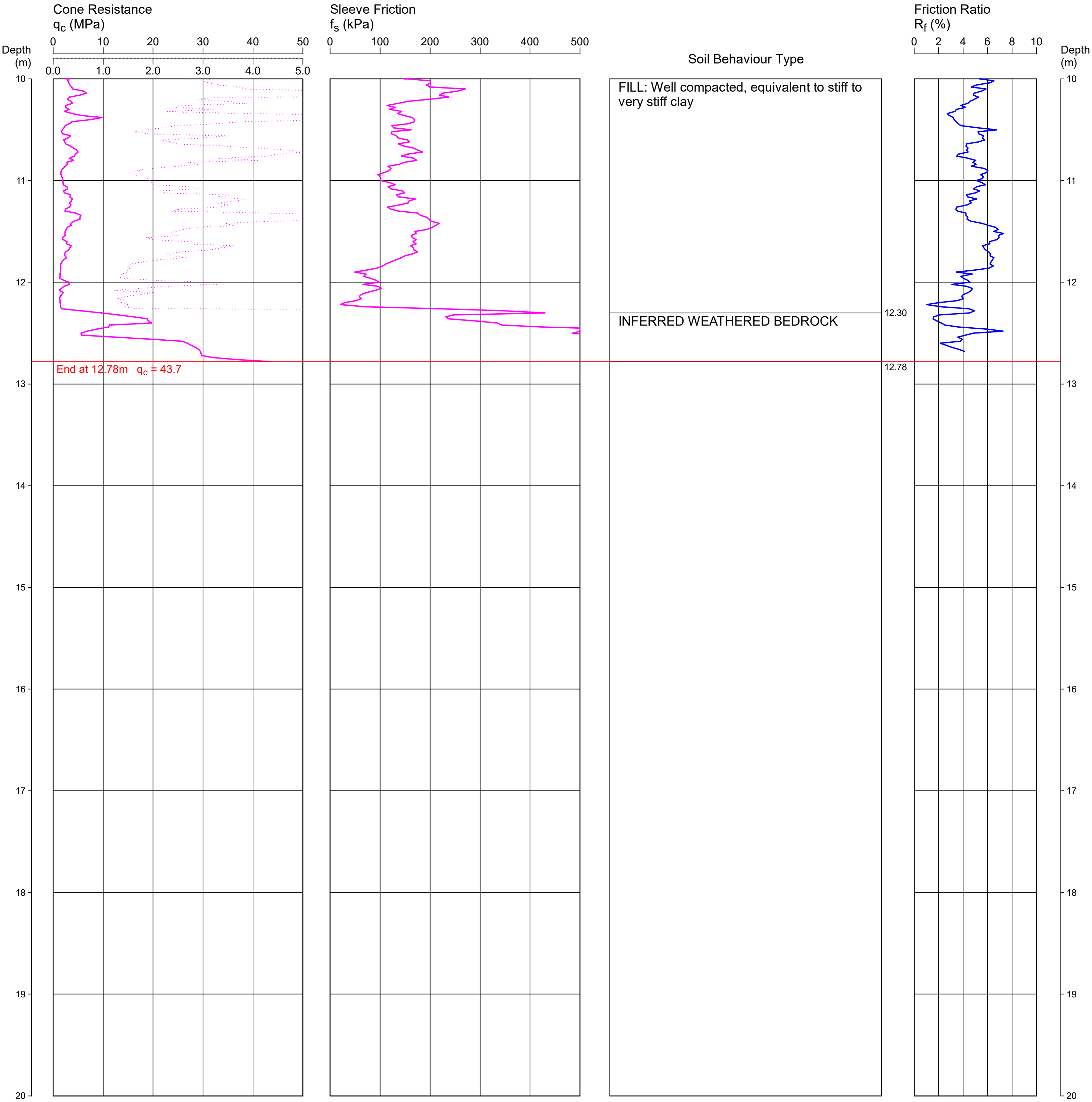
REDUCED LEVEL: 80.7

COORDINATES: 298610.3E 6254808.6N MGA2020

CPT109

DATE 16/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO BENDING NEAR INFERRED WEATHERED ROCK
HOLE COLLAPSED AT 9.5M AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT109A.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: JOHNSTON CRESCENT, HORSLEY PARK

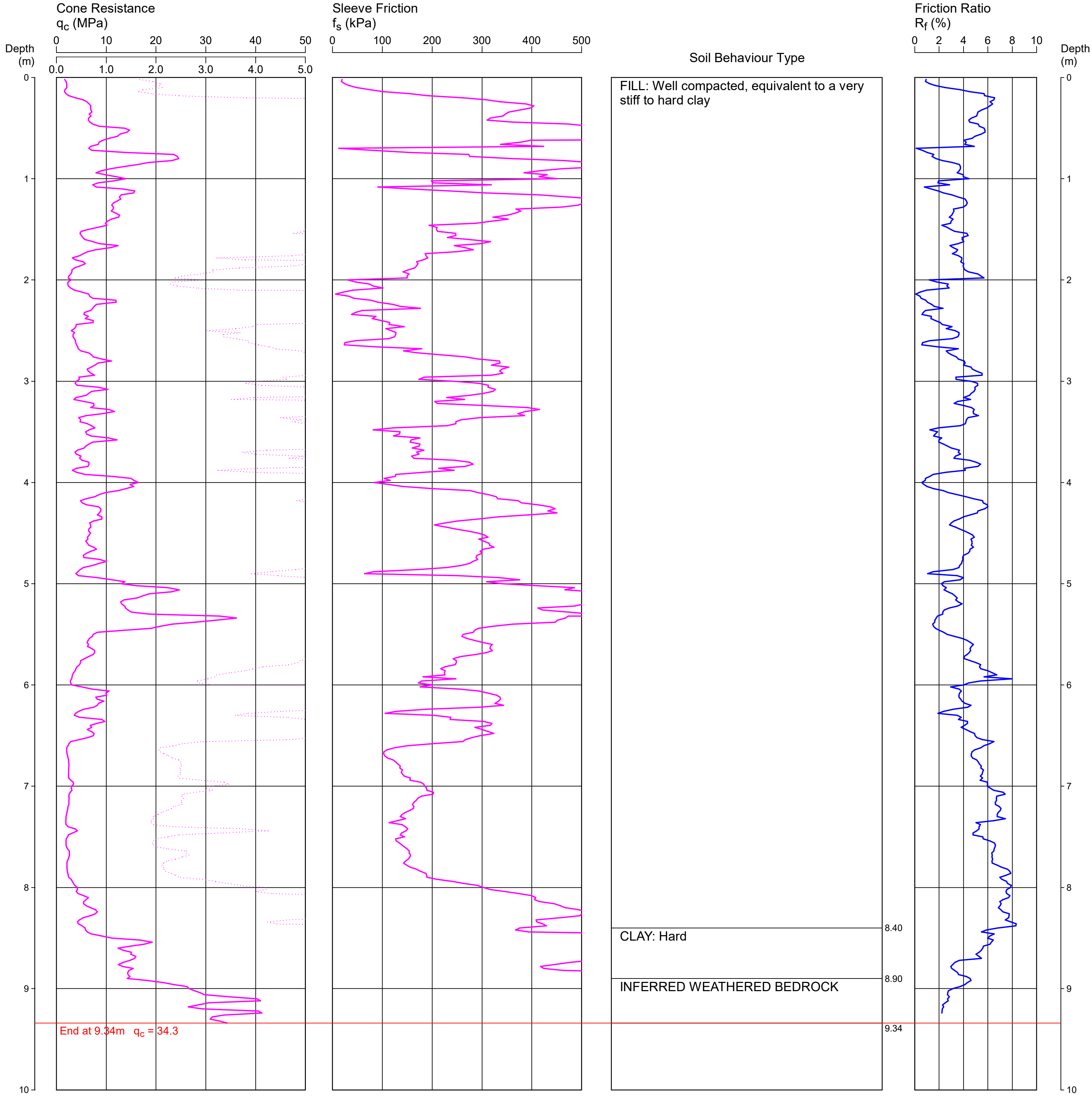
REDUCED LEVEL: 79.8

COORDINATES: 298566.4E 6254811.4N MGA2020

CPT110

DATE 16/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO BENDING ON INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT110.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: JOHNSTON CRESCENT, HORSLEY PARK

