

Appendix 21.

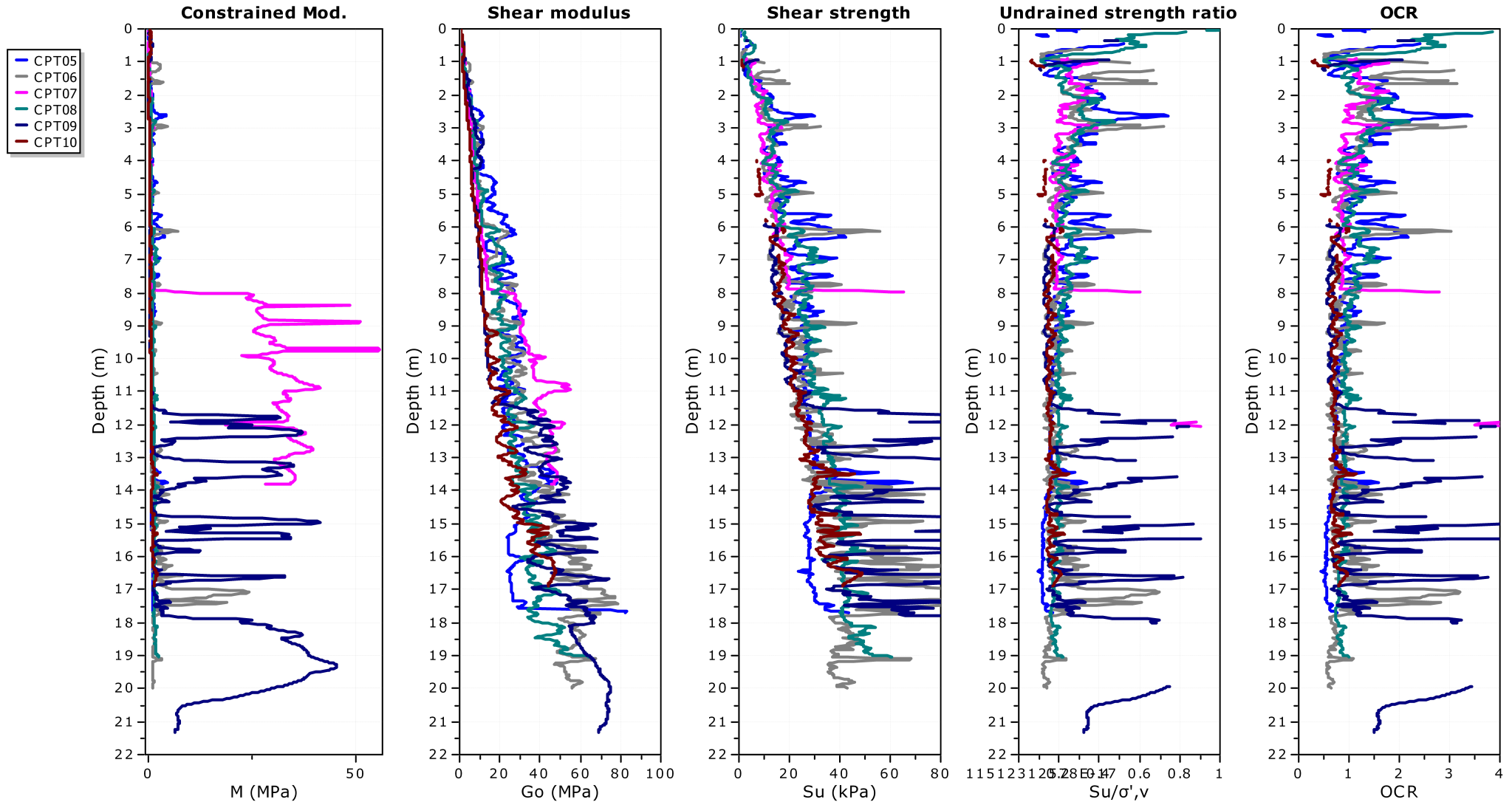
SLR Consulting Australia (2020) *Rum Jungle Rehabilitation – Stage 2A Detailed Design – Main Pit Backfill Strategy, Geotechnical Considerations*. Report to the Department of Mines and Energy, Northern Territory. PART D.



Project: Rum Jungle

Location: NT

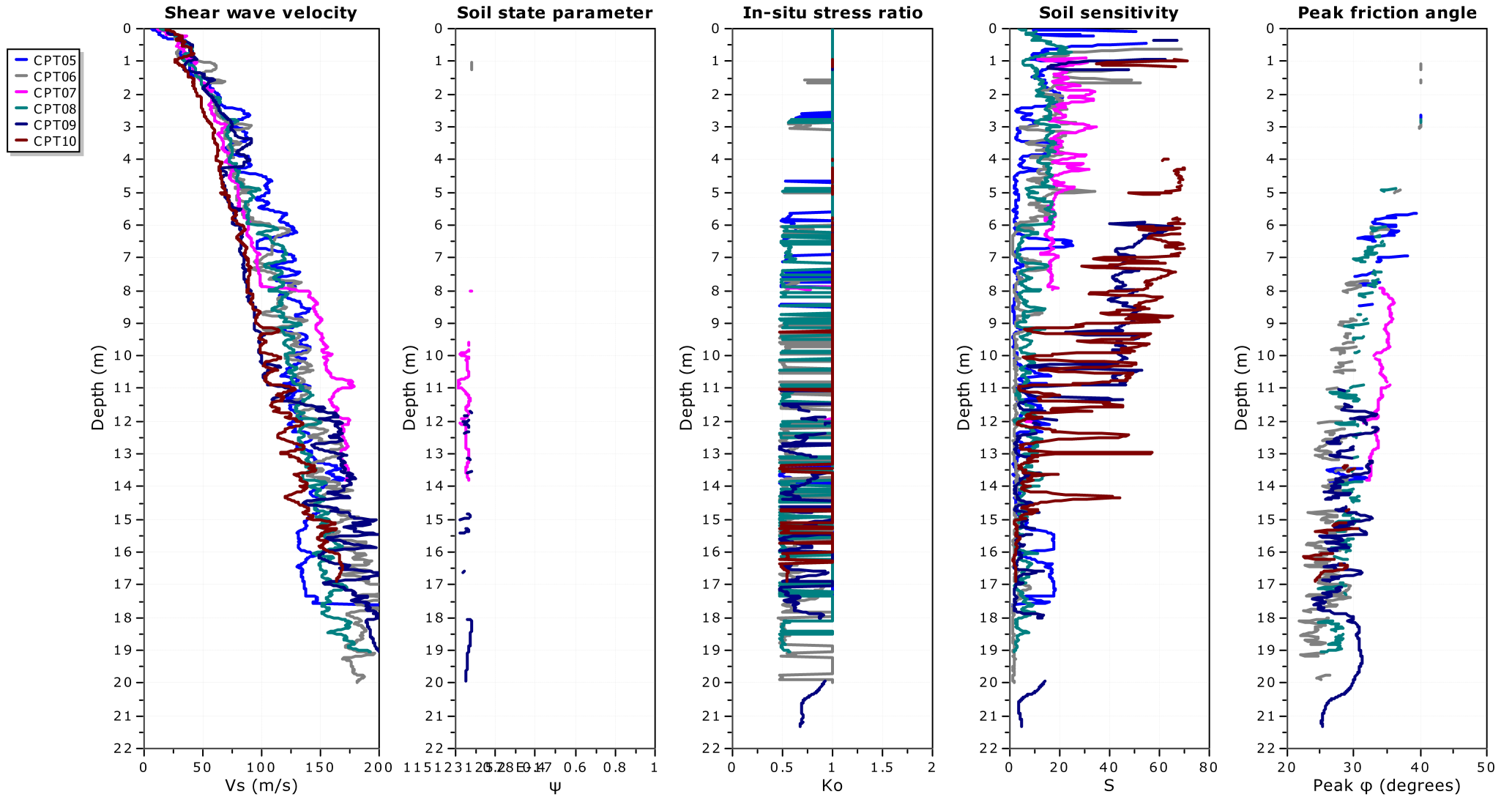
Overlay estimation plots (2)



Project: Rum Jungle



Location: NT

Overlay estimation plots (3)



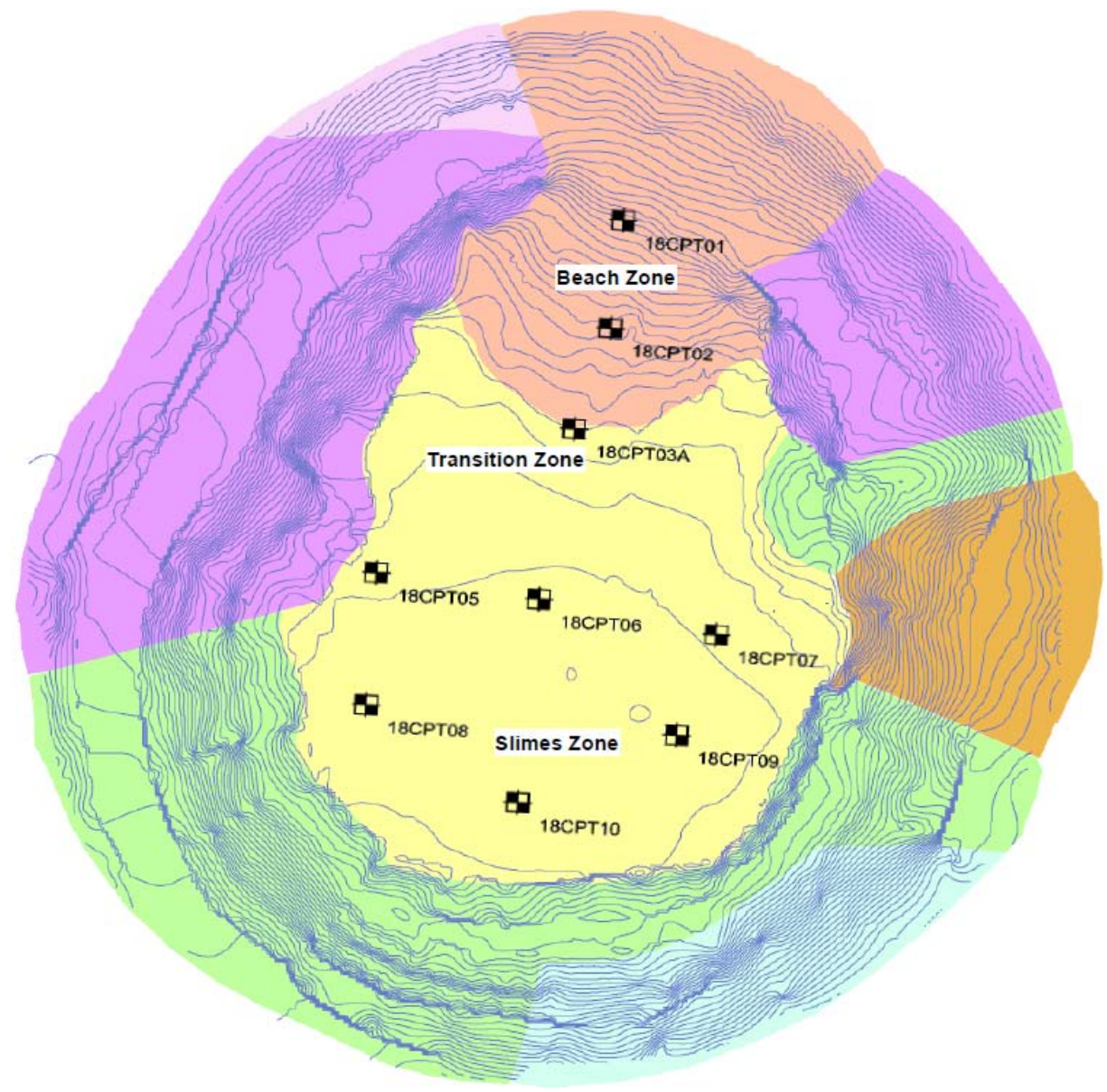
Legend

Inferred Fill Materials

-  Soil
-  Tailings
-  Waste Rock

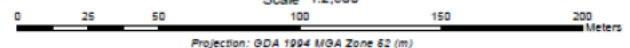
Lithology

-  Quartzite Breccia
(Geolsec Formation)
-  Mudstone Sequence
(Golden Dyke Formation)
-  Black Slate Sequence
(Golden Dyke Formation)
-  Coomalie Dolostone



Rum Jungle Mine Site

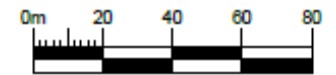
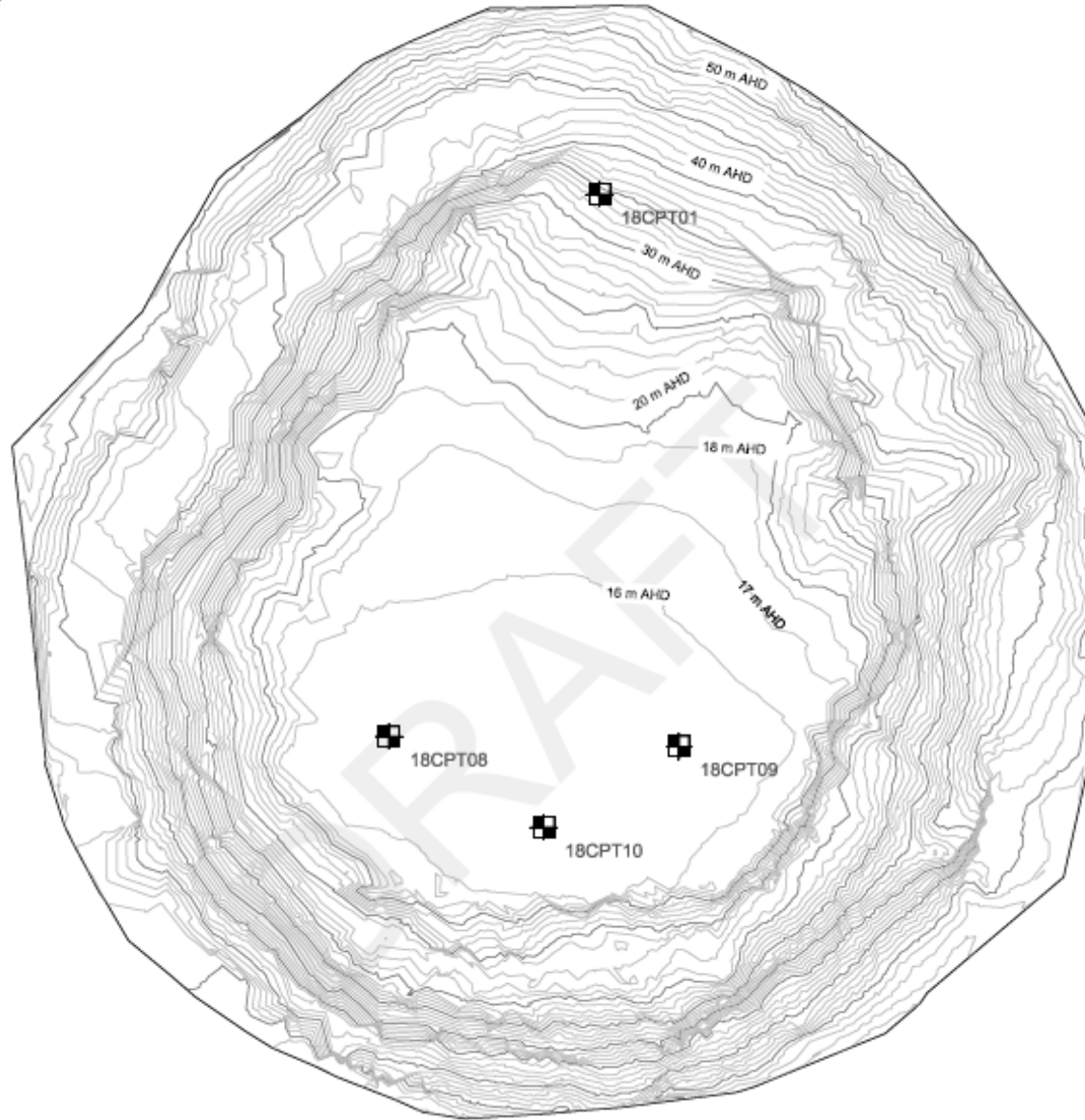
Scale 1:2,500




