Douglas Partners
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Report on
Preliminary Geotechnical Investigation

Newcastle Urban Transformation and Transport
Program - The Store
854 Hunter Street, Newcastle West

Prepared for
UrbanGrowth NSW

Project 81811.01
May 2016

Integrated Practical Solutions

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Document History

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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		26 May 2016
Reviewer		26 May 2016

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Report on Preliminary Geotechnical Investigation
Newcastle Urban Transformation and Transport Program - The Store
854 Hunter Street, Newcastle West

1. Introduction

This report presents the results of a preliminary geotechnical investigation undertaken as part of the Newcastle Urban Transformation and Transport Program (NUTTP) at 854 Hunter Street, Newcastle West, known as 'The Store'. The investigation was commissioned via UrbanGrowth NSW contract 3823/16, dated 25 February 2016 and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal NCL150656.P.002.Rev0 dated 29 January 2016.

It is understood that UrbanGrowth NSW is responsible for the investigation for repurposing of the site, including assessment of the site for various landuses including residential, mixed use and commercial.

At this stage it is also understood that development of The Store site will include supporting development for the adjacent proposed transport interchange comprising a bus interchange, parking and possible retail and residential development.

The aim of the investigation was to provide the following information:

- Subsurface conditions, including depth to groundwater (if encountered);
- Site classification in accordance with the requirements of AS2870;
- Suitable footing types for the proposed development;
- Estimated pile capacities for preliminary pile design;
- Retaining wall design parameters; and
- Recommendations on site preparation and earthworks.

The investigation included a data review of existing geotechnical data, three cone penetration tests, as well as 12 boreholes which were drilled for the Stage 1 Targeted Site Investigation (Contamination) component of the project (reported separately, report 81811.01.R.004.DftA, Ref 1). The details of the field work are presented in this report, together with comments and recommendations on the items listed above.

2. Site Description

The site known as "The Store" is defined as 854-868 Hunter Street, Newcastle West, New South Wales as shown on Drawing 1, Appendix D and comprises the following lots:

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Table 1: Site Description

Lot	DP
4	456091
5	456091
6	456091
70	882529
1	232233
2	573033
1	573033
1	82517
410	705518

The site is bound to the north by the Newcastle Rail Corridor, to the east by Stewart Avenue and Cooper Street, to the south by Hunter Street and to the west by commercial / retail premises. The site is an irregular shape and covers an area of approximately 1.2 ha.

The site is currently zoned B3 Commercial Core.

The extent of the investigation area is shown on Drawing 1, Appendix D.

Reference to the 1:100,000 Newcastle Coalfields Geology geodatabase indicates that the site is underlain by Quaternary alluvium which typically comprises gravel, sand, silt and clay.

Reference to the NSW Contours Central and Hunter Coast LiDAR indicates the site levels vary between approximately 2.0 AHD to 3.5 AHD.

3. Field Work Methods

Field work for the geotechnical component of the project was undertaken on 17 February and 18 February 2016 and comprised three cone penetration tests (CPTs 101 to 103). The tests were taken to depths ranging from 15.0 m to 43.12 m.

The CPTs were conducted using a purpose-built truck-mounted CPT rig. A 35 mm diameter instrumented cone and friction sleeve assembly was hydraulically thrust into the soil at a rate of about 2 cm/sec. Cone tip resistance, sleeve friction and inclination from vertical were recorded by a computer data acquisition system for subsequent plotting and analysis. Upon completion of each test, the remnant hole was dipped to determine the depth to the water table.

Boreholes were also drilled adjacent to the CPTs, associated with Ref 1 works (Bores 1, 5 and 10 respectively). The bores were drilled to depths ranging from 4 m to 5 m using a track mounted or truck mounted rig using dual tube push tube drilling methods.

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The CPT locations were set out by a geotechnical engineer from DP and are presented on Drawing 1, Appendix D. The surface level at the test locations were measured by dumpy level, relative to a local survey benchmark, and is recorded relative to the Australian Height Datum (AHD).

4. Field Work Results

Results from the CPTs are attached, together with inferred strata descriptions, based on published correlations between cone resistance, friction ratio and soil type. These should be read in conjunction with the accompanying notes in Appendix A which explain the descriptive terms and classification methods used in the reports. The detailed borehole logs are presented within Ref 1.

A generalised geotechnical model of the subsurface profile encountered at the test locations is summarised as follows:

FILL:	Bores 1, 5 and 10, drilled at or immediately adjacent to CPTs 101 to 103 respectively, encountered asphalt or concrete surfacing, overlying predominantly granular fill to depths ranging from 2.0 m to 3.7 m.
SAND	Sand with some silty sand / sandy silt in parts, was inferred underlying the fill to depths ranging from 7.6 m to 12.9 m. The sand was initially loose to medium dense, and generally increased to medium dense or denser from depths ranging from 5.5 m to 7 m.
CLAY and SAND	Interbedded clay, silty clay and sand / silty sand was encountered in CPTs 101 and 102, to depths of 12.6 m to 14.5 m. The clay ranged from firm to very stiff in consistency, while the sand typically ranged from loose to dense. Not present in CPT 103.
CLAY:	Clay, with minor lenses of silty sand / sandy silt in parts, was inferred from depths ranging from 12.6 m to 14.5 m at all CPT locations. The clay was typically stiff to very stiff initially, becoming very stiff to hard with depth. CPT 102 was terminated in stiff clay at 15 m depth.
BEDROCK:	CPT refusal was encountered in CPTs 101 and 103 at depths of 41.06 m and 43.12 m respectively. This is likely to correspond to the top of weathered bedrock.

Free groundwater was measured within CPTs 102 and 103 at depths of 1.8 m and 1.9 m respectively, at the time of investigation (i.e. RL0.8 to RL1.0). Hole collapse occurred in CPT 101 following testing, thereby precluding groundwater measurement.

Free groundwater was measured within groundwater wells installed for Ref 1 works in late March 2016. Groundwater was recorded at depths ranging from approximately RL0.6 to RL1.0 m in the wells. It should be noted that groundwater levels are variable and can be affected by such factors as soil permeability, recent weather conditions and tidal influences.

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5. Proposed Development

It is understood that proposed development at the site will consider various potential landuses, including residential, mixed use and commercial.

At this stage it is also understood that development of The Store site will include supporting development for the adjacent proposed transport interchange comprising a bus interchange, parking and possible retail and residential development.

Further details such as structural loads are not known at this stage.

6. Comments

6.1 Subgrade Preparation Measures

It is anticipated that the existing asphalt and concrete surfacing at the site will be removed to facilitate construction of the new development.

The subgrade typically comprises sandy gravel and sand filling, underlain by sand, and the relative strength of the subgrade is variable. At the time of investigation, groundwater was observed at depths ranging from approximately RL0.6 to RL1.0 AHD.

It is recommended that the upper soil profile is compacted to improve the site trafficability, particularly for construction plant. The exposed surface should be proof rolled by at least 6 to 8 passes of a 10 tonne roller in non-vibration mode. Any soft / wet areas should be locally removed and replaced with compacted sand filling or granular fill which has a soaked CBR of 15% or greater. The proof roll should be witnessed by a geotechnical engineer. The surface should be compacted to a dry density ratio of at least 100% Standard or 75% Density Index. Dynamic penetration tests should also be undertaken to confirm the relative density of the subgrade following the above subgrade preparation measures.

Piling rigs and cranes are likely to require a suitable working platform constructed of coarse granular material. The design of the working platform will depend on the type of construction equipment to be used for the project. As a guide, at least 300 mm of granular filling (CBR >60%) is usually provided for piling plant but the design and the working platform should be subject to specific geotechnical assessment once equipment track pressures and track dimensions are available.

6.2 Excavation Conditions

Based on the results of the investigation, excavation of the subgrade soils will be readily achieved by conventional earthmoving equipment such as hydraulic excavators.

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For an open excavation up to 1 m depth, excavation above the water table may have temporary batter slopes of 1V:2H (26°). Depending on groundwater levels at the time of construction, it is possible that groundwater may lead to destabilisation of battered excavations, particularly in sands. Local internal sump and pump arrangements and / or flatter batter slopes may be required to reduce the risk of slumping in this case. Alternatively, excavations could be supported by trench boxes, sheet piling or similar.

Deeper excavations, if required (e.g. for lift wells), would be expected to be below the groundwater level. Such excavations would require temporary support and dewatering using spear points. Large scale dewatering should not be undertaken without assessment of possible effects to adjacent structures. It is also noted that a licence from NSW Office of Water may be required to dewater and potentially discharge water from site.

The earthworks contractor should take appropriate safety precautions to protect workers against collapse of excavation walls and batters. Notwithstanding the above, excavations greater than 1.5 m depth are subject to statutory Workcover requirements.

6.3 Footings / Piles

6.3.1 Shallow Footings

Based on the results of the CPTs and bores, the site contains up to approximately 3.7 m of predominantly sandy filling and therefore the site is classified Class P with reference to AS2870-2011 (Ref 1).

Due to the depth of filling, and the presence of groundwater, the use of shallow pad or strip footings is likely to be limited to lightly loaded structures which are not settlement sensitive. Consideration has therefore been given to piles for support of the majority of structural loads, as discussed below.

6.3.2 Pile Founding Levels

Piles may be founded in soil or rock. Based on the results of the CPTs, the depth to rock is expected to be in excess of about 40 m; hence piles founded in rock are expected to be relatively costly compared to those founded in soil. Founding piles in rock is technically feasible; however, further investigation comprising geotechnical drilling would be required to confirm the depth to rock and its strength.

It is considered that the medium dense to very dense sand presents a potential founding stratum for piles. This layer was encountered from depths ranging from approximately 4.8 m to 5.3 m (RL -1.0 to -2.5 AHD). A plot of the cone tip resistance (q_c) versus RL for all cone penetration tests is presented in Figure 4.

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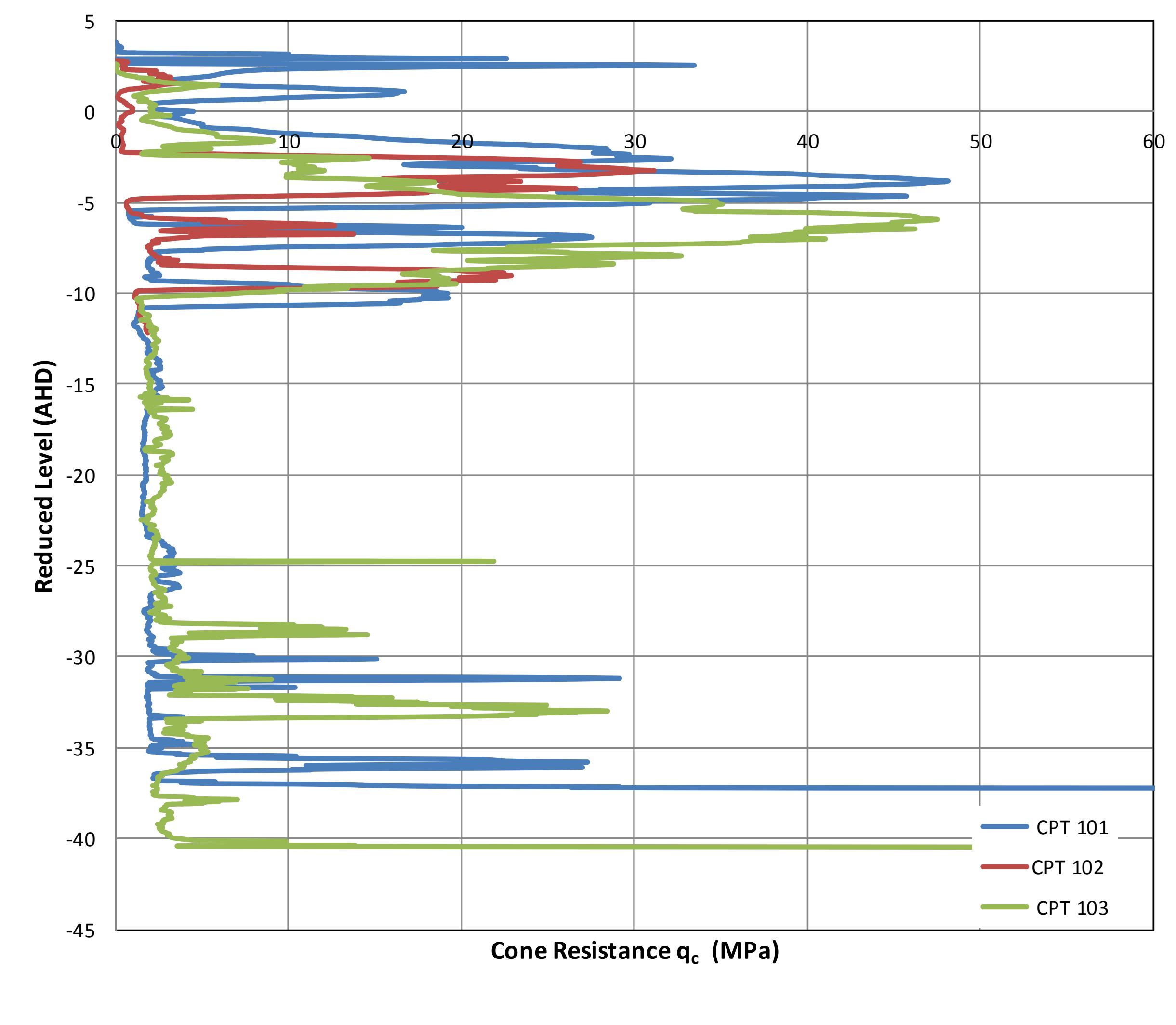

Figure 1: Cone Resistance versus Reduced Level (CPTs 101 to 103)

The results of the CPTs indicate that the subsurface profile is variable is terms of depth to the medium dense to very dense sand layer, as well as in terms of the sand thickness and presence of clay bands within the sand. Layers of firm to stiff clay were encountered beneath the potential founding layer in CPTs 101 and 102 (refer Figure 4, RL -4.7 to -5.2 AHD). The presence of clay layers is significant as founding piles above these could lead to higher magnitudes of settlement, due to consolidation of the clay under load.

Based on pile capacity assessment, presented in the next section, the optimal founding depth is assessed to range from about 6 m to 7 m below existing ground level (approximately RL-2.2 to RL-4.3 AHD), with respect to both capacity and potential consolidation of the underlying clay layers.

6.3.3 Suitable Pile Types and Load Capacities

The pile types considered most suitable for this site comprise continuous flight auger (CFA) piles and concrete screw cast piles. Driven piles are unlikely to be suitable due to the potential vibrations associated with installation, taking into account the close proximity of existing structures. Other pile types could be technically feasible for this site and could be assessed if required.

Geotechnical capacities for piles in compression have been estimated for selected pile types using the CPT results and an in-house program ConePile Version 5.9.1.

The estimations have been carried out for the following piles:

- 0.60 / 0.75 m diameter (CFA or grout-injected);
- 0.56 / 0.71 m diameter screw cast pile (e.g. Atlas).

The pile capacities are expressed in limit state terms as described in the piling code AS 2159-2009 (Ref 3), whereby the Design Geotechnical Strength ($R_{d,g}$) is defined as follows:

$$R_{d,g} = \phi_g R_{ug}, \text{ which must exceed the Design Action Effect } E_d$$

R_{ug} is the ultimate geotechnical strength, which is calculated using static theory, and therefore represents an estimate only. The geotechnical strength reduction factor ϕ_g depends on a number of factors including the extent of site investigation, type of analysis and pile testing regime during construction. For the estimates presented below, a value of $\phi_g = 0.52$ was adopted. Higher values of ϕ_g may be justifiable if sufficient load testing is conducted, as per AS 2159-2009.

The plots of estimated pile capacity against depth are included in Appendix C. Table 2 shows the geotechnical capacity of single piles founded in the medium dense to dense sand at 6 m to 7 m depth, as indicated for the respective test locations.

Table 2: Estimated Limit State Pile Capacities for Selected Piles Founded at 6 m to 7 m Depth

Pile Type	Pile Size	Estimated Design Geotechnical Strength ($R_{d,g}$) (1,3) (kN), $\phi_g = 0.52$		
		CPT101 (6 m depth, RL-2.2)	CPT102 (6 m depth, RL-3.2)	CPT103 (7 m depth, RL-4.3)
Grout – Injected (CFA)	0.60 m diameter	1300	1000	1250
Grout – Injected (CFA)	0.75 m diameter	1800	1400	1700
Screw Cast Concrete	0.51 / 0.66 m diameter[4]	1500	1250	1500
Screw Cast Concrete	0.56 / 0.71 m diameter[4]	1800	1400	1750

Notes to Table: 2

1. All pile types, particularly grout piles, should be checked for structural adequacy.
2. Strength Reduction factor (ϕ_g) = 0.52.
3. Group capacities are not necessarily a straight multiple of individual capacities due to interaction effects.
4. Inner / Outer diameter of screw cast pile.

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Due to the variability in subsurface conditions, a detailed geotechnical investigation comprising additional CPTs would be required to better characterise the subsurface profile, which would allow refinement of pile founding depths and capacities.

The foregoing estimated capacities relate to geotechnical strength only, and the structural adequacy of the piles should also be checked, particularly in the case of grout piles. Prospective piling contractors should confirm the pile capacities and founding depths achievable with their equipment. In regard to verification of load capacity at the time of installation, it is noted that screw cast concrete piles have an advantage over grout-injected piles because torque measurements provide an indication of capacity.

If grout-injected piles are selected for this project, it is recommended that further CPTs be carried out at a high proportion of proposed pile / pile group locations in order to identify and confirm the strength of the founding layer.

6.3.4 Settlement of Pile Groups

Due to the subsurface conditions comprising interbedded clay strata below the proposed pile founding depth, the settlement of the underlying clay strata becomes as important an issue as the geotechnical capacity.

As a guide, the estimated settlement of a single pile, twin pile and a four pile group are shown in Table 3. The settlement estimates have been based on the following:

- Piles founded at depths as presented in Table 2;
- Pile diameter of 0.75 m;
- Working load of 1050 kN per pile (i.e. ~75% of $R_{d,g}$ = 1400 kN); and
- Pile spacing of 2.5 diameters (centre to centre) for the pile group.

Table 3: Settlement Estimates for Piles and Pile Groups

Pile Location	'Immediate' Settlement[1] (mm)	Consolidation of Clay (mm)	Total Settlement (mm)
Single Pile	5-10	0-5	10-15
Two Pile Group	10-15	20-25	30-40
Four Pile Group	20-30	35-45	55-75

Note to Table: 3

1. The settlement of the pile due to sand and interaction effects will not actually be "immediate', as the load is applied gradually as the building is constructed.

The above total settlements could lead to significant differential settlements between columns or other structural elements. The differential settlements will depend on the spatial arrangement of loads and the pile configuration adopted. The total and differential settlements could probably be reduced by utilising a piled raft system, whereby a proportion of the structural load is carried by a stiff raft at basement level. Further analysis would be required to assess this further, based on the actual layout of working loads on columns and wall footings.

If the settlements provided in Table 3 above are too high for the proposed structure, foundations to rock, interpreted at a depth of about 41 m to 43 m based on the CPTs, could be considered. Conventional bored piles constructed under bentonite, grout injected piles or barrettes constructed under bentonite are likely to be the preferred pile options for larger column loads.

For preliminary design and costing of piles founded on rock, the following parameters are suggested for proportioning the dimensions to resist compression loads.

Table 4: Preliminary Pile Design Parameters

Description	Ultimate Strength ($R_{d,ug}$)*		Serviceability/Max Allowable End - Bearing (kPa)	Elastic Modulus (E_{field}) (MPa)
	Design End - Bearing (kPa)	Design Shaft Adhesion (kPa)		
Medium dense or better sand	-	35	-	20
Stiff or better clay	-	40	-	10
Extremely low to very low strength or better siltstone / sandstone	2000	50	700	50

Notes to Table: 4

Ultimate Values occur at large settlements (> 5% of minimum footing diameter).

Shaft adhesion values based on a shaft roughness of R2 or better.

Serviceability / Max Allowable end bearing to cause settlement of < 1% of minimum footing dimension or pile diameter.

AS 2159 – 2009 requires that the contribution of the shaft from finished surface to 1.5 times pile diameter or 1 m (whichever is greater) shall be ignored.

For preliminary analysis of piles in tension, the shaft adhesion parameters should be reduced to 75% of the values in Table 4.

For vertical loading, it is suggested that piles should be spaced at 2.5 pile diameters or greater such that the overall capacity of the pile group can be equivalent to the sum of the individual piles (i.e. group efficiency factor of unity).

The design shaft adhesion values assume the shafts of the piles are rough and free from remoulded material and assume that steel casing is not provided to provide hole support. If piles founded on rock are to be considered for this project, further investigation comprising geotechnical drilling and coring of the bedrock would be required to confirm the depth to rock and its strength.

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6.4 Retaining Wall Design Parameters

Temporary shoring or sheet piling, if installed for the construction period only, and not required to prevent movement of the adjacent ground, may be designed based upon "active" (K_a) earth pressure coefficients. This would comprise any non-propped or laterally unrestrained walls (e.g. cantilever type walls or sheet piles).

Where support for the adjoining ground is to be maintained, retaining walls would require anchoring or propping by some method in order to minimise lateral displacement upon excavation. The earth pressure distribution in this situation should be based on "at-rest" (K_o) earth pressure coefficients.

The suggested design soil parameters are shown in Table 5 below. The earth pressure coefficients are for level backfill and are unfactored. Any additional surcharge loads, during or after construction, should be accounted for in design.

Table 5: Retaining Wall Design Parameters

Parameter	Symbol	Granular Fill, Loose Sand and Sand Filling
Unit weight (above water table)	γ_b	18 kN/m^3
Submerged (buoyant) unit weight (below water table)	γ_{sub}	10 kN/m^3
Angle of Friction	ϕ'	30°
Angle of Wall Friction	δ	20°
Active earth pressure coefficient	K_a	0.33
At-rest earth pressure coefficient	K_o	0.50
Passive earth pressure coefficient	K_P	3.0

Below the water table, γ_{sub} should be used instead of γ_b, and the contribution of hydrostatic water pressure should be added ($\gamma_w.z_w$, where z_w is the depth below the water table, γ_w = 9.81 kN/m^3).