REDUCED LEVEL: 80.0

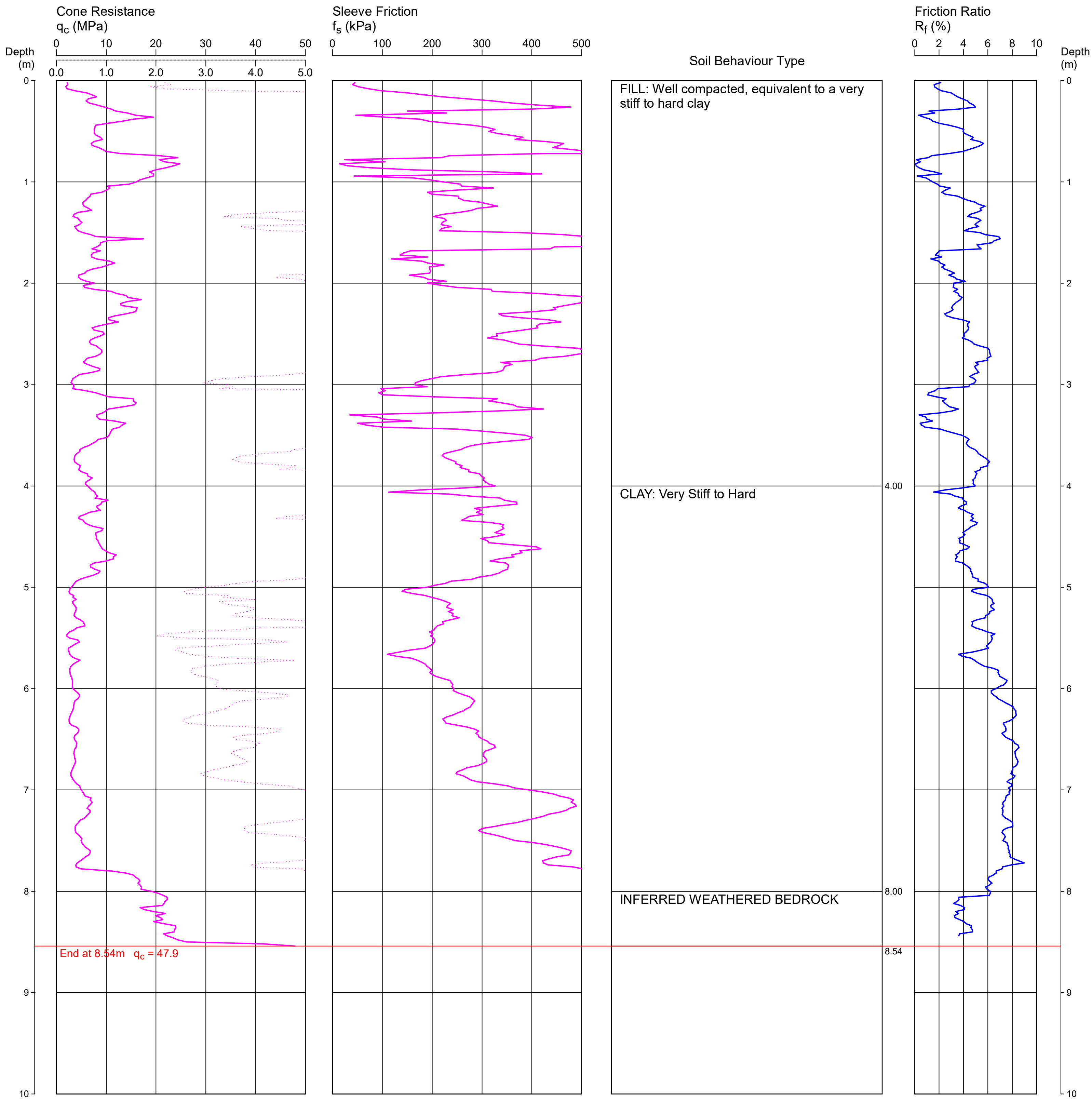
COORDINATES: 298569.0E 6254769.8N MGA2020

CPT111

Page 1 of 1

DATE 16/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT111.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: LOT 301 JOHNSTON CRES, HORSLEY PARK

REDUCED LEVEL: 80.3

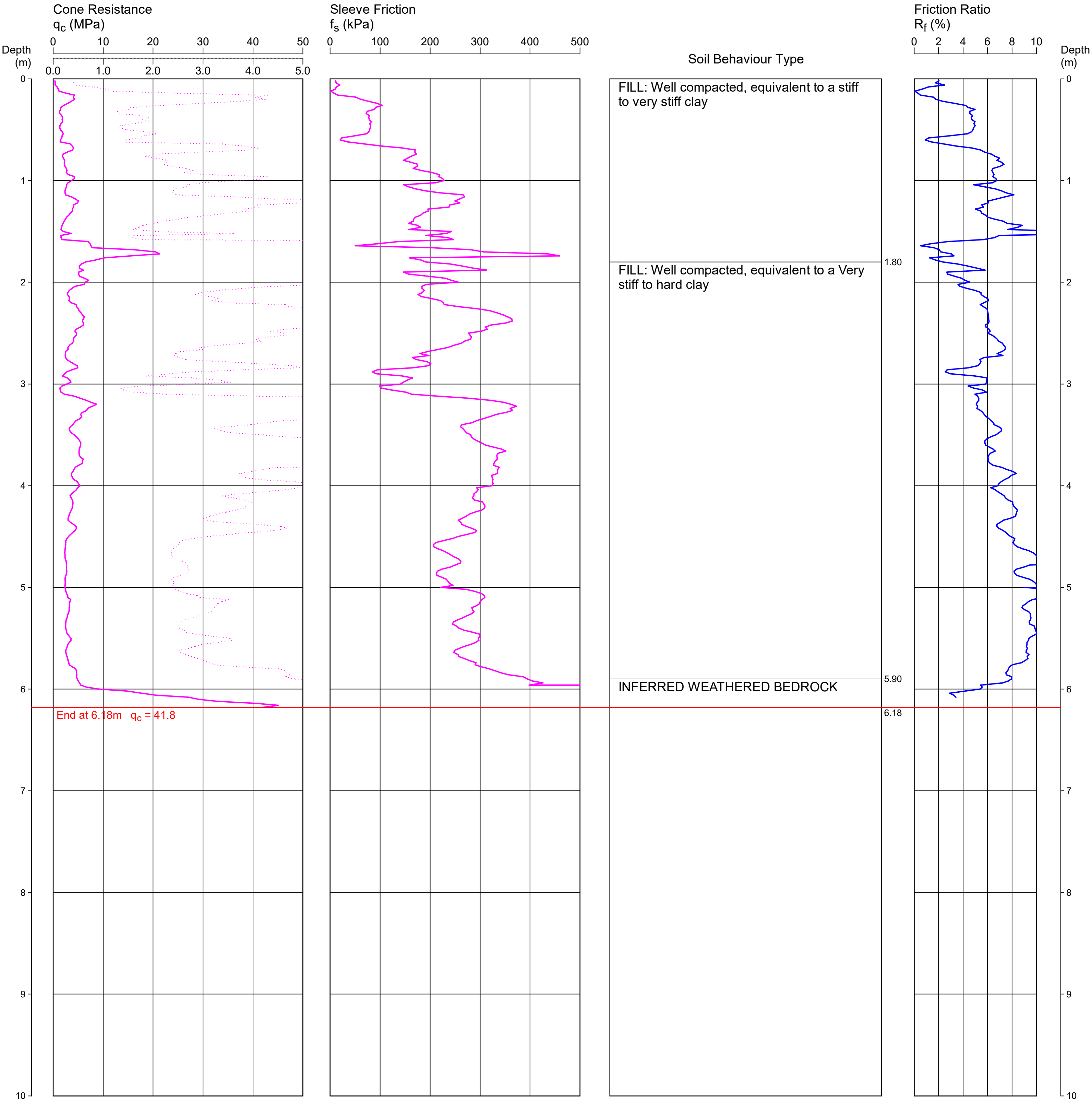
COORDINATES: 298533.5E 6254677.6N MGA2020

CPT112

Page 1 of 1

DATE 12/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON (or NEAR) INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT112A.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: LOT 301 JOHNSTON CRES, HORSLEY PARK

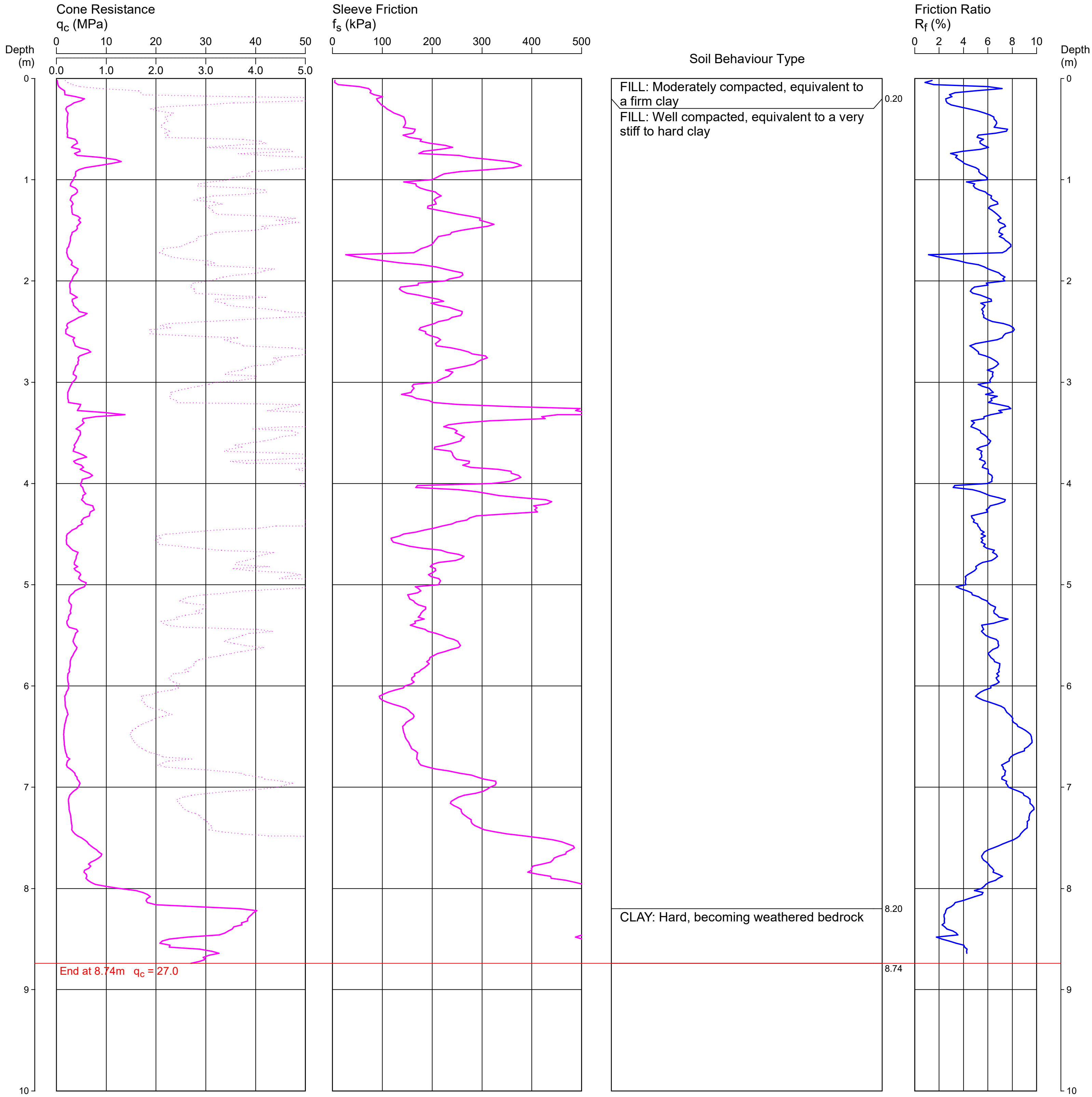
REDUCED LEVEL: 80.8

COORDINATES: 298522.3E 6254604.0N MGA2020

CPT113

DATE 12/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO BENDING ON (or NEAR) INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT113A.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: LOT 301 JOHNSTON CRES, HORSLEY PARK

