

The Manager
Narara Ecovillage Cooperative Ltd
Research Road
Narara NSW

Attention: Joel Green

Dear Sir

FOUNDATION CONDITIONS FOR PROPOSED DWELLINGS, NARARA ECOVILLAGE, LOTS 2 to 14; 16 to 35 and 40 to 48

This report provides design guidance on foundation conditions for proposed dwellings at Lots 2 to 14; 16 to 35 and 40 to 48¹ at the Ecovillage. This advice is based on specific investigations on these Lots following site works by Robeson's. It should be noted that previous investigations by Coffey Partner and by Douglas Partners focussed on the roadway, prior to these site works, and provided only generalised advice on building foundations, stating only that they should be in accordance with AS2870 and with standard 'good practice'.

1. INVESTIGATIONS

Advice in this present report for Lots 2 to 14; 16 to 35 and 40 to 48 is based upon 30 test pits logged by Pells Consulting on 18 July 2017 and on 1 Aug 2017. Pells Consulting also undertook an Unmanned Aerial Vehicle (UAV, or 'drone') survey on 18 July 2017 from which detailed topographic data over the site was constructed using photogrammetric techniques. Reference is also made to previous investigations comprising augered bore hole investigations (Coffey, completed Feb 2015) and Cone penetrometer tests (Douglas Partners, completed April 2013).

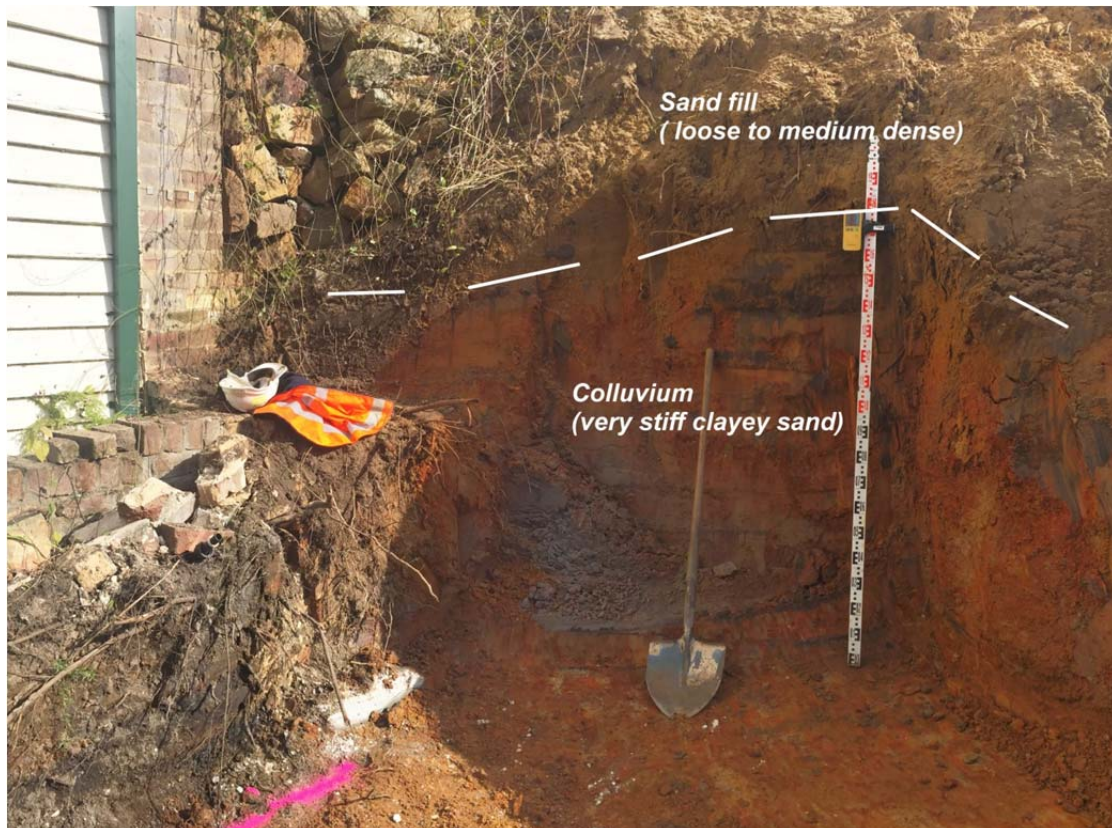
The locations of investigations are shown in Figure 2. Figure 3 shows the same information, but superimposed on detailed topographic data obtained from the UAV survey. Figure 4 shows the assessed gradients across the site, again from UAV survey data. The seven cross sections locations are shown in Figure 3 to 4. Cross-sections are presented in Figures 5 to 11 respectively. Test pit logs are included in Appendix A of this report.

¹ A revised foundation condition assessment for Lot 36 (proposed multi-dwellings) was provided in Pells Consulting report S027.L1.

A sample of residual clay was obtained from Test 15 and was subject to a NATA compliant shrink-swell test.

2. OVERVIEW OF CONDITIONS

The NEV site is underlain by the Terrigal Formation – comprising sandstone and siltstone. Natural residual soils (soil weathered insitu from the underlying rock) over the site typically comprise stiff to very stiff clay. The Lots in question are located on slopes of 10 to 15 degrees gradient. Loose weathered sandstone, derived from the regional Terrigal formation, and perhaps also uphill slopes of Hawkesbury sandstone, has historically fallen and deposited (i.e 'colluvium') at various locations over these slopes, and have weathered in-place to form another clayey horizon. This material may be described as ranging from Clayey Sand to Sandy Clay with extremely weathered sandstone gravel and cobbles (see Photographs 1 and 2 below). There is evidence of weak cementation by iron oxide. The colluvium has been referred to in test pit logs as 'slope-wash' – to indicate that its presence is not considered to be indicative from historical landslides or to give any indication of land instability. The site shows no evidence of transport by landslides. These natural clay materials (either slope wash or residual clays) are considered to be suitable founding materials, where they are at least 'stiff'. Typically, these colluvium or residual clay materials are found at shallow depths (less than 0.5 m) across the site.



Photograph 1 – exposure of colluvium next to the Fisheries Building



Photograph 2 – Outcrop of colluvium ‘slopewash’ (on Lot 32)

Areas of agricultural fill may also be encountered across the NEV site, due to previous agricultural research activities. This fill, which is typically a sand or clayey sand, has not been subject to engineering controls in its selection and placement – it is ‘uncontrolled fill’ and cannot be utilised in its found state as a suitable foundation material.

Other site works across the NEV have resulted in placement of fill. This material may also only serve as a suitable foundation material where documented engineering controls for material selection, placement, compaction and testing are provided.

A summary of conditions as each of the Lots is presented in Table 1 below. A classification based on AS2870 (Table 2.1 – reproduced below) has also been provided. Note Class P applies where sufficient depth of uncontrolled fill exists.

**TABLE 2.1
CLASSIFICATION BASED ON SITE REACTIVITY**

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes

Table 1 – Summary of Lot Ground Conditions

Lot	Previous usage (2010)	Current slope (deg)	Expected depth to stiff natural materials	Expected overburden	Class
2-6	Buildings (now removed)	~1 (benched)	Approximately 0.5 to 1 m	Generally colluvium, but regions of fill and regions of re-compacted softer colluvium (such as backfilling over old services) should be anticipated	P
7	Buildings (now removed)	5 to 9	Approximately 0.5 to 1 m	Generally colluvium, but regions of fill and regions of re-compacted softer colluvium (such as backfilling over old services) should be anticipated	P
8	Buildings (now removed)	6 to 10			P
9	Buildings (now removed)	7 to 11			P
10	Buildings (now removed)	3 to 10	Approximately 1 m	Colluvium, possibly disturbed, to 1.1m. Residual clay at 1.1m.	M or P
11	Cleared for agriculture	3 to 10	Approximately 1 to 1.5 m	Possible agricultural fill.	P
12	Cleared for agriculture	3 to 10	Approximately 1 to 1.5 m	Possible agricultural fill.	P
13	Cleared for agriculture	3 to 10	Approximately 1 to 1.5 m	Possible agricultural fill.	P
14	Cleared for agriculture	4 to 6	Approximately 1.5 m	Possible agricultural fill.	P
15	Cottage (remaining)	3 to 10	-	-	-
16	Partial orchard	4 to 6	Approximately 1 m	Colluvium and topsoil.	S or M
17	Orchard	4 to 6	0.5 to 1m	Colluvium and topsoil.	S or M
18	Orchard	6 to 8	0.5 to 1m	Colluvium and topsoil.	S or M
19	Orchard	8 to 10	0.5 to 1m	Colluvium and topsoil.	S or M
20	Orchard	12 to 14	0.5 to 1m	Colluvium and topsoil.	S or M
21	Partial orchard	12 to 14	Approximately 0.5 m	Colluvium and topsoil.	S
22	Natural wooded	14 to 16	Approximately 0.5 m	Colluvium and topsoil.	S

Lot	Previous usage (2010)	Current slope (deg)	Expected depth to stiff natural materials	Expected overburden	Class
23	Cleared / horticulture	12 to 14	< 0.5	Colluvium and topsoil.	S
24	Cleared / horticulture	13 to 15	< 0.5	Colluvium and topsoil.	S
25	Cleared / horticulture	12 to 14	< 0.5	Colluvium and topsoil.	S
26	Cleared / horticulture	14 to 16	< 0.5	Colluvium and topsoil.	S
27	Cleared / horticulture	9 to 11	Approximately 1.1m	Agricultural fill	P
28	Cleared / horticulture	11 to 13	Approximately 0.5 m	Colluvium and topsoil.	S
29	Cleared / horticulture	13 to 15	Approximately 0.5 m	Colluvium and topsoil.	S
30	Cleared / horticulture	13 to 15	Approximately 0.5 m	Colluvium and topsoil.	S
31	Cleared / horticulture	13 to 15	< 0.5	Colluvium and topsoil.	S
32	Cleared / horticulture	12 to 14	< 0.5	Colluvium and topsoil.	S
33	Cleared / horticulture	12 to 14	< 0.5	Colluvium and topsoil.	S
34	Cleared / horticulture	12 to 14	< 0.5	Colluvium and topsoil.	
35	Natural wooded	13 to 20	Approximately 1 m	Possible fill and scree.	S (possible P)
36	see previous report S027.L1				-
37-39	Horticulture	Not assessed			-
40	Horticulture	7 to 9	Approximately 1.5 m	Possible agricultural fill.	M or P
41	Horticulture	8 to 14	Approximately 1.5 m	Possible agricultural fill.	M or P
42	Horticulture	13 to 15	Approximately 1.5 m	Possible agricultural fill.	M or P
43-48	Buildings (now removed)	~1	Fill has been placed and compacted by site works to over 1.5m depth. Contains soil and rubble, well compacted to approximately 1.5m depth, overlying loose alluvial sands. Official 'controlled' status of fill to be confirmed.		P (unless previously certified)

3. DESIGN RECOMMENDATIONS

3.1 Lots with shallow stiff natural clays or weathered rock

These design recommendations pertain to Lots 16 to 26; and 28 to 30.

