ANNEXURE 13

River Bank Stability – Slope Stability Assessment

South-east Container Storage Area

prepared by

GHD

22, 24, 171 and 220
Bolong Road, Bomaderry

28 May 2018

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Our ref: 2316306-88028
Your ref:

Dear Sir

River Bank Stability
Slope Stability Assessment, South-East Container Storage Area, Manildra Plant, Bolong Road, Bomaderry

1 Introduction

Manildra Group Pty Ltd (Manildra) was previously granted Project Approval (MP06_0228, dated 28 January 2009) by the Minister of Planning for the proposed Shoalhaven Starches Expansion project which encapsulated previous approvals for the general site.

The proposed development includes the south-east container storage area close to the river bank. Manildra requested that GHD provide a slope stability assessment of the stability of the northern bank of the Shoalhaven River at this location based on various loading scenarios and an assumed river bank profile. The position of the container storage area is shown in Figure 1 attached. It is noted that a recent survey of the river bank and bed profile was not available for this analysis, and therefore we have assumed an approximate profile based on surveyed nearby river bed profiles.

2 Scope of work

The proposed slope stability analysis was be based on variable loading scenarios, one assumed river bank profile and ground condition inferred from the nearest engineering borehole data. Our proposed scope of work for the slope stability analysis included the following:

- Review of existing subsurface information, including geotechnical reports in the vicinity of the current container storage area
- Provide an analysis of river bank slope stability (using the software program Slope/W) for the container storage area
- Provide geotechnical advice in relation to setback and loading within the container storage area to the northern bank of Shoalhaven River

3 Methodology

The slope stability analysis has been conducted using Slope/W (GeoStudio 2012, version 8.15.3.11339) and adopting the Morgenstern – Price method of stability analysis. The analysis was carried out based on the following methodology:

- Develop the analysis geometry based on the available information in vicinity of current area
- Develop the geological model and geotechnical parameters based on our interpretation of previous geotechnical investigations carried out by Coffey and more recently by GHD
- Perform the analysis iterations and assess factor of safety based on both rapid drawdown and normal groundwater conditions
- Assume a metastable condition (ie, FoS close to unity) existed during rapid drawdown scenario

4 Assumptions

Assumptions made in undertaking the slope stability analyses are as follows:

1. Loading of the container storage area is based on the container storage configuration provided by Manildra for the maximum loading arrangement. Also the assumed maximum mass for each container is 23.1 tonnes and container dimensions are 6m long x 2.4m wide, as provided by Manildra.
2. Container storage area is setback 2.5m from top of river bank. The assumed pavement thickness is 200mm overlying 1.5m of medium dense fill.
3. A maximum vertical surcharge of 50 kPa was calculated and applied for the stability calculations, to represent the maximum load condition comprising six rows of containers stacked three high. Additional scenarios comprising vertical surcharge of 33 kPa and 17 kPa were also considered based on containers stacked 2 high and 1 high, respectively.
4. The flooding scenario followed by rapid drawdown transient loads are based on raised river level during a flood event (last 5 years) as provided by Manildra. This scenario assumes that the water level within the soil matrix remains at a higher elevation while the river water level has reduced to its average water level.
5. If the river bank profile changes eg. by undercutting or steeper below water profile occurs, or loss of vegetation occurs then the stability of the bank should be re-assessed.

5 Results

The results of the stability analyses undertaken are summarised in Table 1 below, including resulting Factors of Safety (FOS) for a range of groundwater and loading scenarios analysed.

Table 1: Summary of slope stability analyses

Scenario No.	Groundwater condition	Loading configuration	FOS
1	Rapid drawdown	Existing bank geometry with 6 rows x 3 containers high with setback approx. 2.5m from top of bank	1.03
2	Rapid drawdown	5 rows x 2 containers high setback approx. 5m from top of bank	1.23
3	Rapid drawdown	4 rows x 2 containers high setback approx. 7.5m from top of bank	1.27
4	Rapid drawdown	4 rows x 1 container high setback approx. 7.5m from top of bank	1.45
5	Normal condition	Existing bank geometry with 6 rows x 3 containers high setback approx. 2.5m from top of bank fence	1.03
6	Normal condition	5 rows x 2 containers high setback approx. 5m from top of bank	1.23
7	Normal condition	4 rows x 2 containers high setback approx. 7.5m from top of bank	1.26
8	Normal condition	4 rows x 1 container high setback approx. 7.5m from top of bank	1.45

6 Conclusions

The analyses show that the failure scenarios are driven by the container loading and that the groundwater level changes based on the most recent flood event result in little or no change to the factor of safety.