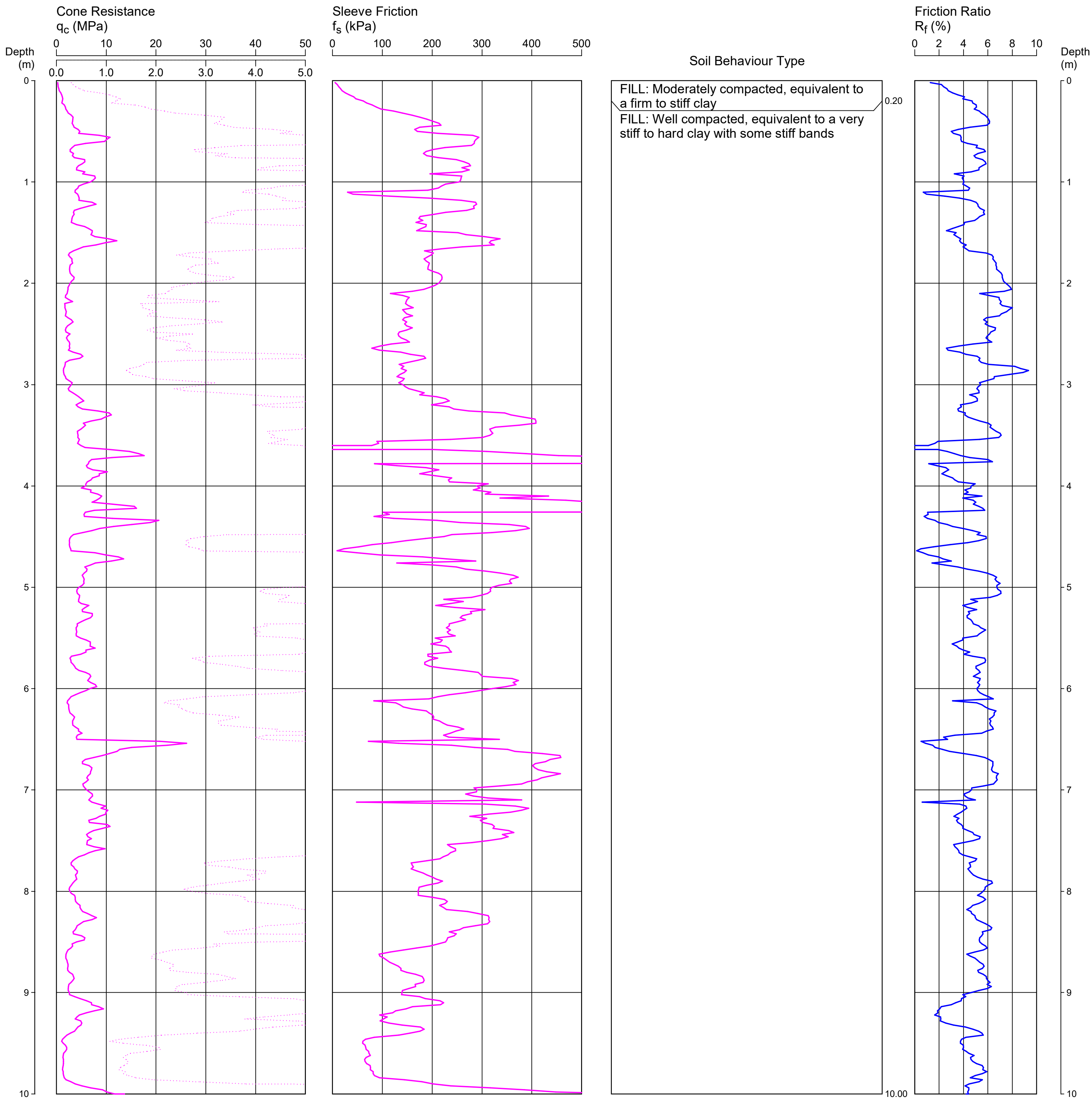
REDUCED LEVEL: 81.3

COORDINATES: 298510.0E 6254523.8N MGA2020

CPT114

DATE 12/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO BENDING ON (or NEAR) INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT114B.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: LOT 301 JOHNSTON CRES, HORSLEY PARK

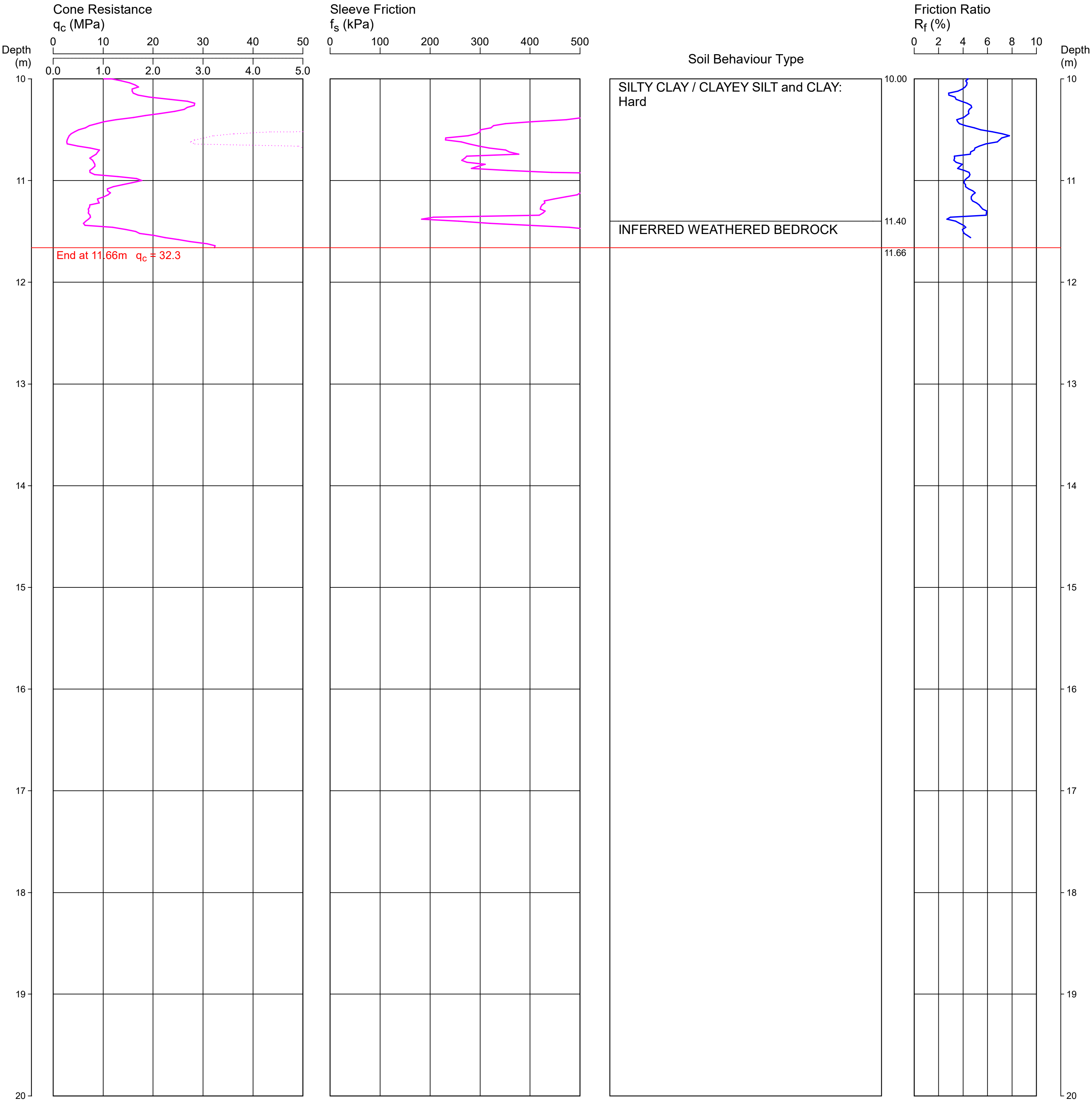
REDUCED LEVEL: 81.3

COORDINATES: 298510.0E 6254523.8N MGA2020

CPT114

DATE 12/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO BENDING ON (or NEAR) INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT114B.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: LOT 301 JOHNSTON CRES, HORSLEY PARK