The stiff to very stiff colluvium and residual clays are suitable for founding pad and strip footings.

SPT values for the upper 1m or so of colluvium were measured by Coffey as:

- BH 15-08 just upslope of Lot 20: SPT= 12 with refusal on weathered rock at about 2.8m
- BH 15-04 at downhill edge of Lot 18: SPT =22 increasing to 30 at 4m depth
- BH 16-08 near uphill corner of Lot 35: SPT =12 with refusal on weathered rock at about 2.8m
- BH 15-07 at uphill corner of Lot 9: SPT = 32 at 2.5m and 25 at 4m

Bearing capacity for strip and pad footings can be estimated from the following:

The undrained shear strength (S_u) can be approximated as²:

$$S_u \text{ (kPa)} = 6N \quad \text{where } N \text{ is the SPT value.} \quad (1)$$

The undrained bearing capacity (Q_u) is given by:

$$Q_u = 5.14 S_u \quad \text{for a strip footing,} \quad (2)$$

$$Q_u = 6.2 S_u \quad \text{for a square pad.} \quad (3)$$

For pad footings, the drained bearing capacity is given by:

$$Q_d = c' N_c \left(1 + \frac{N_q}{N_c} \right) + 0.3 \gamma B N \quad (4)$$

Where:

c' is the effective stress cohesion

γ is the unit weight

B is the footing width

N_c and N_q depend on c' and the effective angle of friction ϕ'

From testing of an undisturbed samples of colluvium conducted for the retaining walls around the Fisheries Building in September 2016 we have $c'=7\text{kPa}$ and $\text{Phi}'=33$ degrees. These parameters reduce Equation (4) above to $Q_u = 50c' + 80B$.

Example strength parameters based on the above information is summarised in Tables 2 and 3 below.

² Kulhawy and Mayne (1990), *Manual on Estimating Soil Properties for Foundation Design*

Table 2 – Undrained (short term) bearing capacity

SPT value	Su (kPa)	Qu (kPa) strip footings	Qu (kPa) pad footings
12	70 (ie 'stiff')	360	430
22	130 (ie 'very stiff')	670	800

Table 3 – Drained bearing capacity

	Qd (kPa) 0.5 m pad	Qd (kPa) 1 m pad
Estimated	390	430
With FOS of 3	130	140

For Lot 36 (Cluster Buildings – see our report S027.L1) we recommended an allowable bearing pressure of 150kPa. That remains a reasonable value for that site and the present because the footings are not at the surface, and a small embedment gives a significant increase in allowable bearing pressure. As per our previous recommendations, if bored concrete or grout injected bored piles are used they may be designed for an allowable end bearing pressure of 250kPa and a side shear of 30kPa in stiff to very stiff colluvium.

Footing systems could be combined with suspended floor slabs (concrete or timber) on pad or strip footings. This is expected to offer significant cost savings over the previous screw pile design. It would also be possible to cut level terraces into the colluvium for slab-on-ground foundations for each building. However, this would have the disadvantage of having ~1m to 1.5m high retaining walls on the uphill side of each building, coupled with the need to provide very good drainage and waterproofing so as to prevent down-slope groundwater seepage from penetrating into the floor slabs.

Settlements could be estimated by adopting a drained modulus of 200MPa for 2m below a pad or strip footing and 400MPa for the next underlying 3m.

3.1.1 Comments on shrink / swell

Shrink / swell testing on a sample of colluvium was undertaken, attached to this report, and demonstrated very low shrink / swell potential. This accords with previous testing for Lot 36 as reported in S027.L1.

3.1.2 Additional comments on construction methodology

Where pad and strip footings are used founded on the colluvium it is essential that the exposed founding surface be sealed against softening by surface water ingress prior to concrete placement. This could be achieved with nominally 20mm of blinding concrete or with 10mm to 15mm sprayed gunnite (as used for swimming pool construction) placed immediately after excavation.

3.2 Lots with some agricultural fill

These design recommendations pertain to Lots 2 to 14; 27 and 40 to 42.

Buildings cannot be founded on uncontrolled fills, and where such fill is too deep to be economically removed, piles may be required to distribute loads onto underlying stiff natural clays or weathered rock.

On many Lots where fill exists, colluvium and residual extremely weathered sandstone is close to the surface over the upslope portion of the lot, but the downslope near-edge of the platform comprises over 1.5m of uncontrolled sand fill over slope-wash and colluvium. Thus there is a wedge of fill within the down slope of the Lot. Pad and strip footings founded on colluvium are appropriate (as detailed in Section 3.1 above) over these upslope portions, but piers and piles of suitable length edge are required over the portions overlain with fill.

Conditions for buildings 2 to 10 typically comprise colluvium or residual clay at sufficiently shallow depth to allow pad footings and short piers designed for allowable bearing pressure of 150kPa. However, the investigations showed that there are areas of disturbed colluvium (typically soft to firm) associated with previous works in the area such as installation of pipework for irrigation and supply to the previous buildings. It is not possible to know from the test pits where such disturbed area are located. Therefore careful observation is necessary during excavation for footings to check for such situations so that appropriate changes can be made to particular footings. It is for this reason that these lots have been classified as P.

We note that the sides of the test pits in the fill-sand were stable for up to 20min. This suggests that open hole bored piles drilled by auger could be appropriate. This should be checked by undertaking some trial augering before committing to this simple pile solution.

If bored concrete or grout injected bored piles are used they may be designed for an allowable end bearing pressure of 250kPa and a side shear of 30kPa in stiff to very stiff colluvium. It is possible that extremely weathered rock may be encountered at about 1.5m below the surface of the slop-wash colluvium surface.

Yours sincerely



PHILIP PELLIS
FTSE BSc(Eng) MSc(Eng) DSc DIC FIEAust MASCE



STEVEN PELLIS
BE (Eng) M Eng Sc PhD

Figures



 Pells Consulting

0 25 50 100 150 200 Meters

Figure 1

- Test Pits 18 July 2017
- Test Pits 1 Aug 2017
- ⊗ Coffey Investigations
- ▲ Douglas Investigations
- Cross Section Locations