If containers are to be stored in the current south-eastern area over the short term (ie. up to about 3 months) then a FOS of 1.3 should apply. For this case, we recommend that the containers be setback at least 7.5m from top of river bank and stacked no higher or wider than as described in Scenario 7.

If containers are to be stored in the current south-eastern area over the longer term (ie. greater than 3months) then a FOS of 1.5 should apply. For this case, we recommend that the containers be setback at least 7.5m from top of river bank and be stacked no higher or wider than as described in Scenario 8.

The analyses are based on the assumptions outlined above. If any aspects of the assumptions made are incorrect or changes occur to the current site conditions then GHD should be notified and the analysis should be re-assessed.

7 Limitations

This report: has been prepared by GHD for Manildra and may only be used and relied on by Manildra for the purpose agreed between GHD and the Manildra as set out in Section 1 of this report. GHD otherwise disclaims responsibility to any person other than Manildra arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report. The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

Sincerely
GHD

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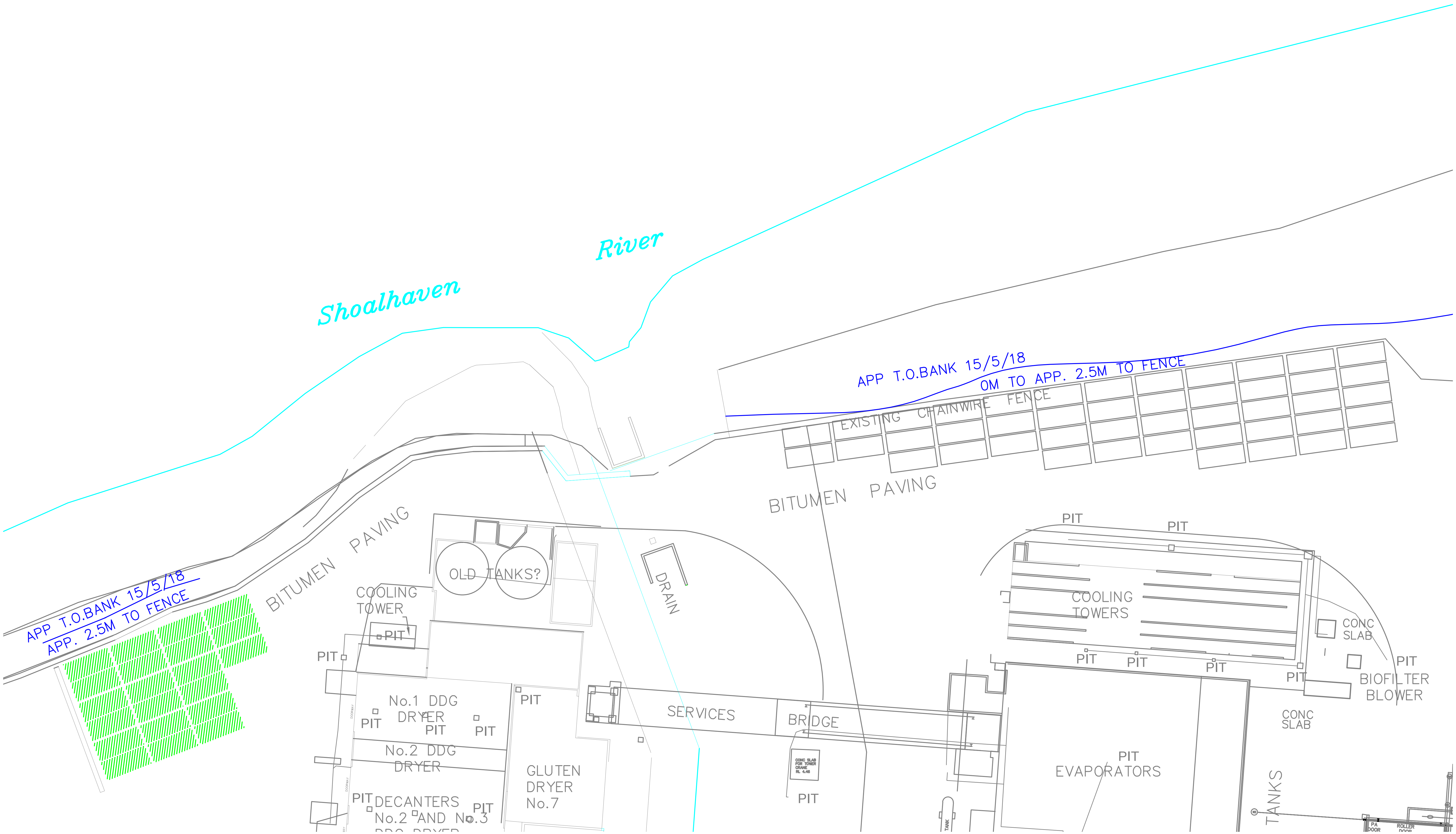
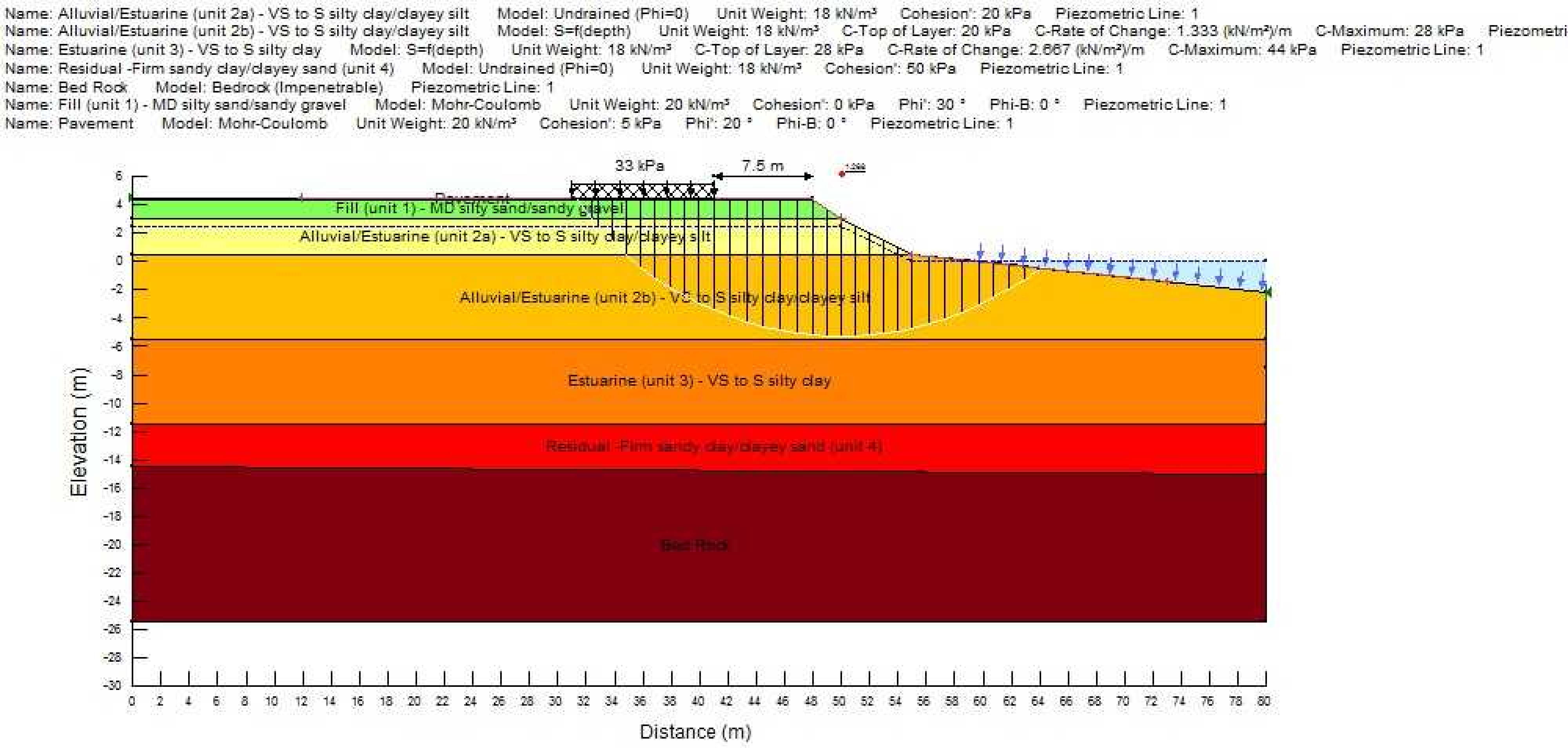
Attachments