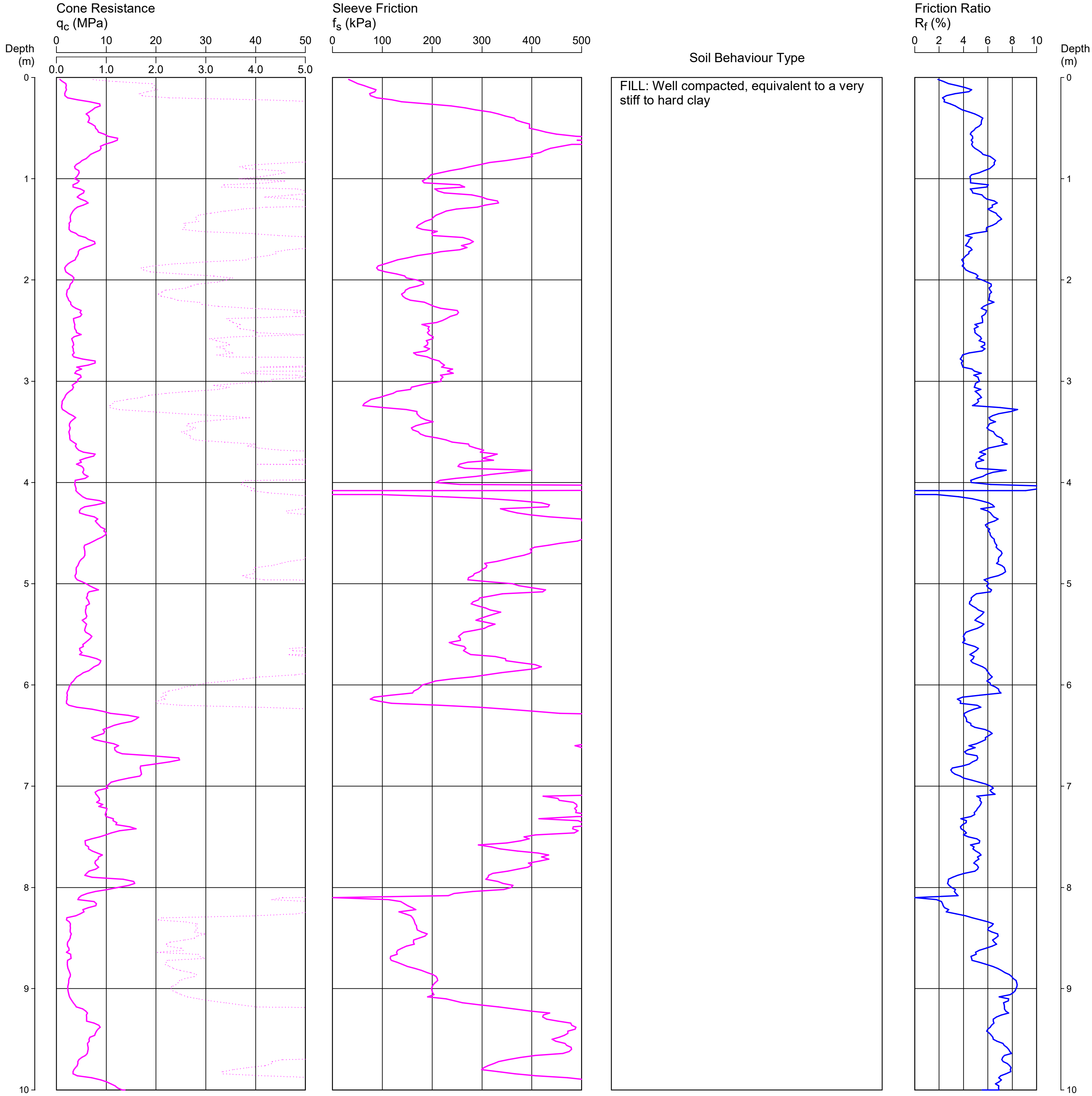
REDUCED LEVEL: 81.7

COORDINATES: 298498.3E 6254458.3N MGA2020

CPT115

DATE 12/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO BENDING ON (or NEAR) INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT115.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: LOT 301 JOHNSTON CRES, HORSLEY PARK

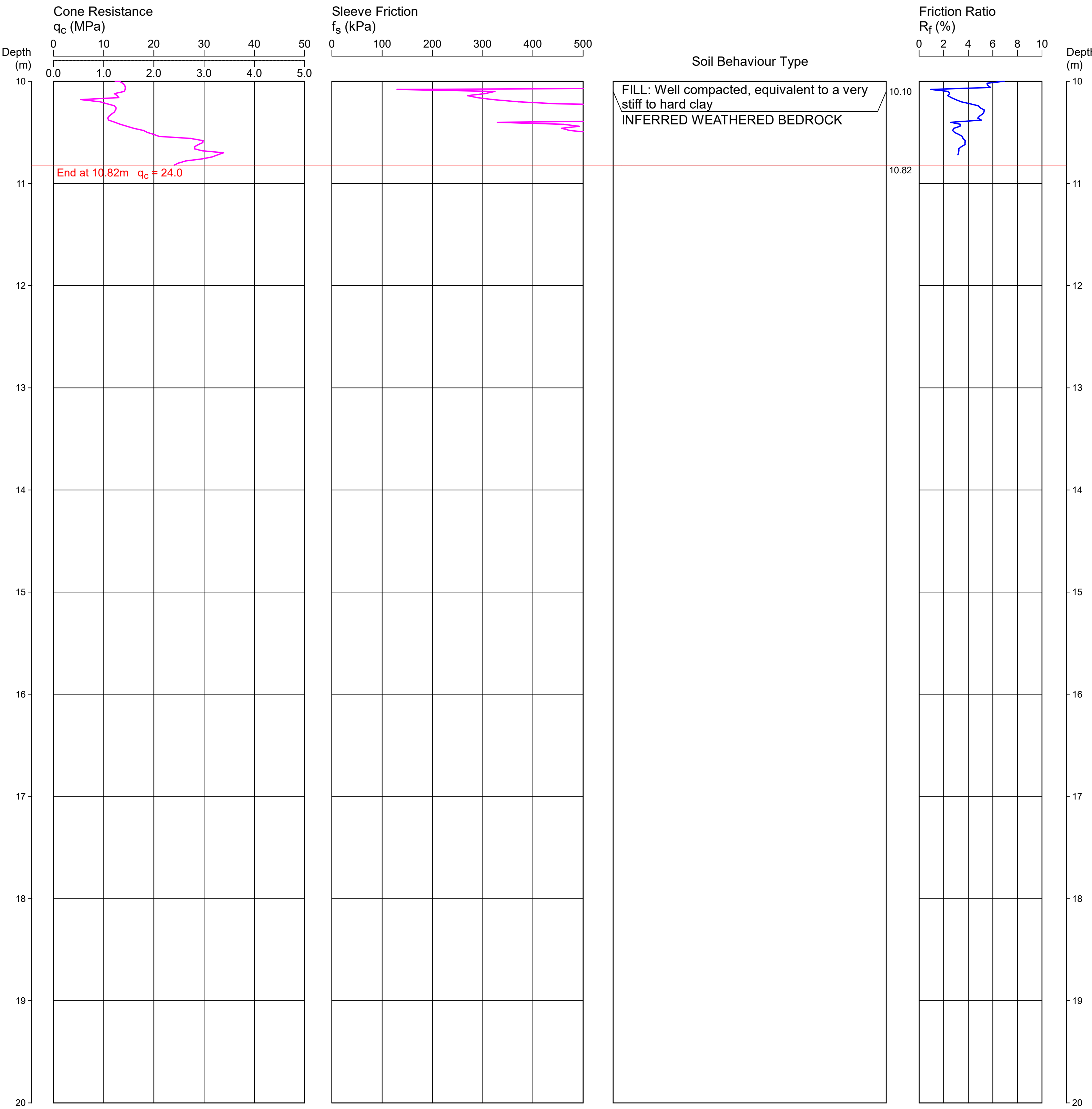
REDUCED LEVEL: 81.7

COORDINATES: 298498.3E 6254458.3N MGA2020

CPT115

DATE 12/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO BENDING ON (or NEAR) INFERRED WEATHERED ROCK
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT115.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: ESR AUSTRALIA