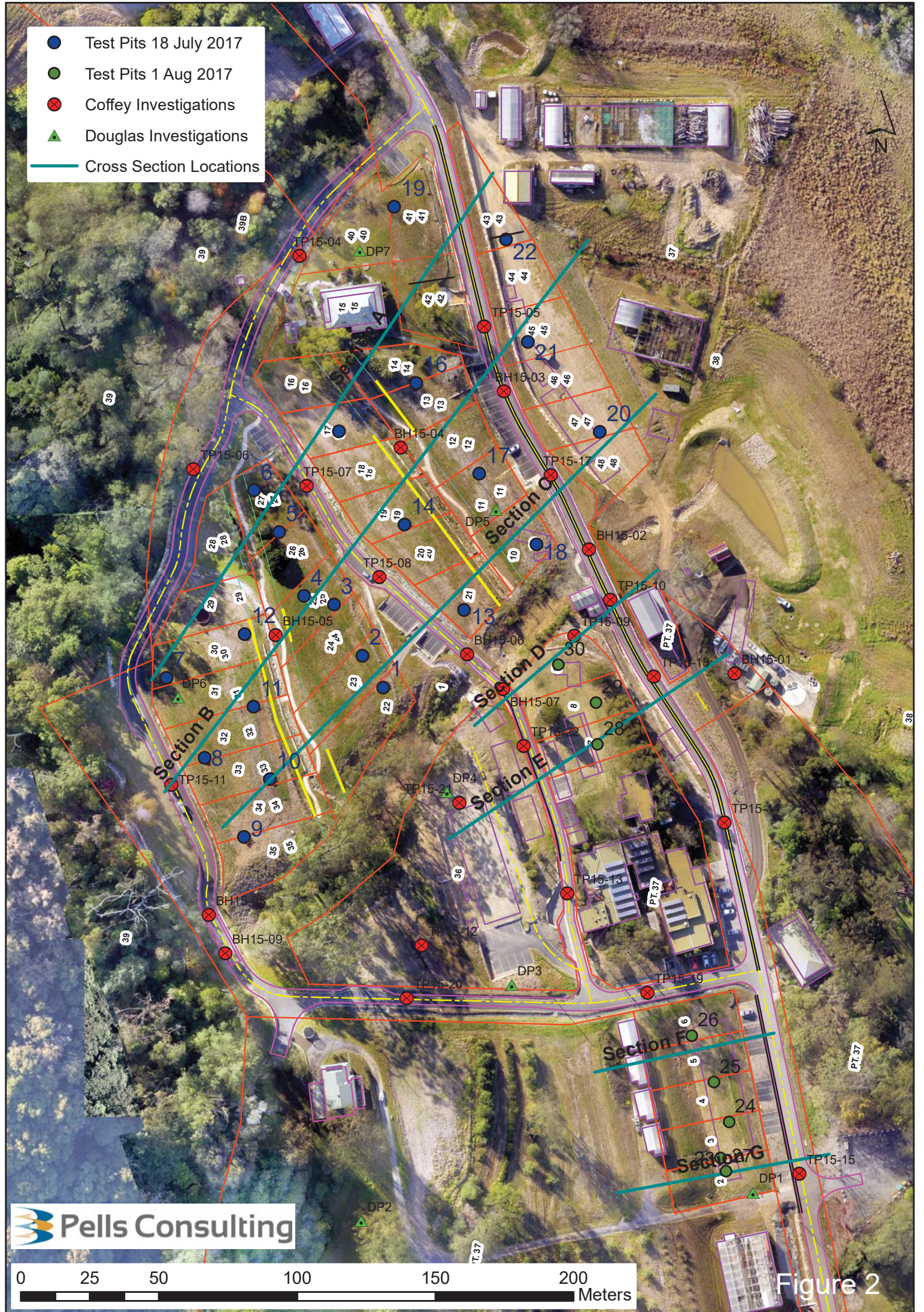
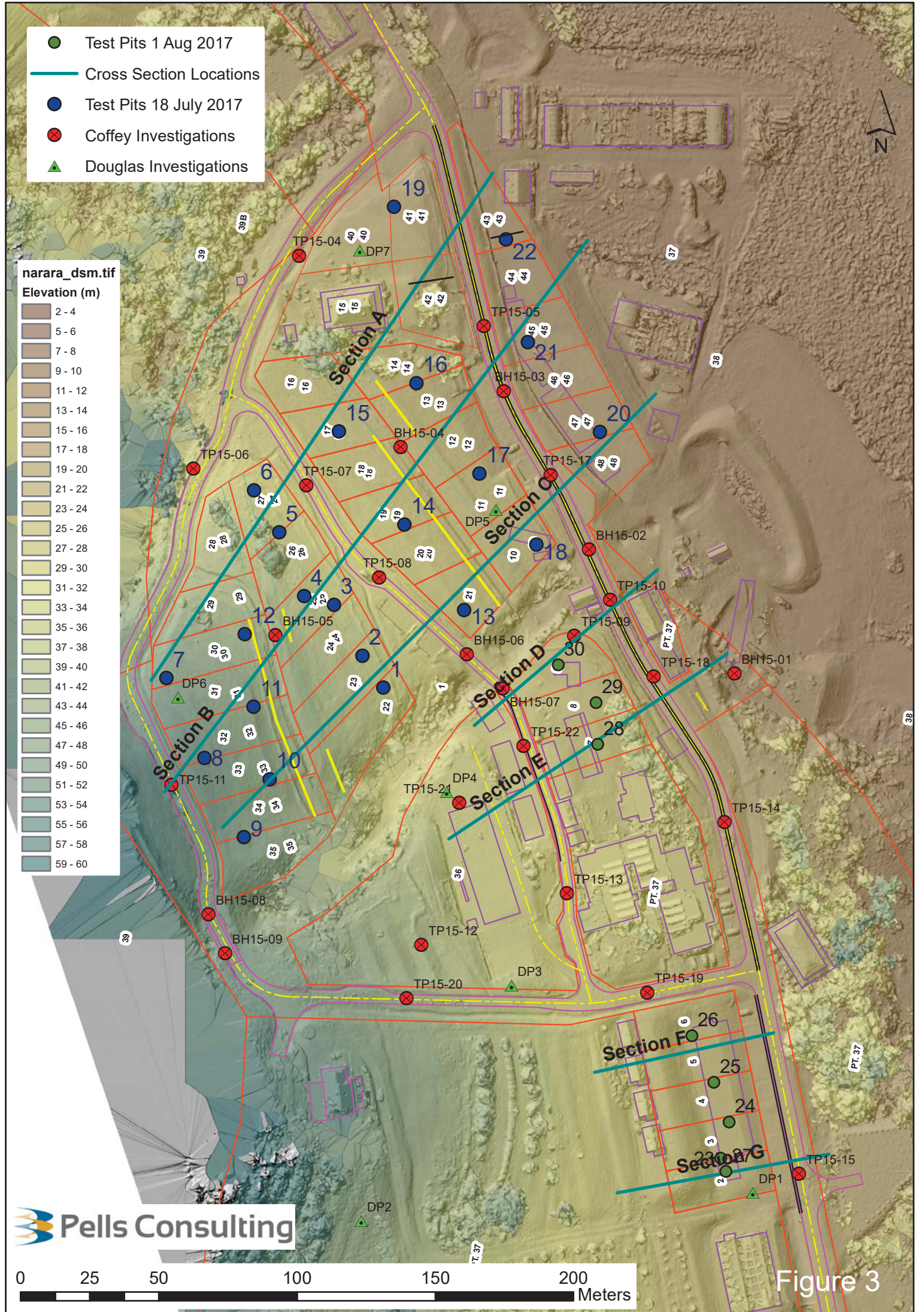


Figure 2

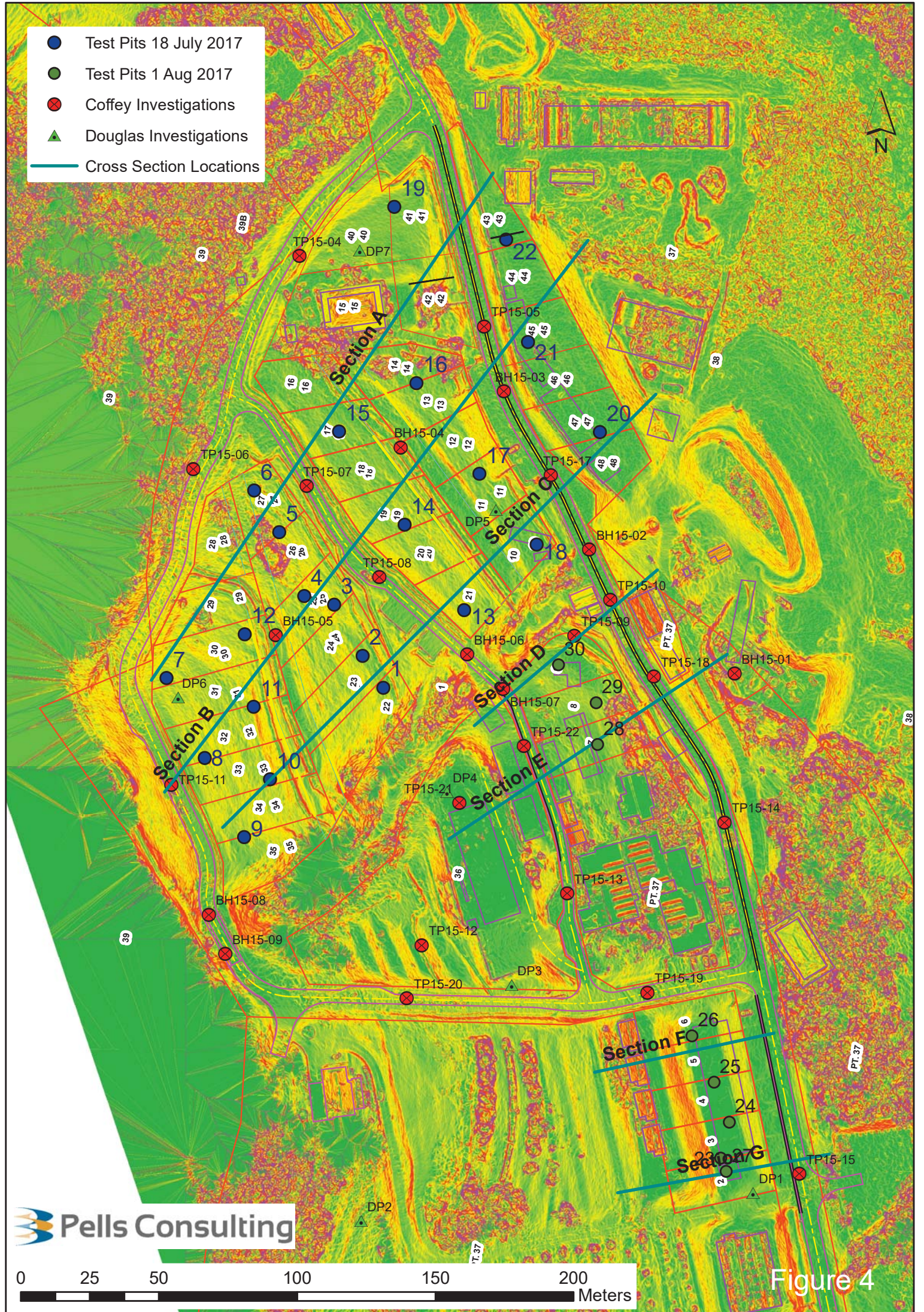
- Test Pits 1 Aug 2017
- Test Pits 18 July 2017
- ⊗ Coffey Investigations
- ▲ Douglas Investigations

narara_dsm.tif
Elevation (m)

2 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 14
15 - 16
17 - 18
19 - 20
21 - 22
23 - 24
25 - 26
27 - 28
29 - 30
31 - 32
33 - 34
35 - 36
37 - 38
39 - 40
41 - 42
43 - 44
45 - 46
47 - 48
49 - 50
51 - 52
53 - 54
55 - 56
57 - 58
59 - 60



- Test Pits 18 July 2017
- Test Pits 1 Aug 2017
- ⊗ Coffey Investigations
- ▲ Douglas Investigations
- Cross Section Locations