In order to ensure adequate toe restraint, it is likely that any cantilever type or sheet pile wall would have to extend some depth below the base of the excavation level.

Free draining material should be used for backfilling behind the wall, such as a uniformly graded gravel of nominal size 10 mm to 20 mm.

6.5 Mine Subsidence

Reference to the Mine Subsidence Board's (MSB) Mine Subsidence District map for Newcastle indicates that the site is located immediately to the north of the mapped Newcastle Mine Subsidence District boundary. Furthermore, preliminary correspondence from the MSB regarding the site indicates that no restrictions would be expected to be imposed on development.

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Notwithstanding the above, it is recommended that a formal application be made to the MSB for approval of any proposed development on the site.

7. References

1. Douglas Partners Pty Ltd, "Report on Preliminary Geotechnical Investigation Newcastle Urban Transformation and Transport Program - The Store, 854 Hunter Street, Newcastle West, Report 81811.01.R.004.DftA dated 28 April 2016.
2. Australian Standard AS 2870-2011 "Residential Slabs and Footings", 2011, Standards Australia.
3. Australian Standard AS 2159–2009, "Piling – design and installation", Standards Australia.

8. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report (or services) for this project at 854 Hunter Street, Newcastle West in accordance with DP's proposal NCL150656-2 dated 29 January 2016 and acceptance received from UrbanGrowth NSW dated 13 April 2016. The work was carried out under contract No 3823/16, dated 25 February 2016. This report is provided for the exclusive use of UrbanGrowth NSW 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 DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP 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 DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP 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.

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. DP 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 DP. This is because this report has been written as advice and opinion rather than instructions for construction.

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The scope for work for this investigation / report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

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Appendix A

About This Report
Sampling Methods
Soil Descriptions
Symbols and Abbreviations
Information on Cone Penetration Tests

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About this Report

Douglas Partners

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.

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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.

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

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

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General

 Asphalt

 Road base

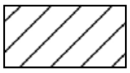
 Concrete

 Filling

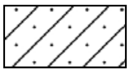
Soils

 Topsoil

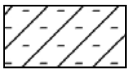
 Peat

 Clay

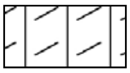
 Silty clay

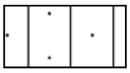
 Sandy clay

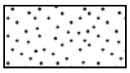
 Gravelly clay

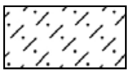
 Shaly clay

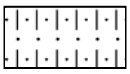
 Silt

 Clayey silt

 Sandy silt

 Sand

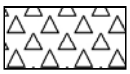
 Clayey sand

 Silty sand

 Gravel

 Sandy gravel

 Cobbles, boulders

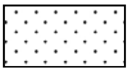
 Talus

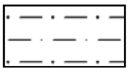
Sedimentary Rocks

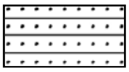
 Boulder conglomerate

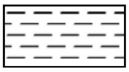
 Conglomerate

 Conglomeratic sandstone

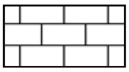
 Sandstone

 Siltstone

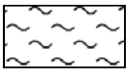
 Laminite

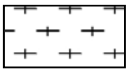
 Mudstone, claystone, shale

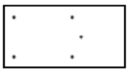
 Coal

 Limestone

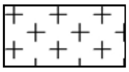
Metamorphic Rocks

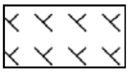
 Slate, phyllite, schist

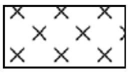
 Gneiss

 Quartzite

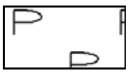
Igneous Rocks

 Granite

 Dolerite, basalt, andesite

 Dacite, epidote

 Tuff, breccia

 Porphyry

Cone Penetration Tests

Douglas Partners

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

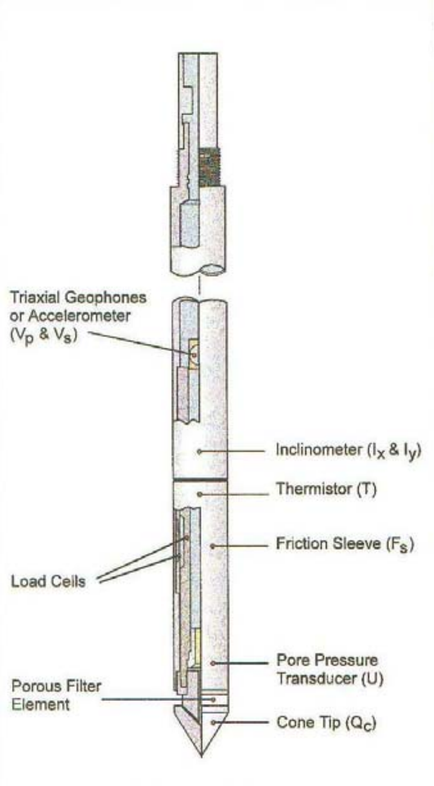


Figure 1: Cone Diagram

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 (q_c, f_s, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (σ) plus basic parameters
Seismic	Shear wave velocity (V_s), compression wave velocity (V_p), 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 Tests

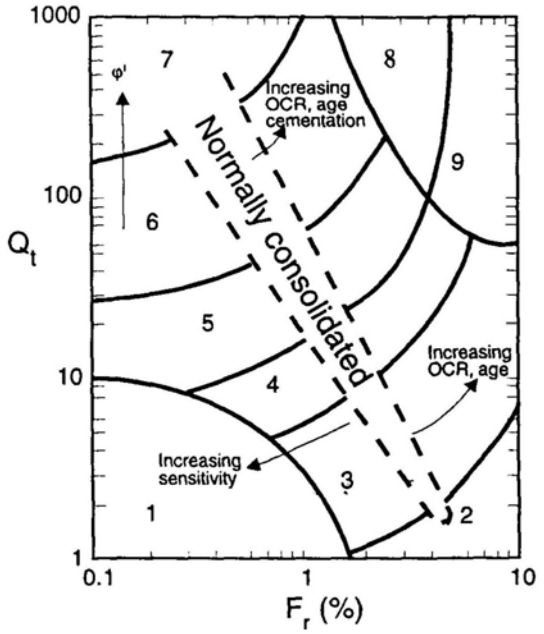


Figure 3: Soil Classification Chart

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 G_0. 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.

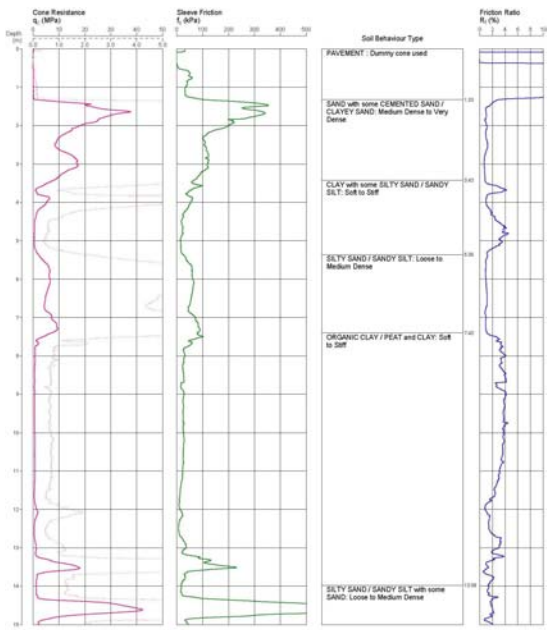


Figure 4: Sample Cone Plot

Appendix B

Cone Penetration Tests (CPTs 1 to 3)

DRAFT

CONE PENETRATION TEST

CLIENT: URBAN GROWTH NSW

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM

LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE

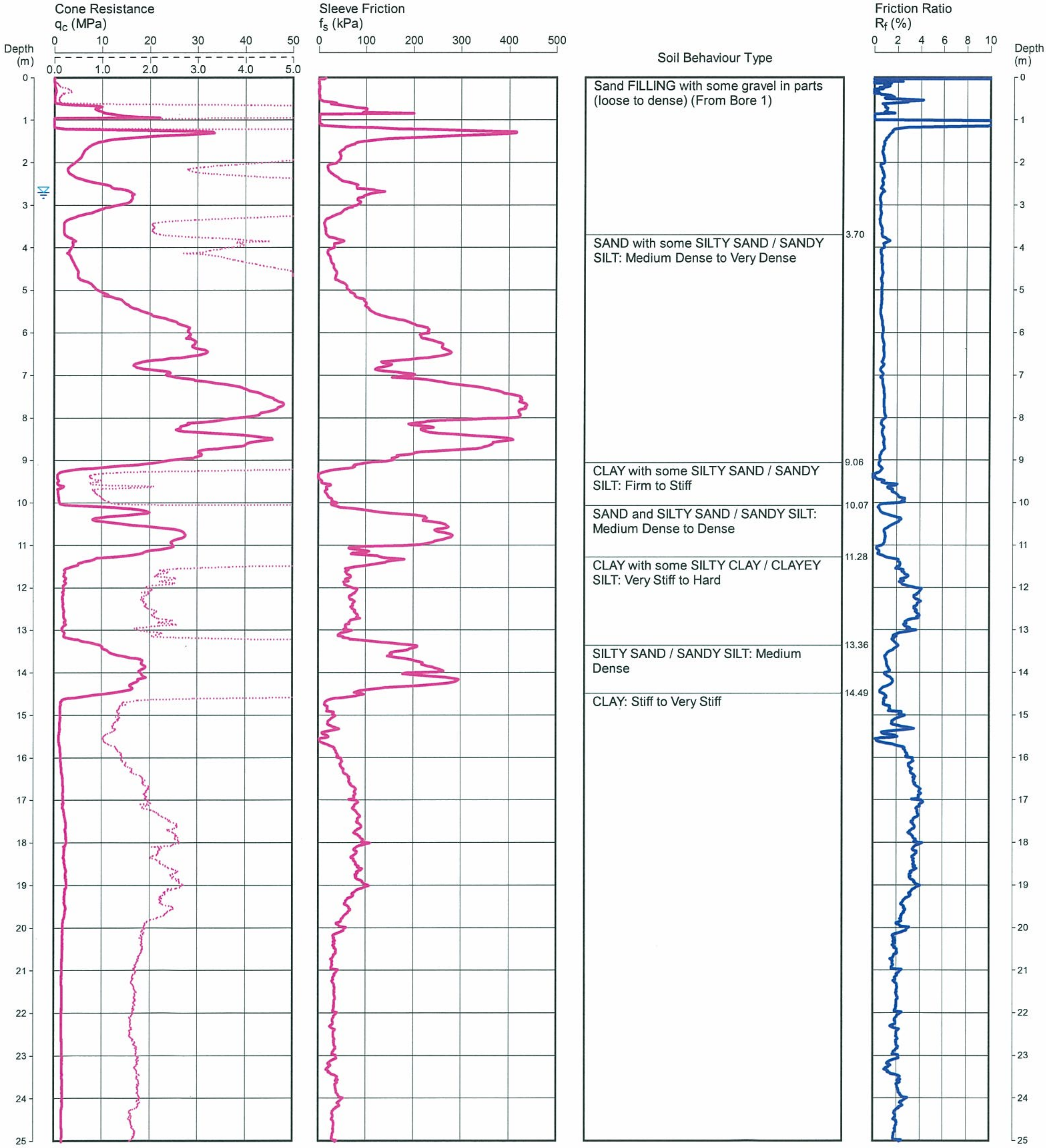
REDUCED LEVEL: 3.8 AHD

COORDINATES:

101

DATE 17/3/2016

PROJECT No: 81811.01



REMARKS: TEST DISCONTINUED DUE TO CONE REFUSAL. TEST LOCATION PRE-DRILLED TO 0.7M DEPTH PRIOR TO TEST. DUMMY CONE UTILISED FROM 0.94M TO 1.3M DEPTH DUE TO OBSTRUCTIONS IN FILLING. HOLE COLLAPSE MEASURED AT 2.7M DEPTH AFTER WITHDRAWAL OF RODS.

Water depth after test: 2.70m depth (assumed)

File: P:\81811.01 - Newcastle West, Hunter Street The Store\4.0 Field Work\4.2 Testing\CPT\CPT101.CP5
Cone ID: 120630 **Type:** I-CFXY-10

ConePlot Version 5.9.2
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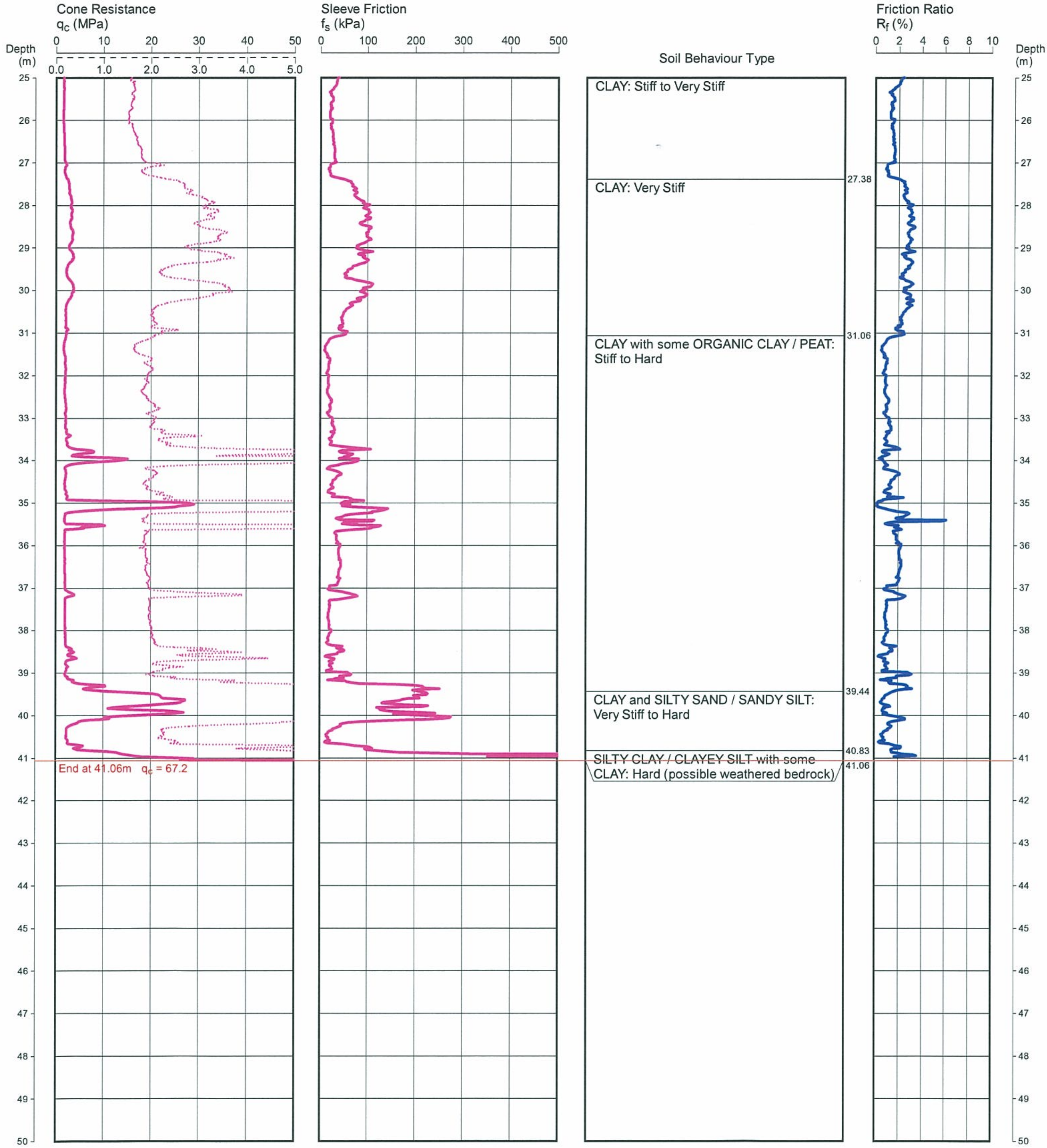
CONE PENETRATION TEST

CLIENT: URBAN GROWTH NSW	**LOCATION:** THE STORE - 854 HUNTER STREET, NEWCASTLE	**101** Page 2 of 2
PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM	**REDUCED LEVEL:** 3.8 AHD	**DATE** 17/3/2016
	COORDINATES:	**PROJECT No:** 81811.01



REMARKS: TEST DISCONTINUED DUE TO CONE REFUSAL. TEST LOCATION PRE-DRILLED TO 0.7M DEPTH PRIOR TO TEST. DUMMY CONE UTILISED FROM 0.94M TO 1.3M DEPTH DUE TO OBSTRUCTIONS IN FILLING. HOLE COLLAPSE MEASURED AT 2.7M DEPTH AFTER WITHDRAWAL OF RODS.

Water depth after test: 2.70m depth (assumed)

File: P:\81811.01 - Newcastle West, Hunter Street The Store\4.0 Field Work\4.2 Testing\CPT\CPT101.CP5
Cone ID: 120630 **Type:** I-CFXY-10

ConePlot Version 5.9.2
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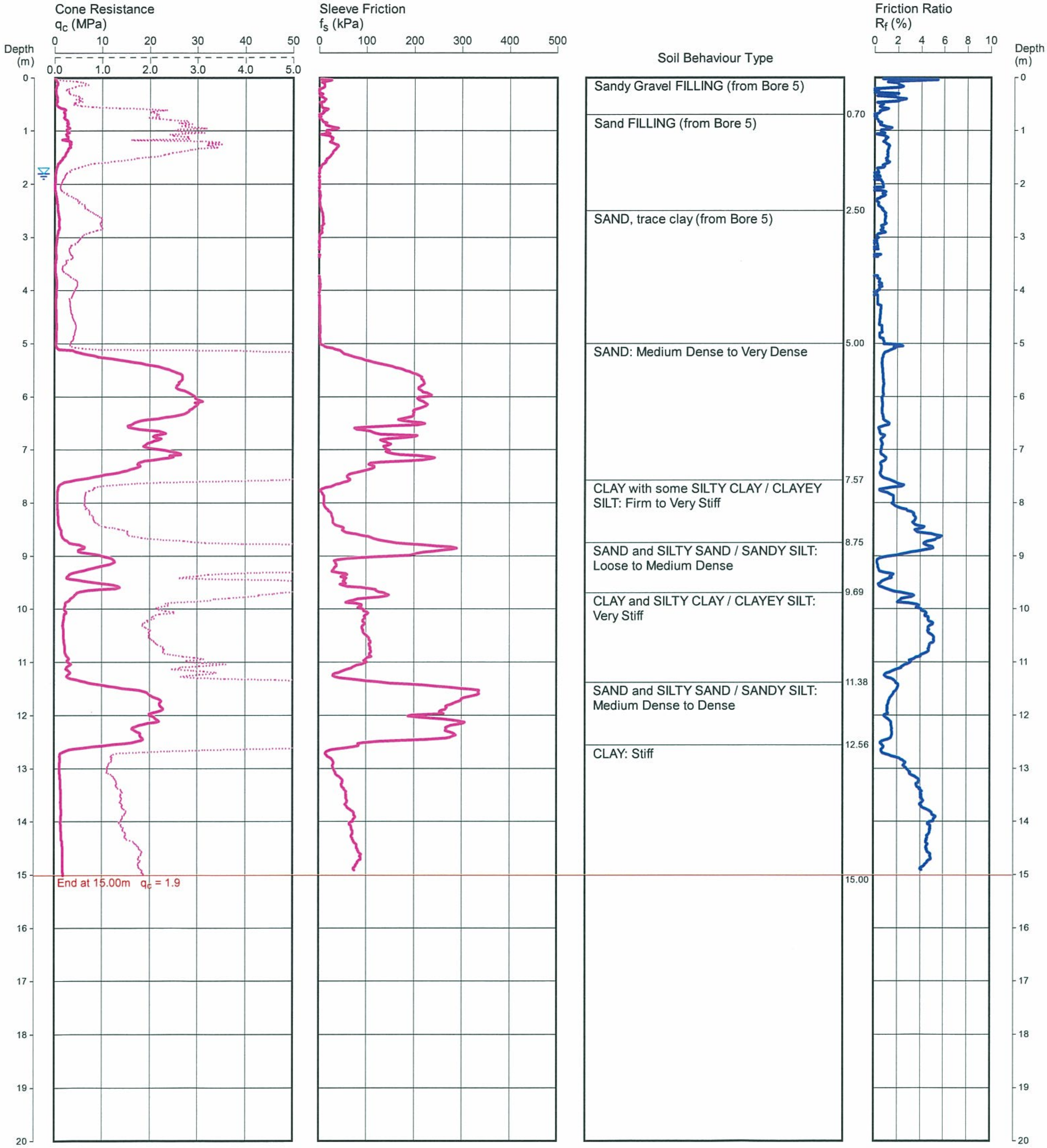
CONE PENETRATION TEST

CLIENT: URBAN GROWTH NSW	**LOCATION:** THE STORE - 854 HUNTER STREET, NEWCASTLE	**102** Page 1 of 1
PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM	**REDUCED LEVEL:** 2.8 AHD	**DATE** 17/3/2016
	COORDINATES:	**PROJECT No:** 81811.01



REMARKS: TEST DISCONTINUED DUE TO TARGET DEPTH REACHED. TEST CARRIED OUT THROUGH BACKFILLED BOREHOLE TO 5M DEPTH. GROUNDWATER MEASURED AT 1.8M DEPTH AFTER WITHDRAWAL OF RODS.