PROJECT: PROPOSED INDUSTRIAL DEVELOPMENT

LOCATION: LOT 301 JOHNSTON CRES, HORSLEY PARK

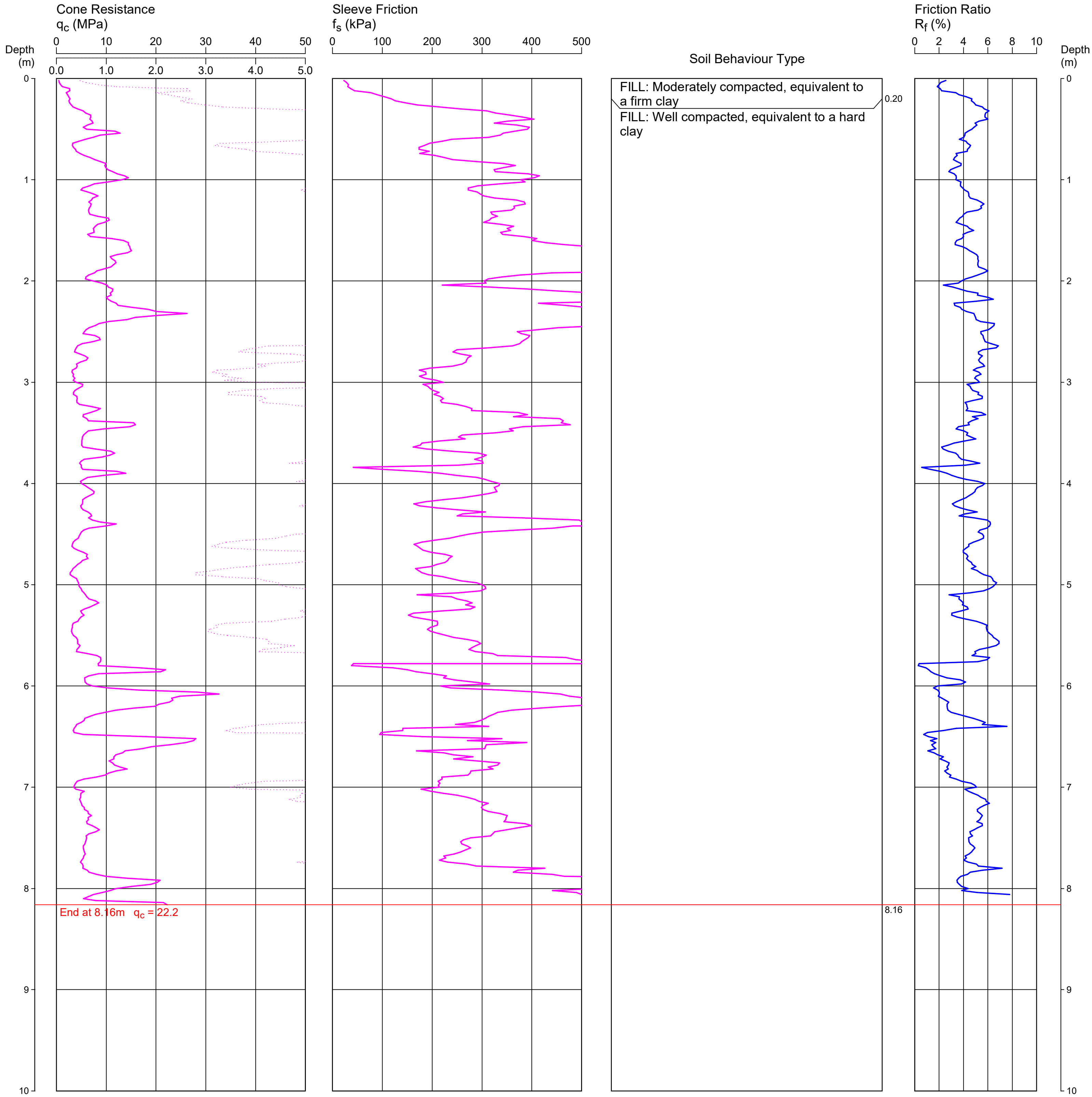
REDUCED LEVEL: 83.3

COORDINATES: 298546.5E 6254399.5N MGA2020

CPT116

DATE 12/07/2024

PROJECT No: 86826.09



REMARKS: TEST DISCONTINUED DUE TO BENDING ON FILLING
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\86826.09 - HORSLEY PARK, Lot 301 Johnston Cres GEO\4.0 Field Work\4.2 Testing\CPTs Current 16.07.2024\CP5\CPT116.CP5
Cone ID: 161226 **Type:** I-CFXY-10

ConePlot Version 5.9.2

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Appendix D

Laboratory Test Results

Material Test Report

Report Number:	**86826.09-1**
Issue Number:	1
Date Issued:	01/08/2024
Client:	ESR Australia Level 12, Sydney NSW
Contact:	Daniel Galea
Project Number:	86826.09
Project Name:	Proposed Industrial Development
Project Location:	Johnston Crescent, Horsley Park NSW
Work Request:	11581
Sample Number:	SY-11581A
Date Sampled:	12/07/2024
Dates Tested:	15/07/2024 - 29/07/2024
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Preparation Method:	AS 1289.1.1 - Sampling and Preparation of Soils
Sample Location:	**BH101 (0.5 - 1.5m)**
Material:	FIILL / Gravelly CLAY: brown, fine to coarse, siltstone and sandstone gravel, trace brick fragments

Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Email: andrew.hutchings@douglaspartners.com.au

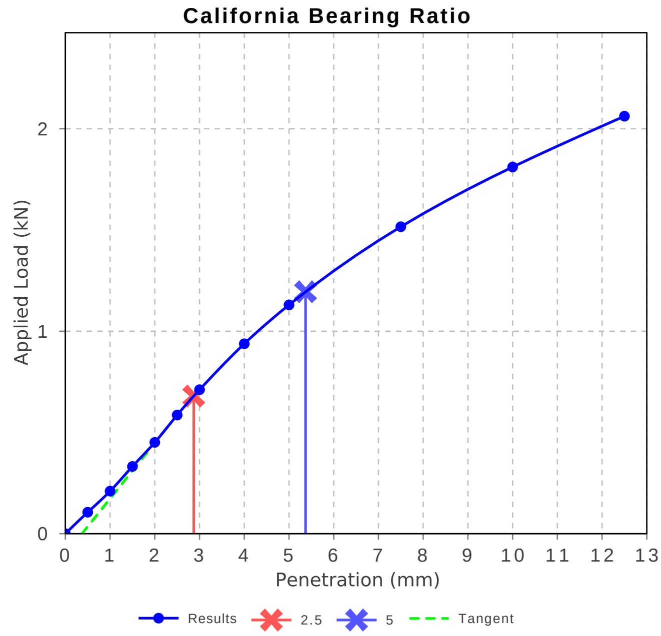
Accredited for compliance with ISO/IEC 17025 - Testing

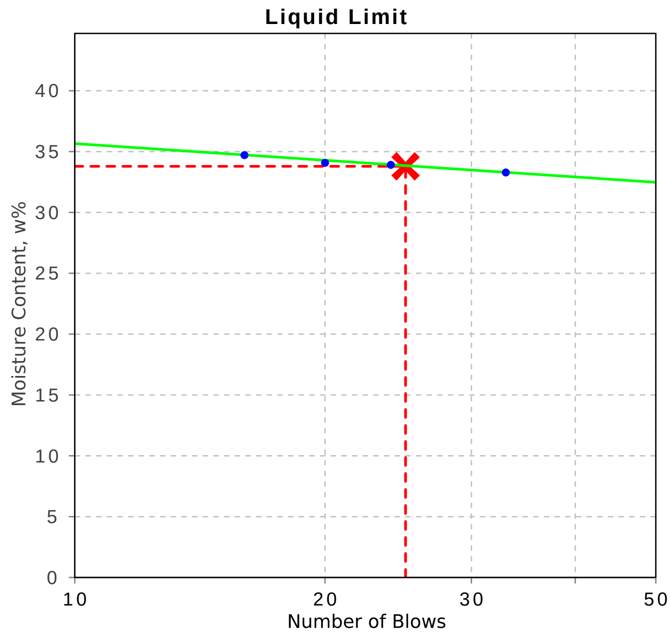
Approved Signatory: Andrew Hutchings
Associate / Laboratory Manager
Laboratory Accreditation Number: 828

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**6**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS1289.5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.99		
Optimum Moisture Content (%)	11.0		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	94.5		
Dry Density after Soaking (t/m^3)	1.93		
Field Moisture Content (%)	9.4		
Moisture Content at Placement (%)	10.4		
Moisture Content Top 30mm (%)	15.0		
Moisture Content Rest of Sample (%)	14.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours (h)	141.6		
Swell (%)	3.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	3.5		
Sample moulded 0.6% dry of OMC			

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	34		
Plastic Limit (%)	18		
Plasticity Index (%)	**16**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**9.5**		
Cracking Crumbling Curling	None		





Material Test Report

Report Number:	**86826.09-1**
Issue Number:	1
Date Issued:	01/08/2024
Client:	ESR Australia
	Level 12, Sydney NSW
Contact:	Daniel Galea
Project Number:	86826.09
Project Name:	Proposed Industrial Development
Project Location:	Johnston Crescent, Horsley Park NSW
Work Request:	11581
Sample Number:	SY-11581B
Date Sampled:	12/07/2024
Dates Tested:	15/07/2024 - 29/07/2024
Sampling Method:	Sampled by Engineering Department
	The results apply to the sample as received
Preparation Method:	AS 1289.1.1 - Sampling and Preparation of Soils
Sample Location:	**BH102 (0.5 - 1.5m)**
Material:	FILL / Gravelly CLAY: brown, fine to coarse, siltstone and sandstone gravel, trace brick fragments

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ilac-MRA NATA

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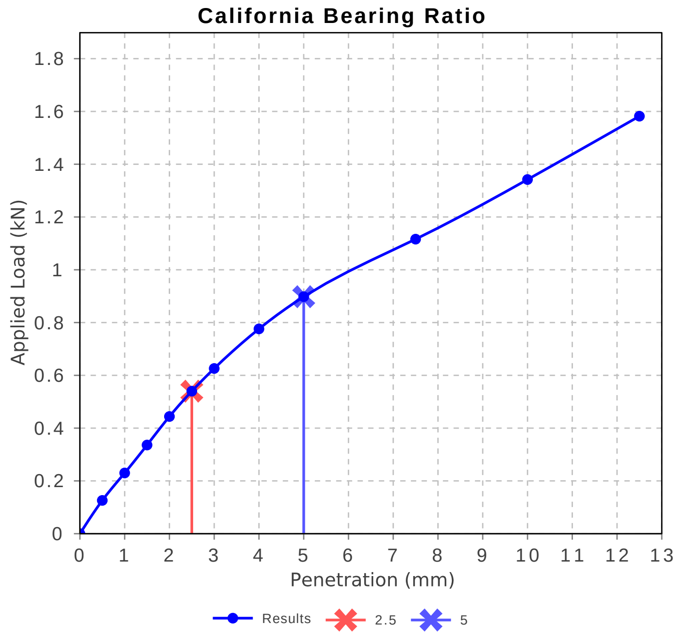
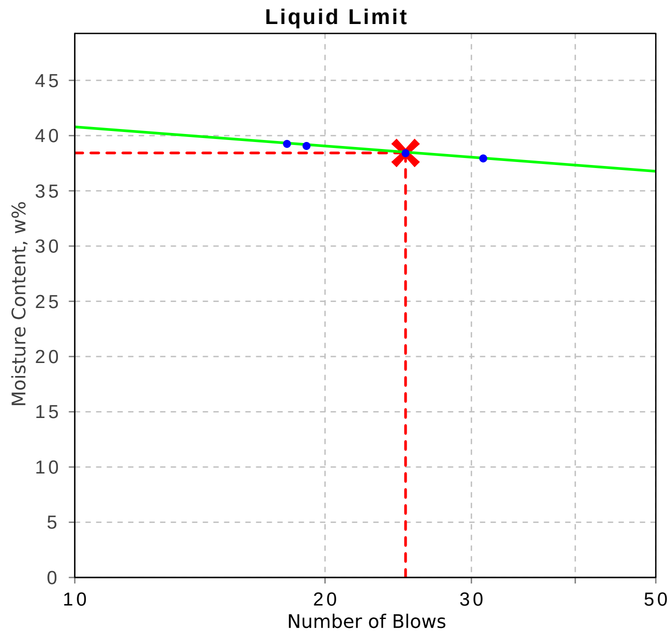
Approved Signatory: Andrew Hutchings
Associate / Laboratory Manager
Laboratory Accreditation Number: 828