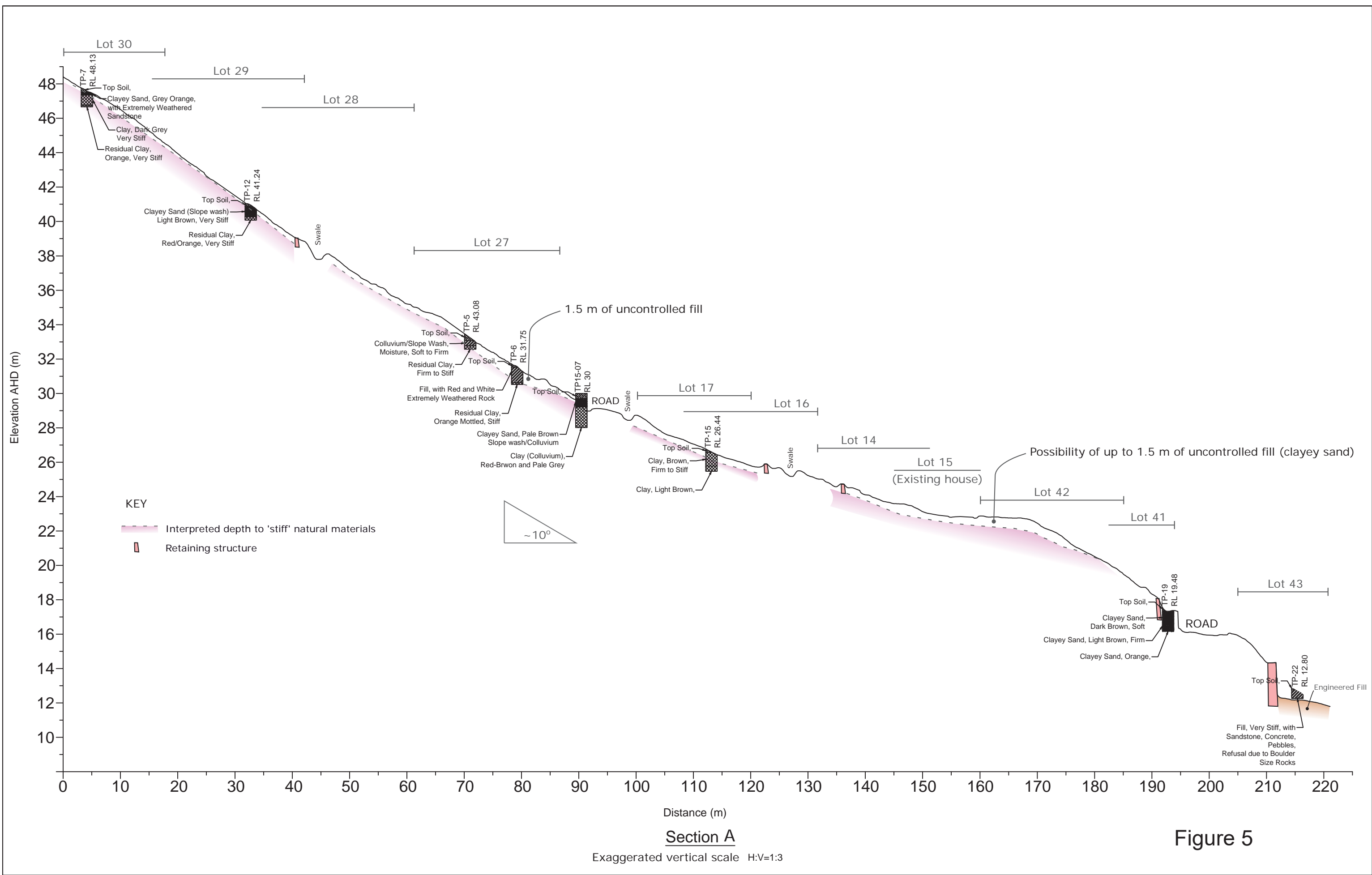
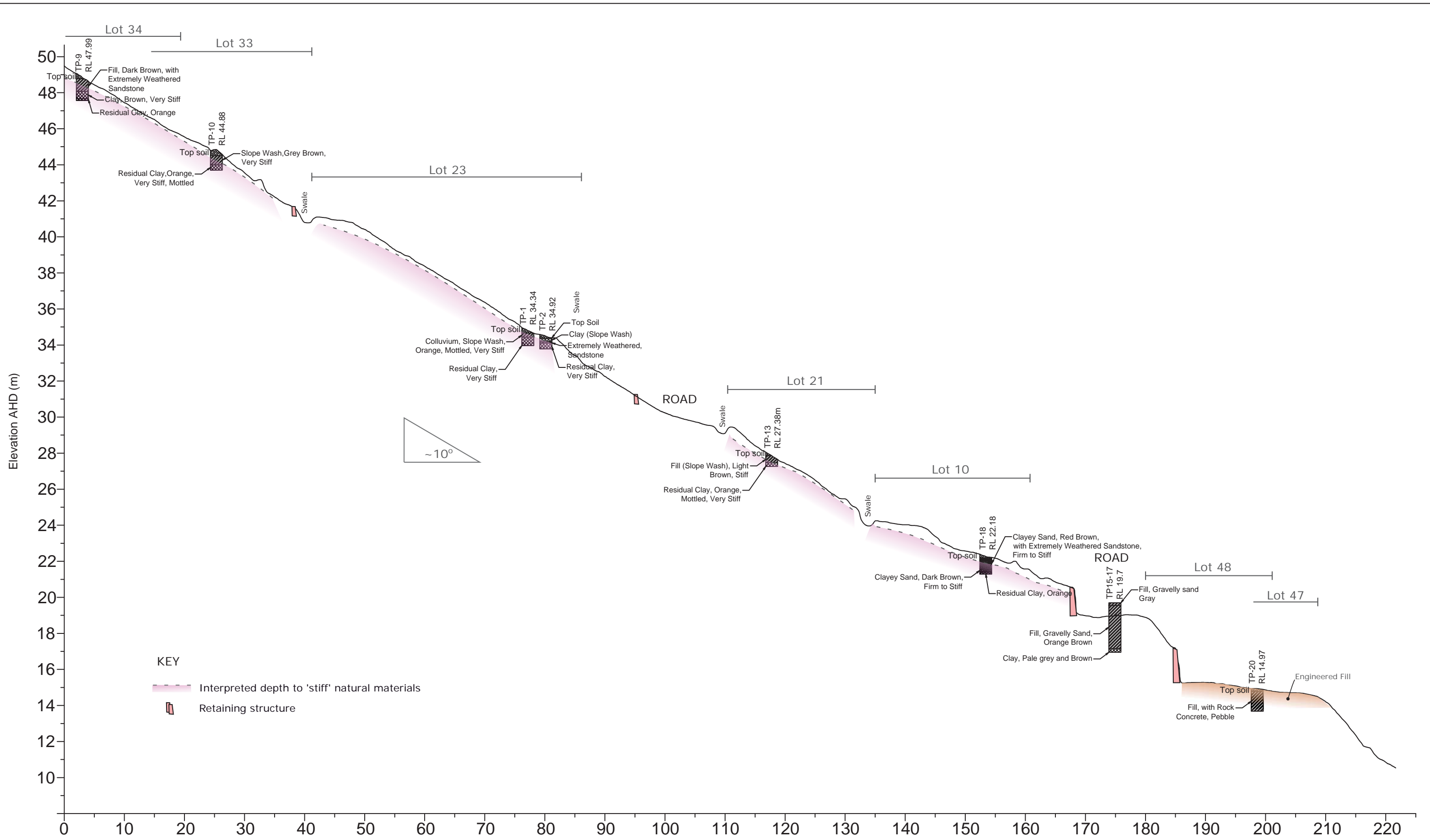