Figure 1 – Site Plan

Slope stability analyses scenarios 7 and 8


Shoalhaven
River
APP T.O.BANK 15/5/18
0M TO APP. 2.5M TO FENCE
EXISTING CHAINWIRE FENCE
BITUMEN PAVING
APP T.O.BANK 15/5/18
APP. 2.5M TO FENCE
BITUMEN PAVING
OLD TANKS?
COOLING TOWER
PIT
DRAIN
PIT
COOLING TOWERS
CONC SLAB
BIOFILTER BLOWER
No.1 DDG DRYER
No.2 DDG DRYER
GLUTEN DRYER No.7
SERVICES
BRIDGE
EVAPORATORS
TANKS
DECANTERS No.2 AND No.3



Name: Alluvial/Estuarine (unit 2a) - VS to S silty clay/clayey silt Model: Undrained (Phi=0) Unit Weight: 18 kN/m³ Cohesion': 20 kPa Piezometric Line: 1
Name: Alluvial/Estuarine (unit 2b) - VS to S silty clay/clayey silt Model: S=f(depth) Unit Weight: 18 kN/m³ C-Top of Layer: 20 kPa C-Rate of Change: 1.333 (kN/m²)/m C-Maximum: 28 kPa Piezometri
Name: Estuarine (unit 3) - VS to S silty clay Model: S=f(depth) Unit Weight: 18 kN/m³ C-Top of Layer: 28 kPa C-Rate of Change: 2.667 (kN/m²)/m C-Maximum: 44 kPa Piezometric Line: 1
Name: Residual -Firm sandy clay/clayey sand (unit 4) Model: Undrained (Phi=0) Unit Weight: 18 kN/m³ Cohesion': 50 kPa Piezometric Line: 1
Name: Bed Rock Model: Bedrock (Impenetrable) Piezometric Line: 1
Name: Fill (unit 1) - MD silty sand/sandy gravel Model: Mohr-Coulomb Unit Weight: 20 kN/m³ Cohesion': 0 kPa Phi': 30 ° Phi-B: 0 ° Piezometric Line: 1
Name: Pavement Model: Mohr-Coulomb Unit Weight: 20 kN/m³ Cohesion': 5 kPa Phi': 20 ° Phi-B: 0 ° Piezometric Line: 1
33 kPa
7.5 m
Pavement
Fill (unit 1) - MD silty sand/sandy gravel
Alluvial/Estuarine (unit 2a) - VS to S silty clay/clayey silt
Alluvial/Estuarine (unit 2b) - VS to S silty clay/clayey silt
Estuarine (unit 3) - VS to S silty clay
Residual -Firm sandy clay/clayey sand (unit 4)
Bed Rock
Elevation (m)
Distance (m)
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80

Name: Alluvial/Estuarine (unit 2a) - VS to S silty clay/clayey silt Model: Undrained (Phi=0) Unit Weight: 18 kN/m³ Cohesion': 20 kPa Piezometric Line: 1
Name: Alluvial/Estuarine (unit 2b) - VS to S silty clay/clayey silt Model: S=f(depth) Unit Weight: 18 kN/m³ C-Top of Layer: 20 kPa C-Rate of Change: 1.333 (kN/m²)/m C-Maximum: 28 kPa Piezometri
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Name: Fill (unit 1) - MD silty sand/sandy gravel Model: Mohr-Coulomb Unit Weight: 20 kN/m³ Cohesion': 0 kPa Phi': 30 ° Phi-B: 0 ° Piezometric Line: 1
Name: Pavement Model: Mohr-Coulomb Unit Weight: 20 kN/m³ Cohesion': 5 kPa Phi': 20 ° Phi-B: 0 ° Piezometric Line: 1