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**4.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.95		
Optimum Moisture Content (%)	13.0		
Laboratory Density Ratio (%)	101.0		
Laboratory Moisture Ratio (%)	94.0		
Dry Density after Soaking (t/m^3)	1.91		
Field Moisture Content (%)	12.6		
Moisture Content at Placement (%)	12.3		
Moisture Content Top 30mm (%)	15.8		
Moisture Content Rest of Sample (%)	14.0		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours (h)	163.8		
Swell (%)	2.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	3.3		
Sample moulded 0.8% dry of OMC			

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	38		
Plastic Limit (%)	16		
Plasticity Index (%)	**22**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**11.5**		
Cracking Crumbling Curling	None		





Material Test Report

Report Number: **86826.09-1**
Issue Number: 1
Date Issued: 01/08/2024
Client: ESR Australia
Level 12, Sydney NSW
Contact: Daniel Galea
Project Number: 86826.09
Project Name: Proposed Industrial Development
Project Location: Johnston Crescent, Horsley Park NSW
Work Request: 11581
Sample Number: SY-11581C
Date Sampled: 12/07/2024
Dates Tested: 15/07/2024 - 23/07/2024
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and Preparation of Soils
Sample Location: **BH103 (0.5 - 1.5m)**
Material: FILL / Gravelly CLAY: brown, fine to coarse, siltstone and sandstone gravel, trace brick fragments

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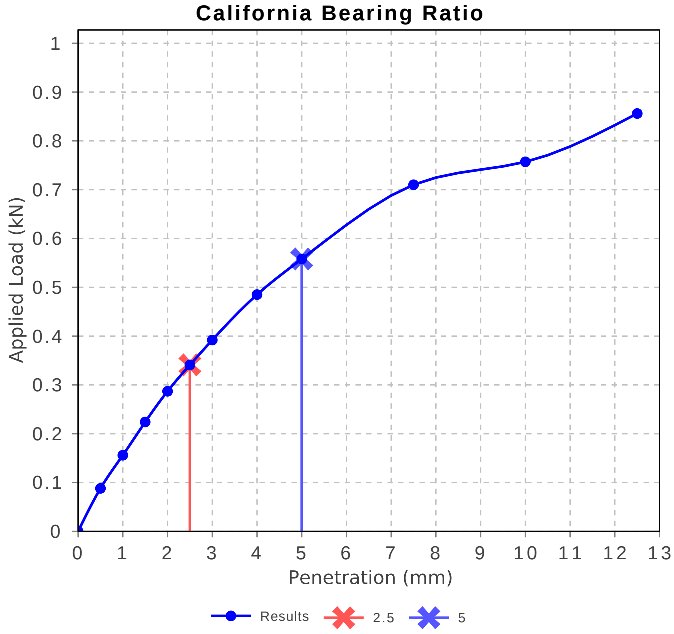
Approved Signatory: Andrew Hutchings
Associate / Laboratory Manager
Laboratory Accreditation Number: 828

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**3.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS1289.5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.91		
Optimum Moisture Content (%)	13.5		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	104.0		
Dry Density after Soaking (t/m^3)	1.85		
Field Moisture Content (%)	11.8		
Moisture Content at Placement (%)	13.9		
Moisture Content Top 30mm (%)	18.0		
Moisture Content Rest of Sample (%)	15.0		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours (h)	68.0		
Swell (%)	2.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

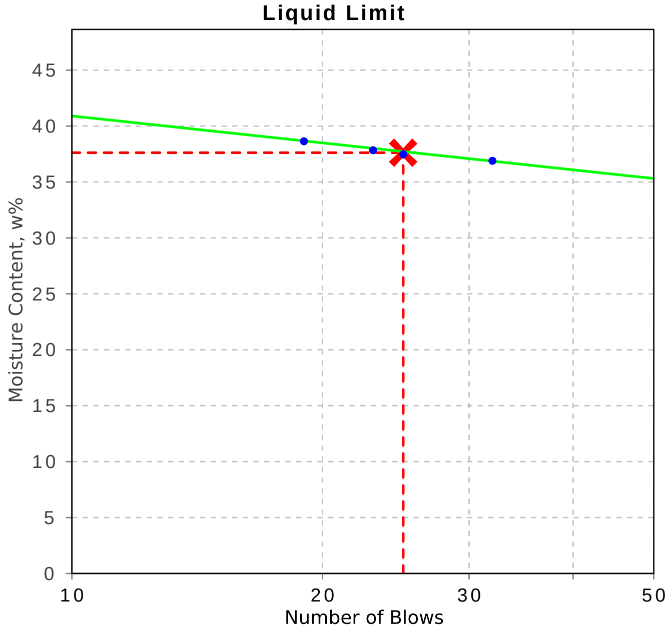
Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	38		
Plastic Limit (%)	18		
Plasticity Index (%)	**20**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**11.0**		
Cracking Crumbling Curling	None		

California Bearing Ratio



Liquid Limit



Material Test Report

Report Number:	**86826.09-1**
Issue Number:	1
Date Issued:	01/08/2024
Client:	ESR Australia
	Level 12, Sydney NSW
Contact:	Daniel Galea
Project Number:	86826.09
Project Name:	Proposed Industrial Development
Project Location:	Johnston Crescent, Horsley Park NSW
Work Request:	11581
Sample Number:	SY-11581D
Date Sampled:	12/07/2024
Dates Tested:	15/07/2024 - 26/07/2024
Sampling Method:	Sampled by Engineering Department
	The results apply to the sample as received
Preparation Method:	AS 1289.1.1 - Sampling and Preparation of Soils
Sample Location:	**BH104 (0.5 - 1.5m)**
Material:	FILL / Gravelly CLAY: brown, fine to coarse, siltstone and sandstone gravel, with silt, trace brick fragments

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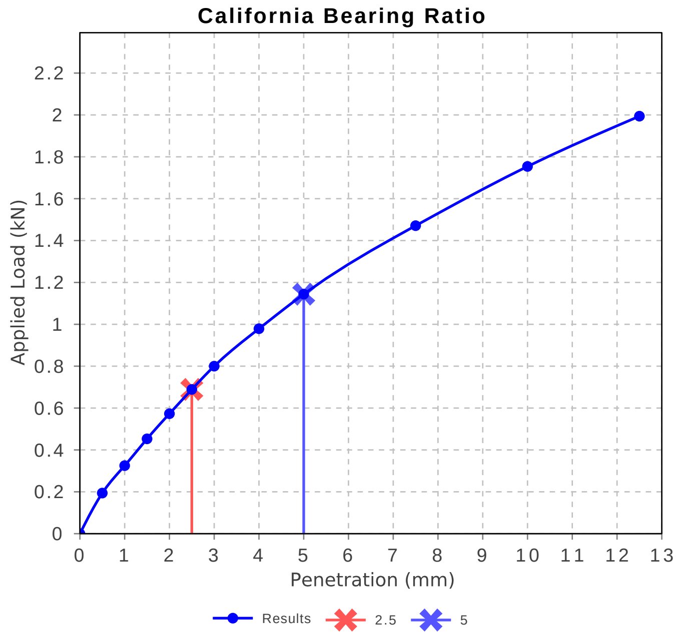
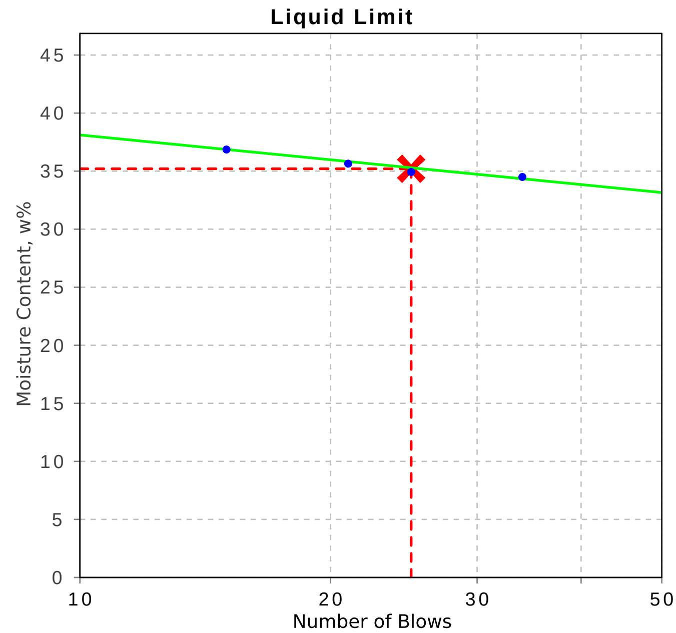
Laboratory Accreditation Number: 828

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**6**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.94		
Optimum Moisture Content (%)	12.0		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	97.0		
Dry Density after Soaking (t/m^3)	1.92		
Field Moisture Content (%)	11.0		
Moisture Content at Placement (%)	11.7		
Moisture Content Top 30mm (%)	16.4		
Moisture Content Rest of Sample (%)	13.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours (h)	93.2		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	3.0		

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	35		
Plastic Limit (%)	17		
Plasticity Index (%)	**18**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**10.0**		
Cracking Crumbling Curling	None		