Figure 5



Section C
Exaggerated vertical scale H:V=1:3

Figure 6

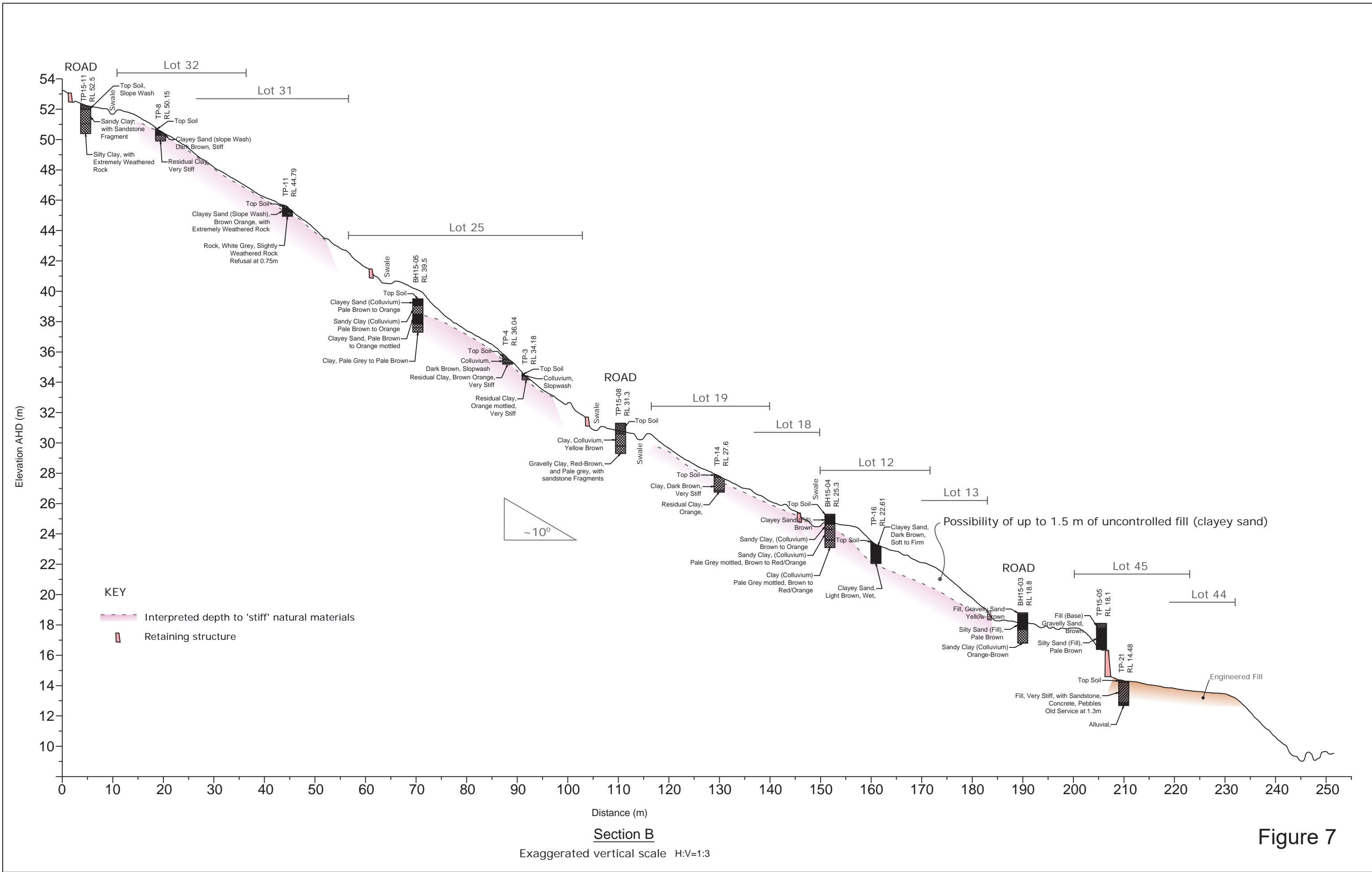
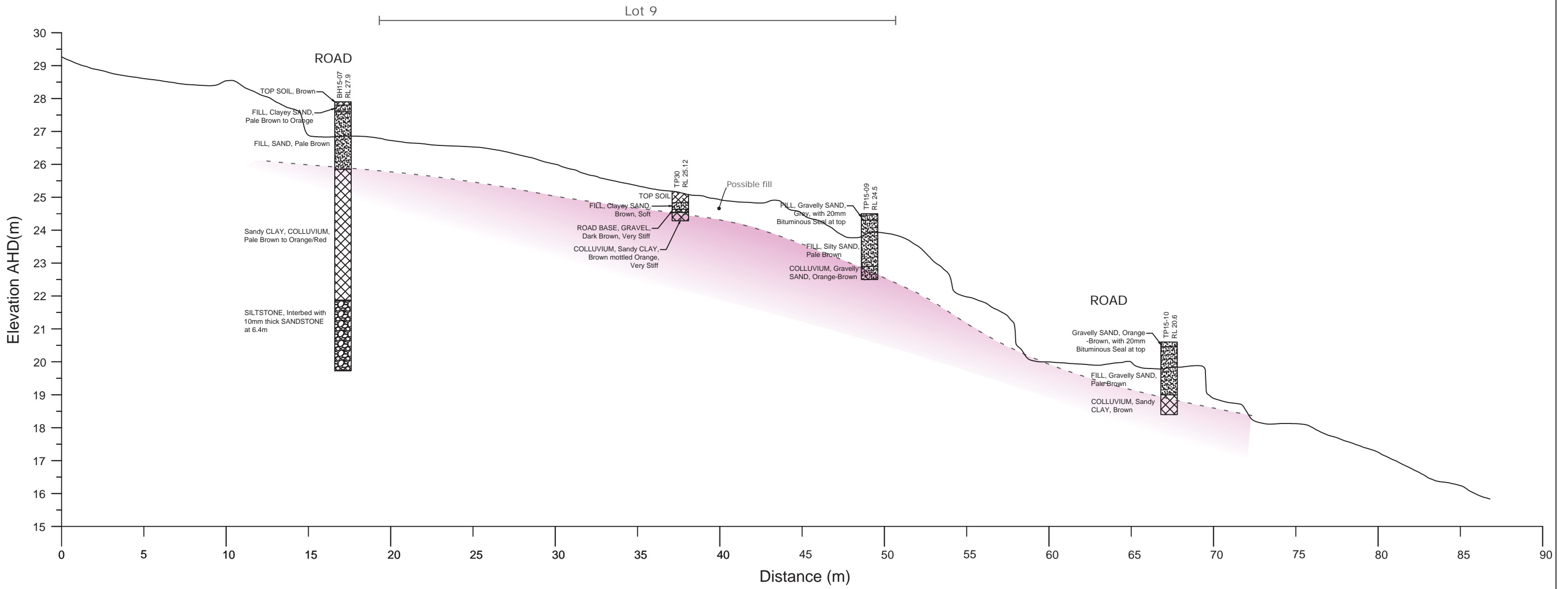


Figure 7



Section D

Exaggerated vertical scale H:V=1:2

Figure 8

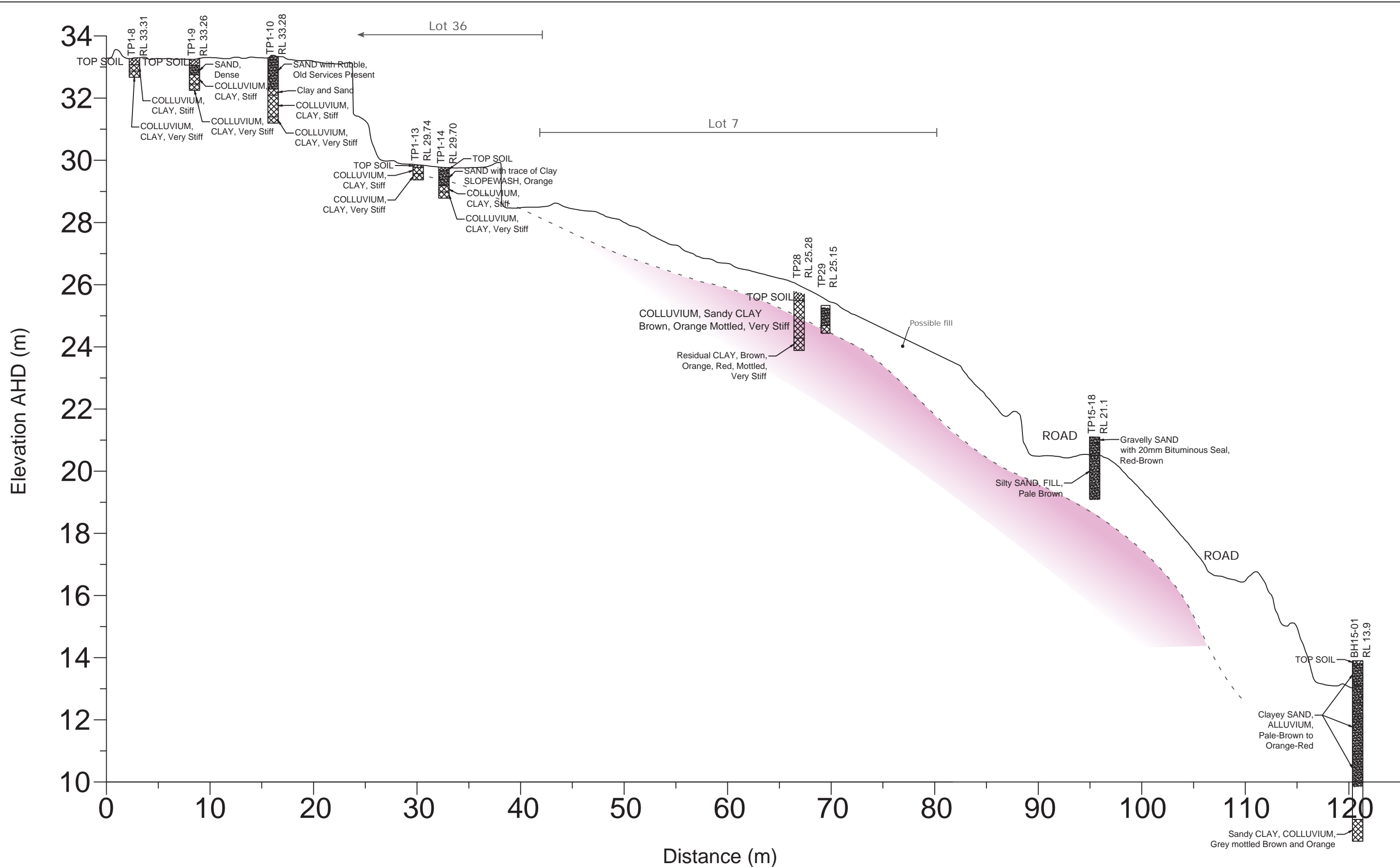
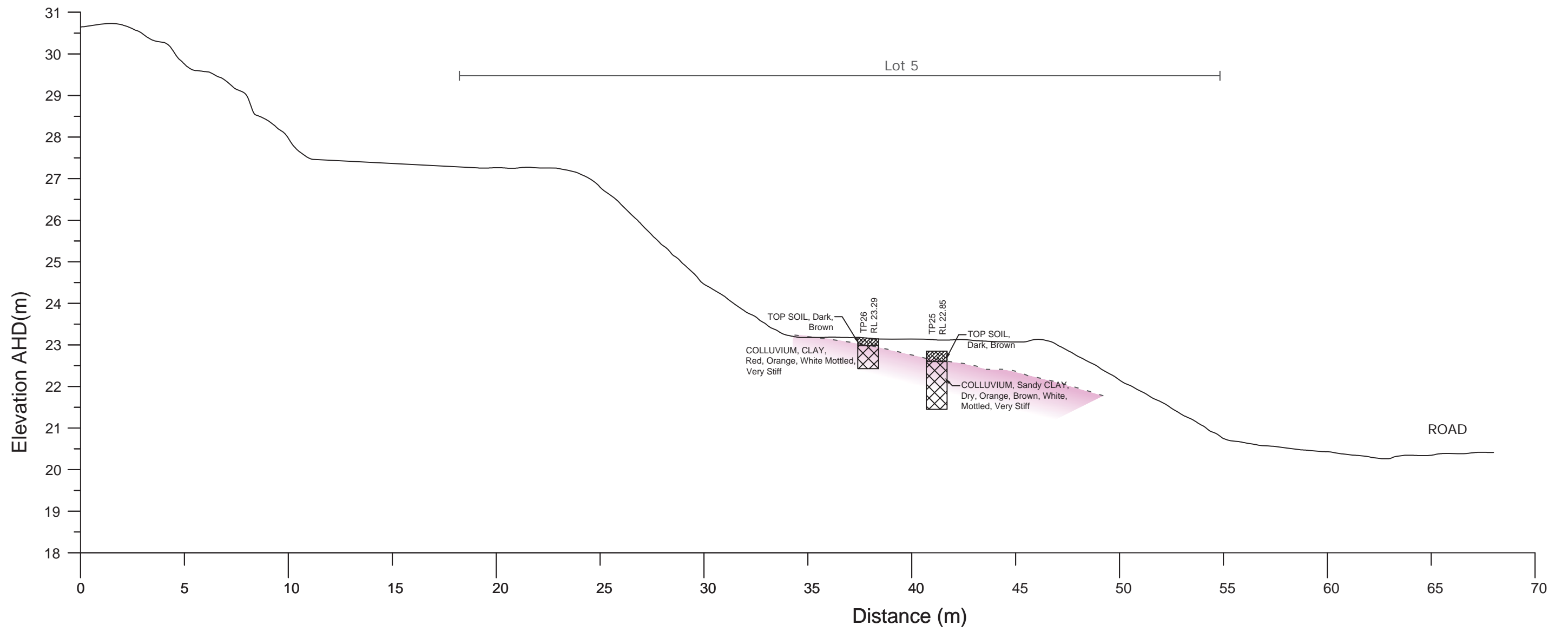