Water depth after test: 1.80m depth (measured)

File: P:\81811.01 - Newcastle West, Hunter Street The Store\4.0 Field Work\4.2 Testing\CPT\CPT102.CP5
Cone ID: 120630 **Type:** I-CFXY-10

ConePlot Version 5.9.2
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CONE PENETRATION TEST

CLIENT: URBAN GROWTH NSW

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM

LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE

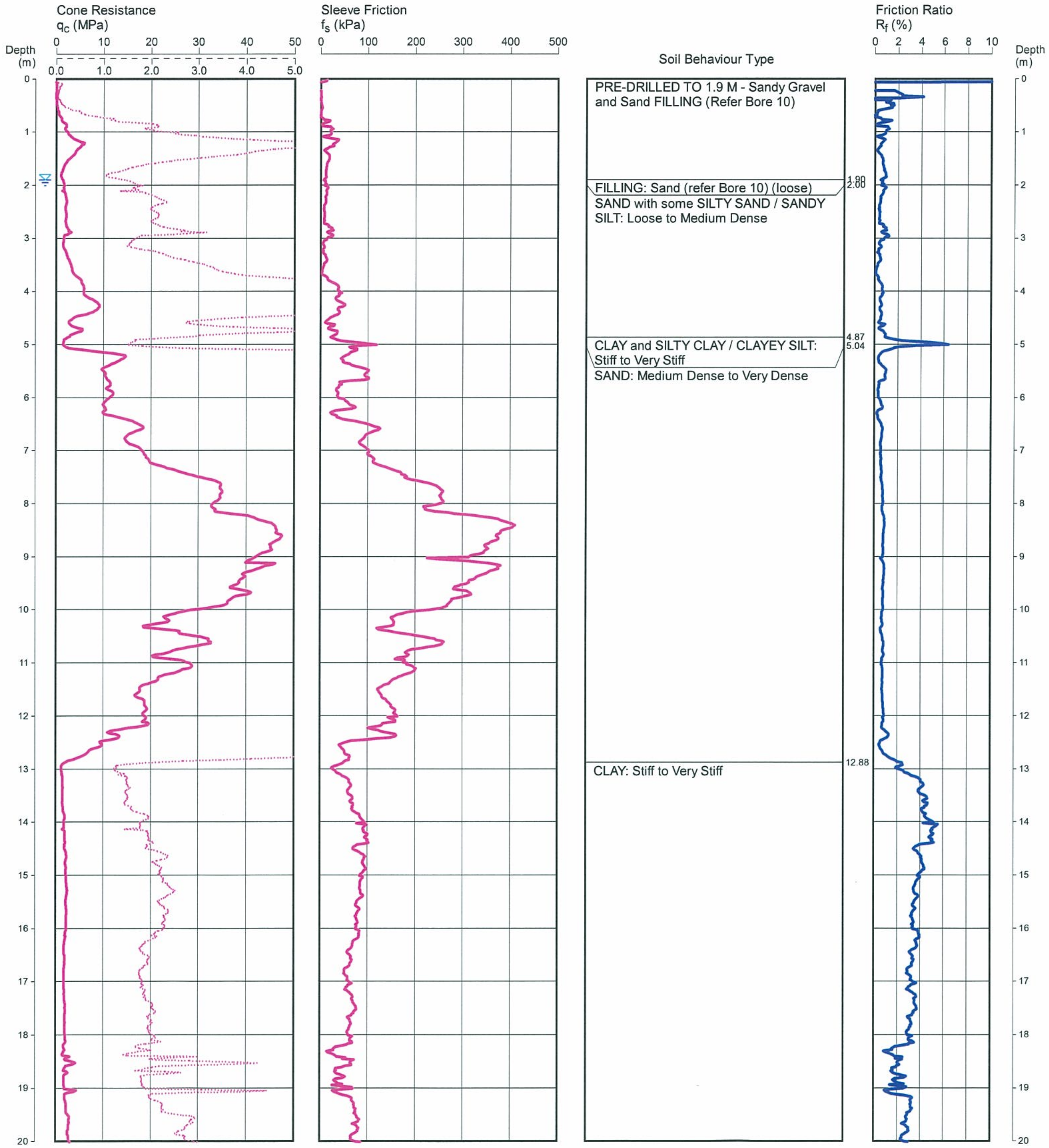
REDUCED LEVEL: 2.7 AHD

COORDINATES:

CPT103

DATE 17/3/2016

PROJECT No: 81811.01



REMARKS: TEST DISCONTINUED DUE TO CONE REFUSAL. TEST LOCATION PRE-DRILLED TO 1.1M DEPTH PRIOR TO TEST. GROUNDWATER MEASURED AT 1.9M DEPTH AFTER WITHDRAWAL OF RODS.

Water depth after test: 1.90m depth (measured)

File: P:\81811.01 - Newcastle West, Hunter Street The Store\4.0 Field Work\4.2 Testing\CPT\CPT103.CP5
Cone ID: 120630 **Type:** I-CFXY-10

ConePlot Version 5.9.2
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CONE PENETRATION TEST

CLIENT: URBAN GROWTH NSW

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM

LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE

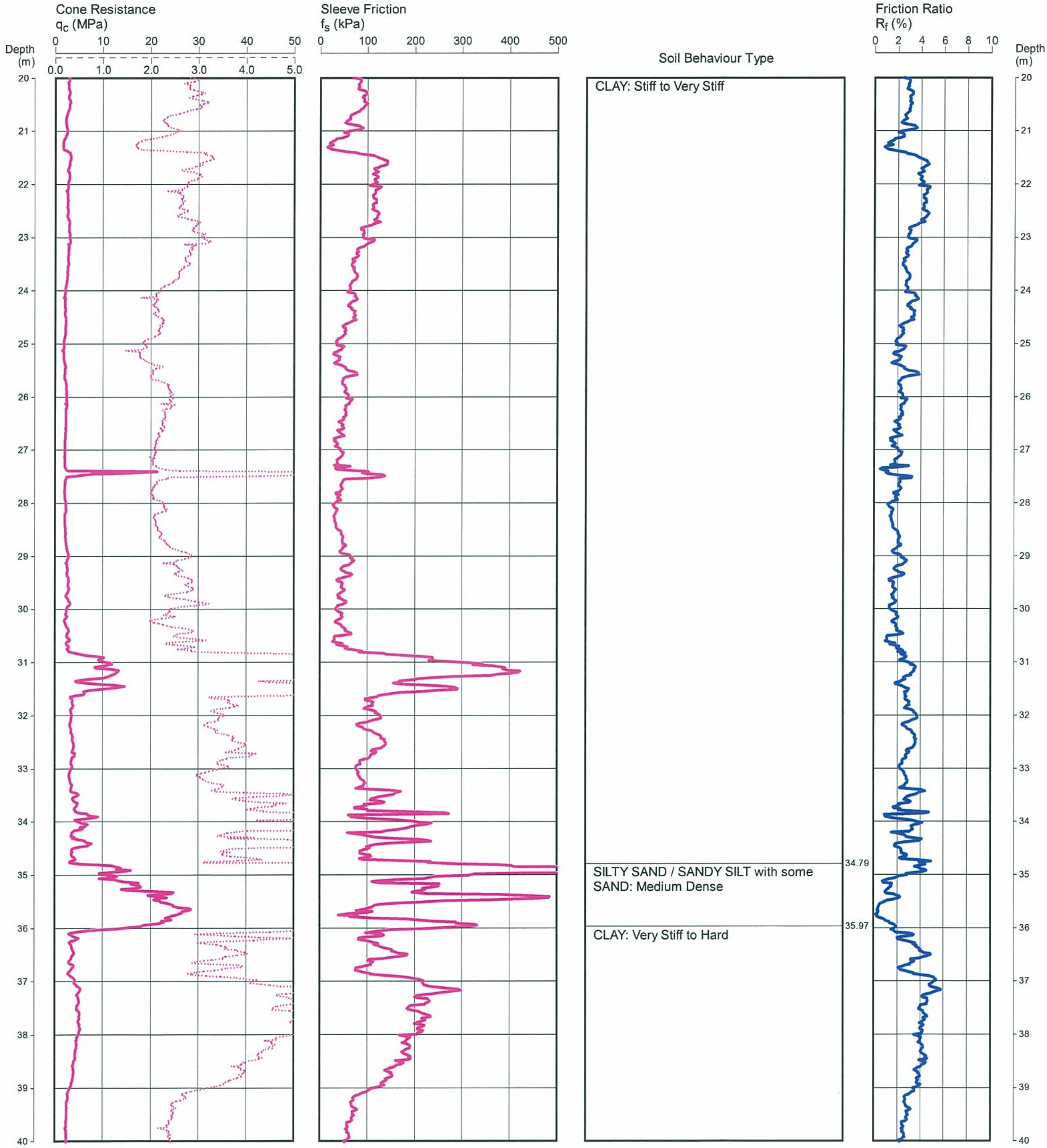
REDUCED LEVEL: 2.7 AHD

COORDINATES:

CPT103

DATE 17/3/2016

PROJECT No: 81811.01



REMARKS: TEST DISCONTINUED DUE TO CONE REFUSAL. TEST LOCATION PRE-DRILLED TO 1.1M DEPTH PRIOR TO TEST. GROUNDWATER MEASURED AT 1.9M DEPTH AFTER WITHDRAWAL OF RODS.

Water depth after test: 1.90m depth (measured)

File: P:\81811.01 - Newcastle West, Hunter Street The Store\4.0 Field Work\4.2 Testing\CPT\CPT103.CP5
Cone ID: 120630 **Type:** I-CFXY-10

ConePlot Version 5.9.2
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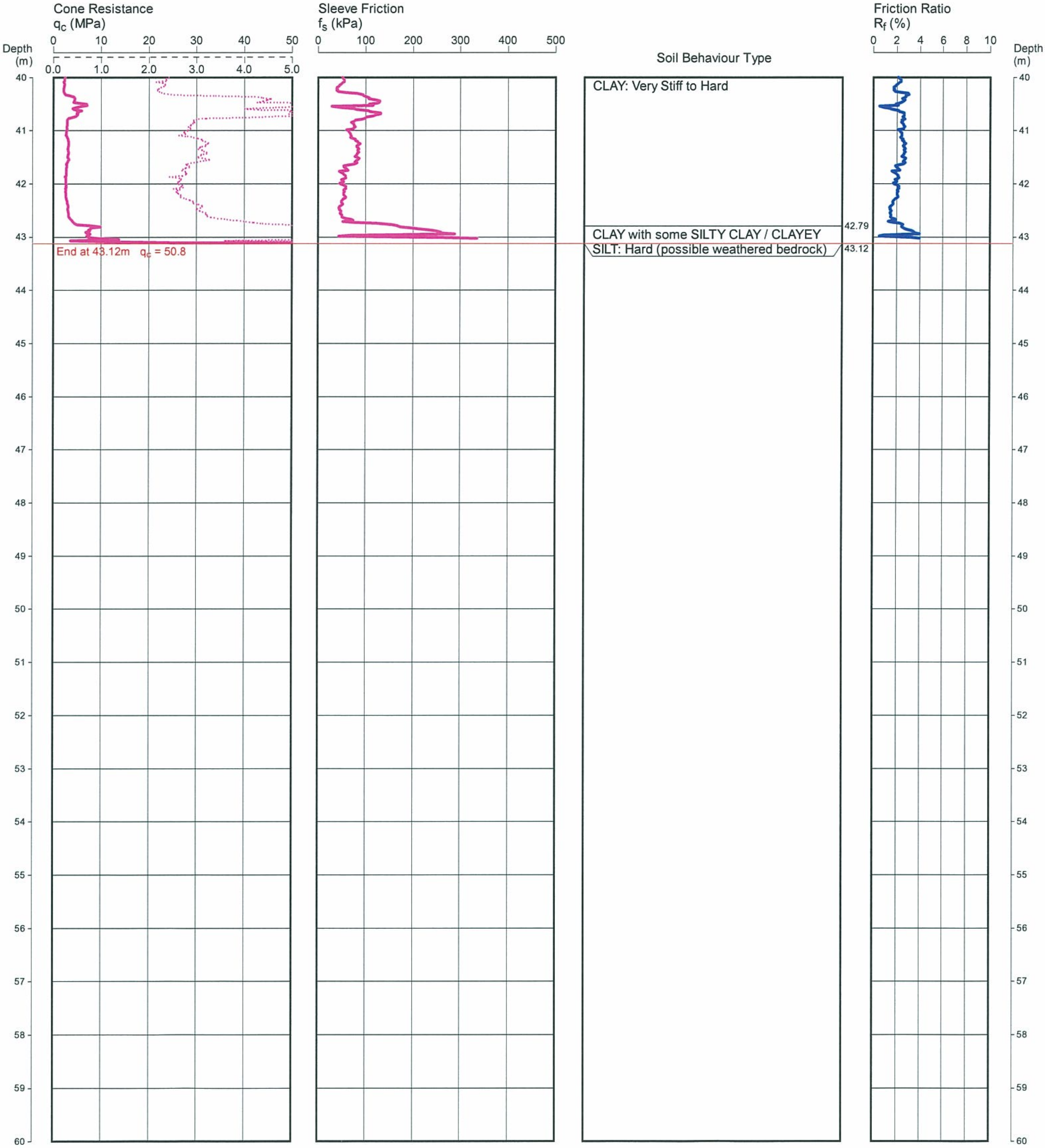
CONE PENETRATION TEST

CLIENT: URBAN GROWTH NSW	**LOCATION:** THE STORE - 854 HUNTER STREET, NEWCASTLE	**CPT103** Page 3 of 3
PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM	**REDUCED LEVEL:** 2.7 AHD	**DATE** 17/3/2016
	COORDINATES:	**PROJECT No:** 81811.01



REMARKS: TEST DISCONTINUED DUE TO CONE REFUSAL. TEST LOCATION PRE-DRILLED TO 1.1M DEPTH PRIOR TO TEST. GROUNDWATER MEASURED AT 1.9M DEPTH AFTER WITHDRAWAL OF RODS.

Water depth after test: 1.90m depth (measured)

File: P:\81811.01 - Newcastle West, Hunter Street The Store\4.0 Field Work\4.2 Testing\CPT\CPT103.CP5
Cone ID: 120630 **Type:** I-CFXY-10

ConePlot Version 5.9.2
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Appendix C

ConePile CFA 0.6 m diameter – CPTs 1 to 3
ConePile CFA 0.75 m diameter – CPTs 1 to 3
ConePile Screw Cast Concrete (0.51 m / 0.66 m diameter) – CPTs 1 to 3
ConePile Screw Cast Concrete (0.56 m / 0.71 m diameter) – CPTs 1 to 3

DRAFT

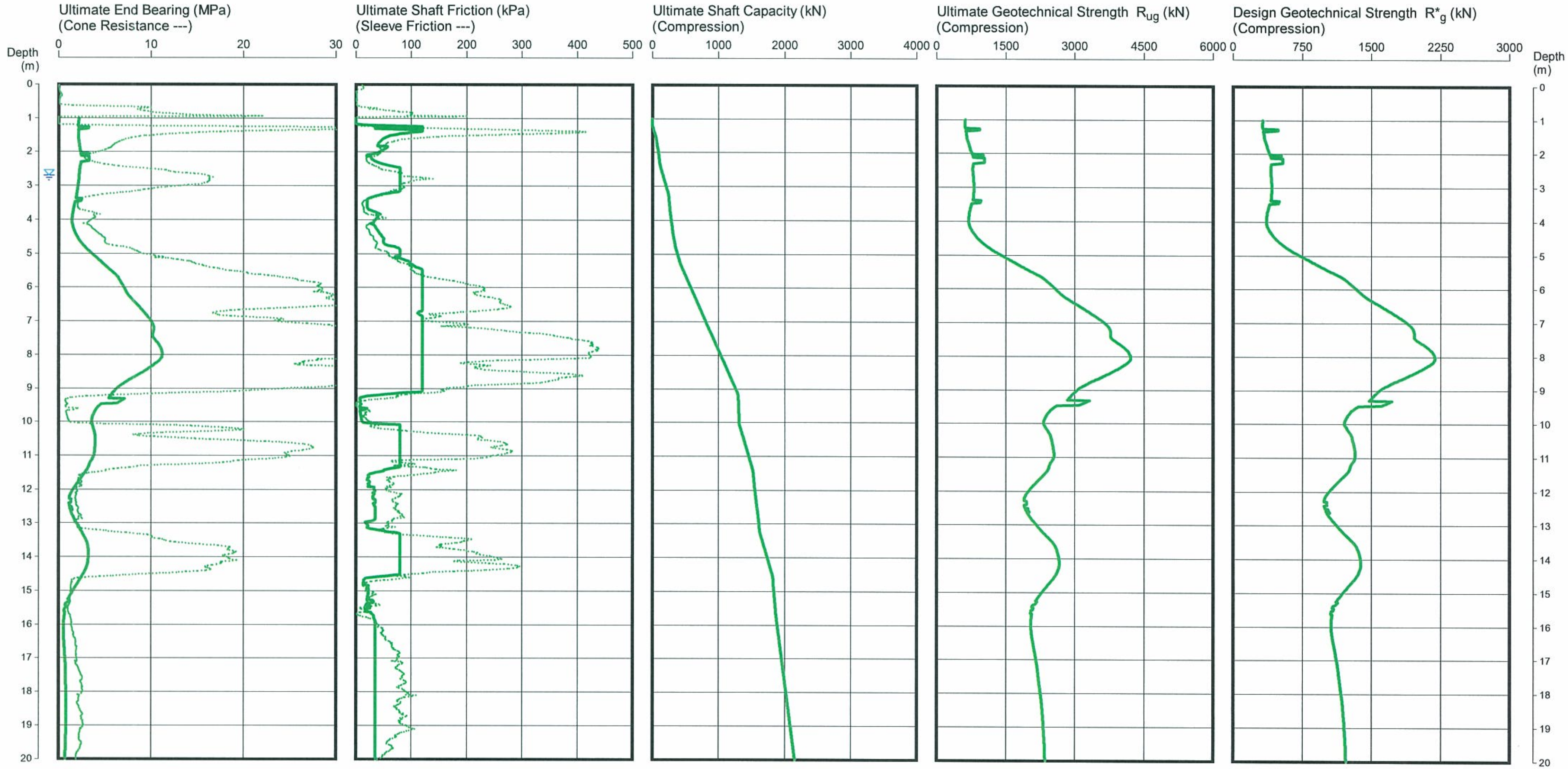
PILE CAPACITY ESTIMATE

PILE TYPE: Grout-Injected
PILE SHAPE: Round
PILE SIZE: Diameter = 0.60
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
CLIENT: URBAN GROWTH NSW

101

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 3.8 AHD



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Water depth after test: 2.70m depth

File: P:\81811.01 - Newcastle West, Hunter Street The Store\4.0 Field Work\4.2 Testing\CPT\CPT101.CP5
Cone ID: 120630 **Type:** I-CFXY-10

ConePile Version 5.9.1
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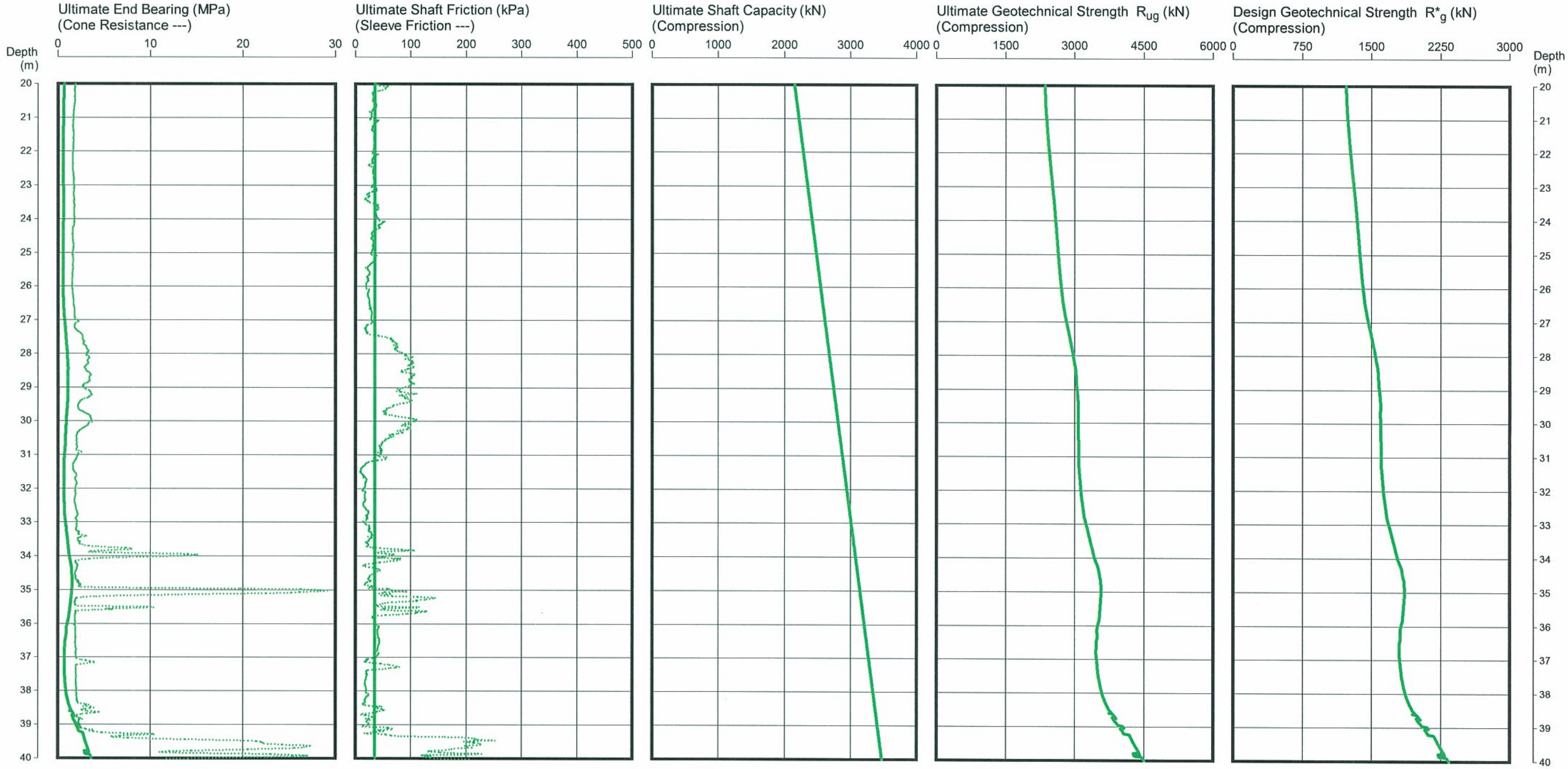
PILE CAPACITY ESTIMATE

PILE TYPE: Grout-Injected
PILE SHAPE: Round
PILE SIZE: Diameter = 0.60
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
CLIENT: URBAN GROWTH NSW