Material Test Report

Report Number:	**86826.09-1**
Issue Number:	1
Date Issued:	01/08/2024
Client:	ESR Australia Level 12, Sydney NSW
Contact:	Daniel Galea
Project Number:	86826.09
Project Name:	Proposed Industrial Development
Project Location:	Johnston Crescent, Horsley Park NSW
Work Request:	11581
Sample Number:	SY-11581E
Date Sampled:	12/07/2024
Dates Tested:	15/07/2024 - 29/07/2024
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Preparation Method:	AS 1289.1.1 - Sampling and Preparation of Soils
Sample Location:	**BH105 (0.5 - 1.5m)**
Material:	FILL / Gravelly CLAY: brown, fine to coarse, siltstone and sandstone gravel, with silt, trace brick fragments

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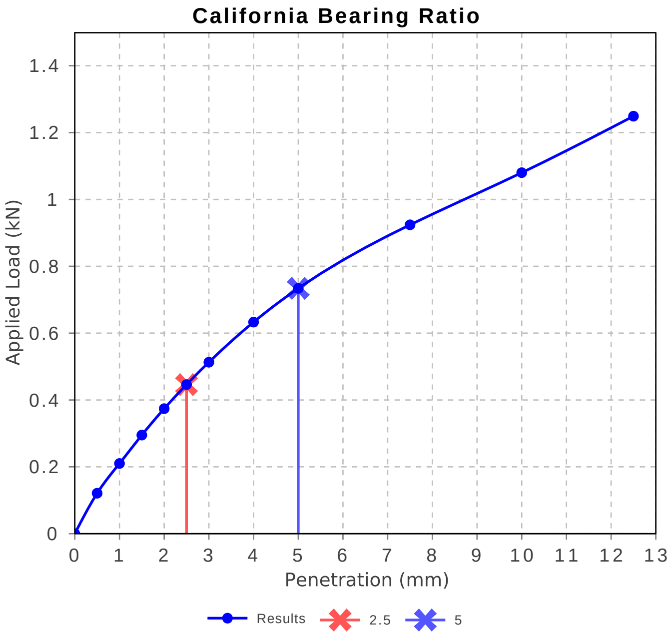
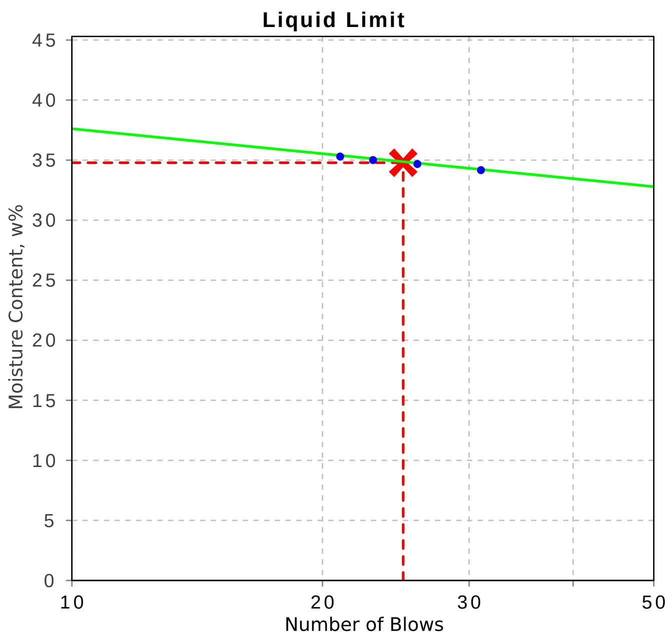
Approved Signatory: Andrew Hutchings
Associate / Laboratory Manager
Laboratory Accreditation Number: 828

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**3.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS1289.5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.94		
Optimum Moisture Content (%)	13.0		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	96.0		
Dry Density after Soaking (t/m^3)	1.90		
Field Moisture Content (%)	11.7		
Moisture Content at Placement (%)	12.3		
Moisture Content Top 30mm (%)	16.5		
Moisture Content Rest of Sample (%)	13.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours (h)	68.5		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	2.5		

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	35		
Plastic Limit (%)	17		
Plasticity Index (%)	**18**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**10.5**		
Cracking Crumbling Curling	None		





Material Test Report

Report Number:	**86826.09-1**
Issue Number:	1
Date Issued:	01/08/2024
Client:	ESR Australia Level 12, Sydney NSW
Contact:	Daniel Galea
Project Number:	86826.09
Project Name:	Proposed Industrial Development
Project Location:	Johnston Crescent, Horsley Park NSW
Work Request:	11581
Sample Number:	SY-11581F
Date Sampled:	12/07/2024
Dates Tested:	15/07/2024 - 29/07/2024
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Preparation Method:	AS 1289.1.1 - Sampling and Preparation of Soils
Sample Location:	**BH106 (0.5 - 1.5m)**
Material:	FILL / Gravelly CLAY: brown, fine to coarse, siltstone and sandstone gravel, trace brick fragments

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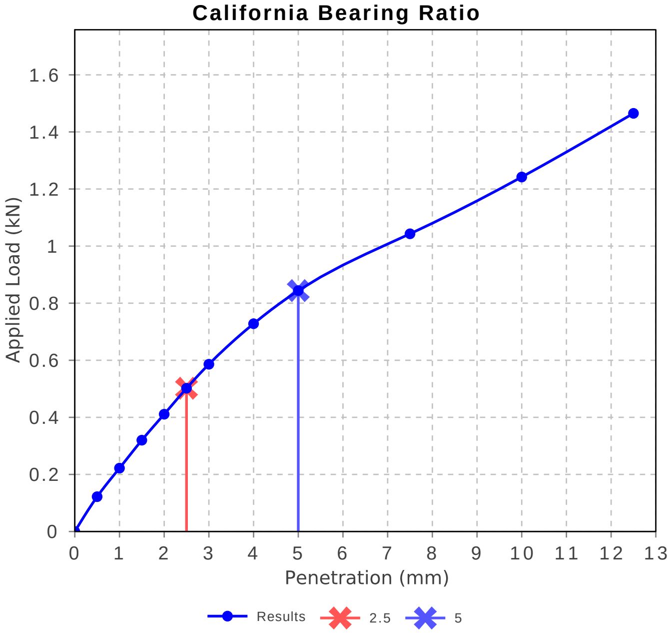
Approved Signatory: Andrew Hutchings
Associate / Laboratory Manager
Laboratory Accreditation Number: 828

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**4.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS1289.5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.93		
Optimum Moisture Content (%)	12.5		
Laboratory Density Ratio (%)	99.0		
Laboratory Moisture Ratio (%)	103.0		
Dry Density after Soaking (t/m^3)	1.87		
Field Moisture Content (%)	11.8		
Moisture Content at Placement (%)	13.1		
Moisture Content Top 30mm (%)	17.4		
Moisture Content Rest of Sample (%)	14.6		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours (h)	69.3		
Swell (%)	2.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	1.9		

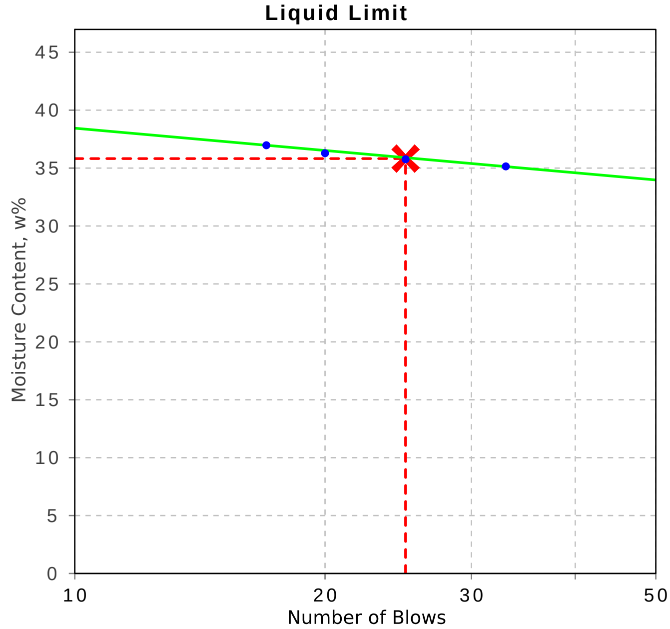
Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	36		
Plastic Limit (%)	17		
Plasticity Index (%)	**19**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	**10.5**		
Cracking Crumbling Curling	None		

California Bearing Ratio



Liquid Limit



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CERTIFICATE OF ANALYSIS 356648

Client Details

Client	Douglas Partners Pty Ltd
Attention	Ray2 Blinman
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**86826.09 - Horsley Park**
Number of Samples	15 Soil
Date samples received	16/07/2024
Date completed instructions received	16/07/2024

Analysis Details

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

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

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

Report Details

Date results requested by	23/07/2024
Date of Issue	23/07/2024

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Results Approved By
Diego Bigolin, Inorganics Supervisor
Loren Bardwell, Development Chemist

Authorised By
Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		356648-1	356648-2	356648-3	356648-4	356648-5
Your Reference	UNITS	BH101	BH101	BH101	BH102	BH102
Depth		0.4-0.5	2.5-2.95	4-4.45	0.4-0.5	2.5-2.95
Date Sampled		12/07/2024	12/07/2024	12/07/2024	12/07/2024	12/07/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	18/07/2024	18/07/2024	18/07/2024	18/07/2024	18/07/2024
Date analysed	-	18/07/2024	18/07/2024	18/07/2024	18/07/2024	18/07/2024
pH 1:5 soil:water	pH Units	9.1	8.5	9.4	8.3	8.3
Chloride, Cl 1:5 soil:water	mg/kg	230	170	130	240	370
Sulphate, SO4 1:5 soil:water	mg/kg	130	190	120	310	270