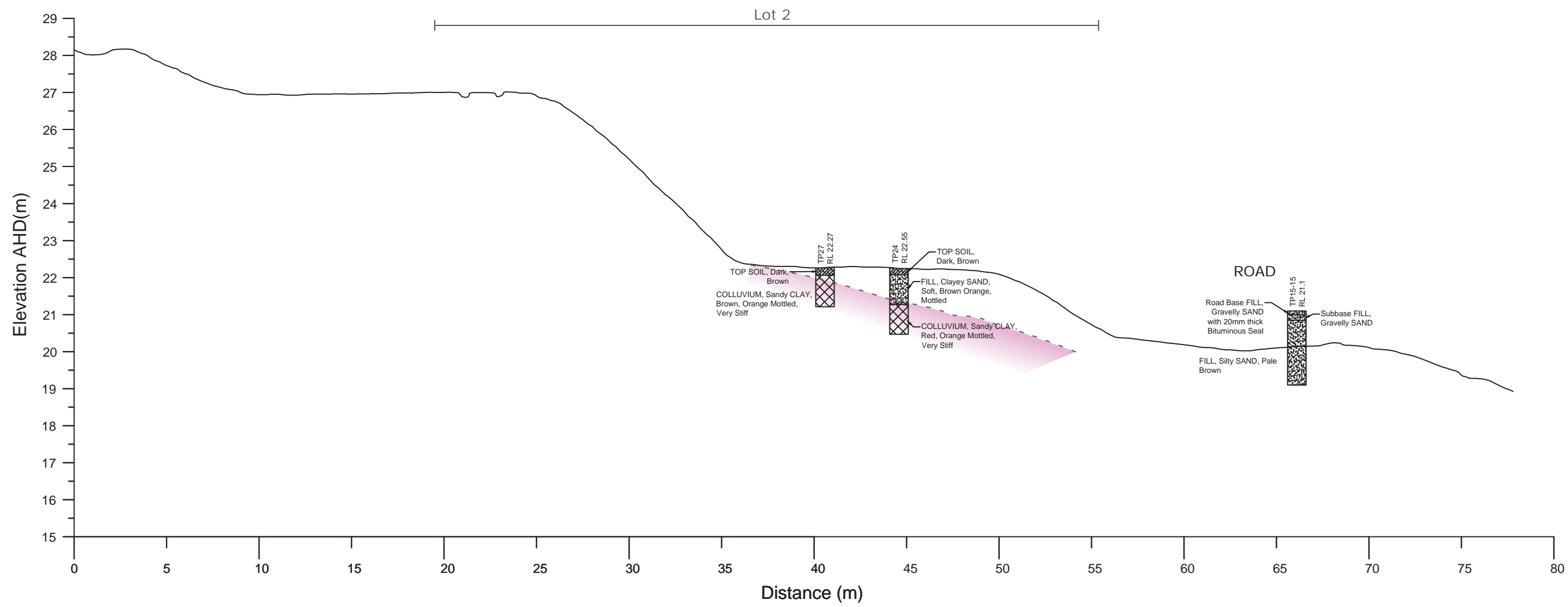
Figure 9



Section F

Exaggerated vertical scale H:V=1:2

Figure 10



Section G

Exaggerated vertical scale H:V=1:2

Figure 11

Attachments

**Test Pit Logs
Shrink-swell test**

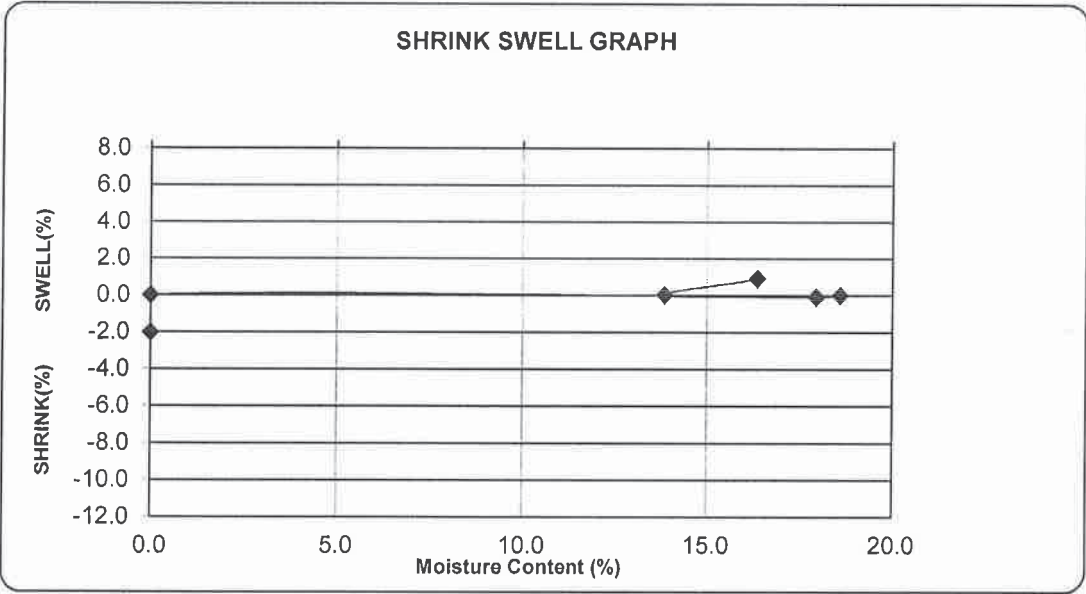
TABLE A
SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

Client: Pells Consulting
Project: Soil Testing

STS Job No: L4037E
Report: A
Report Date: 27/07/2017
Page: 1 of 1

SAMPLE ID: 1		DEPTH: N/A	
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH	
BEFORE TEST	AFTER TEST	BEFORE TEST	AFTER TEST
13.9%	16.4%	300, 300 kPa	400, 360 kPa
LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION	SWELL ON SATURATION	SHRINKAGE
25	0.1%	0.9%	2.0%

SHRINK SWELL GRAPH



SHRINK SWELL INDEX
1.38 %/pF

Notes:

- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Inert Inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 24/07/2017. Sample supplied by client.