101

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 3.8 AHD



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PILE CAPACITY ESTIMATE

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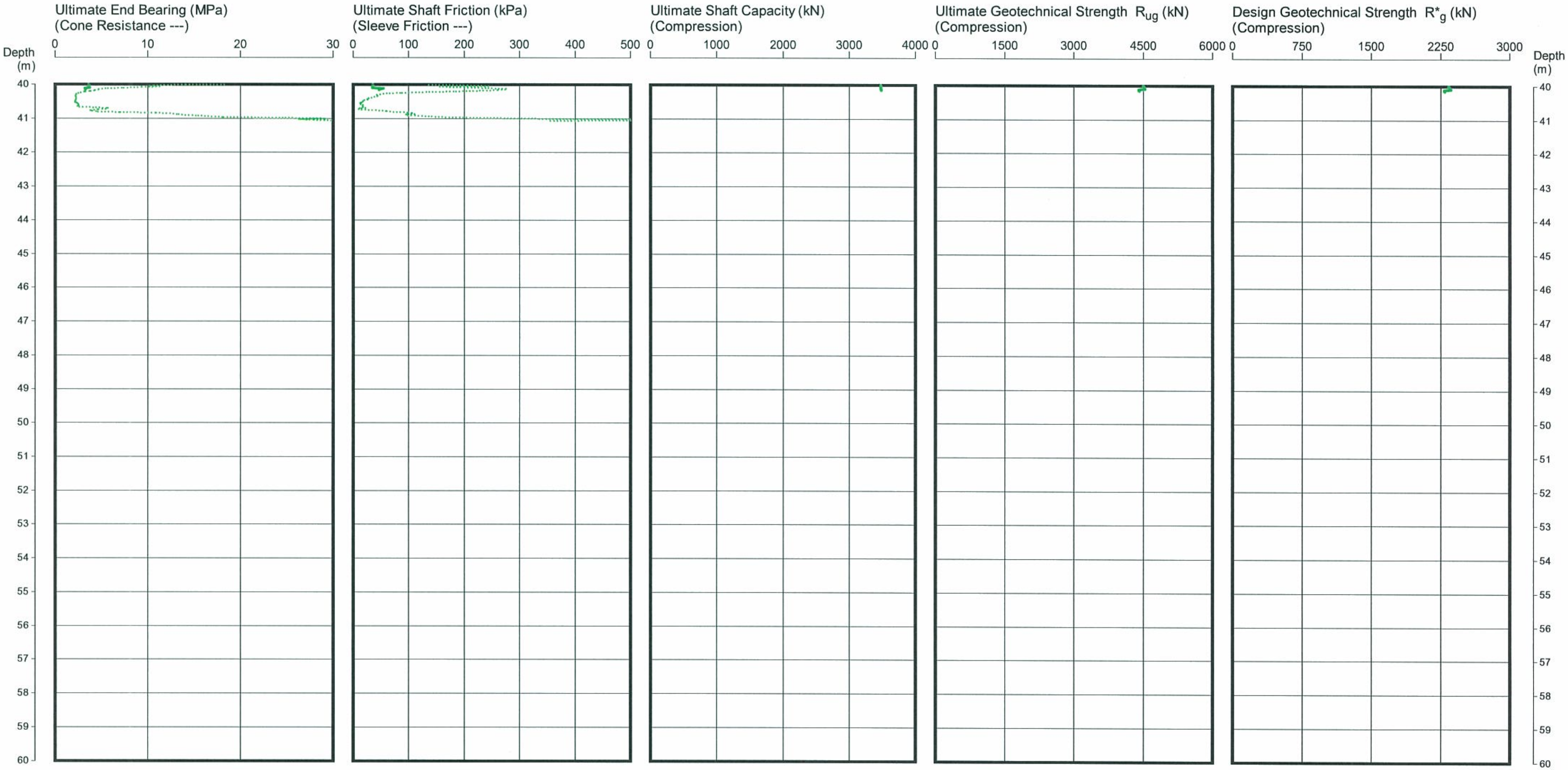
CLIENT: URBAN GROWTH NSW

101

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 3.8 AHD



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PILE CAPACITY ESTIMATE

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PILE SHAPE: Round
PILE SIZE: Diameter = 0.75
STRENGTH REDUCTION FACTOR $\emptyset_g$: 0.52
CALCULATION METHOD: LCPC Method

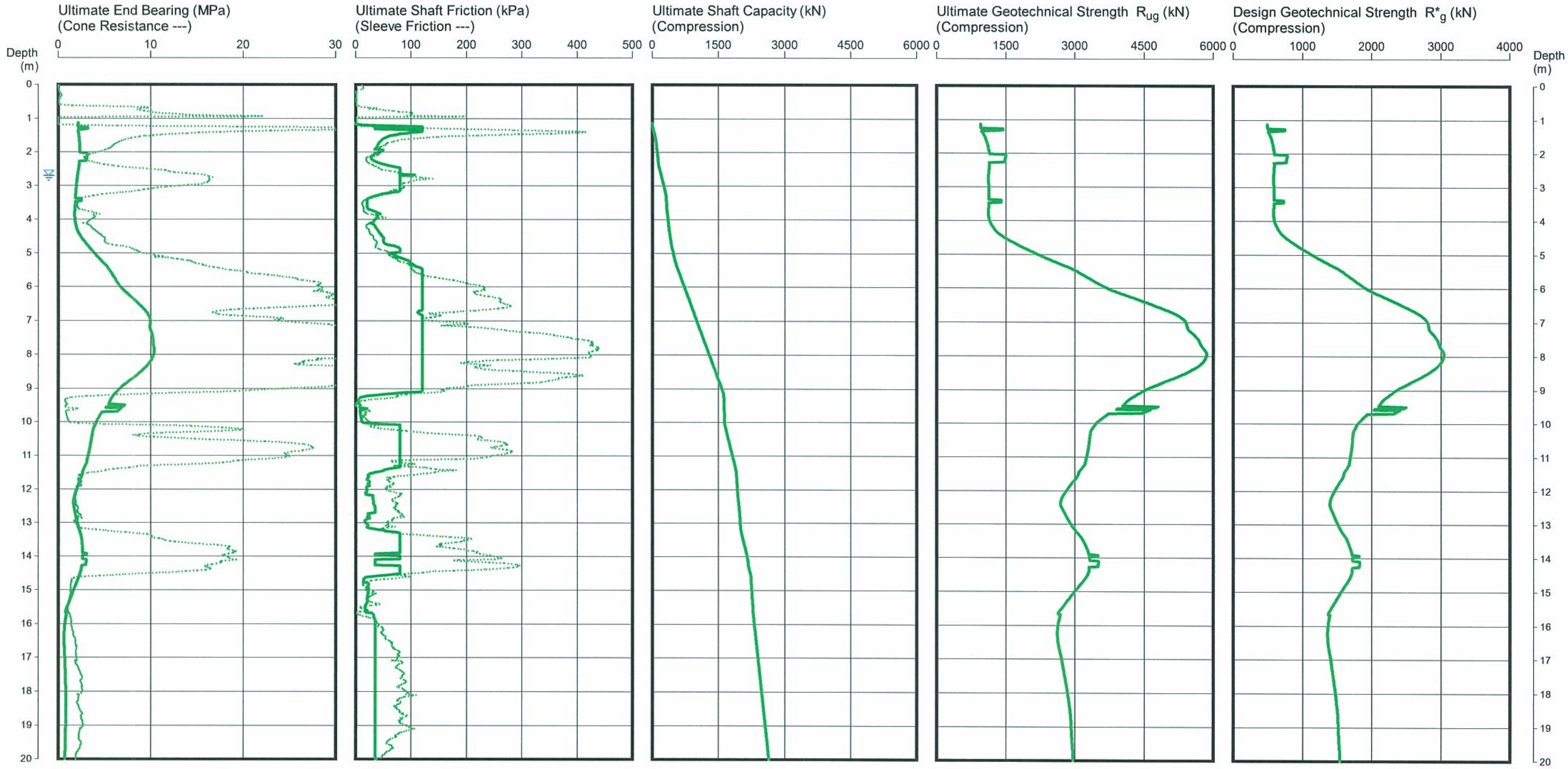
PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM

LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE

CLIENT: URBAN GROWTH NSW

101

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 3.8 AHD



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PILE CAPACITY ESTIMATE

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PILE SIZE: Diameter = 0.75
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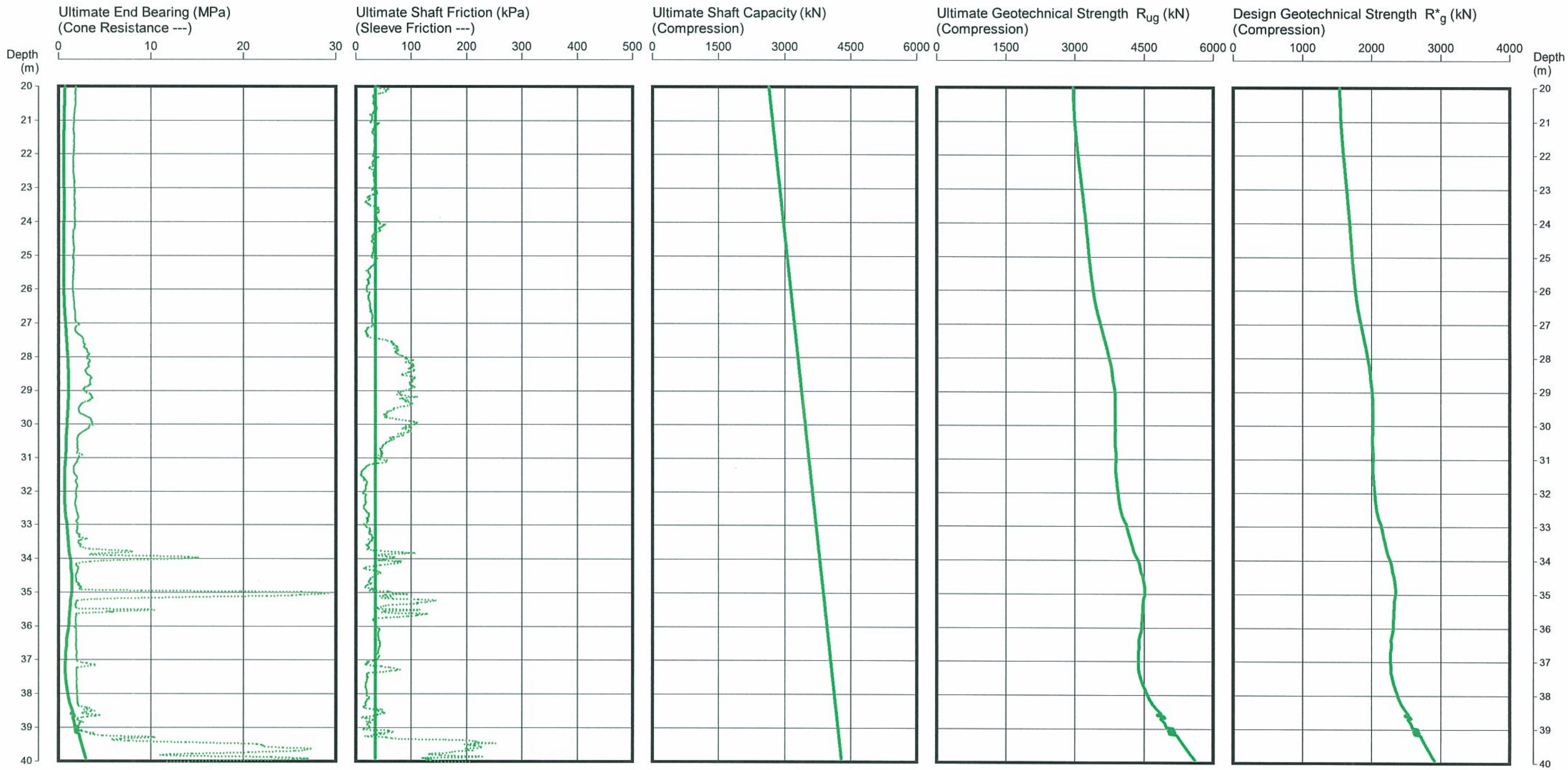

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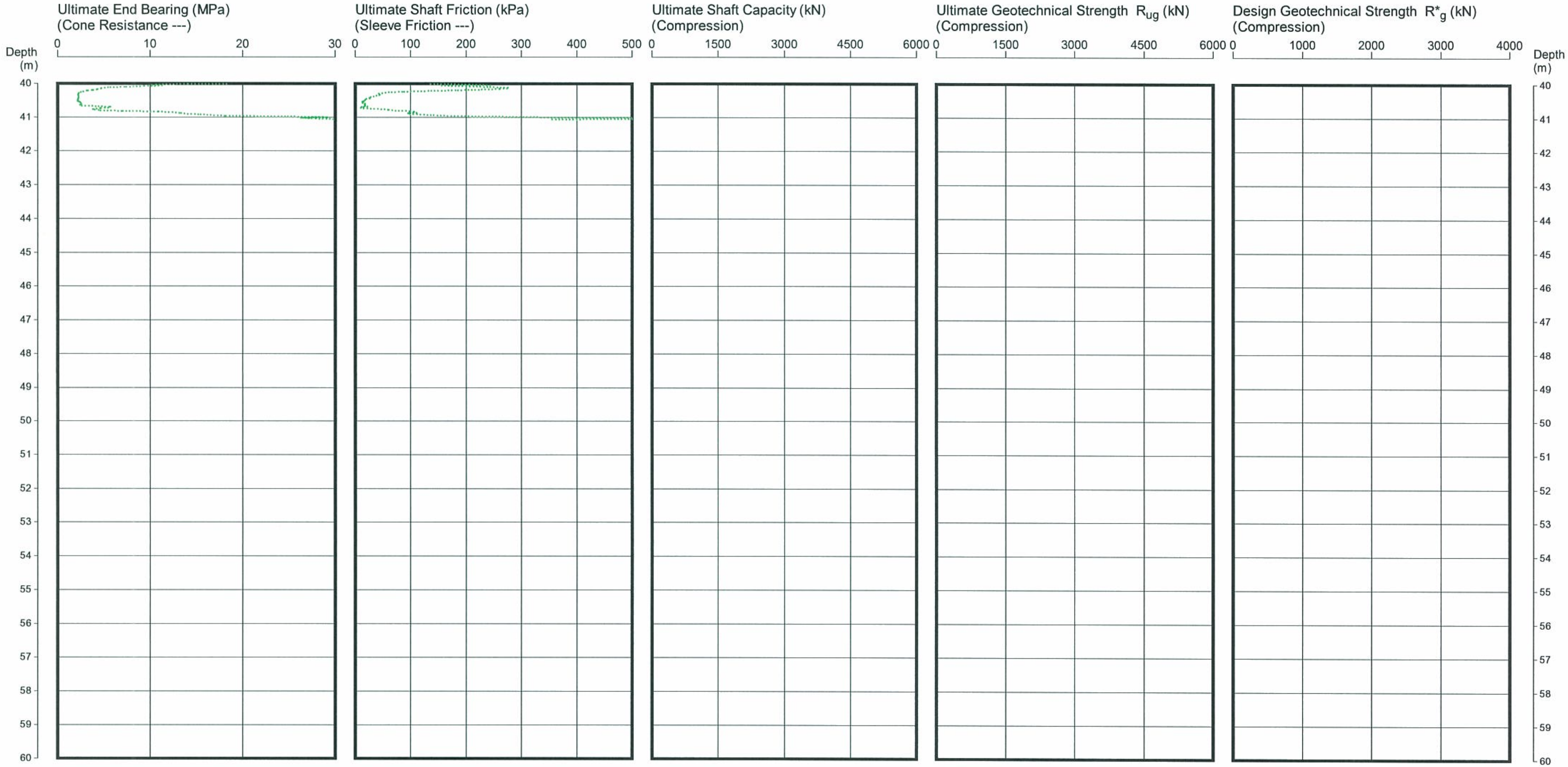
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
CLIENT: URBAN GROWTH NSW

101

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 3.8 AHD



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Cone ID: 120630 **Type:** I-CFXY-10

ConePile Version 5.9.1
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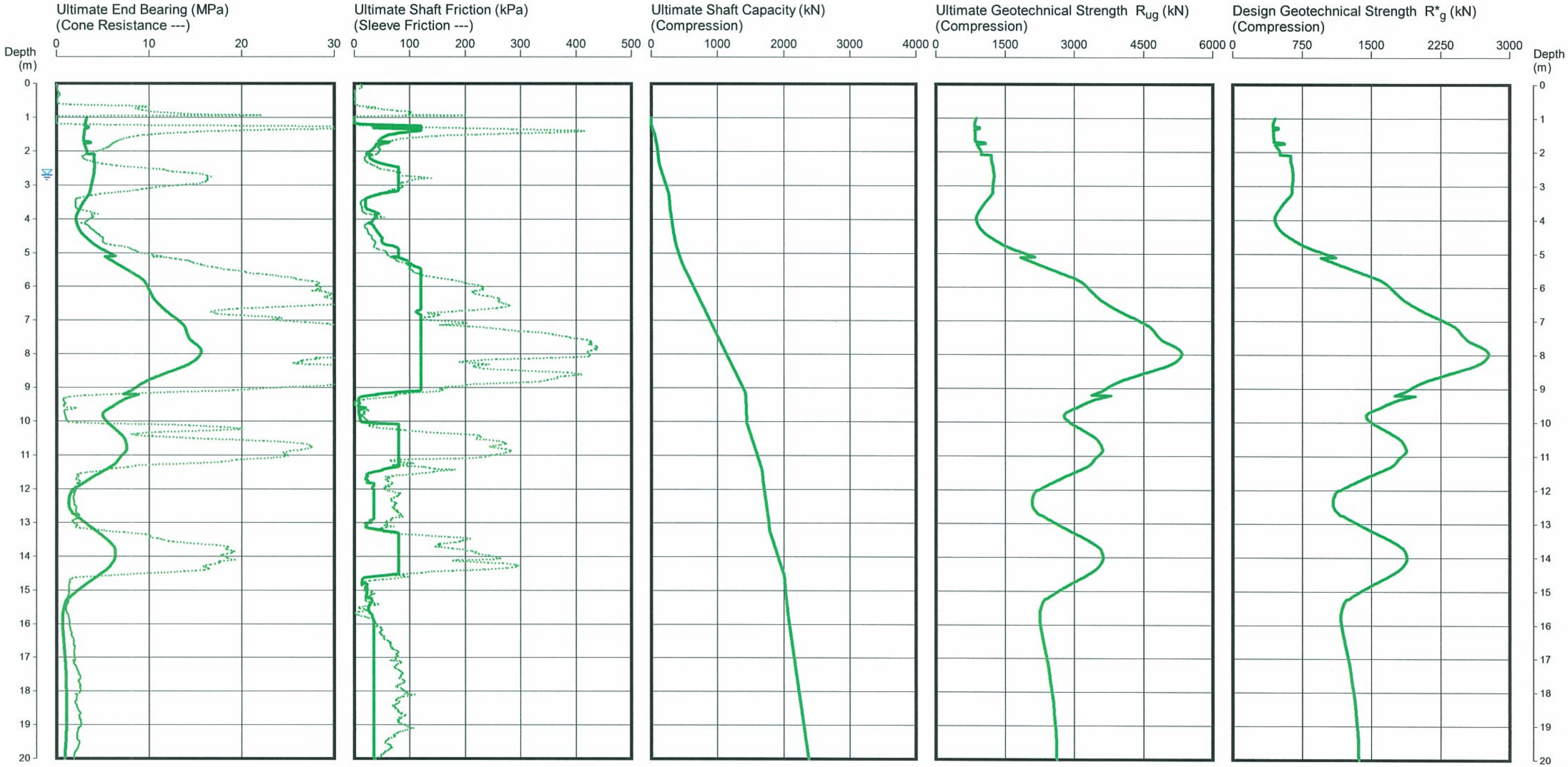
PILE CAPACITY ESTIMATE

PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.51 Outer Diameter = 0.66
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
CLIENT: URBAN GROWTH NSW

101

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 3.8 AHD



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PILE CAPACITY ESTIMATE

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STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
CLIENT: URBAN GROWTH NSW

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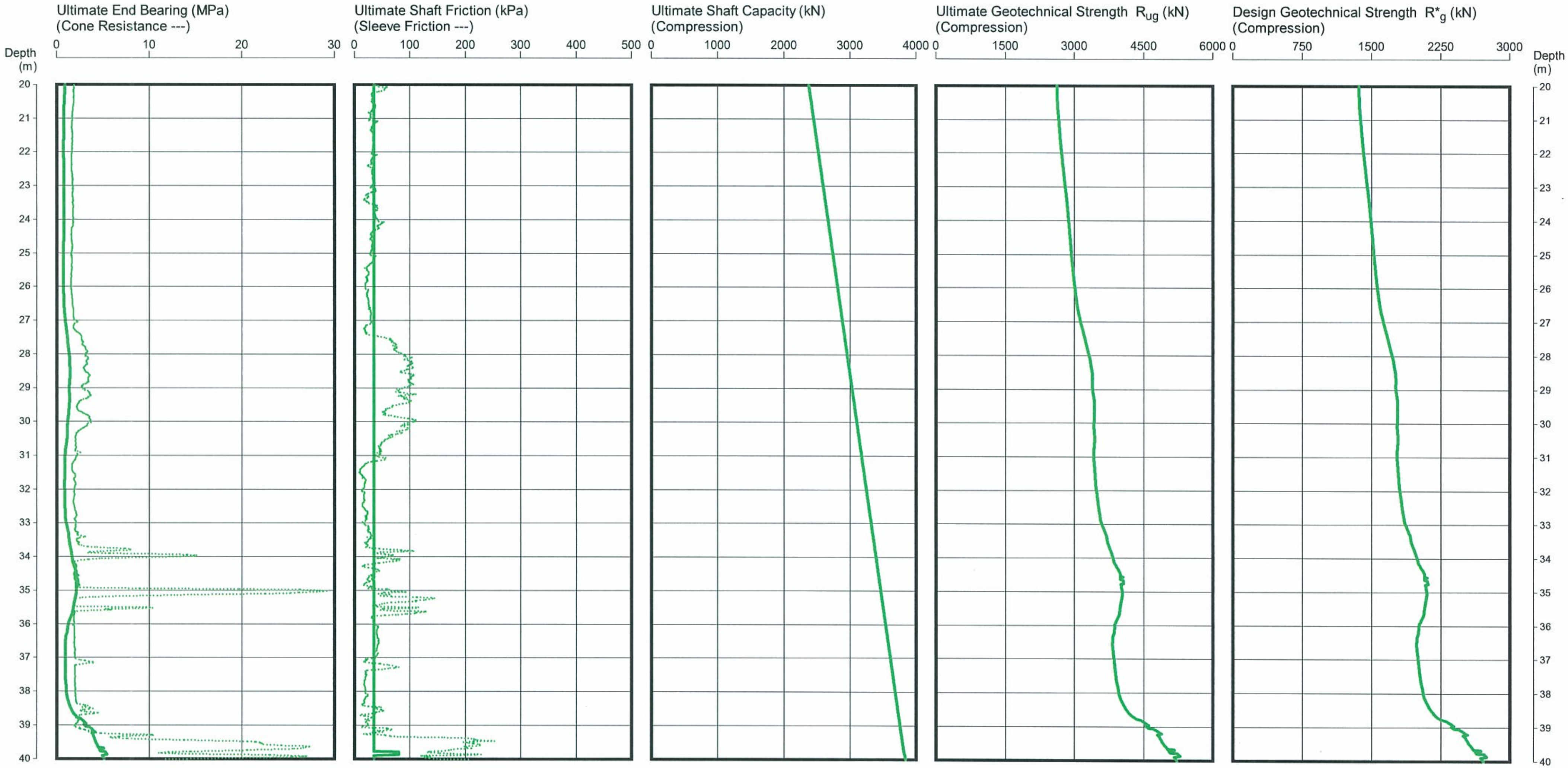
DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 3.8 AHD