Misc Inorg - Soil						
Our Reference		356648-6	356648-7	356648-8	356648-9	356648-10
Your Reference	UNITS	BH102	BH103	BH103	BH103	BH104
Depth		4-4.45	0.4-0.5	2.5-2.95	4-4.45	0.4-0.5
Date Sampled		12/07/2024	12/07/2024	12/07/2024	12/07/2024	12/07/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	18/07/2024	18/07/2024	18/07/2024	18/07/2024	18/07/2024
Date analysed	-	18/07/2024	18/07/2024	18/07/2024	18/07/2024	18/07/2024
pH 1:5 soil:water	pH Units	7.7	8.3	7.1	8.8	8.5
Chloride, Cl 1:5 soil:water	mg/kg	290	210	250	250	210
Sulphate, SO4 1:5 soil:water	mg/kg	130	260	150	120	180

Misc Inorg - Soil						
Our Reference		356648-11	356648-12	356648-13	356648-14	356648-15
Your Reference	UNITS	BH104	BH104	BH105	BH105	BH105
Depth		2.5-2.95	4-4.45	0.4-0.5	2.5-2.95	4-4.45
Date Sampled		12/07/2024	12/07/2024	12/07/2024	12/07/2024	12/07/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	18/07/2024	18/07/2024	18/07/2024	18/07/2024	18/07/2024
Date analysed	-	18/07/2024	18/07/2024	18/07/2024	18/07/2024	18/07/2024
pH 1:5 soil:water	pH Units	9.3	9.4	8.4	9.3	8.8
Chloride, Cl 1:5 soil:water	mg/kg	130	190	230	150	190
Sulphate, SO4 1:5 soil:water	mg/kg	290	290	150	250	280

ESP/CEC						
Our Reference		356648-1	356648-2	356648-3	356648-4	356648-5
Your Reference	UNITS	BH101	BH101	BH101	BH102	BH102
Depth		0.4-0.5	2.5-2.95	4-4.45	0.4-0.5	2.5-2.95
Date Sampled		12/07/2024	12/07/2024	12/07/2024	12/07/2024	12/07/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/07/2024	19/07/2024	19/07/2024	19/07/2024	19/07/2024
Date analysed	-	19/07/2024	19/07/2024	19/07/2024	19/07/2024	19/07/2024
Exchangeable Ca	meq/100g	11	6.3	13	12	5.4
Exchangeable K	meq/100g	0.2	0.3	0.2	0.2	0.2
Exchangeable Mg	meq/100g	6.3	7.0	3.6	5.2	6.5
Exchangeable Na	meq/100g	2.7	3.8	1.5	1.5	2.6
Cation Exchange Capacity	meq/100g	20	17	18	19	15
ESP	%	13	22	8	8	18

ESP/CEC						
Our Reference		356648-6	356648-7	356648-8	356648-9	356648-10
Your Reference	UNITS	BH102	BH103	BH103	BH103	BH104
Depth		4-4.45	0.4-0.5	2.5-2.95	4-4.45	0.4-0.5
Date Sampled		12/07/2024	12/07/2024	12/07/2024	12/07/2024	12/07/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/07/2024	19/07/2024	19/07/2024	19/07/2024	19/07/2024
Date analysed	-	19/07/2024	19/07/2024	19/07/2024	19/07/2024	19/07/2024
Exchangeable Ca	meq/100g	2.8	10	3.9	6.1	9.0
Exchangeable K	meq/100g	0.2	0.2	0.2	0.2	0.1
Exchangeable Mg	meq/100g	6.9	4.5	6.7	7.4	5.7
Exchangeable Na	meq/100g	3.0	1.7	4.3	4.5	3.1
Cation Exchange Capacity	meq/100g	13	17	15	18	18
ESP	%	23	10	29	25	17

ESP/CEC						
Our Reference		356648-11	356648-12	356648-13	356648-14	356648-15
Your Reference	UNITS	BH104	BH104	BH105	BH105	BH105
Depth		2.5-2.95	4-4.45	0.4-0.5	2.5-2.95	4-4.45
Date Sampled		12/07/2024	12/07/2024	12/07/2024	12/07/2024	12/07/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/07/2024	19/07/2024	19/07/2024	19/07/2024	19/07/2024
Date analysed	-	19/07/2024	19/07/2024	19/07/2024	19/07/2024	19/07/2024
Exchangeable Ca	meq/100g	9.3	9.2	2.9	5.8	8.4
Exchangeable K	meq/100g	0.4	0.4	0.2	0.5	0.4
Exchangeable Mg	meq/100g	4.7	4.9	6.7	4.7	4.6
Exchangeable Na	meq/100g	2.4	2.6	3.7	3.1	2.6
Cation Exchange Capacity	meq/100g	17	17	14	14	16
ESP	%	14	15	27	22	16

Texture and Salinity*						
Our Reference		356648-1	356648-2	356648-3	356648-4	356648-5
Your Reference	UNITS	BH101	BH101	BH101	BH102	BH102
Depth		0.4-0.5	2.5-2.95	4-4.45	0.4-0.5	2.5-2.95
Date Sampled		12/07/2024	12/07/2024	12/07/2024	12/07/2024	12/07/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	17/07/2024	17/07/2024	17/07/2024	17/07/2024	17/07/2024
Date analysed	-	17/07/2024	17/07/2024	17/07/2024	17/07/2024	17/07/2024
Electrical Conductivity 1:5 soil:water	µS/cm	390	320	330	420	480
Texture Value	-	9.0	7.0	7.0	7.0	7.0
Texture	-	CLAY LOAM	MEDIUM CLAY	MEDIUM CLAY	MEDIUM CLAY	MEDIUM CLAY
ECe	dS/m	3.5	2.2	2.3	2.9	3.4
Class	-	SLIGHTLY SALINE	SLIGHTLY SALINE	SLIGHTLY SALINE	SLIGHTLY SALINE	SLIGHTLY SALINE

Texture and Salinity*						
Our Reference		356648-6	356648-7	356648-8	356648-9	356648-10
Your Reference	UNITS	BH102	BH103	BH103	BH103	BH104
Depth		4-4.45	0.4-0.5	2.5-2.95	4-4.45	0.4-0.5
Date Sampled		12/07/2024	12/07/2024	12/07/2024	12/07/2024	12/07/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	17/07/2024	17/07/2024	17/07/2024	17/07/2024	17/07/2024
Date analysed	-	17/07/2024	17/07/2024	17/07/2024	17/07/2024	17/07/2024
Electrical Conductivity 1:5 soil:water	µS/cm	290	460	280	330	350
Texture Value	-	7.0	7.0	7.0	7.0	9.0
Texture	-	MEDIUM CLAY	MEDIUM CLAY	MEDIUM CLAY	MEDIUM CLAY	CLAY LOAM
ECe	dS/m	2.1	3.2	<2	2.3	3.2
Class	-	SLIGHTLY SALINE	SLIGHTLY SALINE	NON SALINE	SLIGHTLY SALINE	SLIGHTLY SALINE

Texture and Salinity*						
Our Reference		356648-11	356648-12	356648-13	356648-14	356648-15
Your Reference	UNITS	BH104	BH104	BH105	BH105	BH105
Depth		2.5-2.95	4-4.45	0.4-0.5	2.5-2.95	4-4.45
Date Sampled		12/07/2024	12/07/2024	12/07/2024	12/07/2024	12/07/2024
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	17/07/2024	17/07/2024	17/07/2024	17/07/2024	17/07/2024
Date analysed	-	17/07/2024	17/07/2024	17/07/2024	17/07/2024	17/07/2024
Electrical Conductivity 1:5 soil:water	µS/cm	430	460	290	360	440
Texture Value	-	6.0	6.0	9.0	6.0	9.0
Texture	-	HEAVY CLAY	HEAVY CLAY	CLAY LOAM	HEAVY CLAY	CLAY LOAM
ECe	dS/m	2.6	2.7	2.6	2.2	3.9
Class	-	SLIGHTLY SALINE	SLIGHTLY SALINE	SLIGHTLY SALINE	SLIGHTLY SALINE	SLIGHTLY SALINE

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
INORG-123	Determined using a "Texture by Feel" method.
Metals-020	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-OES analytical finish.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	356648-15
Date prepared	-			18/07/2024	4	18/07/2024	18/07/2024		18/07/2024	18/07/2024
Date analysed	-			18/07/2024	4	18/07/2024	18/07/2024		18/07/2024	18/07/2024
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	4	8.3	8.1	2	99	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	4	240	220	9	108	118
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	4	310	270	14	110	98

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	14	18/07/2024	18/07/2024		[NT]	[NT]
Date analysed	-			[NT]	14	18/07/2024	18/07/2024		[NT]	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	14	9.3	[NT]		[NT]	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	14	150	150	0	[NT]	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	14	250	250	0	[NT]	[NT]

QUALITY CONTROL: ESP/CEC					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			19/07/2024	10	19/07/2024	19/07/2024		19/07/2024	[NT]
Date analysed	-			19/07/2024	10	19/07/2024	19/07/2024		19/07/2024	[NT]
Exchangeable Ca	meq/100g	0.1	Metals-020	<0.1	10	9.0	7.9	13	93	[NT]
Exchangeable K	meq/100g	0.1	Metals-020	<0.1	10	0.1	0.1	0	98	[NT]
Exchangeable Mg	meq/100g	0.1	Metals-020	<0.1	10	5.7	5.2	9	91	[NT]
Exchangeable Na	meq/100g	0.1	Metals-020	<0.1	10	3.1	2.8	10	112	[NT]
ESP	%	1	Metals-020	[NT]	10	17	18	6	[NT]	[NT]

QUALITY CONTROL: Texture and Salinity*						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			17/07/2024	4	17/07/2024	17/07/2024		17/07/2024	[NT]
Date analysed	-			17/07/2024	4	17/07/2024	17/07/2024		17/07/2024	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	4	420	380	10	101	[NT]
Texture Value	-		INORG-123	[NT]	4	7.0	7.0	0	[NT]	[NT]

Result Definitions

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

Quality Control Definitions

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

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

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

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

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

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

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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