NATA Accredited Laboratory
 Number:1327

Accredited for compliance with ISO/IEC 17025 - Testing.
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Authorised Signature / Date
 (A. Tatikonda) 27/7/17
[Signature]



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP30

MGA Easting: 344532.58

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303966.39

Machine: KOMATSU PC-50

R.L. Surface: 25.12m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0	TOP SOIL		Dark, Brown
	0.05			
	0.1			
	0.15			
	0.2			
	0.25	FILL		Clayey SAND, Brwon, Soft
	0.3			
	0.35			
	0.4			
	0.45			
	0.5	ROAD BASE		GRAVEL, Dark Brown, Very Stiff
	0.55			
	0.6			
	0.65			
	0.7			
	0.75	COLLUVIUM		Sandy CLAY, Orange Brown, Mottled, Very Stiff
	0.8			
	0.85			
	0.9			
	0.95			

Name: Luke Pan

Date: 01-Aug-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP29

MGA Easting: 344546.22

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303952.70

Machine: KOMATSU PC-50

R.L. Surface: 25.15m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.05			
	0.1		TOP SOIL	Dark, Brown
	0.15			
	0.2			
	0.25			
	0.3			
	0.35			
	0.4			
	0.45			
	0.5		FILL	Clayey SAND, Brown, Stiff, Old Service Cable at 0.25m
	0.55			
	0.6			
	0.65			
	0.7			
	0.75			
	0.8			
	0.85		COLLUVIUM	Sandy CLAY, Orange, Brown Mottled, Very Stiff
	0.9			
	0.95			

Name: Luke Pan

Date: 01-Aug-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP28

MGA Easting: 344546.82

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303937.61

Machine: KOMATSU PC-50

R.L. Surface: 26.28m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		TOP SOIL	Dark Brown, Old Service at 0.1m
	0.2			
	0.3			
	0.4			
	0.5			
	0.6			
	0.7			
	0.8			
	0.9		COLLUVIUM	Sandy CLAY, Brown, Orange Mottled, Very Stiff
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			
	1.6			
	1.7		Residual CLAY	Brown, Orange, Red, Mottled, Very Stiff
	1.8			

Name: Luke Pan

Date: 01-Aug-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP27

MGA Easting: 344593.24

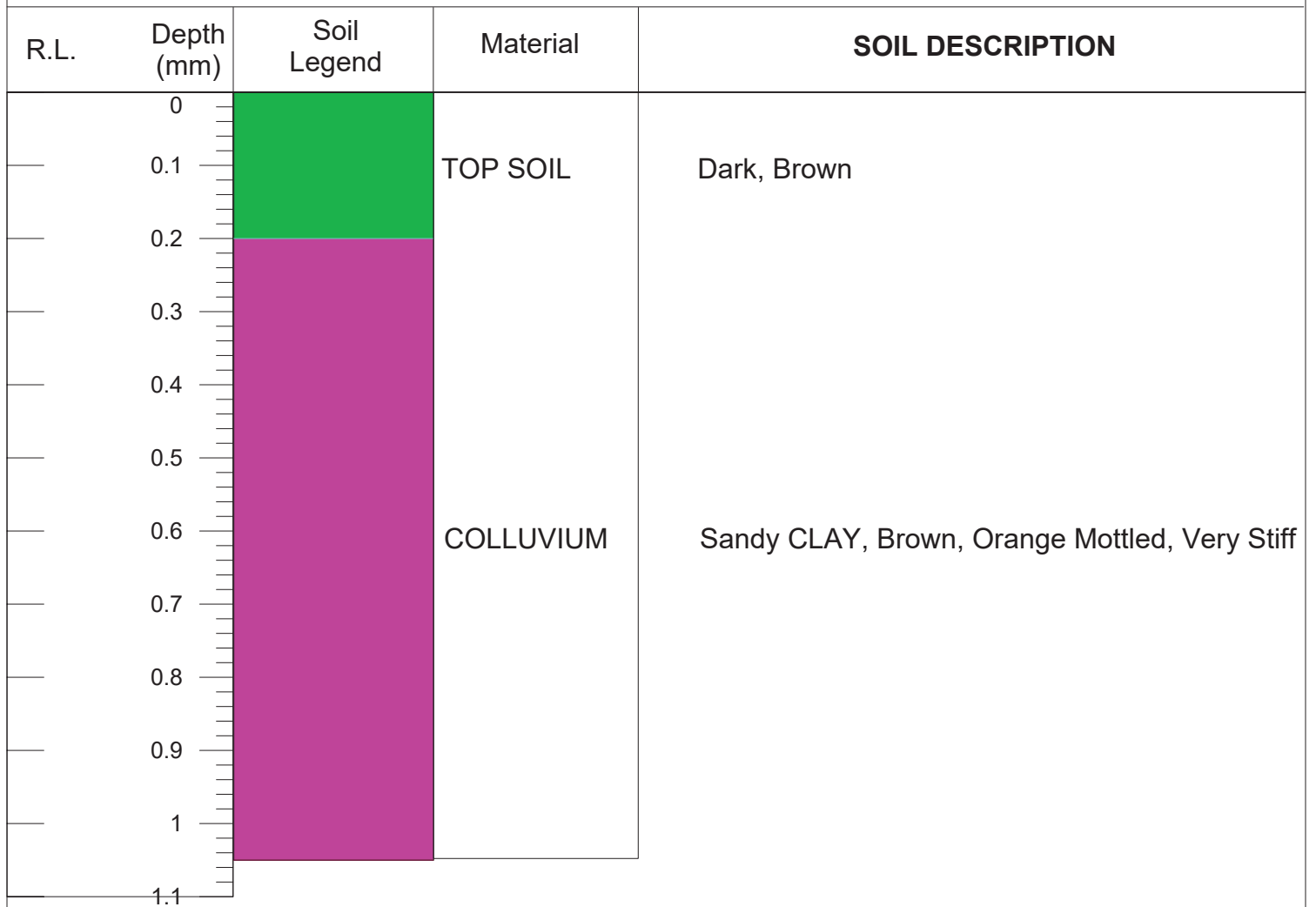
Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303783.16

Machine: KOMATSU PC-50

R.L. Surface: 22.27m

Datum: AHD



Name: Luke Pan

Date: 01-Aug-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP26

MGA Easting: 344580.91

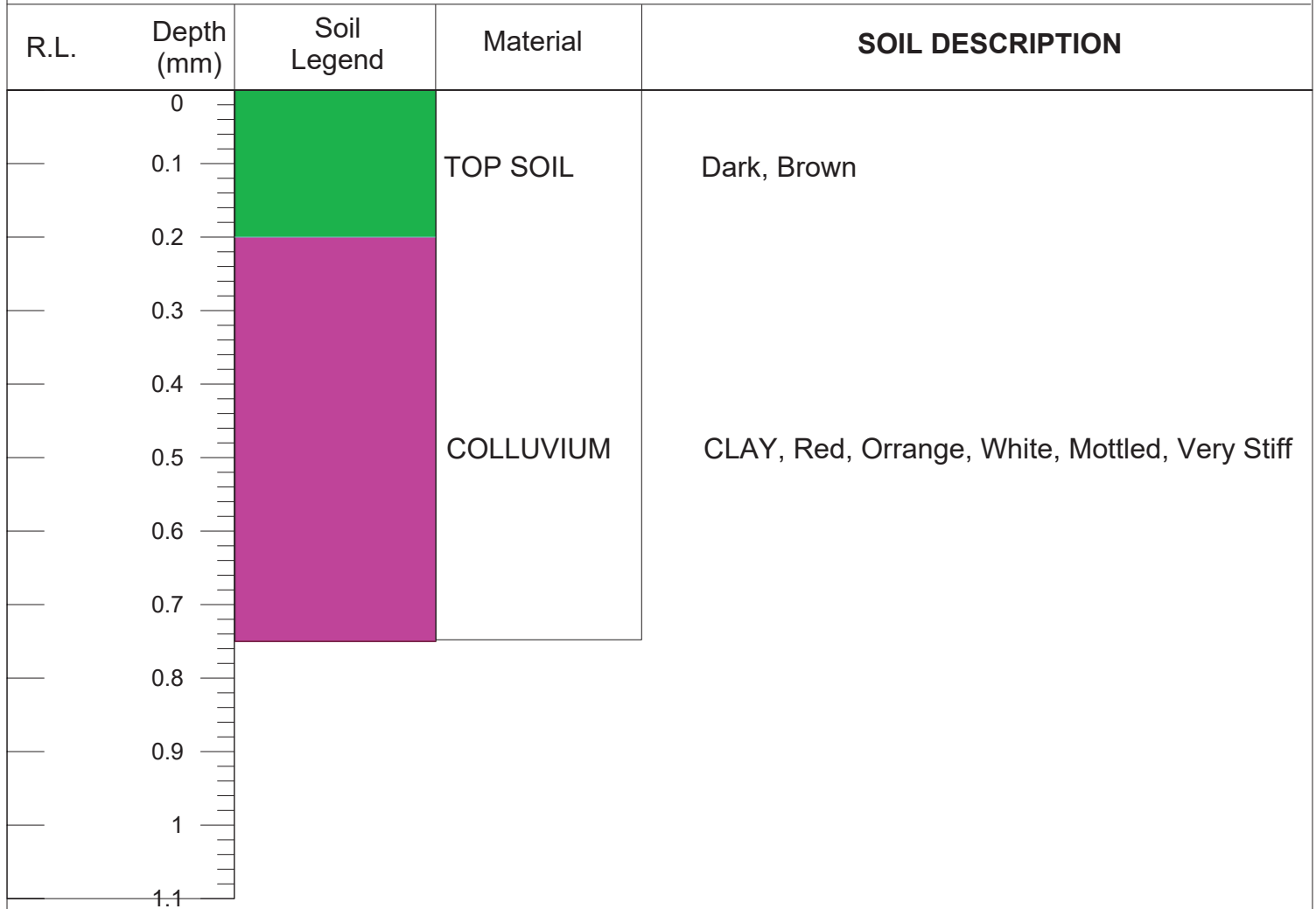
Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303832.22

Machine: KOMATSU PC-50

R.L. Surface: 23.29m

Datum: AHD



Name: Luke Pan

Date: 01-Aug-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP25

MGA Easting: 344588.89

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303815.38

Machine: KOMATSU PC-50

R.L. Surface: 22.85m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		TOP SOIL	Dark, Brown
	0.2			
	0.3			
	0.4			
	0.5			
	0.6			
	0.7			
	0.8		COLLUVIUM	Sandy CLAY, Dry, Orange Brown, White Mottled, Very Stiff
	0.9			
	1			
	1.1			
	1.2			
	1.3			

Name: Luke Pan

Date: 01-Aug-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP24

MGA Easting: 344594.40

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303800.97

Machine: KOMATSU PC-50

R.L. Surface: 22.55m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		TOP SOIL	Dark, Brown
	0.2			
	0.3			
	0.4			
	0.5		FILL	Clayey SAND, Soft, Brown Orange Mottled
	0.6			
	0.7			
	0.8			
	0.9			
	1			
	1.1			
	1.2			
	1.3		COLLUVIUM	Sandy CLAY, Very Stiff, Red, Orange, Mottled
	1.4			
	1.5			
	1.6			
	1.7			