Projection: GDA 1994 MGA Zone 62 (m)



CLIENT Northern Territory Government		PROJECT Rum Jungle Rehabilitation Stage 2a	
DRAWN FC	DATE 20/11/2019	TITLE Main Pit Material Zoning at Surface	
CHECKED PD	DATE 20/11/2019		
SCALE	PROJECT No 680.10421	FIGURE No F.3.1	REV No A4



LEGEND

 Ball-Cone Penetration Test Locations


NOTES

Based on 2015 bathymetry survey



CLIENT Northern Territory Government		PROJECT Rum Jungle Rehabilitation Stage 2a	
DRAWN FC	DATE 20/11/2019	TITLE Location of Ball Cone Tests	
CHECKED PD	DATE 20/11/2019		
SCALE	PROJECT No 680.10421	FIGURE No F.3.2	REV No A4

Unit	Geological origin	Geological description	Predominant material type	Sub-unit	Consistency / Density / Inferred strength
SB	Uncontrolled Fill (Soil & Beach deposits)	End dumped soil and reconstituted waste rock forming submerged soil slopes and beaches	Cohesive / fine grained	SB-C	Generally stiff (consolidated under overburden)
			Granular / coarse grained	SB-G	Very Loose to <u>Loose</u> , generally uncompacted
T	Uncontrolled Fill (Tailings)	Hydraulically placed tailings and slimes	Cohesive / fine grained	T	Very soft to stiff, normally consolidated. Interbedded with SB-G in places.
BL	Bedding Layer (Site-won granitic sand)	Hydraulically placed sand (spreader pontoon + diffuser)	Granular / coarse grained	BL	Very Loose to <u>Loose</u>
WRB	Waste Rock (Site-won waste rock fill)	Hydraulically placed waste rock (split barge or spreader pontoon)	Granular / coarse grained	WR	Very Loose to <u>Loose</u> sandy Gravel, comprising DW-XW weathered shale

	CLIENT Northern Territory Government		PROJECT Rum Jungle Rehabilitation Stage 2a		
	DRAWN FC	DATE 20/11/2019	TITLE Main Pit Soil Units		
	CHECKED PD	DATE 20/11/2019			
	SCALE	PROJECT No 680.10421	FIGURE No F.3.3	REV No A4	

Unit Weights From Lab Data

ID	Depth Range (m)	Specific Gravity (kN/m ³)	Unit Weight (kN/m ³)
18CPT10	Composite (See Note1)	2.79	
18CPT10	1.0-1.5	2.79*	14.2
18CPT10	4.0-4.5	2.79*	13.8
18CPT10	9.0-9.5	2.79*	16.7

$$\gamma = \frac{G_s(1+w)}{1+e} \cdot \gamma_w$$

Notes:

- * Specific Gravity assumed equivalent to composite sample
- Average value of 16.0 kN/m³ adopted for tailings in stability analysis.

Unit Weights Adopted in CPT Interp

Zone:	Soil Behaviour Type:	Estimated Unit Weight (see Lunne et al., 1997)
		Soil Behaviour Type (SBT) Approx. Unit Weight
		SBT Zone Sat Unit Wt (kN/m ³)
1. Sensitive fine grained	5. Clayey silt to silty clay	1 17.5
2. Organic material	6. Sandy silt to clayey silt	2 12.5
3. Clay	7. Silty sand to sandy silt	3 17.5
4. Silty clay to clay	8. Sand to silty sand	4 18
	9. Sand	5 18
	10. Gravelly sand to sand	6 18
	11. Very stiff fine grained*	7 18.5
	12. Sand to clayey sand*	8 19
		9 19.5
		10 20
		11 20.5
		12 19

Typical Range 12.5 to 17.5 for Tailings (SBT 2 to 2.7)


TABLE 1
TESTING PROGRAM - TAILINGS (SLIMES)

ID.	Sample	Depth (m)	Type	Weight (kg) ¹	Tests ³
21318	CPT10 P1	1.0 - 1.5	Piston	~ 2.3	MC, DD, PSD-H & GA
21418	CPT10 P2	4.0 - 4.5	Piston	~ 2.0	MC, DD, PSD-H and PI
21518	CPT10 P4	9.0 - 9.5	Piston	~ 2.1	MC, DD, PSD-H & GA
21618	CPT10 1004	1.5 - 2.0	Bulk	~ 1.5	-
21718	CPT10 1010	4.5 - 5.0	Bulk	~ 1.8	-
21818	CPT10 1020	9.5 - 10.0	Bulk	~ 1.1	-
21918	CPT10 1034	18.0 - 18.5	Bulk	~ 3.1	MC, PSD-H, PI & GA
22018	Composite Tailings (CPT10)			~ 12 ²	SG, PSD-H, PI and RC

Note 1: A single composite sample was made from all the sub samples above, then used for consolidation testing (Rowe Cell)

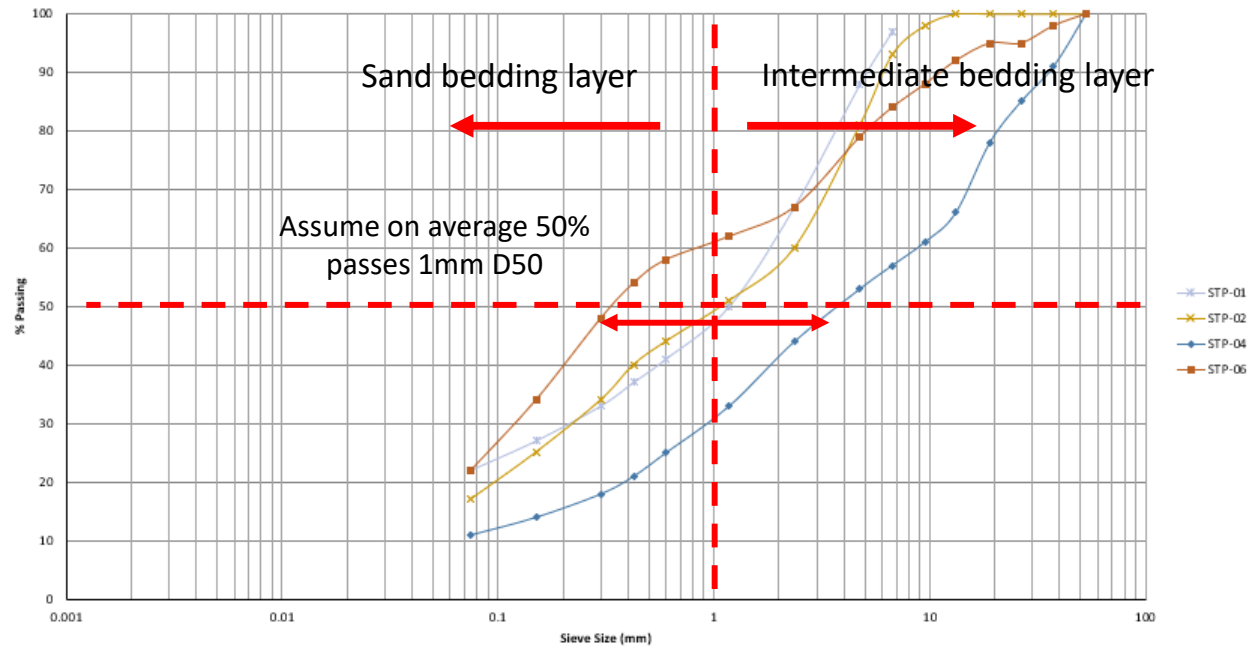
TABLE 3
AS-RECEIVED DRY DENSITY - TAILINGS (SLIMES) & SOILS (PIT RIM)

Register Number	Sample	Depth (m)	Type	In-situ Dry Density (t/m ³)
Tailings (Slimes)				
21318	CPT 10 P1	1.0 - 1.5 m	Piston	0.9
21418	CPT 10 P2	4.0 - 4.5 m	Piston	0.9
21518	CPT 10 P4	9.0 - 9.5 m	Piston	1.1
Soils (Pit Rim)				
19618	DH02 6	2.7 - 3.0	Core	1.9
19918	DH03 18	6.9 - 7.2	Core	2.2

	CLIENT Northern Territory Government		PROJECT Rum Jungle Rehabilitation Stage 2a		
	DRAWN FC	DATE 20/11/2019	TITLE Summary of Intrinsic Soil Parameters		
	CHECKED PD	DATE 20/11/2019			
	SCALE	PROJECT No 680.10421	FIGURE No F.3.4	REV No A4	

Particle Size Distribution
sand BORROW
SLR JULY 2019 Investigation

Sieve Size (mm)	STP-01 0.70 - 1.00m	STP-02 1.40 - 1.60m	STP-04 0.30 - 0.60m	STP-06 0.70 - 1.00m
53	100	100	100	100
37.5	100	100	91	98
26.5	100	100	85	95
19	100	100	78	95
13.2	100	100	66	92
9.5	100	98	61	88
6.7	97	93	57	84
4.75	88	81	53	79
2.36	67	60	44	67
1.18	50	51	33	62
0.6	41	44	25	58
0.425	37	40	21	54
0.3	33	34	18	48
0.15	27	25	14	34
0.075	22	17	11	22

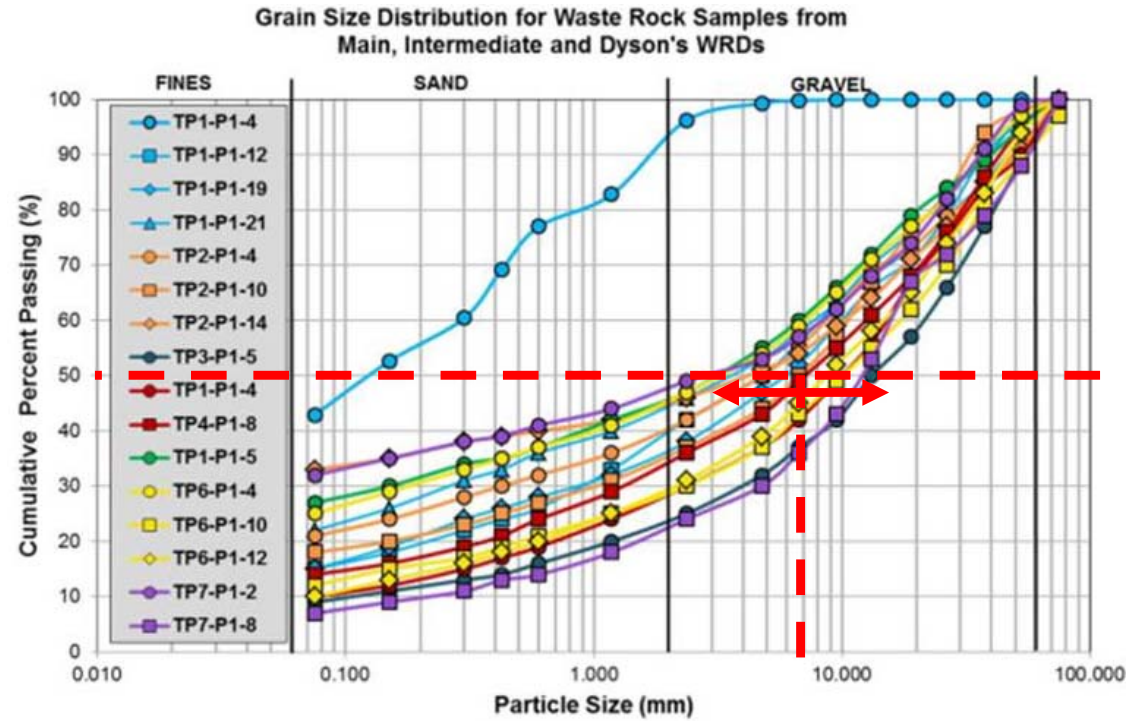


	CLIENT Northern Territory Government		PROJECT Rum Jungle Rehabilitation Stage 2a	
	DRAWN FC	DATE 20/11/2019	TITLE Summary of Sand Borrow Grading	
	CHECKED PD	DATE 20/11/2019		
	SCALE	PROJECT No 680.10421	FIGURE No F.3.5	REV No A4

Figure 4-1. Particle Size Distributions of Waste Rock.

Sample ID	Depth, m	Moisture Content, %	+75 mm fraction, %	-75 mm fraction, %	-75 mm			Classification (-75 mm size fraction)
					Gravel, %	Sand, %	Fines, %	
<i>Main WRD</i>								
TP1-P1-4	3 to 4 m	7	50	50	17	40	43	silty sand with gravel
TP1-P1-12	11 to 12 m	9	15	85	67	18	15	silty gravel with sand
TP1-P1-19	18 to 19 m	9	80	20	68	17	15	silty/clayey gravel with sand
TP1-P1-21	20 to 21 m	13	75	25	60	18	22	clayey gravel with sand
TP2-P1-4	3 to 4 m	11	10	90	64	15	21	silty/clayey gravel with trace sand
TP2-P1-10	9 to 10 m	11	30	70	69	13	18	silty/clayey gravel with trace sand
TP2-P1-14	13 to 14 m	15	20	80	58	9	33	silty/clayey gravel with trace sand
TP3-P1-5	4 to 5 m	8	50	50	80	11	9	gravel with fines and trace sand
<i>Intermediate WRD</i>								
TP4-P1-4	3 to 4 m	6	50	50	76	14	10	gravel with fines and trace sand
TP4-P1-8	7 to 8 m	8	40	60	71	15	14	silty/clayey gravel with trace sand
TP5-P1-5	4 to 5 m	17	5	95	58	15	27	silty/clayey gravel with trace sand
TP7-P1-2	1 to 2 m	15	30	70	56	12	32	silty/clayey gravel with trace sand
TP7-P1-8	7 to 8 m	4	40	60	82	11	7	gravel with fines and trace sand
<i>Dyson's WRD</i>								
TP6-P1-4	3 to 4 m	13	10	90	59	16	25	silty/clayey gravel with sand
TP6-P1-10	9 to 10 m	9	40	60	75	13	12	gravel with fines and trace sand
TP6-P1-12	11 to 12 m	8	40	60	75	15	10	gravel with fines and trace sand

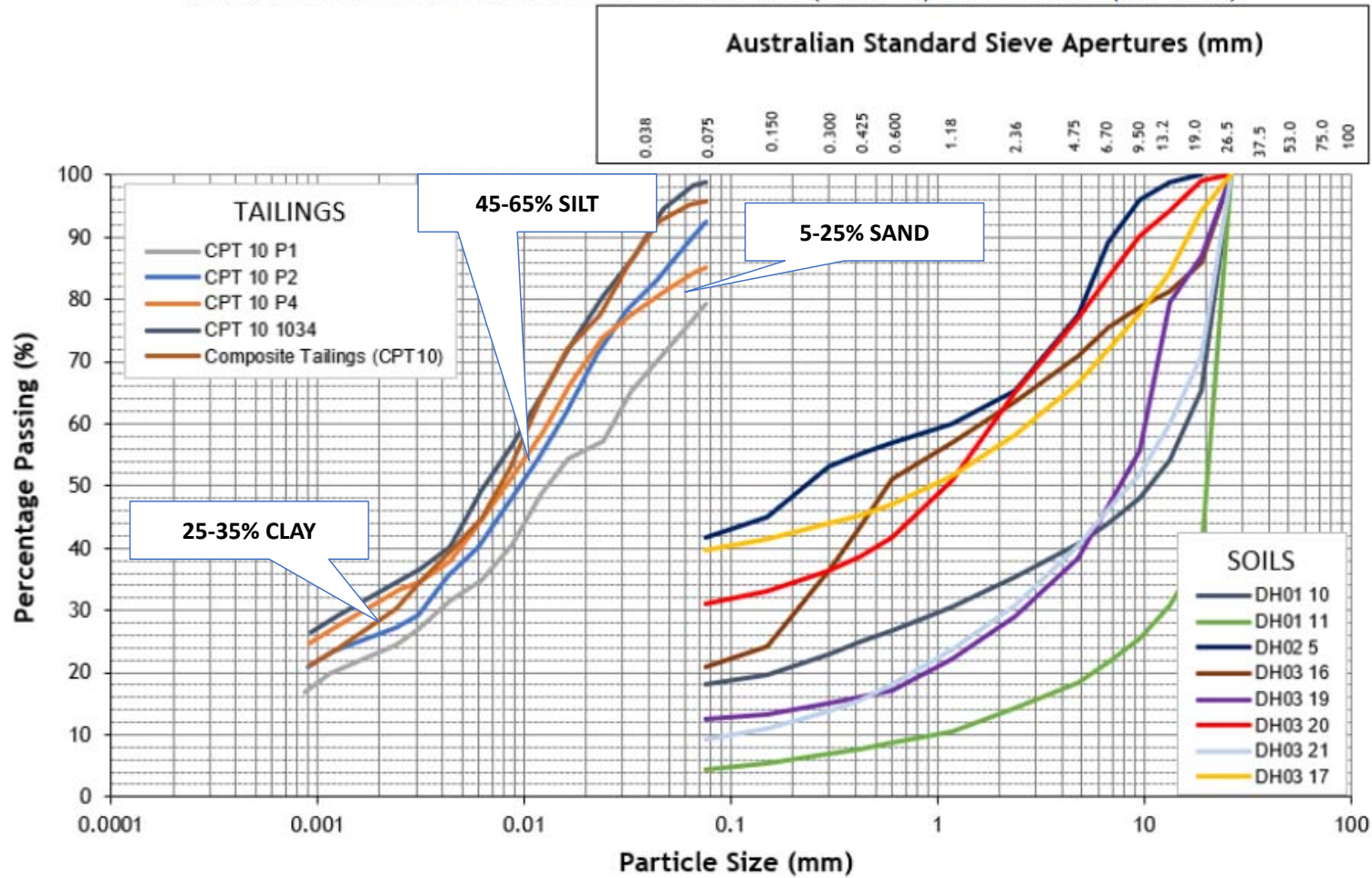
Notes: Gravel (4 to 19 mm), sand (1 to 4 mm) and fines (< 1 mm)



Typical D50 is 6mm i.e. mainly fine-med gravel

	CLIENT Northern Territory Government		PROJECT Rum Jungle Rehabilitation Stage 2a	
	DRAWN FC	DATE 20/11/2019	TITLE Summary of Waste Rock Grading	
	CHECKED PD	DATE 20/11/2019		
	SCALE	PROJECT No 680.10421	FIGURE No F.3.6	REV No A4

PLATE 2 PARTICLE SIZE DISTRIBUTIONS - TAILINGS (SLIMES) AND SOILS (PIT RIM)



CLAY	SILT			SAND			GRAVEL			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.06	0.2	0.6	2	6	20	60

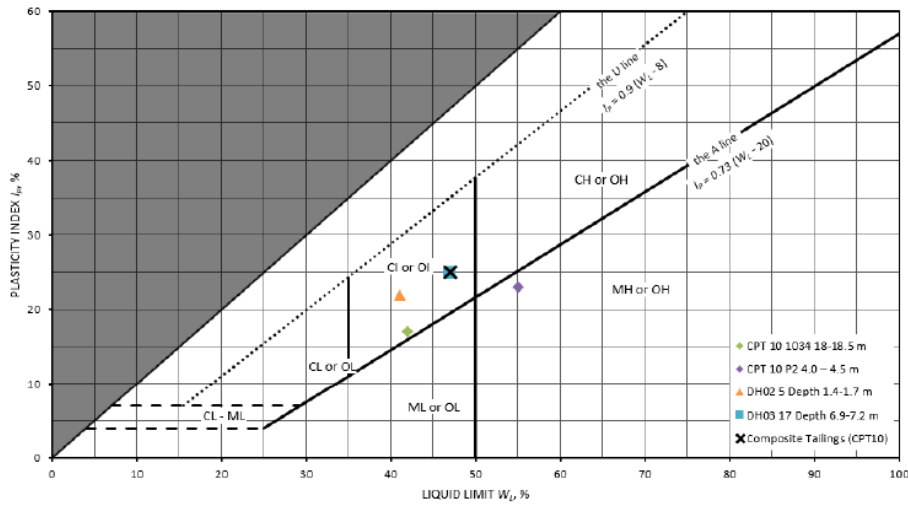
	CLIENT Northern Territory Government		PROJECT Rum Jungle Rehabilitation Stage 2a		
	DRAWN FC	DATE 20/11/2019	TITLE Summary of Tailings Grading		
	CHECKED PD	DATE 20/11/2019			
	SCALE	PROJECT No 680.10421	FIGURE No F.3.7	REV No A4	

Parameter Plots – Tailings

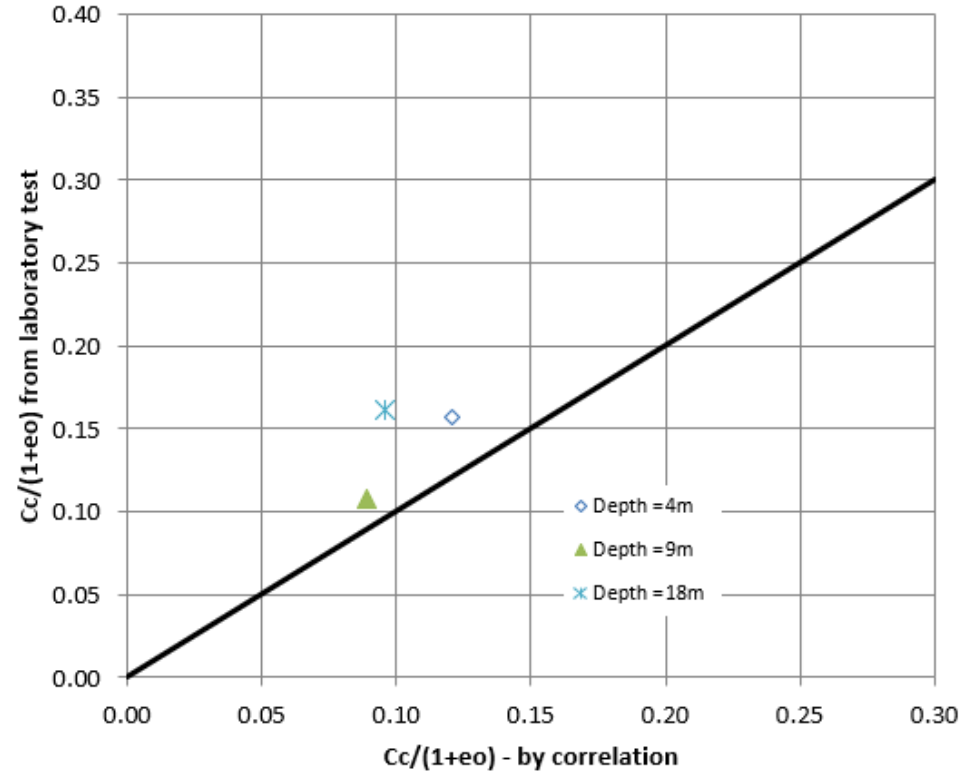
TABLE 5
ATTERBERG LIMITS - TAILINGS (SLIMES) AND SOILS (PIT RIM)

ID.	Sample Description	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Category
Tailings (Slimes)					
21418	CPT 10 P2 4.0 - 4.5 m	55	32	23	MH (High Plasticity Silt)
21918	CPT 10 1034 18-18.5 m	42	25	17	CI (Intermediate Plasticity Clay)
22018	Composite Tailings (CPT10)	45	27	18	CI (Intermediate Plasticity Clay)
Soils (Pit Rim)					
19518	DH02 5 Depth 1.4-1.7 m	41	19	22	CI (Intermediate Plasticity Clay)
19818	DH03 17 Depth 6.9-7.2 m	47	22	25	CI (Intermediate Plasticity Clay)

PLATE 3
ATTERBERG LIMITS - TAILINGS (SLIMES) AND SOILS (PIT RIM)

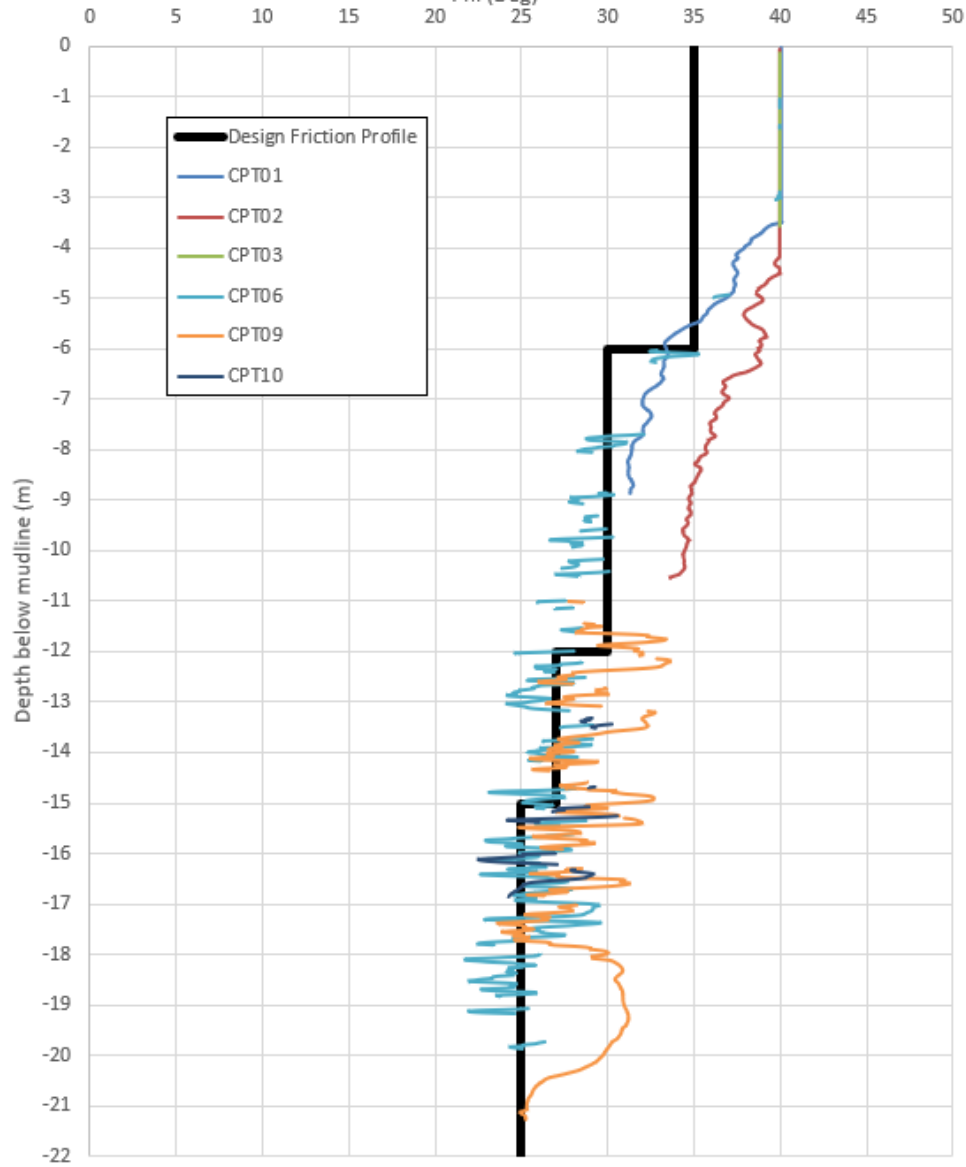


Cc/(1+eo) Correlation Vs Laboratory - Rum Jungle

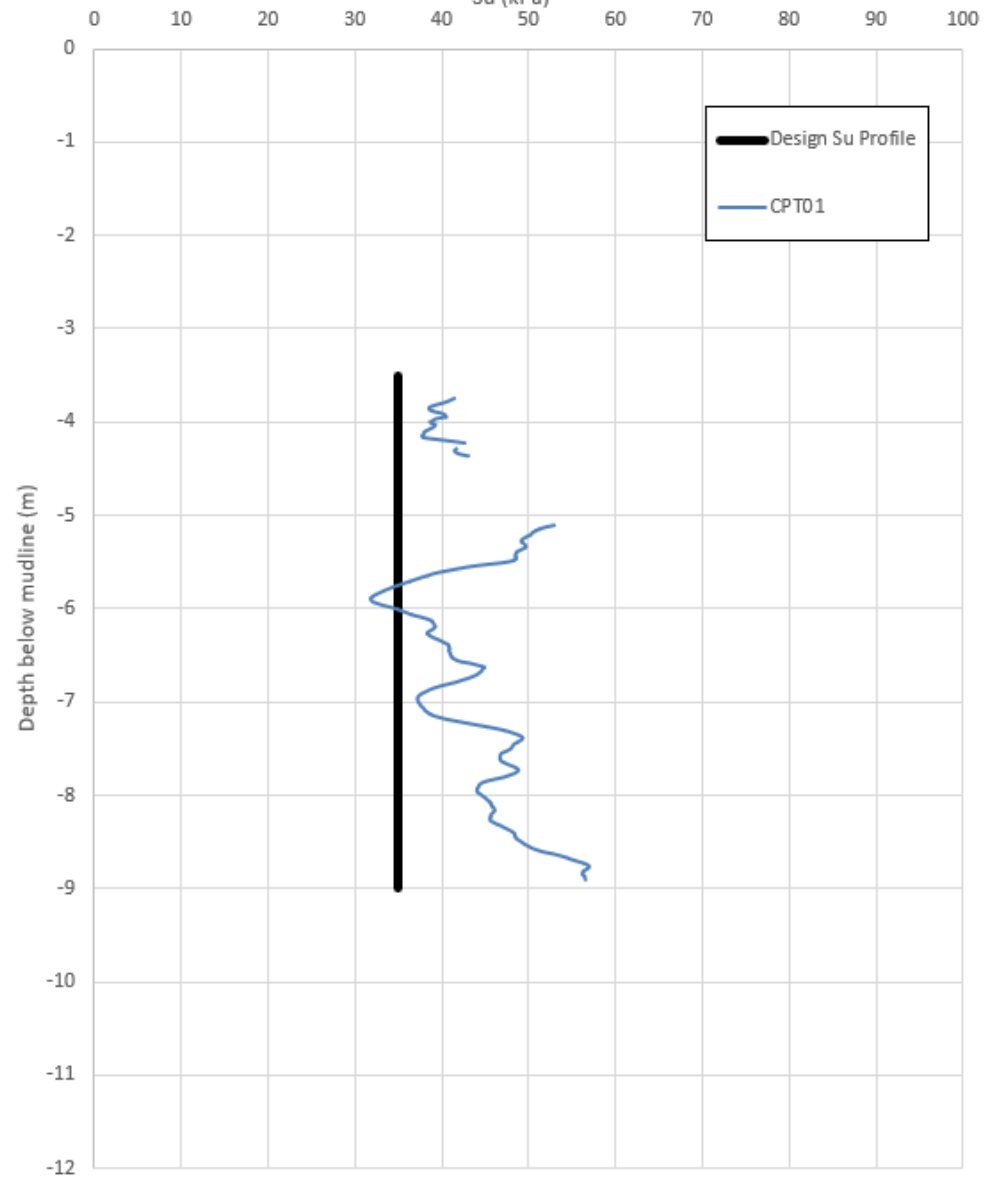


	CLIENT Northern Territory Government		PROJECT Rum Jungle Rehabilitation Stage 2a	
	DRAWN FC	DATE 20/11/2019	TITLE Tailings Plasticity and Consolidation	
	CHECKED PD	DATE 20/11/2019		
	SCALE	PROJECT No 680.10421	FIGURE No F.3.8	REV No A4

Unit SB-G Fill
Friction Angle
Phi (Deg)



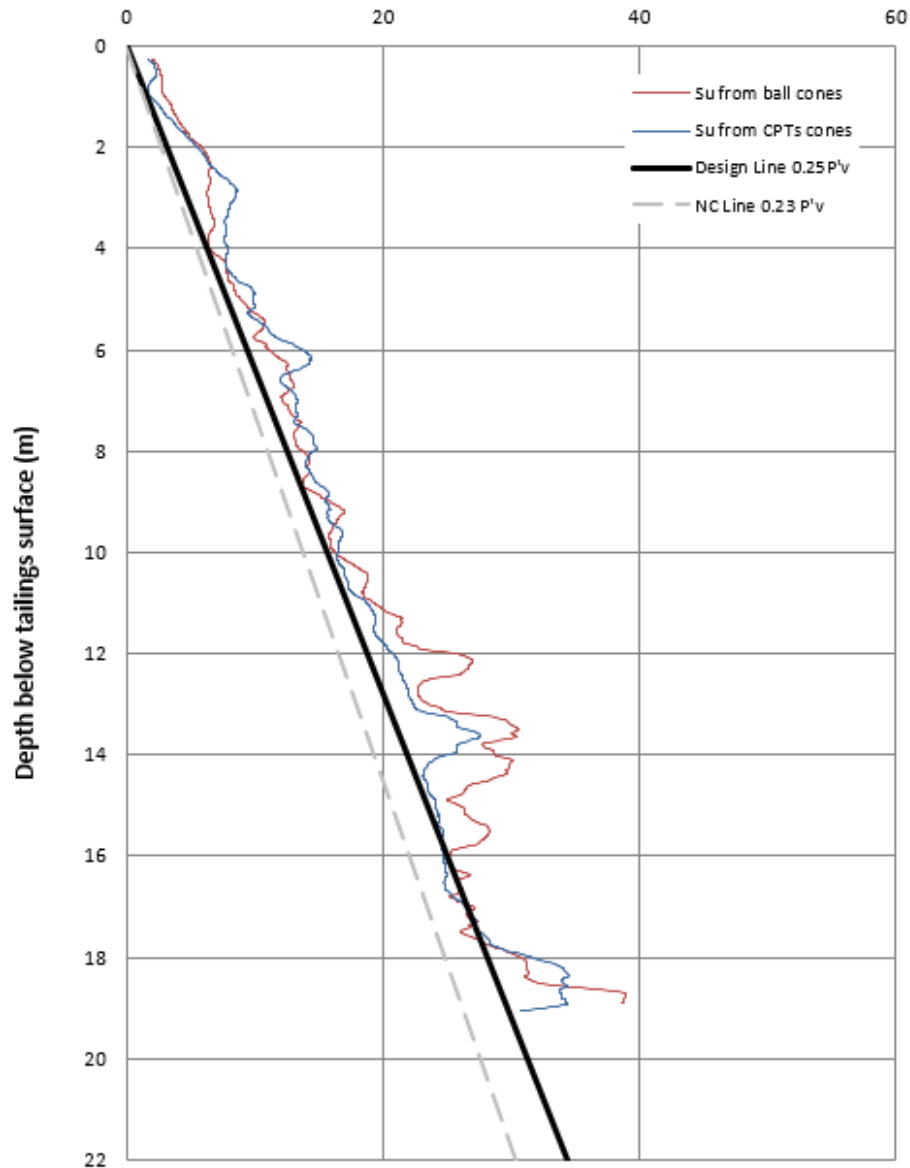
Unit SB-C Fill
Undrained Shear Strength (kPa)
Su (kPa)



CLIENT Northern Territory Government		PROJECT Rum Jungle Rehabilitation Stage 2a	
DRAWN FC	DATE 20/11/2019	TITLE Soil/Beach Deposits Strength Parameters	
CHECKED PD	DATE 20/11/2019	PROJECT No 680.10421	FIGURE No F.3.9
SCALE		REV No A4	

Parameter Plots – Tailings

Average Undrained Shear Strength Rolling 0.5m average (kPa)
 N_{Ball}=10, N_{kt}*=13 to 18



References/Correlations:

1. C_c correlation with Atterberg Limits: Average of values proposed by Terzaghi and Peck(1967) and Nagaraj and Srinivasa (1985,1986) (Refer Table 2-5 Bowles, 2005)
2. $C_a=0.025 C_c$: calibrated using consolidation test results (Mesri et al.,1990)
3. C_v correlated to LL taken from NAVFAC Design Manual DM-7, 1971.
4. $C_h/C_v=2$ is assumed to estimate C_h using consolidation lab results or correlation to LL.
5. **Overconsolidation Ratio, OCR ::**

$$k_{OCR} = \left[\frac{Q_{tn}^{0.20}}{0.25 \cdot (10.50 \cdot +7 \cdot \log(F_r))} \right]^{-1.25} \text{ or user defined}$$


$$OCR = k_{OCR} \cdot Q_{tn}$$

Robertson, P.K. (2009) Interpretation of Cone Penetration Tests – a unified approach. Can. Geotech. Journal 46 (11): 1337-1355.

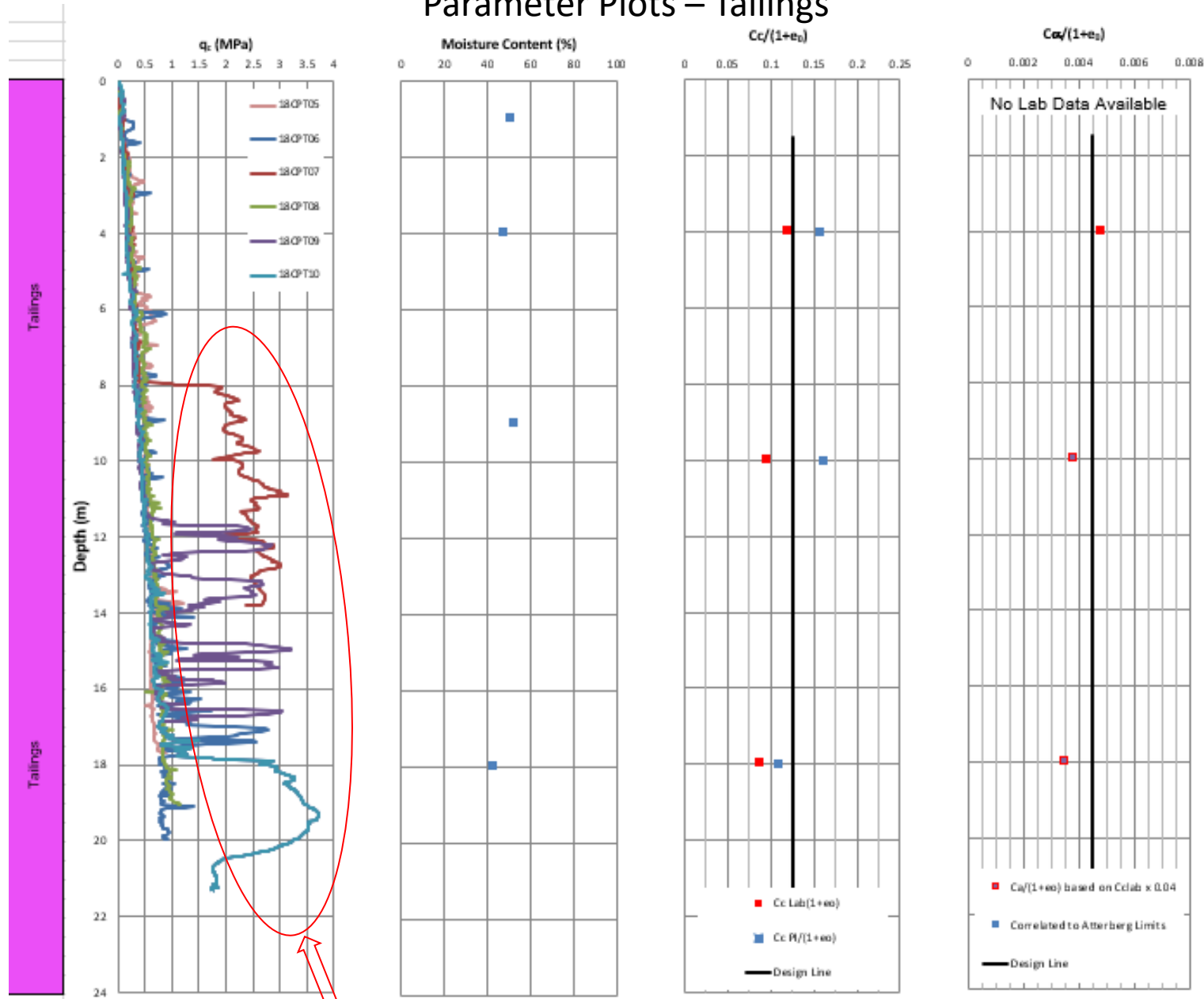
6. Undrained shear strength, S_u (Robertson, 2009):

$$S_u = \frac{(q_t - \sigma_v)}{N_{kt}}$$

In absence of shear vane or triaxial shear strength data, N_{kt} for cone has been derived by matching CPT shear strength to Ball cone assuming:
 $N_{ball} = 10$ (Typ range 10 to 13) – to give near-normally consolidated strength profile
 N_{kt} varies from 13.5 to 18 to match ball interpretation

	CLIENT Northern Territory Government		PROJECT Rum Jungle Rehabilitation Stage 2a		
	DRAWN FC	DATE 20/11/2019	TITLE Tailings Strength Parameter Summary		
	CHECKED PD	DATE 20/11/2019			
	SCALE		PROJECT No 680.10421	FIGURE No F.3.10	REV No A4

Parameter Plots – Tailings



Interbedded deposits of granular backfill – inferred to be washed-in fluvial deposits and debris flows of unit SB-G sand



CLIENT Northern Territory Government		PROJECT Rum Jungle Rehabilitation Stage 2a	
DRAWN FC	DATE 20/11/2019	TITLE Tailing Parameter Plot Summary – Part 1	
CHECKED PD	DATE 20/11/2019	PROJECT No 680.10421	FIGURE No F.3.11
SCALE		REV No A4	

Project: Rum Jungle

Location: NT

Overlay basic interpretation plots