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Cone ID: 120630 **Type:** I-CFXY-10

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PILE CAPACITY ESTIMATE

PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.51 Outer Diameter = 0.66
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

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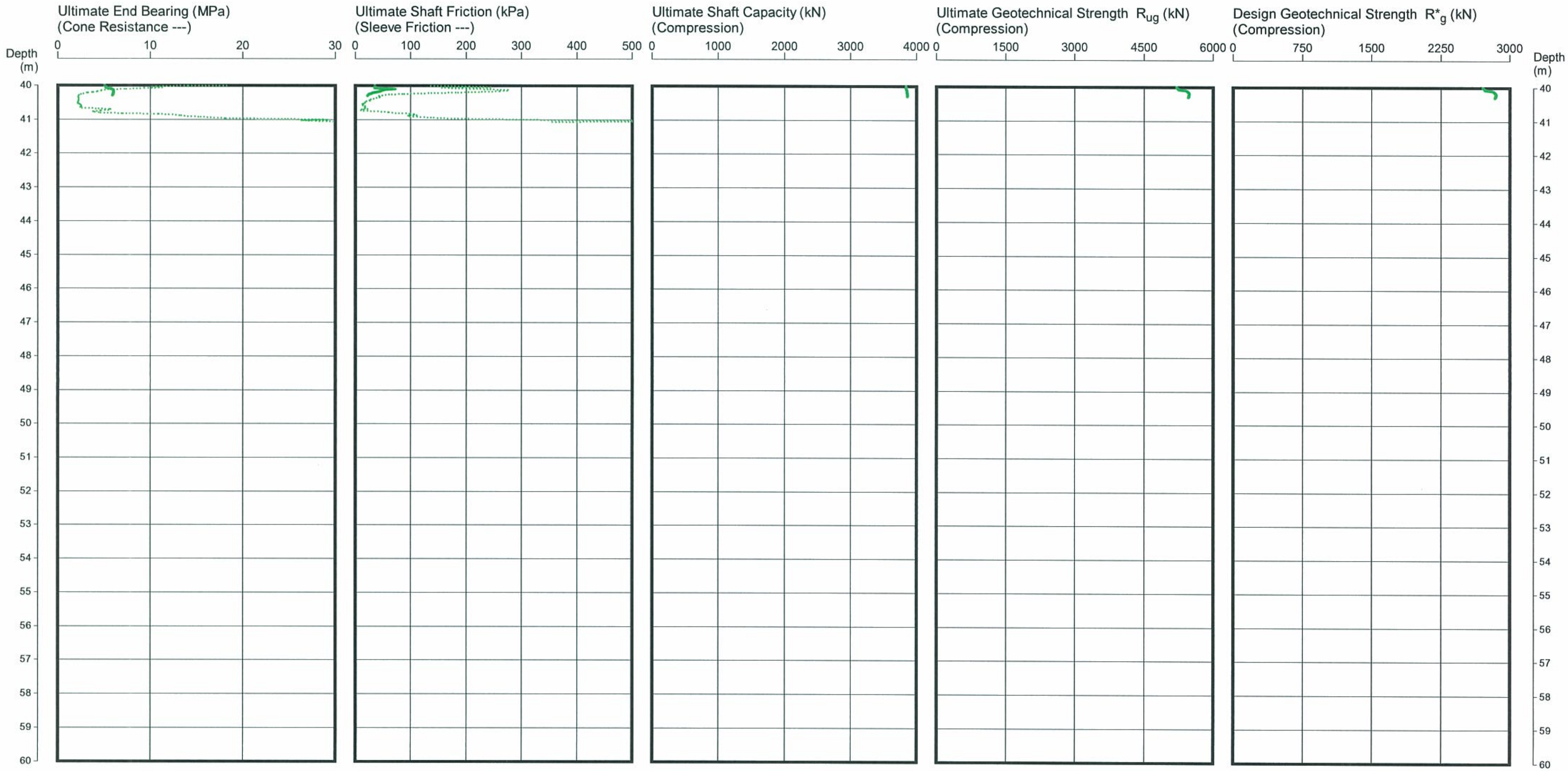
CLIENT: URBAN GROWTH NSW

101

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 3.8 AHD



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Cone ID: 120630 **Type:** I-CFXY-10

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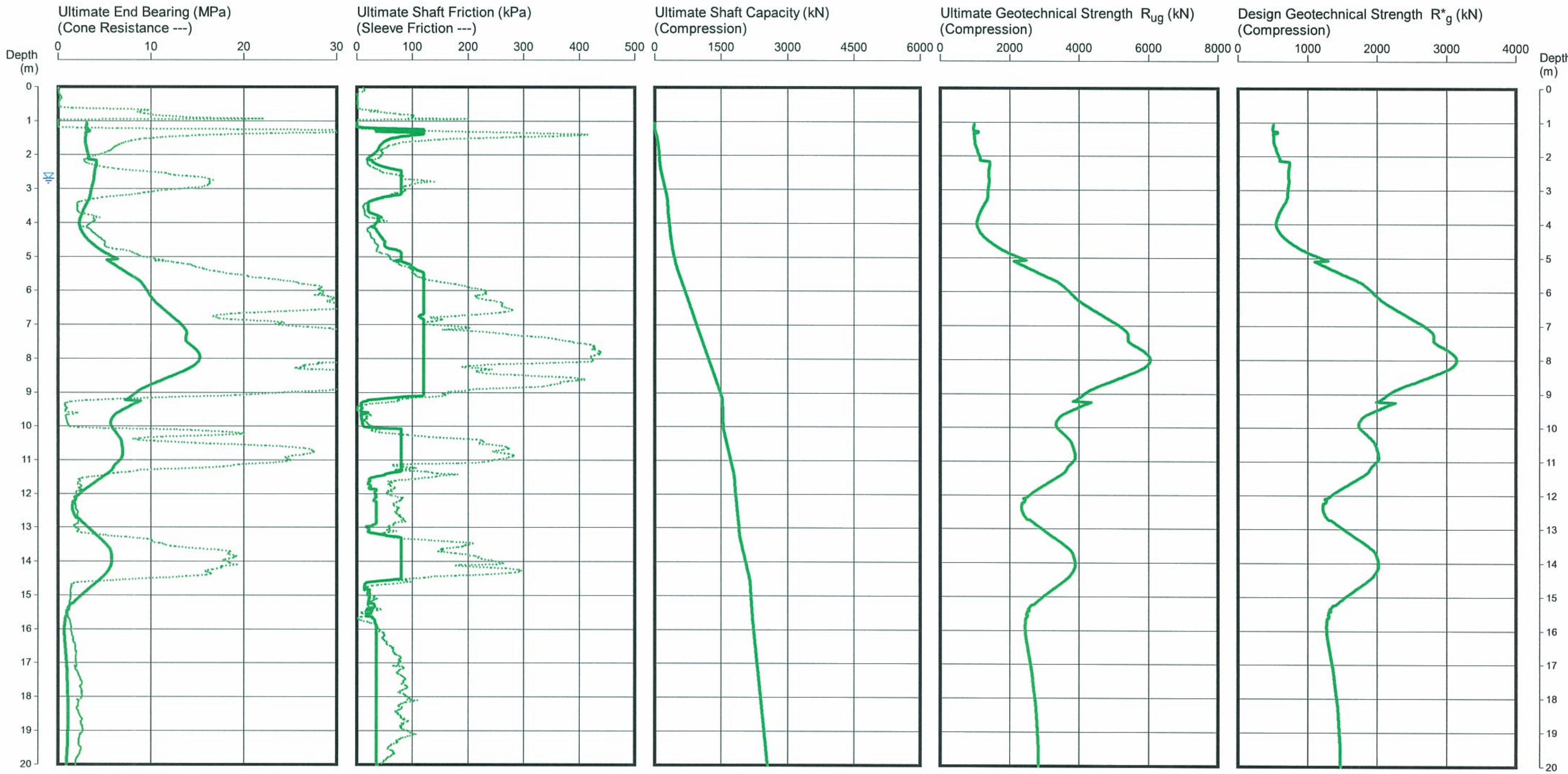
PILE CAPACITY ESTIMATE

PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.56 Outer Diameter = 0.71
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
CLIENT: URBAN GROWTH NSW

101
Page 1 of 3
DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 3.8 AHD



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Cone ID: 120630 **Type:** I-CFXY-10

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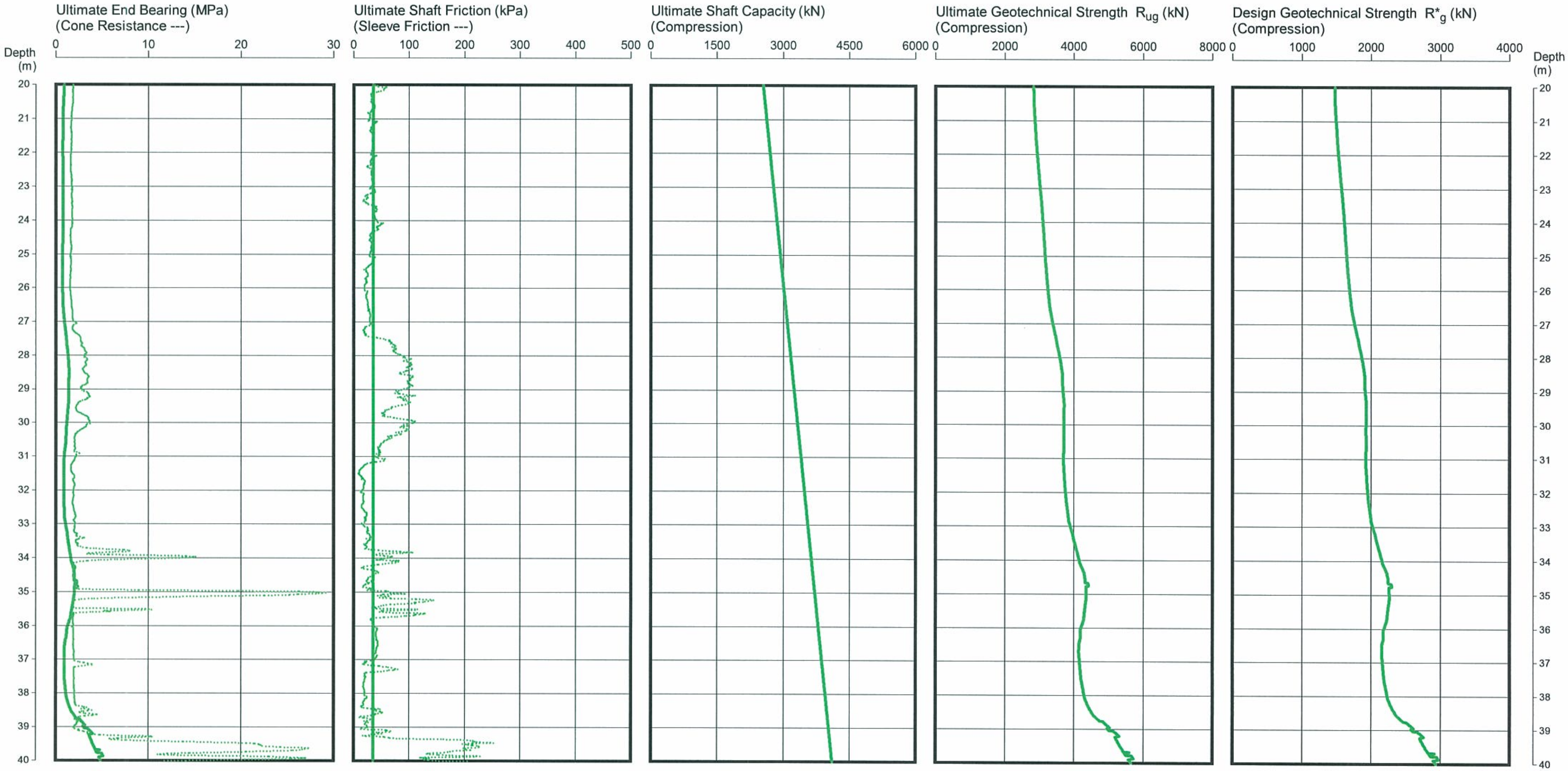
PILE CAPACITY ESTIMATE

PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.56 Outer Diameter = 0.71
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
CLIENT: URBAN GROWTH NSW

101

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 3.8 AHD



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Cone ID: 120630 **Type:** I-CFXY-10

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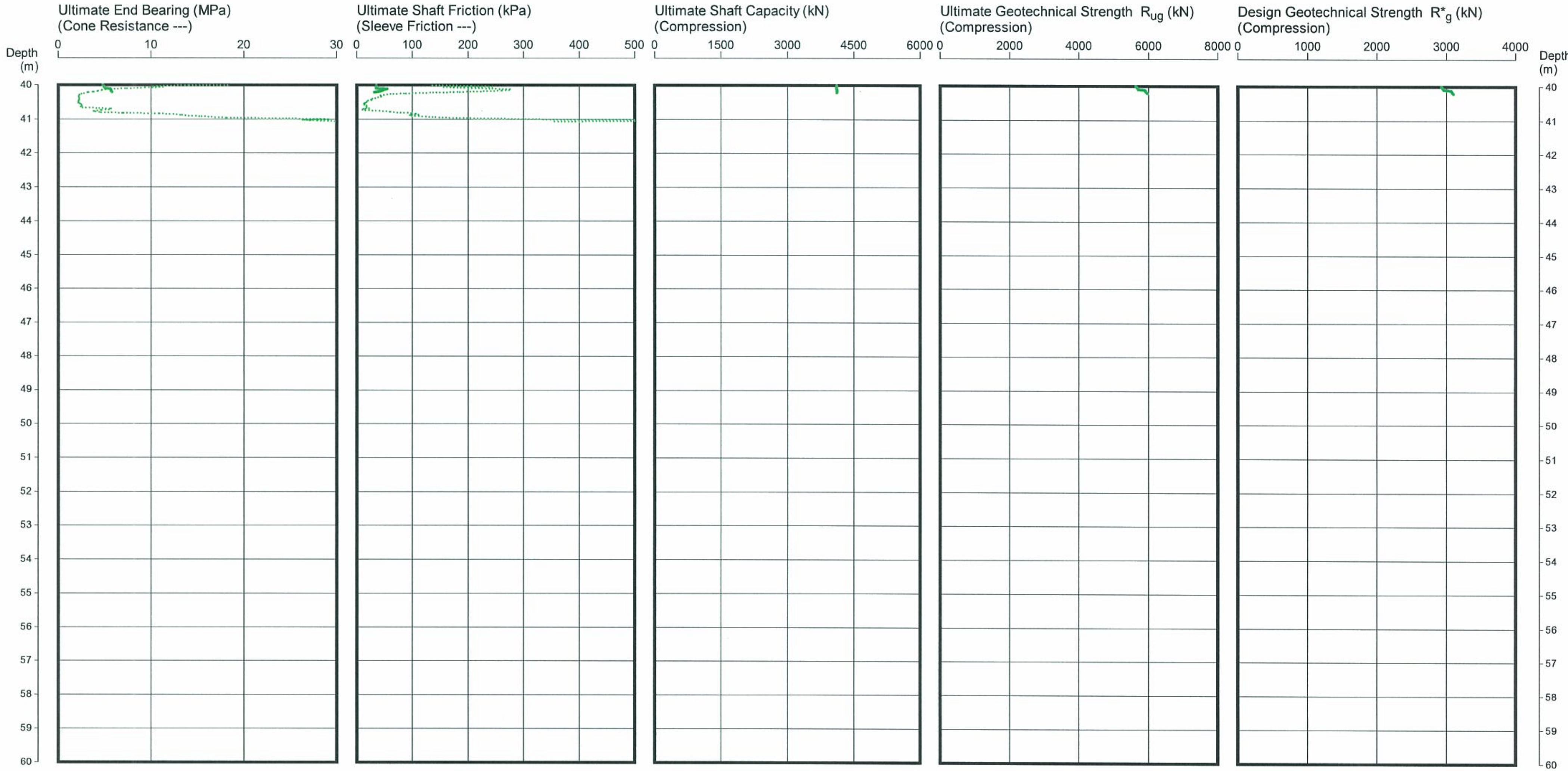
PILE CAPACITY ESTIMATE

PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.56 Outer Diameter = 0.71
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
CLIENT: URBAN GROWTH NSW

101

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 3.8 AHD



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Cone ID: 120630 **Type:** I-CFXY-10

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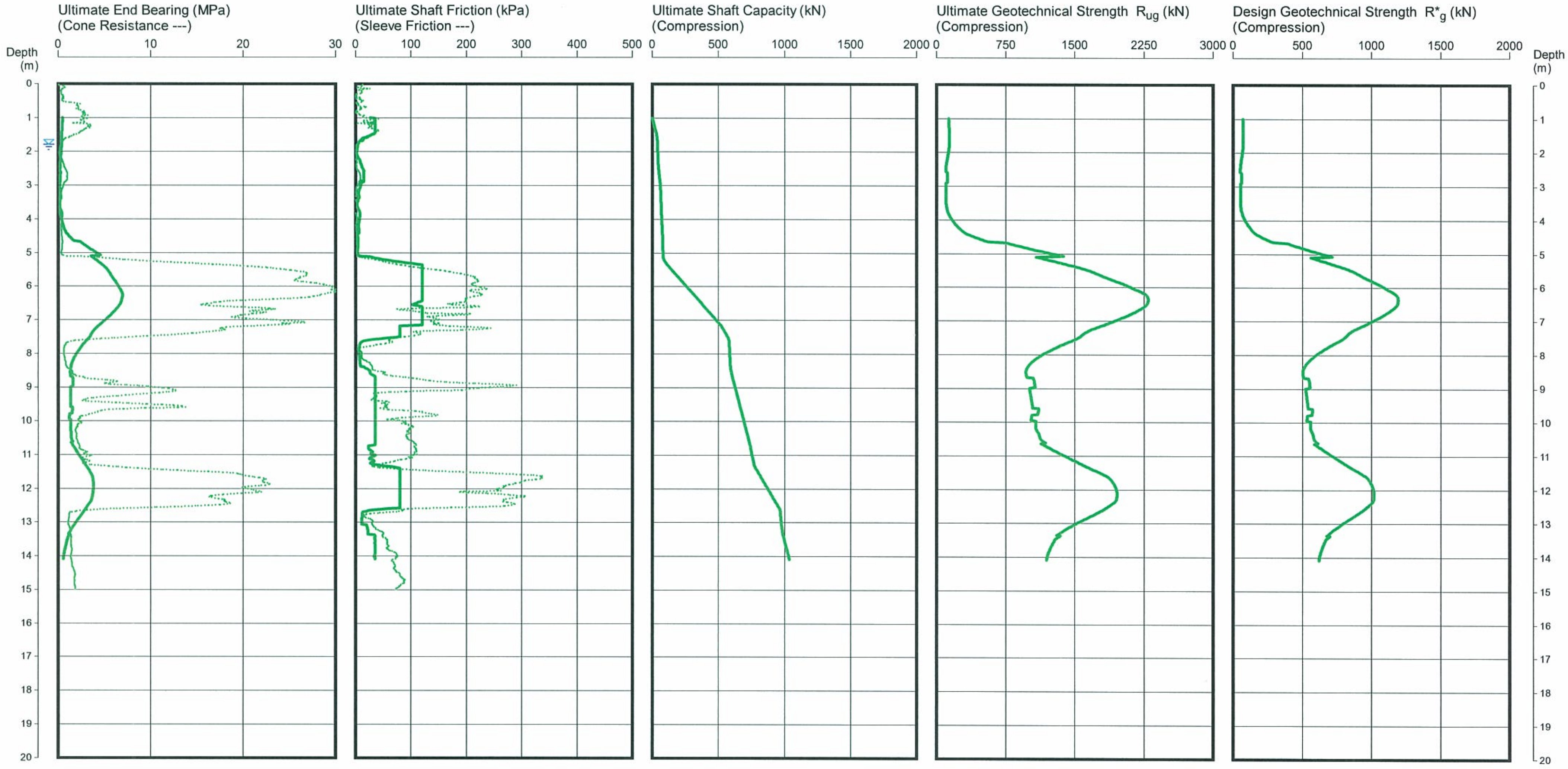
PILE CAPACITY ESTIMATE

PILE TYPE: Grout-Injected
PILE SHAPE: Round
PILE SIZE: Diameter = 0.60
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
CLIENT: URBAN GROWTH NSW

102

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 2.8 AHD



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Water depth after test: 1.80m depth

File: P:\81811.01 - Newcastle West, Hunter Street The Store\4.0 Field Work\4.2 Testing\CPT\CPT102.CP5
Cone ID: 120630 **Type:** I-CFXY-10

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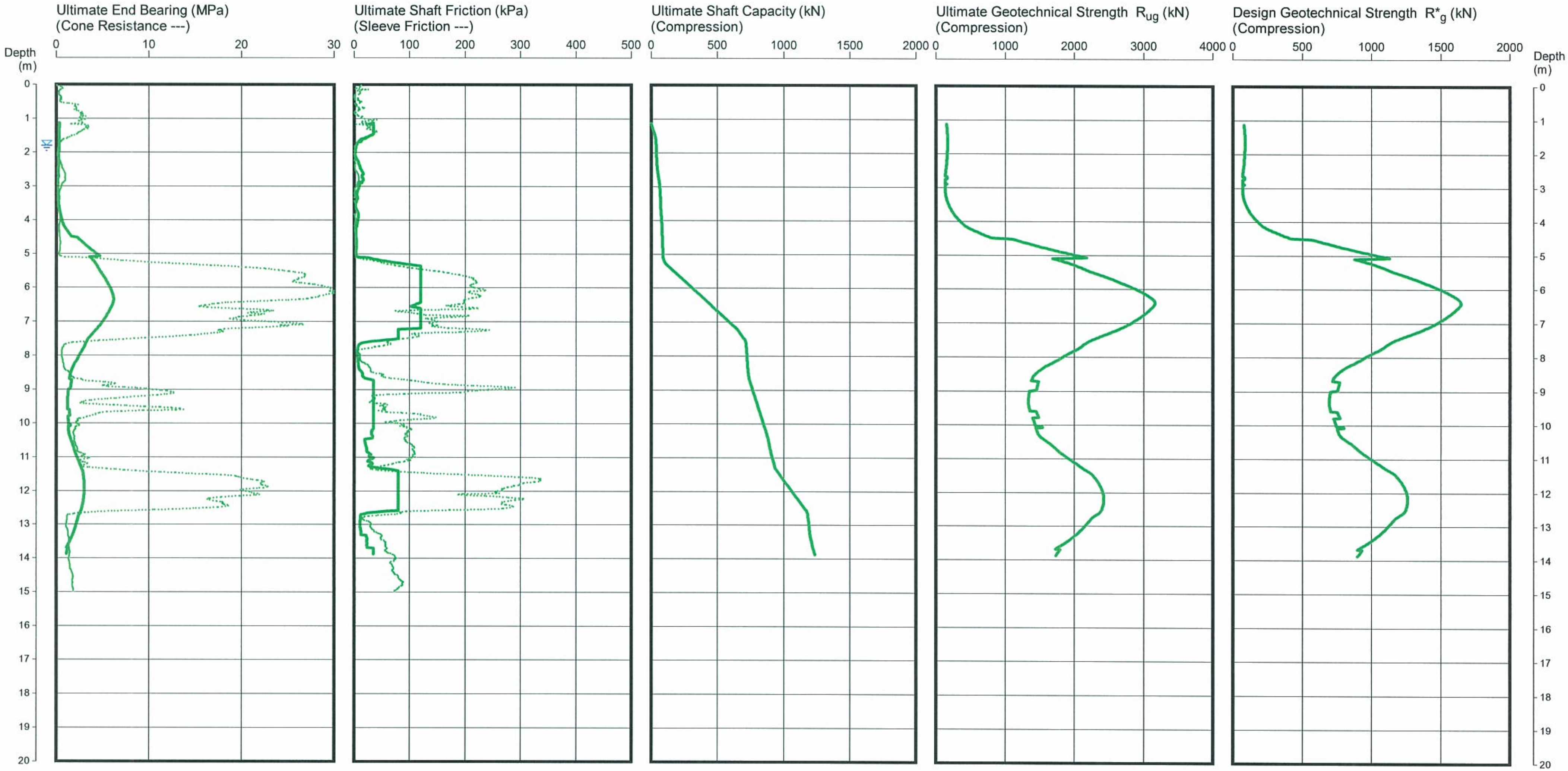
PILE CAPACITY ESTIMATE

PILE TYPE: Grout-Injected
PILE SHAPE: Round
PILE SIZE: Diameter = 0.75
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
CLIENT: URBAN GROWTH NSW

102

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 2.8 AHD



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Water depth after test: 1.80m depth

File: P:\81811.01 - Newcastle West, Hunter Street The Store\4.0 Field Work\4.2 Testing\CPT\CPT102.CP5
Cone ID: 120630 **Type:** I-CFXY-10

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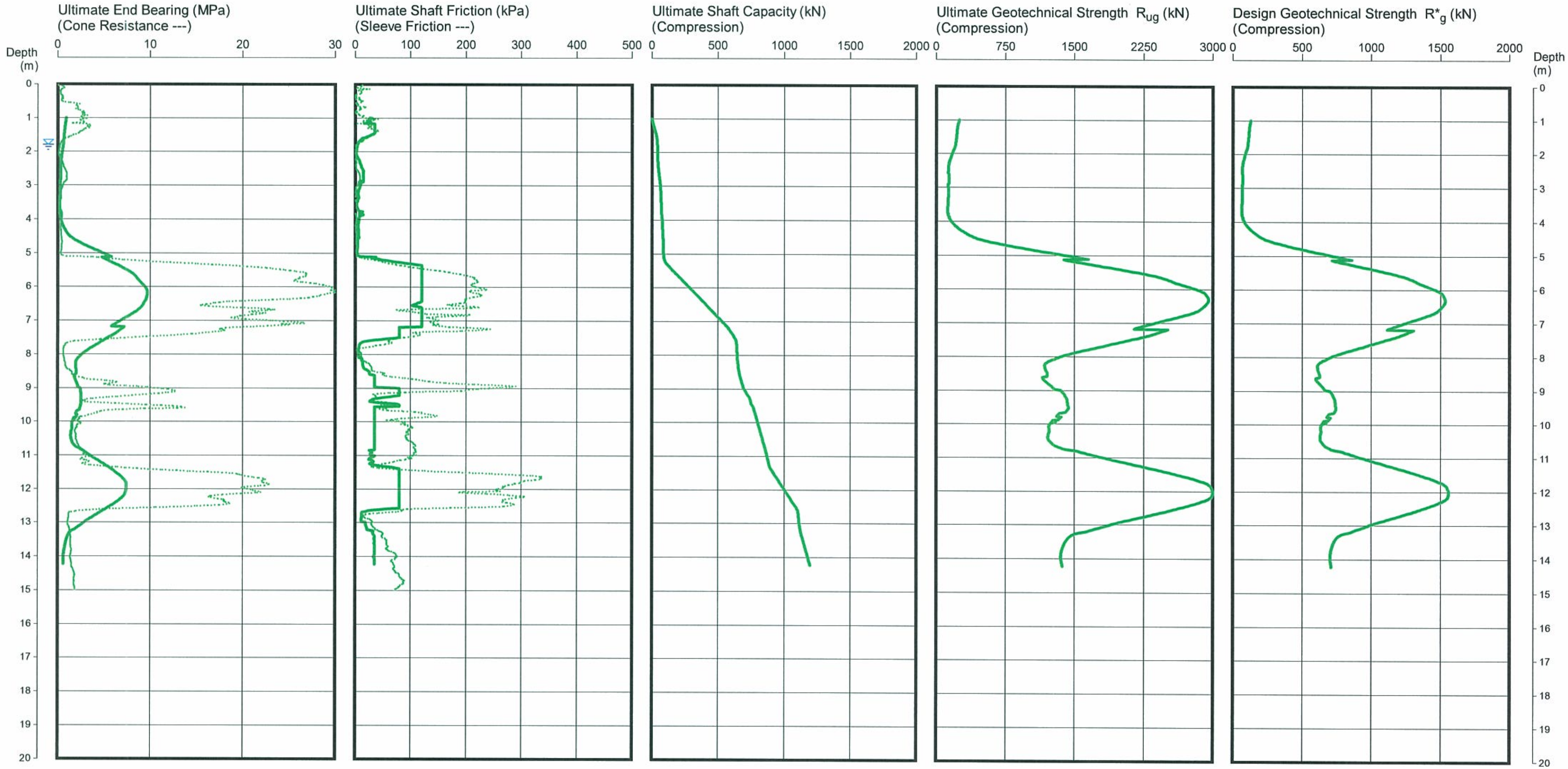
PILE CAPACITY ESTIMATE

PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.51 Outer Diameter = 0.66
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
CLIENT: URBAN GROWTH NSW

102

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 2.8 AHD



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Water depth after test: 1.80m depth

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Cone ID: 120630 **Type:** I-CFXY-10

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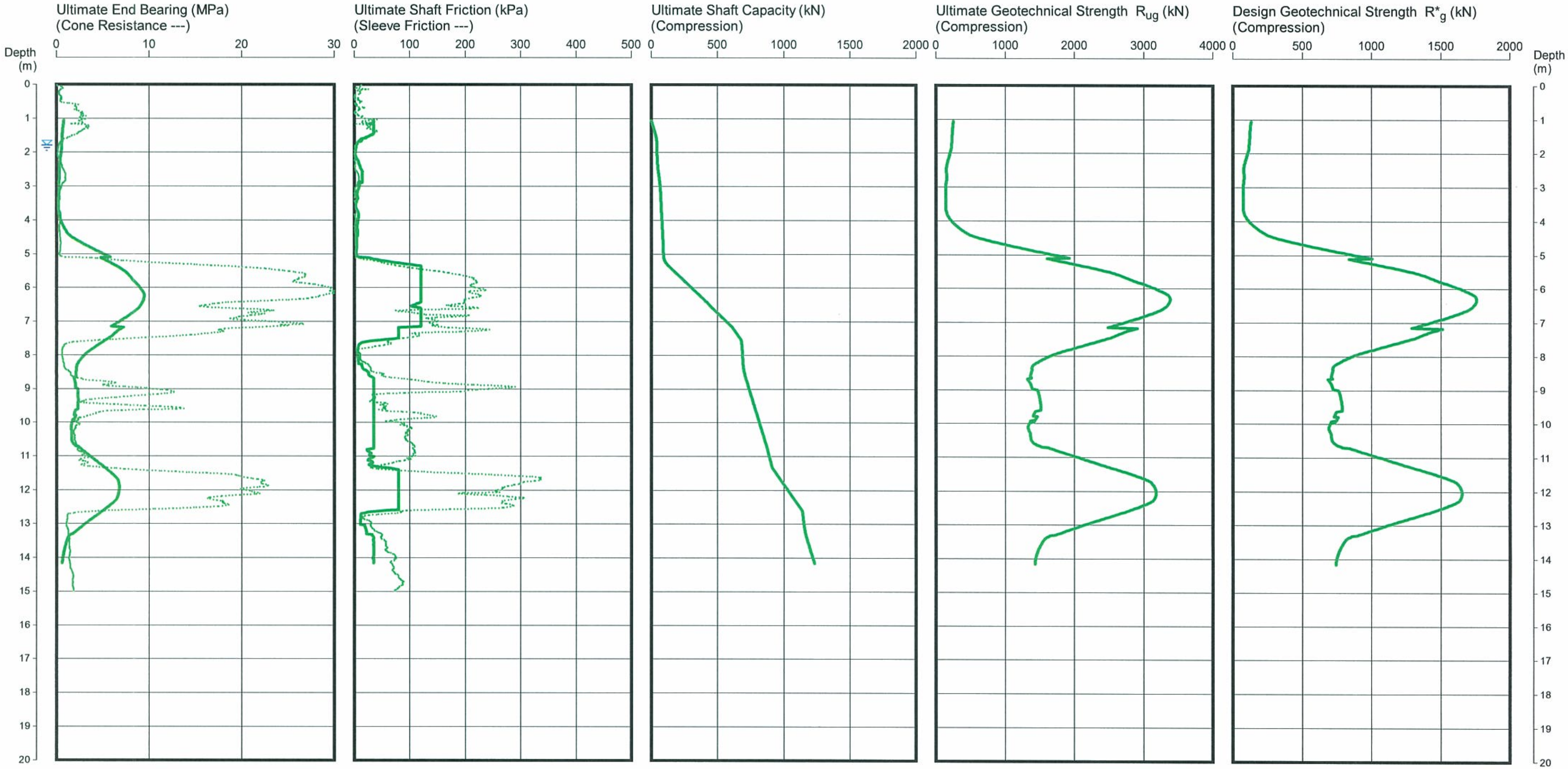
PILE CAPACITY ESTIMATE

PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.56 Outer Diameter = 0.71
STRENGTH REDUCTION FACTOR $\O_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
CLIENT: URBAN GROWTH NSW

102

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 2.8 AHD



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Water depth after test: 1.80m depth

File: P:\81811.01 - Newcastle West, Hunter Street The Store\4.0 Field Work\4.2 Testing\CPT\CPT102.CP5
Cone ID: 120630 **Type:** I-CFXY-10

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PILE CAPACITY ESTIMATE

PILE TYPE: Grout-Injected
PILE SHAPE: Round
PILE SIZE: Diameter = 0.60
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

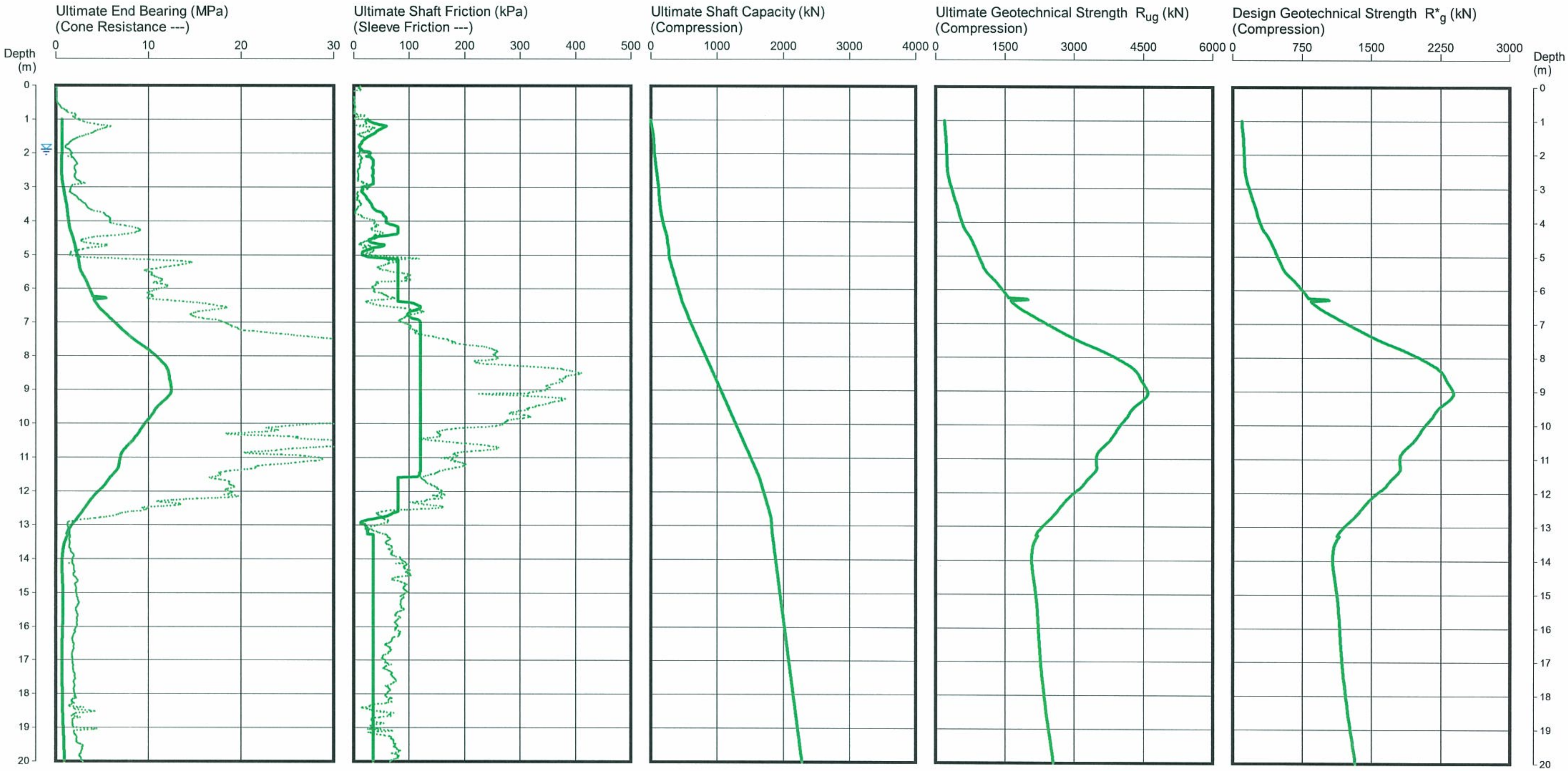
PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM

LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE

CLIENT: URBAN GROWTH NSW

CPT103

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 2.7 AHD



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Water depth after test: 1.90m depth

File: P:\81811.01 - Newcastle West, Hunter Street The Store\4.0 Field Work\4.2 Testing\CPT\CPT103.CP5
Cone ID: 120630 **Type:** I-CFXY-10

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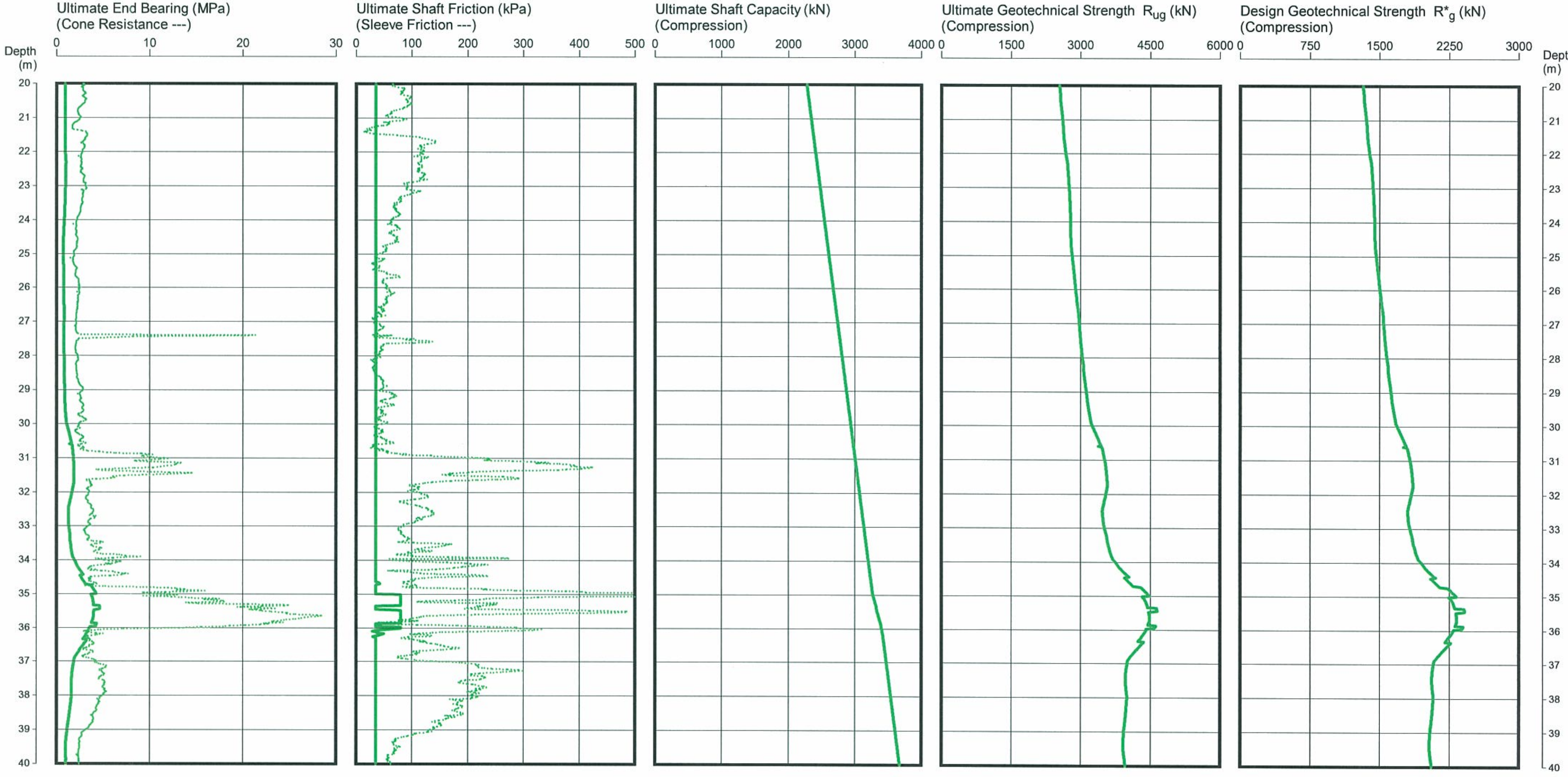
PILE CAPACITY ESTIMATE

PILE TYPE: Grout-Injected
PILE SHAPE: Round
PILE SIZE: Diameter = 0.60
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
CLIENT: URBAN GROWTH NSW

CPT103

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 2.7 AHD



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Water depth after test: 1.90m depth

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CALCULATION METHOD: LCPC Method

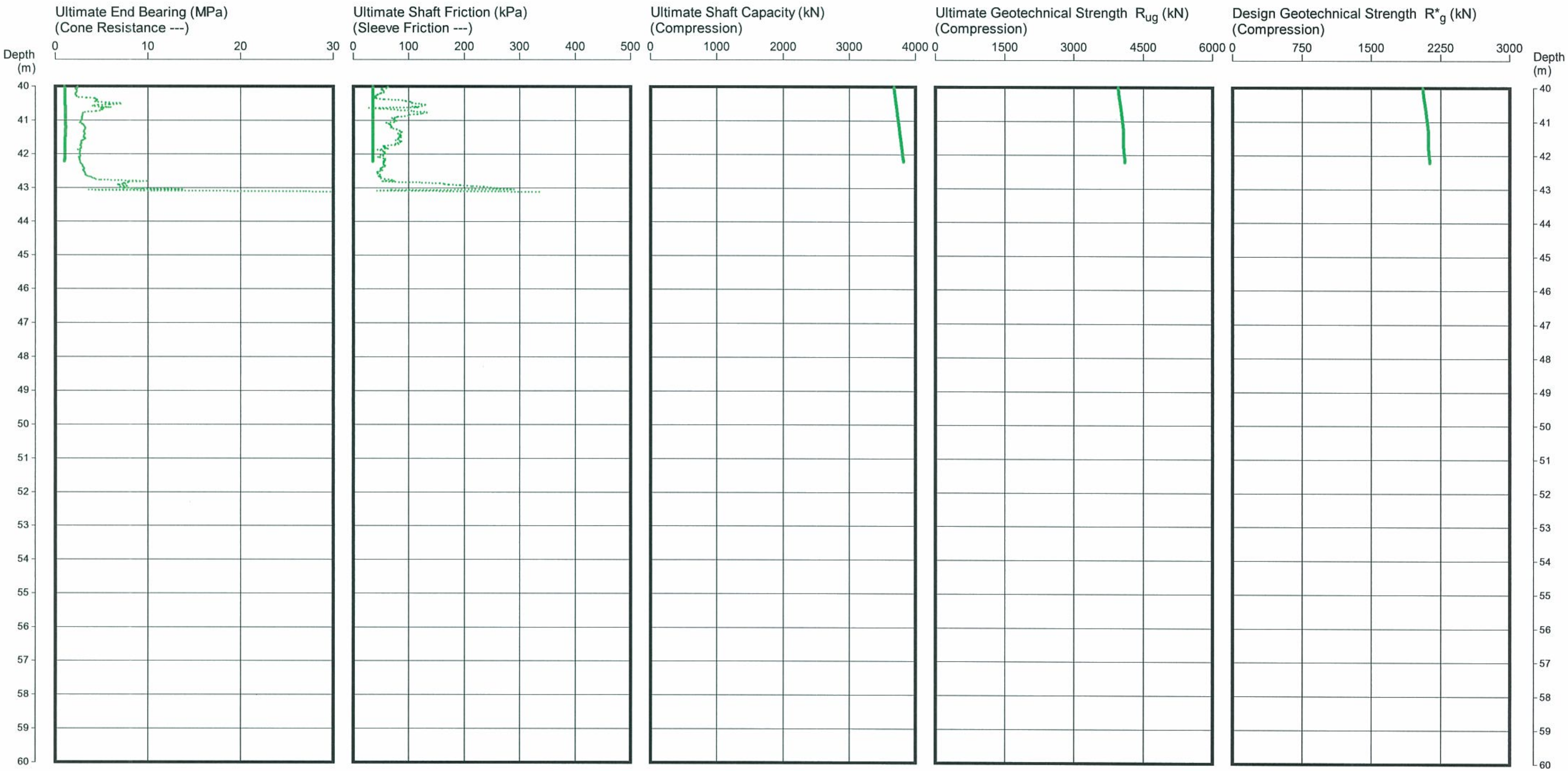
PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM

LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE

CLIENT: URBAN GROWTH NSW

CPT103

DATE 17/03/2016
PROJECT No: 81811.01
SURFACE RL: 2.7 AHD



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Water depth after test: 1.90m depth

File: P:\81811.01 - Newcastle West, Hunter Street The Store\4.0 Field Work\4.2 Testing\CPT\CPT103.CP5
Cone ID: 120630 **Type:** I-CFXY-10

ConePile Version 5.9.1
© 2003 Douglas Partners Pty Ltd

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Geotechnics / Environment / Groundwater

PILE CAPACITY ESTIMATE

PILE TYPE: Grout-Injected
PILE SHAPE: Round
PILE SIZE: Diameter = 0.75
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM

LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE

CLIENT: URBAN GROWTH NSW

CPT103

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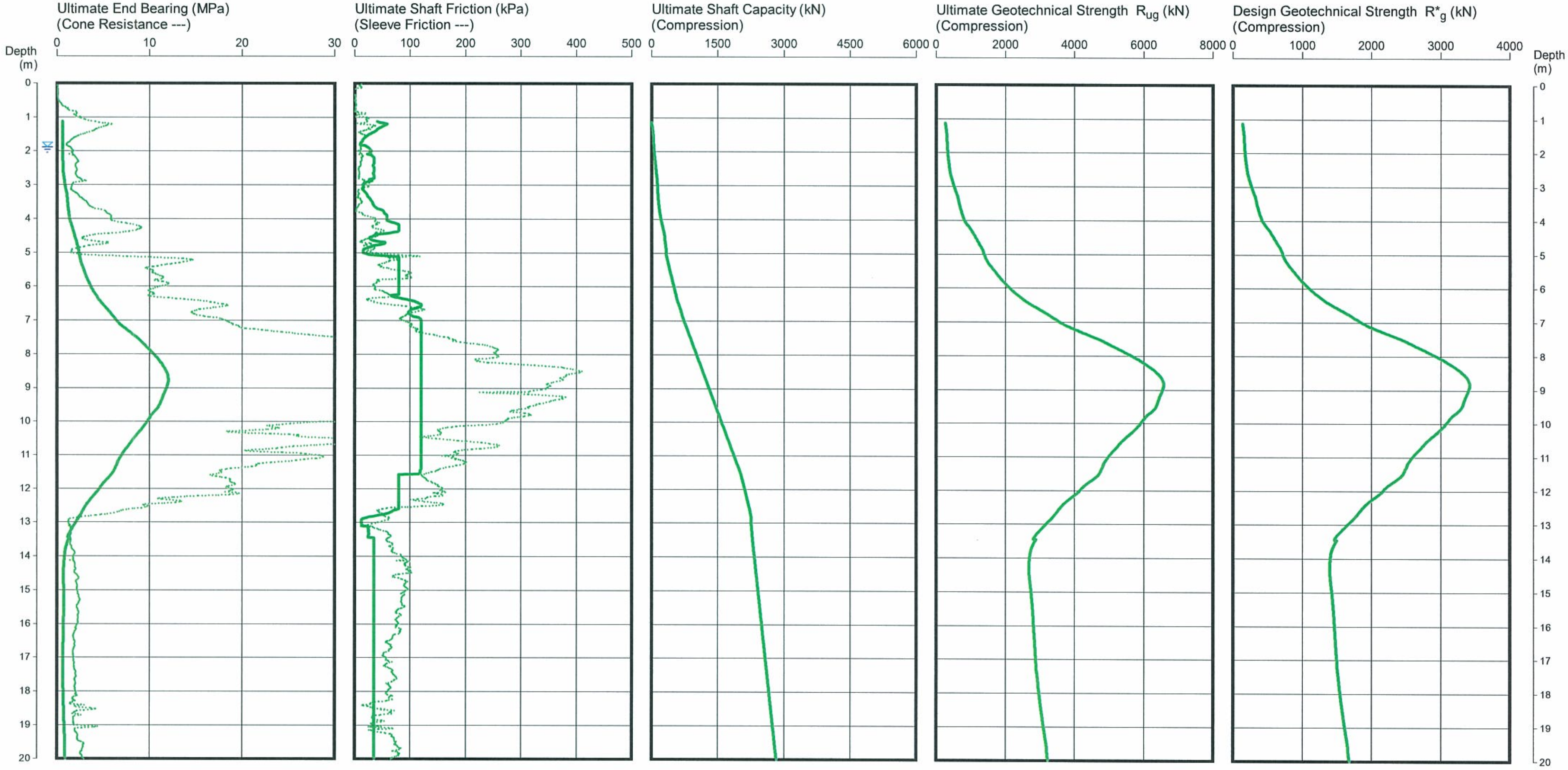

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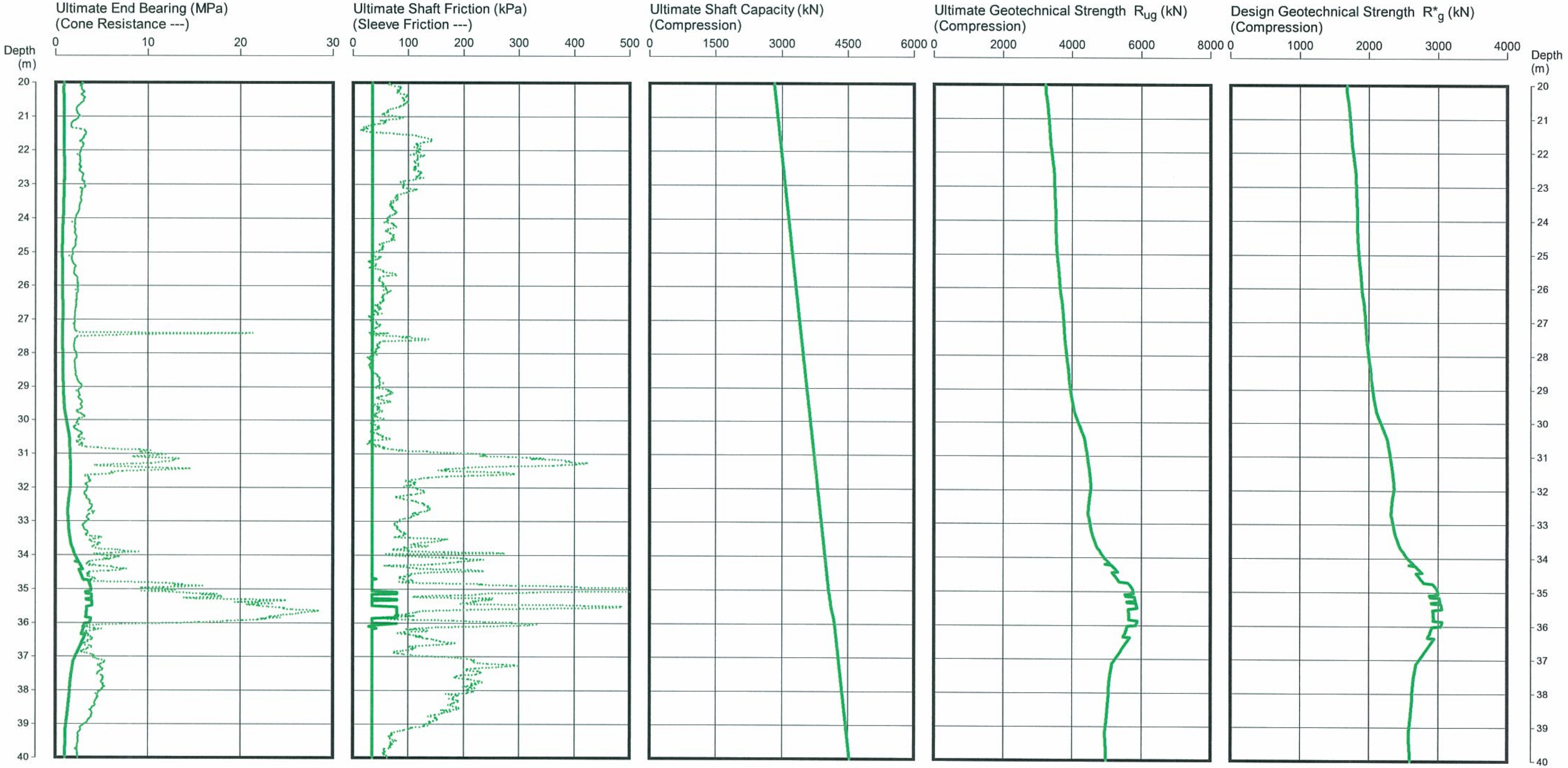

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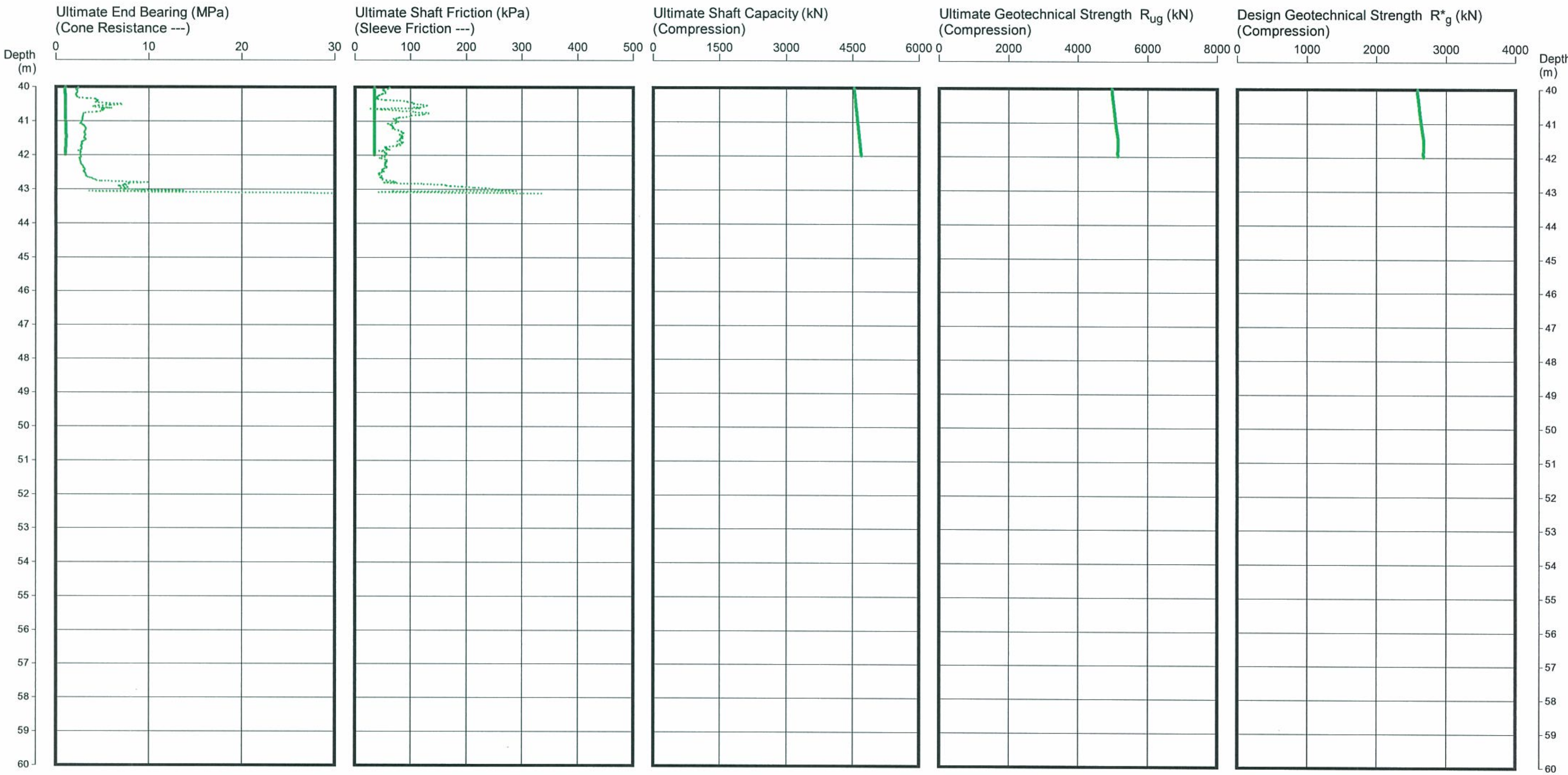

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PILE CAPACITY ESTIMATE

PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.51 Outer Diameter = 0.66
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
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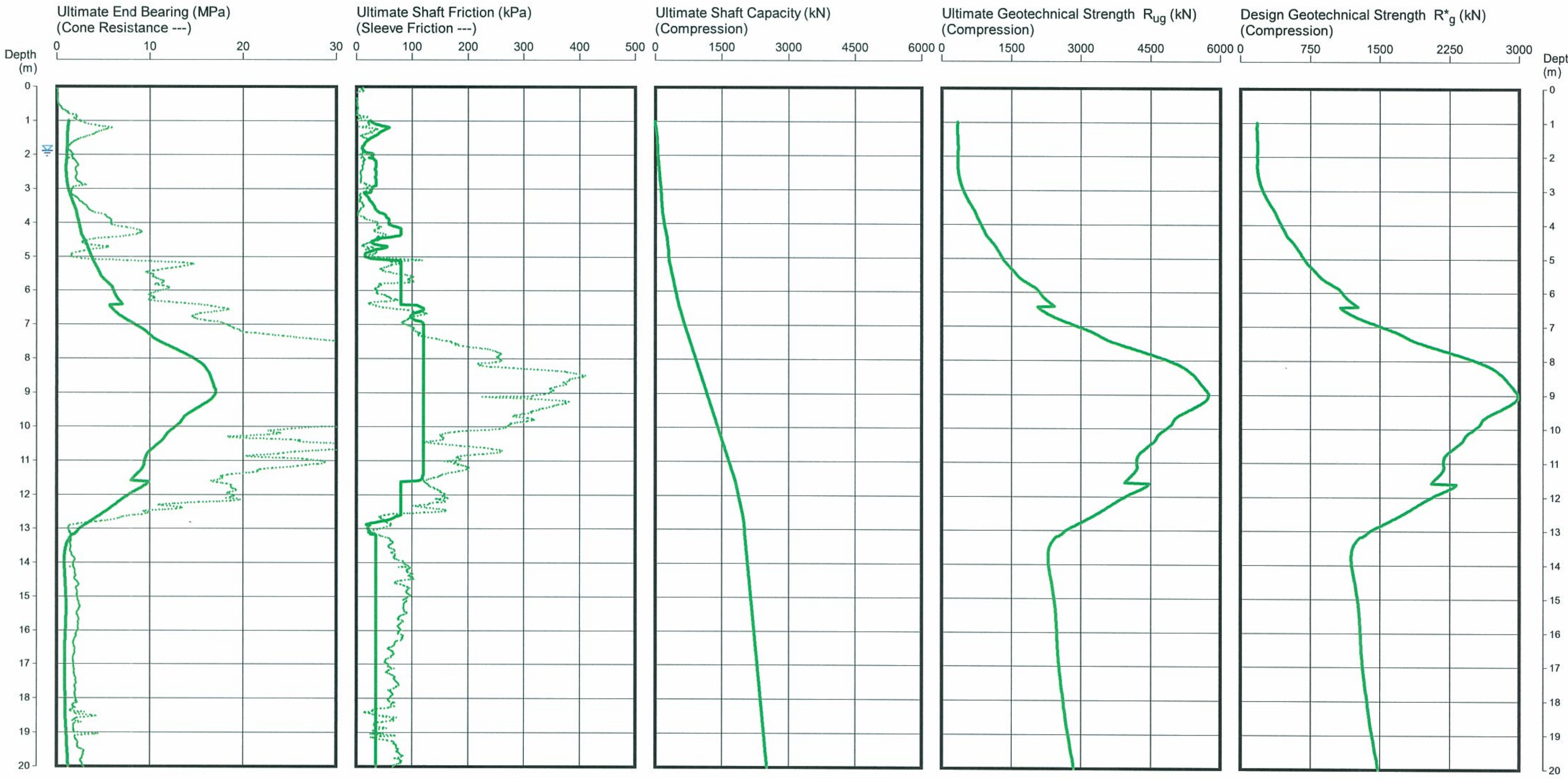

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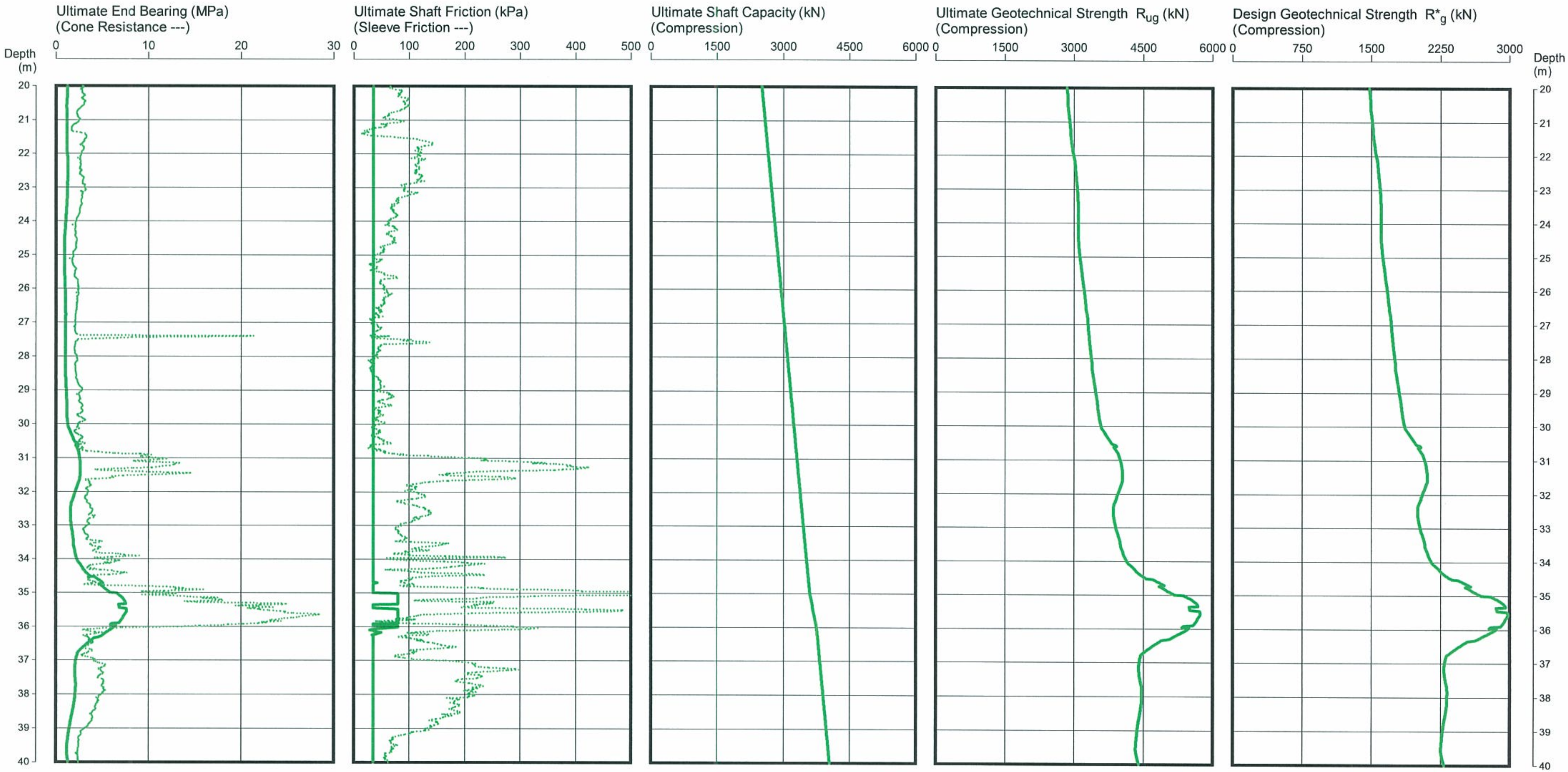

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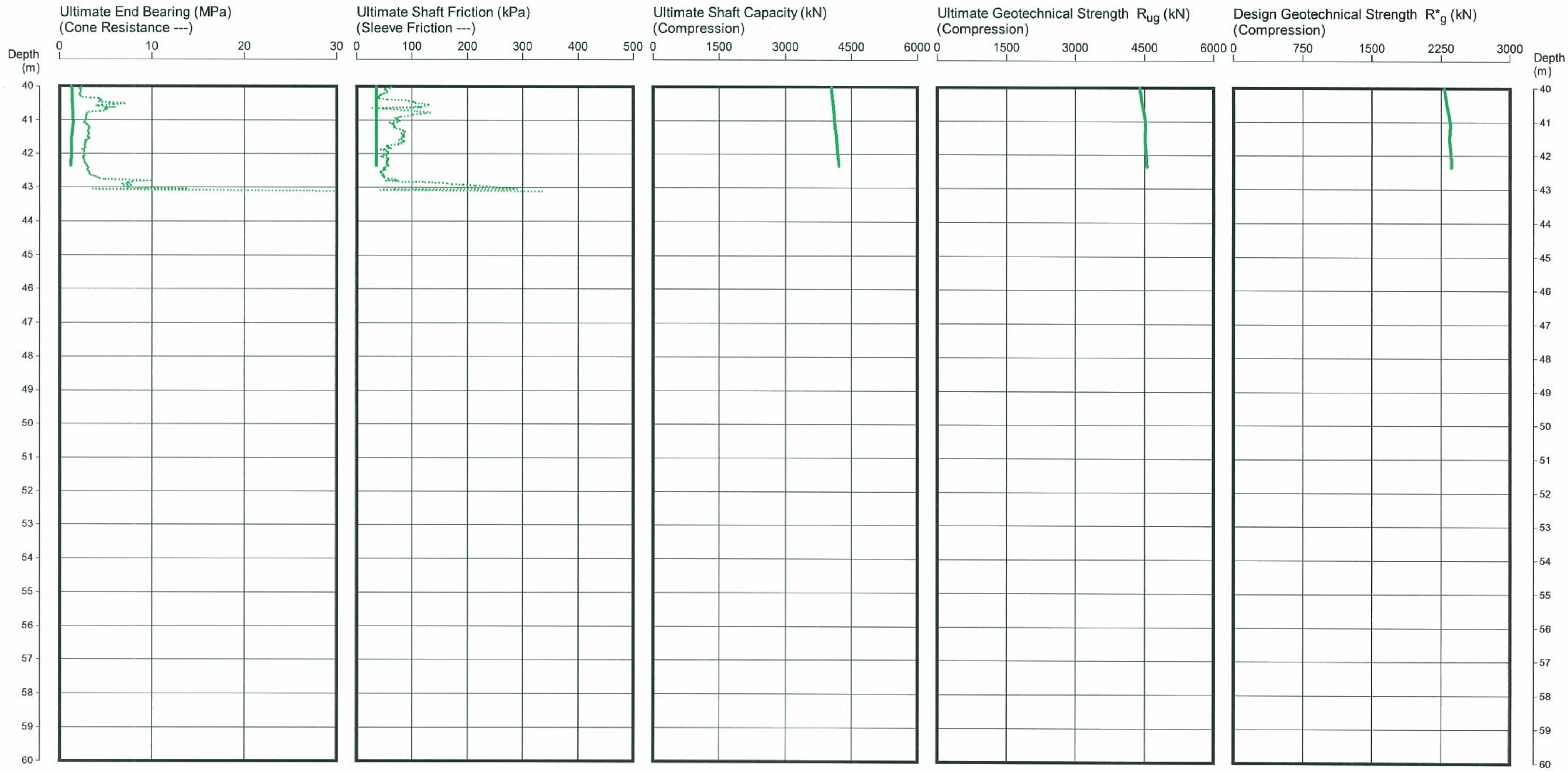

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PILE CAPACITY ESTIMATE

PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.56 Outer Diameter = 0.71
STRENGTH REDUCTION FACTOR $Ø_g$: 0.52
CALCULATION METHOD: LCPC Method

PROJECT: NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM
LOCATION: THE STORE - 854 HUNTER STREET, NEWCASTLE
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CPT103

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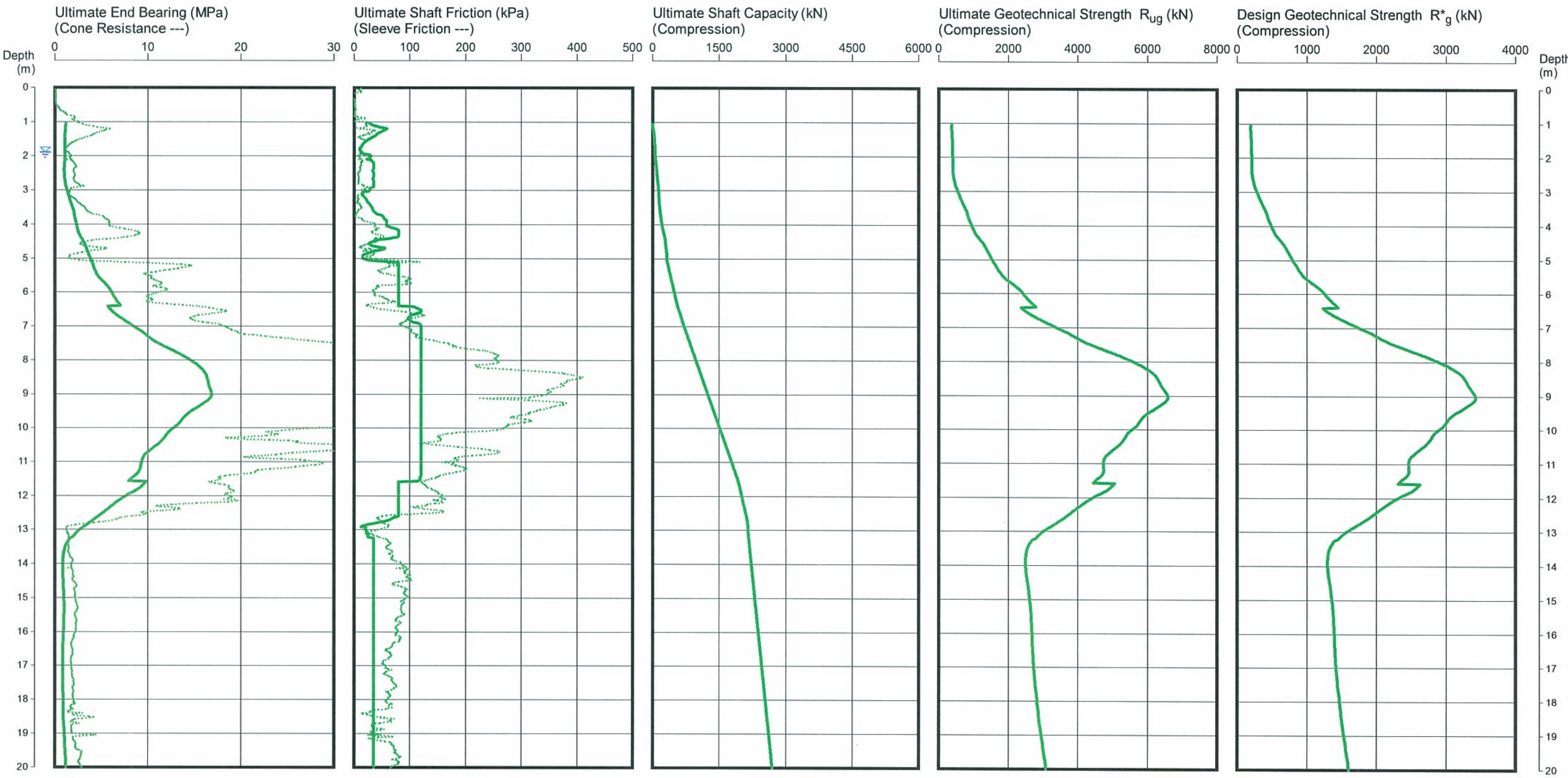

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Cone ID: 120630 **Type:** I-CFXY-10

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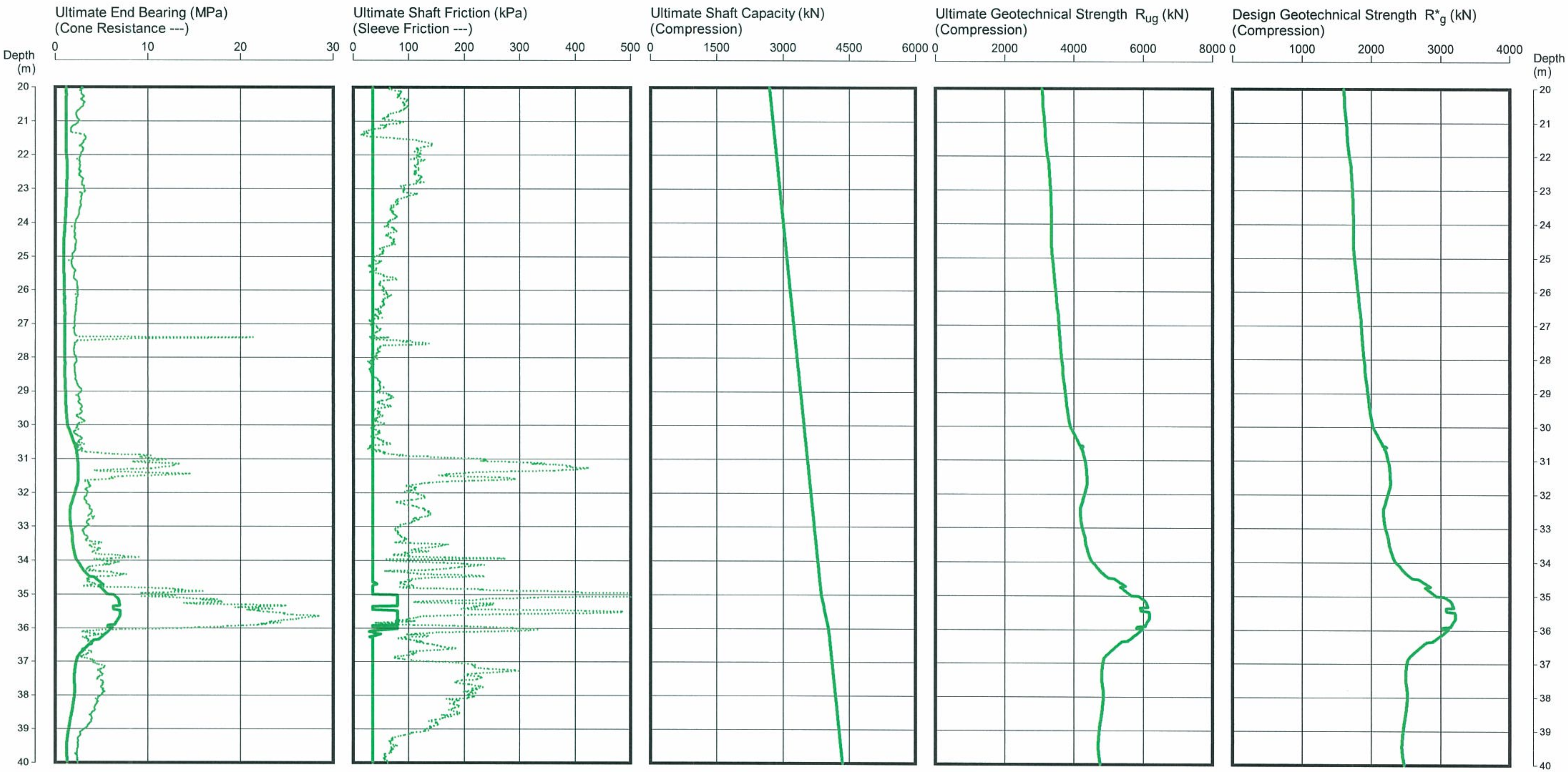

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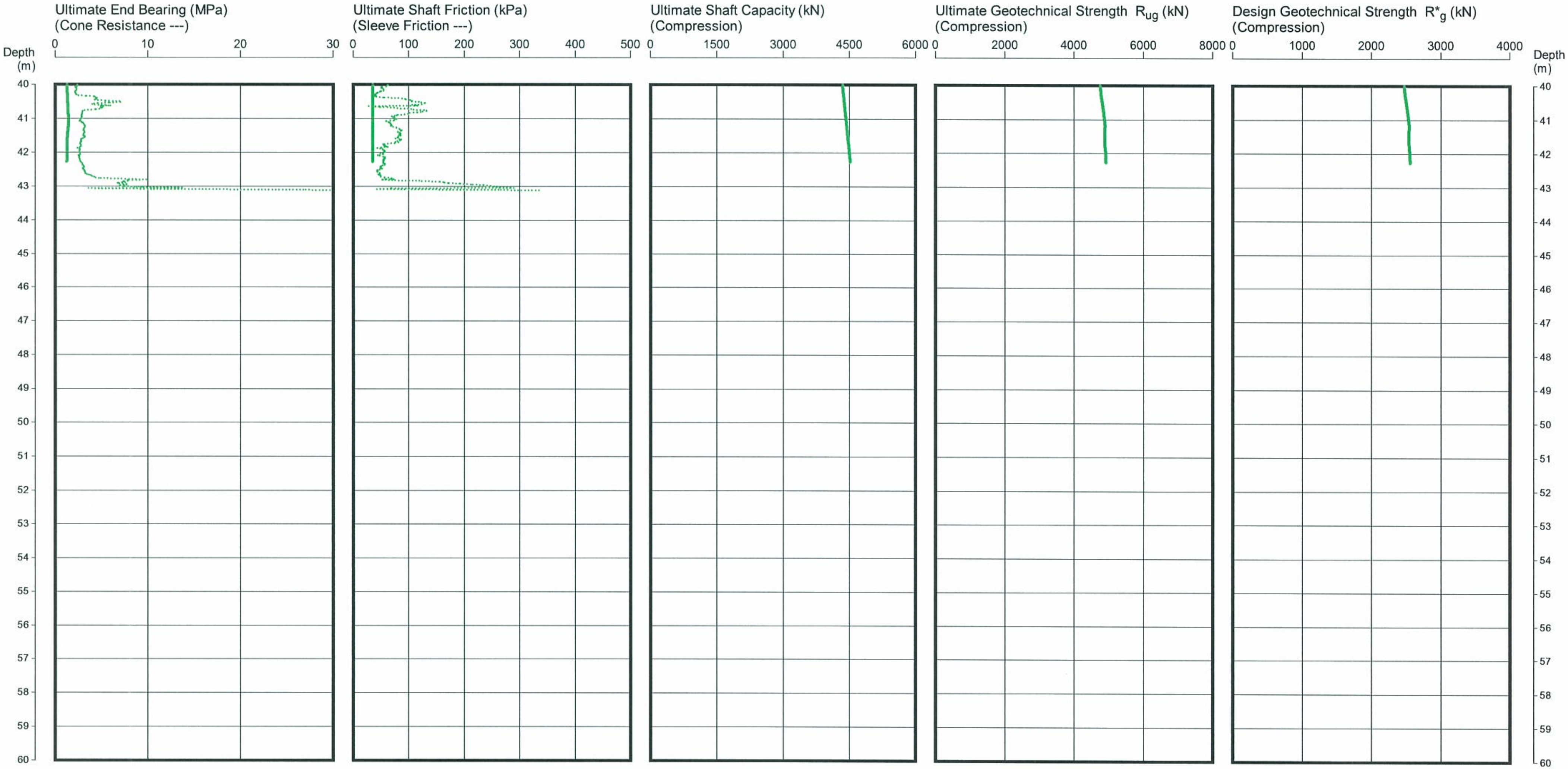
PILE CAPACITY ESTIMATE **PILE TYPE:** Screw Cast Concrete **PILE SHAPE:** Round Screw **PILE SIZE:** Inner Diameter = 0.56 Outer Diameter = 0.71 **STRENGTH REDUCTION FACTOR $Ø_g$:** 0.52 **CALCULATION METHOD:** LCPC Method	**PROJECT:** NEWCASTLE URBAN TRANSFORMATION AND TRANSPORT PROGRAM **LOCATION:** THE STORE - 854 HUNTER STREET, NEWCASTLE **CLIENT:** URBAN GROWTH NSW	**CPT103** **Page 3 of 3** **DATE** 17/03/2016 **PROJECT No:** 81811.01 **SURFACE RL:** 2.7 AHD



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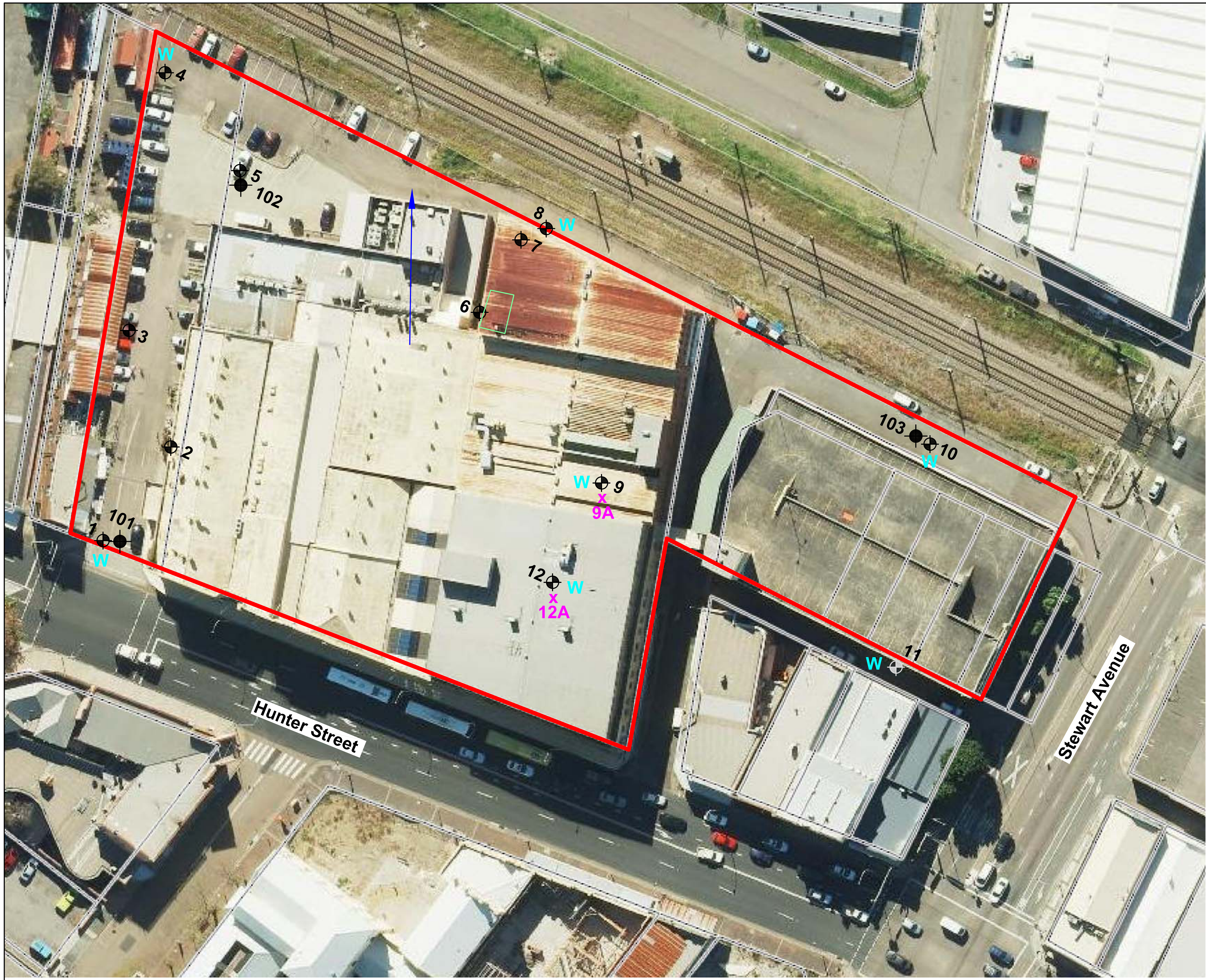
Appendix D

Appendix D: Drawing 1 – Test Location Plan

DRAFT



Locality Plan

NOTE: Base drawing from Nearmap Image dated 8 May 2015

LEGEND

- Approximate Site Boundary
- Approximate Borehole Location
- W Groundwater Monitoring Well Installed at Borehole Location
- Approximate CPT Location
- x Approximate Basement Well Location
- Observed Possible Asbestos Containing Materials at the Surface
- Approximate Inferred Groundwater Flow Direction

0 5 10 15 20 30 40 50 75m

1:750 @ A3

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CLIENT: UrbanGrowth NSW		TITLE: **Test Location Plan, Stage 1 Targeted Site Investigation**	PROJECT No: 81811.01
OFFICE: Newcastle	DRAWN BY: PLH	**NUTTP - The Store**	DRAWING No: 1
SCALE: 1:750@A3 Sheet	DATE: 29.04.2016	**854 - 868 Hunter Street, Newcastle West**	REVISION: 0