Name: Luke Pan

Date: 01-Aug-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, refusal at 1.9m due to water emerges from pipe

PIT/Hole No: TP23

MGA Easting: 344591.32

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303787.96

Machine: KOMATSU PC-50

R.L. Surface: 22.37m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		TOP SOIL	Dark, Brown
	0.2			
	0.3			
	0.4			
	0.5			
	0.6			
	0.7		COLLUVIUM	Sandy CLAY, Soft to Firm, Orange Brown, Pale, Mottled, Old Service Pipe at 1m,
	0.8			
	0.9			Refusal due to Water Emerges from Old Service Pipe
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			
	1.6			
	1.7			
	1.8			

Name: Luke Pan

Date: 01-Aug-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, refusal recorded at Depth of 0.6m

PIT/Hole No: TP-22

MGA Easting: 344513.64

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6304120.20

Machine: KOMATSU PC-50

R.L. Surface: 12.80m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0		Top Soil	Dark, Brown
	0.1		Fill	Very Stiff, with Sandstone, Concrete, Pebbles, Refusal due to Boulder Size Rocks
	0.2			
	0.3			
	0.4			
	0.5			
	0.6			
	0.7			
	0.8			
	0.9			
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-21

MGA Easting: 344521.64

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6304083.09

Machine: KOMATSU PC-50

R.L. Surface: 14.48m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3			
	0.4			
	0.5			
	0.6			
	0.7		Fill	Very Stiff, with Sandstone, Concrete, Pebbles, Old Services at 1.3m depth
	0.8			
	0.9			
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			
	1.6		Alluvial	

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-20

MGA Easting: 344547.65

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6304050.54

Machine: KOMATSU PC-50

R.L. Surface: 14.97m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3			
	0.4			
	0.5			
	0.6			
	0.7		Fill	With Sandstone, Concrete, Pebbles
	0.8			
	0.9			
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-19

MGA Easting: 344473.20

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6304132.04

Machine: KOMATSU PC-50

R.L. Surface: 19.48m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3			
	0.4			
	0.5		Clayey Sand	Dark Brown, Soft
	0.6			
	0.7			
	0.8			
	0.9			
	1			
	1.1		Clayey Sand	Light Brown, Firm
	1.2			
	1.3			
	1.4		Clayey Sand	Orange
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-18

MGA Easting: 344524.70

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6304009.89

Machine: KOMATSU PC-50

R.L. Surface: 22.18m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3			
	0.4			
	0.5		Clayey Sand	Red Brown, with Extremely Weathered Sandstone, Firm to Stiff
	0.6			
	0.7			
	0.8			
	0.9		Clayey Sand	Dark Brown, Firm to Stiff
	1			
	1.1		Residual Clay	Orange
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-17

MGA Easting: 344504.04

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6304035.49

Machine: KOMATSU PC-50

R.L. Surface: 22.55m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3		Clayey Sand	Brown, Very Stiff
	0.4			
	0.5			
	0.6			
	0.7		Clayey Sand	Light Brown, Hard
	0.8			
	0.9			
	1			
	1.1			
	1.2			
	1.3		Clayey Sand	Red Brown, Wet,
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-16

MGA Easting: 344481.27

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6304068.23

Machine: KOMATSU PC-50

R.L. Surface: 22.61m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3			
	0.4		Clayey Sand	Dark Brown, Soft to Firm
	0.5			
	0.6			
	0.7			
	0.8			
	0.9			
	1		Clayey Sand	Light Brown, Wet,
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-15

MGA Easting: 344453.20

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6304050.74

Machine: KOMATSU PC-50

R.L. Surface: 26.44m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3			
	0.4			
	0.5			
	0.6		Clay	Brown, Firm to Stiff
	0.7			
	0.8			
	0.9			
	1			
	1.1		Clay	Light Brown,
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-14

MGA Easting: 344476.92

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6304017.07

Machine: KOMATSU PC-50

R.L. Surface: 27.60m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3			
	0.4			
	0.5			
	0.6		Clay	Dark Brown, Very Stiff
	0.7			
	0.8			
	0.9			
	1			
	1.1		Residual Clay	Orange,
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-13

MGA Easting: 344398.54

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303986.14

Machine: KOMATSU PC-50

R.L. Surface: 27.38m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3			
	0.4		Fill	Light Brown, Slope Wash, Stiff
	0.5			
	0.6			
	0.7		Residual Clay	Orange, Mottled, Very Stiff
	0.8			
	0.9			
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-12

MGA Easting: 344419.14

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303977.47

Machine: KOMATSU PC-50

R.L. Surface: 41.24m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3			
	0.4			
	0.5		Clayey Sand	Light Brown, Slope Wash, Very Stiff
	0.6			
	0.7			
	0.8			
	0.9		Residual Clay	Red Orange, Very Stiff
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, refusal recorded at Depth of 0.75m

PIT/Hole No: TP-11

MGA Easting: 344422.23

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303951.16

Machine: KOMATSU PC-50

R.L. Surface: 44.79m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3			
	0.4		Clayey Sand	Brown Orange, Slope Wash, with Extremely Weathered Rock
	0.5			
	0.6			
	0.7		Rock	White Grey, Slightly Weathered Rock, Hard, Refusal due to Rock
	0.8			
	0.9			
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-10

MGA Easting: 344428.22

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303924.97

Machine: KOMATSU PC-50

R.L. Surface: 44.80m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3			
	0.4			
	0.5		Fill	Very Stiff, Grey Brown, Slope Wash
	0.6			
	0.7			
	0.8			
	0.9		Residual Clay	Very Stiff, Orange, Mottled
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-9

MGA Easting: 344418.88

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303904.05

Machine: KOMATSU PC-50

R.L. Surface: 47.99m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3			
	0.4			
	0.5			
	0.6		Fill	Dark Brown, With Extremely Weathered Sandstone
	0.7			
	0.8			
	0.9			
	1			
	1.1			
	1.2		Clay	Brown, Very Stiff
	1.3			
	1.4			
	1.4		Residual Clay	Orange
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-8

MGA Easting: 344404.61

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303932.64

Machine: KOMATSU PC-50

R.L. Surface: 50.15m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3		Clayey Sand	Dark Brown, Stiff, Slope Wash
	0.4			
	0.5			
	0.6			
	0.7		Clay	Very Stiff
	0.8			
	0.9			
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-7

MGA Easting: 344390.82

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303961.56

Machine: KOMATSU PC-50

R.L. Surface: 48.13m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3		Clayey Sand	With Grey and Orange Extremely Weathered Sandstone
	0.4			
	0.5			
	0.6			
	0.7		Clay	Dark Grey, Very Stiff
	0.8			
	0.9			
	1		Residual Clay	Orange, Very Stiff
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-6

MGA Easting: 344422.50

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6304029.47

Machine: KOMATSU PC-50

R.L. Surface: 31.75m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3			
	0.4			
	0.5			
	0.6		Fill	With White and Red Extremely Weathered Sandstone
	0.7			
	0.8			
	0.9			
	1			
	1.1		Residual Clay	Orange Mottled, Stiff
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-5

MGA Easting: 344431.62

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6304014.35

Machine: KOMATSU PC-50

R.L. Surface: 33.08m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0	[Green Box]	Top Soil	Dark, Brown
	0.1			
	0.2			
	0.3	[Purple Box]	Colluvium	Moisture Soil, Slope Wash, Soft to Firm
	0.4			
	0.5			
	0.6			
	0.7	[Orange Box]	Residual Clay	Firm to Stiff
	0.8			
	0.9			
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-4

MGA Easting: 344440.68

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303991.22

Machine: KOMATSU PC-50

R.L. Surface: 36.04m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0	[Green Box]	Top Soil	Dark, Brown
	0.1			
	0.2			
	0.3	[Purple Box]	Colluvium	Dark Brown, Slopewash
	0.4			
	0.5			
	0.6	[Orange Box]	Residual Clay	Brown Orange, Mottled, Very Stiff
	0.7			
	0.8			
	0.9			
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-3

MGA Easting: 344451.44

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303988.10

Machine: KOMATSU PC-50

R.L. Surface: 34.18m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2		Colluvium	Slopewash
	0.3			
	0.4		Residual Clay	Orange Mottled, Very Stiff
	0.5			
	0.6			
	0.7			
	0.8			
	0.9			
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-2

MGA Easting: 344461.80

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303969.65

Machine: KOMATSU PC-50

R.L. Surface: 34.92m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1		Top Soil	Dark, Brown
	0.2			
	0.3		Clay	Slopewash
	0.4			
	0.5		Sandstone	Extremely Weathered
	0.6			
	0.7		Residual Clay	Very Stiff
	0.8			
	0.9			
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17



Pells Consulting

PROJECT: Geotechnical Investigation

Client: NARARA Eco Village

PROJECT No: M010

Remarks: No water table recorded, no refusal recorded

PIT/Hole No: TP-1

MGA Easting: 344469.25

Excavation Dimensions: 400mm wide bucket

MGA Northing: 6303958.12

Machine: KOMATSU PC-50

R.L. Surface: 34.34m

Datum: AHD

R.L.	Depth (mm)	Soil Legend	Material	SOIL DESCRIPTION
	0			
	0.1			
	0.2		Top Soil	Dark, Brown
	0.3			
	0.4		Colluvium	Slopewash, orange mottled, very stiff
	0.5			
	0.6			
	0.7			
	0.8		Residual Clay	very stiff
	0.9			
	1			
	1.1			
	1.2			
	1.3			
	1.4			
	1.5			

Name: Luke Pan

Date: 18-Jul-17

Position: