

MEMORANDUM

To:	Venturex Resources Limited	Date:	26 June 2018
Attn:	Emma Bamforth	Our Ref:	PE18-00601
		KP File Ref.:	PE801-00300/05-A dss M18005
cc:		From:	Dean Sawyer/Peter Veld

RE: SULPHUR SPRINGS PROJECT – TAILINGS PHYSICAL TESTING

1. INTRODUCTION

Knight Piésold Pty Ltd (KP) has been engaged by Venturex Resources Limited (Venturex) to undertake the preliminary design of the Tailings Storage Facility (TSF) for the Sulphur Springs Project in Western Australia. As part of the study, two tailings samples were generated for testing in order to determine density and water release characteristics for the TSF design.

2. SAMPLES DESCRIPTION AND TESTING

The metallurgical assessment for the Sulphur Springs orebody is being undertaken by Lycopodium Minerals Pty Ltd (Lycopodium). The following information was provided by Lycopodium regarding the physical properties for the two tailings samples:

- Copper and zinc transition composites for bulk flotation;
- Target grid size is 63 µm;
- Copper Transition Composite target %solids w/w = 55%;
- Zinc Transition Composite target %solids w/w = 50%; and
- Transition ore representative of first 2.5 years of production.

The samples were generated by ALS Metallurgy on behalf of Venturex and sent to the KP laboratory in Perth in June 2018. The samples arrived in slurry form and were labelled as “A18701 Bulk #1 Zn CT + Rotail” and “A18701 Bulk #2 Cu CT + Rotail” and are referred to as Zn Tails and Cu Tails respectively, for the purposes of this memorandum.

The samples were received at approximately 60% and 54% w/w solids respectively. The samples were modified in order to achieve the target of 50% w/w solids for the Zn Tails and 55% w/w solids for the Cu Tails as instructed by Lycopodium.

The following tests were carried out on the samples:

- i. Classification tests to determine:
 - Particle size distribution of the tailings;
 - Supernatant liquor density and pH;
 - Tailings solids particle density; and
 - Atterberg limits of the tailings solids.
- ii. Undrained and drained sedimentation tests;
- iii. Air drying tests;
- iv. Permeability tests; and
- v. High strain consolidation tests.

During laboratory testing it is KP's normal practice to duplicate each test as a means to verify the consistency of the test results. The results of each individual test are plotted on the corresponding figures. The interpreted mean values are provided in the tables and text of the document. Geochemical tests were also conducted and presented in a separate memorandum.

3. PHYSICAL TESTING

The following section discusses the physical testing results for the Zn Tails and Cu Tails. Predicted tailings behaviour is discussed in Section 4; however, it should be noted that field results are also dependent on the facility area, deposition strategy, pond size and height of the storage facility, climatic conditions at site blending of samples, and operating parameters of the processing plant.

3.1 CLASSIFICATION TESTING

Classification testing of the Zn Tails and Cu Tails were completed by Trilab in Perth. Where appropriate, classification tests were conducted in accordance with relevant Australian Standards. The results of the classification tests for the samples and relevant Australian Standards are summarised in Table 3.1. The Trilab laboratory test reports for the samples are presented in Appendix A.

Table 3.1: Classification testing – results and relevant standards

Test	Zn Tails	Cu Tails	AS1289
Solids Particle Density (t/m ³)	3.72	3.53	3.5.1
Supernatant Density (t/m ³)	1.001	1.001	(hydrometer)
Supernatant pH	8.0	7.6	(pH meter)
Liquid Limit (%)	N.O.	N.O.	3.1.2
Plastic Limit (%)	N.P.	N.P.	3.2.1
Plasticity Index (%)	N.P.	N.P.	3.3.1
Linear Shrinkage (%)	N.O.	N.O.	3.4.1

Note: N.O. = Not obtainable; N.P. = Non-plastic

The particle size distribution analysis for the Zn Tails and Cu Tails were completed in accordance with AS1289 3.6.1 and AS1289 3.6.3. The measured particle size distributions are presented in Table 3.2 and the grading curves for the samples are shown in Figure 3.1.

Table 3.2: Particle size distribution

		Zn Tails	Cu Tails
Fraction	Particle Size (µm)	Percent Passing (%)	Percent Passing (%)
Sand	600	100	100
	200	100	100
Silt	75	96	86
	20	43	38
	6	16	18
Clay	2	6	9

The Zn Tails consisted of 4% sand, 90% silt and 6% clay. The testing indicates that the material is non-plastic SILT with trace sand and clay, and would be classified as ML in accordance with the Geotechnical Site Investigation Standard, AS1726-2017. The sample P₈₀ is approximately 58 µm.

The Cu Tails consisted of 14% sand, 77% silt and 9% clay. The testing indicates that the material is non-plastic SILT with sand and clay, and would be classified as ML in accordance with the Geotechnical Site Investigation Standard, AS1726-2017. The sample P₈₀ is approximately 68 µm.

The grading curve indicates that both the samples fall inside the boundary of potentially liquefiable tailings samples and therefore liquefaction of the tailings should be considered in design.

3.2 SEDIMENTATION TEST

Drained and undrained sedimentation tests were carried out to determine the settling rate, volume of supernatant, and settled dry density of the tailings.

In the undrained sedimentation test tailings slurry is allowed to settle in a measuring cylinder. This is equivalent to the deposition of tailings underwater. The results indicate the expected rate and quantity of supernatant release and enable the minimum expected dry density of the tailings to be determined.

In the drained sedimentation test, tailings slurry is allowed to settle and drain in a cylinder with a fine sand filter drain at the base. This simulates the deposition of tailings where both settling and free drainage can occur. The results indicate the relative quantities of supernatant and underdrainage released by the settling slurry and enables the dry density of the drained tailings to be determined. The underdrainage values are maximum values, as the drainage layer is free-draining without back pressure and the tailings is deposited directly over the drainage medium.

The results of the sedimentation tests are presented in figures 3.2 and 3.3. Table 3.3 presents a summary of the measured sedimentation test data.

Table 3.3: Sedimentation test results

	Test	Initial Solids (%)	Supernatant (% of initial water volume)	Underdrainage (% of initial water volume)	Time to Achieve 90% final Density (days)	Time to Achieve Final Density (days)	Final Dry Density (t/m ³)	Final Void Ratio	Figure
Zn Tails	Undrained	50	66	-	<0.1	0.1	1.64	1.27	3.2
	Drained	49	55	16	0.2	0.3	1.74	1.14	3.3
Cu Tails	Undrained	53	54	-	0.3	0.9	1.44	1.44	3.2
	Drained	53	45	19	0.9	2.3	1.70	1.07	3.3

The tests indicate that the Zn Tails will settle very rapidly with complete settlement taking only a few hours. The sample released approximately 66% of water in slurry to supernatant in the undrained test, reducing to 55% in the drained test. The sample achieved high absolute dry densities from settlement before air drying or consolidation. For high SG tailings the final void ratio indicates the samples showed moderate to good settling characteristics.

The tests indicate that the Cu Tails will settle rapidly with complete settlement taking about a day. The sample released approximately 54% of water in slurry to supernatant in the undrained test, reducing to 45% for the drained test. The sample achieved high

absolute dry densities from settlement before air drying or consolidation. For high SG tailings the final void ratio indicates the samples showed moderate to good settling characteristics.

3.3 AIR DRYING TESTS

Air drying tests were carried out on slurry samples to determine the effect of natural drying of the tailings after initial settling and removal of supernatant liquor, thereby simulating conditions expected following sub-aerial deposition. Continuous monitoring of the weight and volume of each specimen was carried out in order to quantify the relationship between dry density, moisture content, volumetric change and the degree of saturation of the tailings against a measured evaporation rate.

A direct relationship exists between dry density and moisture content up to a breakaway point, at which the degree of saturation falls below 100%. At this point negative pore water pressures are developed, which further consolidates the tailings. Drying below a limiting saturation produces no further consolidation, and the density at this point represents the maximum that can be achieved via air drying of the tailings.

The results of the air drying tests are presented in figures 3.4 to 3.7, and are summarised in Table 3.4.

Table 3.4: Results of air drying tests

	Moisture Content at Breakaway Point (%MC)	Dry Density at Breakaway Point (t/m ³)	Limiting Saturation Value (%Sat)	Final Dry Density (t/m ³)	Figures
Zn Tails	65	1.3	50	2.15	3.4, 3.5
Cu Tails	22	2.01	40	2.15	3.6, 3.7

The Zn Tails achieved a maximum dry density from air drying of 2.15 t/m³ taking 4 - 5 days at an average evaporation rate of 9.7 mm/day (approximately 40 to 50 mm of total evaporation). This is an increase of 24% over the density achieved in the drained sedimentation test. The dry density is high with a void ratio of approximately 0.73. This is in the lower end of the normal void ratio range for laboratory air dried tailings.

The Cu Tails achieved a maximum dry density from air drying of 2.15 t/m³ taking 5 - 6 days at an average evaporation rate of 9.6 mm/day (approximately 45 - 55 mm of total evaporation). This is an increase of 26% over the density achieved in the drained sedimentation test. The dry density is high with a void ratio of approximately 0.65. This is in the lower end of the normal void ratio range for laboratory air dried tailings.

3.4 CONSOLIDATION TESTS

The consolidation of the tailings can be quantified in terms of the compression index C_c and the coefficient of consolidation C_v . The compression index relates the void ratio or tailings density to the effective stress of the tailings samples. The larger the value of C_c , the more compressible the tailings are. The coefficient of consolidation defines the rate of excess pore water dissipation, and hence the rate of increase in effective stress within the tailings. Higher values of C_v indicate more rapid consolidation of the samples.

The void ratio and dry density relative to the stress condition is presented in figures 3.8 and 3.9 and the results of the consolidation tests are summarised in Table 3.5.

Table 3.5: Consolidation test results

	Void Ratio	Dry Density (t/m ³)	Stress Range (kPa)	Coeff. of Consolidation, C _v (m ² /year)	Coeff. of Volume Decrease, M _v (m ² /kN)	Comp. Index, C _c
Zn Tails	1.29 – 1.11	1.63 – 1.76	1.89 - 5.27	112	0.023	0.396
Cu Tails	1.43 – 1.23	1.45 – 1.58	1.94 - 5.22	23	0.025	0.462

The results indicate that the Zn Tails has moderately high compressibility and will consolidate quickly with loading.

The results indicate that the Cu Tails has high compressibility and will consolidate moderately quickly with loading.

3.5 PERMEABILITY TESTS

Falling head permeability tests were completed on saturated tailings samples, with drainage through the drained sedimentation samples being measured. In addition, permeability values were derived from the results of the consolidation tests. Measured permeability data are summarised in Table 3.6 and presented in figures 3.8 and 3.9.

Table 3.6: Permeability test results

	Test Type	Void Ratio	Dry Density (t/m ³)	Permeability (m/s)
Zn Tails	Falling Head	1.15	1.73	5.6 x 10 ⁻⁷
		1.12	1.75	5.7 x 10 ⁻⁷
	Consolidation Test	1.25	1.65	1.5 x 10 ⁻⁵
		1.19	1.70	2.1 x 10 ⁻⁶
		1.11	1.76	6.3 x 10 ⁻⁷
Cu Tails	Falling Head	1.13	1.66	1.9 x 10 ⁻⁷
		1.02	1.75	1.9 x 10 ⁻⁷
	Consolidation Test	1.42	1.46	8.2 x 10 ⁻⁶
		1.34	1.51	5.4 x 10 ⁻⁷
		1.23	1.58	1.9 x 10 ⁻⁷

The Zn Tails results represent the vertical permeability of saturated settled tailings but no significant desiccation and indicate the tailings has relatively high permeability. In the range of expected settled densities, the vertical permeability is approximately 5 x 10⁻⁷ m/s.

The Cu Tails results represent the vertical permeability of saturated settled tailings but no significant desiccation and indicate the permeability of Cu Tails is slightly lower than Zn Tails. In the range of expected settled densities, the vertical permeability is approximately 2 x 10⁻⁷ m/s.

4. INTERPRETATION OF RESULTS

The discharge percent solids has been nominated at around 50% w/w solids for Zn Tails and around 55% w/w solids for Cu Tails during the initial phase of the operation. It should be noted that field results are also dependent on the processing plant operation, and the layout and design of the TSF. The interpretation of the test results provided herein is based on the target operating percent solids.

4.1 WATER PRODUCTION

The release of supernatant/underdrainage following deposition can be estimated based on the climatic conditions, particle size distribution and permeability of the tailings, and the results of the undrained and drained sedimentation tests. The rate of supernatant release will also affect the potential decant recovery.

The testing indicated that the rate of supernatant release for the Zn Tails was quick, with the majority of water released in under a day. The expected water release would be around 55 – 65% of the water in slurry, not accounting for rainfall and evaporation but considering the loss of water to re-saturate lower tailings layers.

Comparatively, the testing indicated that the rate of supernatant release for the Cu Tails was also relatively quick but slower than the Zn Tails, with the majority of water released in 1 - 2 days. The expected water release would be around 45 – 55% of the water in slurry, not accounting for rainfall and evaporation but considering the loss of water to re-saturate lower tailings layers.

4.2 TAILINGS DENSITY

The settled dry density deposited into a tailings storage facility can be predicted from the laboratory test work, facility design and site climatic conditions. It has been observed over a number of years that densities achieved in the field are generally lower than those obtained in the laboratory. In addition, field densities achieved are dependent on the area available for drying and the thickness of deposited layers.

The tests provided final dry density values as follows:

Zn Tails

- | | |
|-------------------|-------------------------|
| • Undrained test | 1.64 t/m ³ . |
| • Drained test | 1.74 t/m ³ . |
| • Air drying test | 2.15 t/m ³ . |

Cu Tails

- | | |
|-------------------|-------------------------|
| • Undrained test | 1.44 t/m ³ . |
| • Drained test | 1.70 t/m ³ . |
| • Air drying test | 2.15 t/m ³ . |

The test work indicated that for the Zn Tails, there is a moderate difference in the density achieved between tailings based on settlement and tailings exposed to air drying. With suitable air drying of the tailings slurry, a settled density of approximately 1.95 to 2.05 t/m³ is expected in the facility.

For the Cu Tails, there is a considerable difference in the density achieved between tailings based on settlement and tailings exposed to air drying. With suitable air drying of the tailings slurry, a settled density of approximately 1.90 to 2.0 t/m³ is expected in the facility.

For both samples, the air drying test achieved a high density primarily associated with the high solids particle density. Assuming that the fresh ore is consistent with the high SG of the two transition ore it is recommended that the TSF filling model be modified to match the physical tailings testing results.

We trust that this memorandum meets your requirements; however, if you have any questions please do not hesitate to contact us.

Yours faithfully
KNIGHT PIÉSOLD PTY LTD

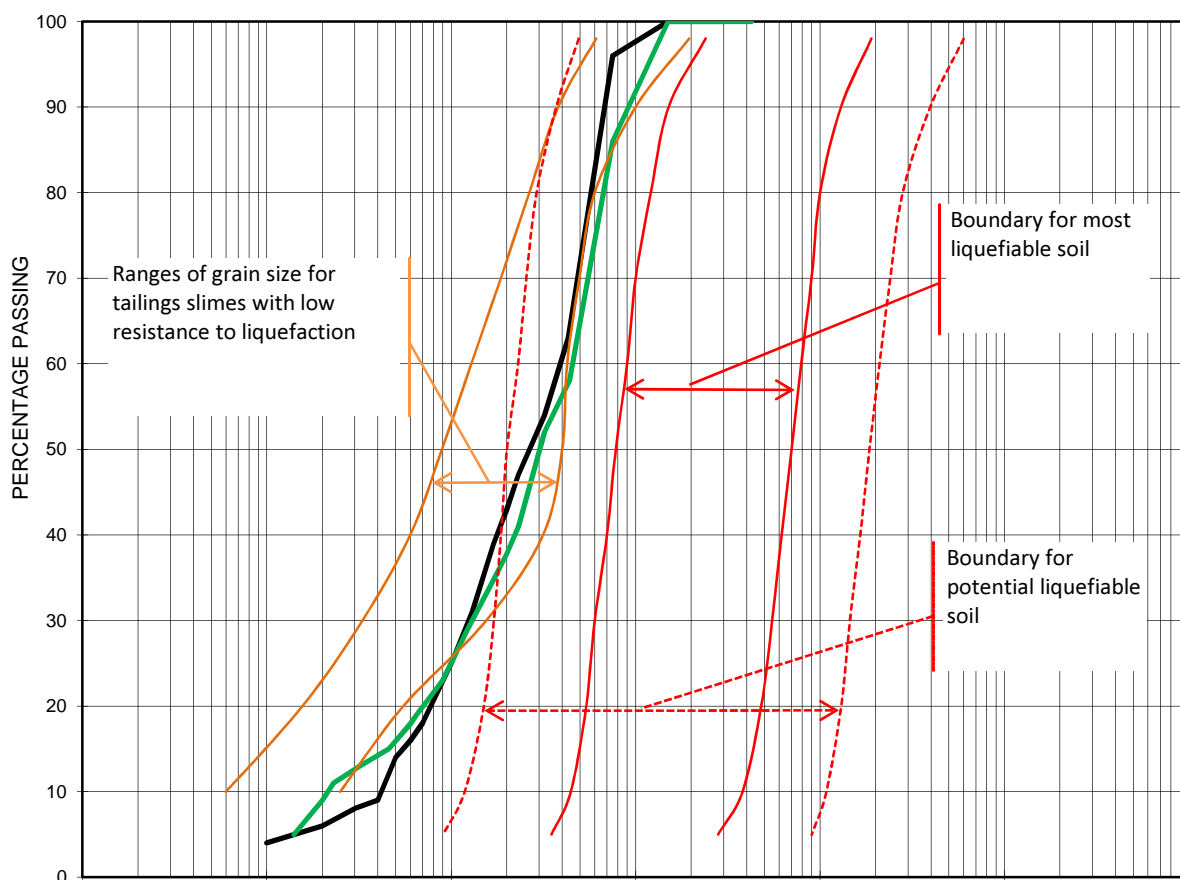
DEAN SAWYER
Senior Engineer

A handwritten signature in black ink, appearing to read "Pete Veld". The signature is written in a cursive, flowing style.

PETER VELD
Technical Consultant

FIGURES

PARTICLE SIZE DISTRIBUTION



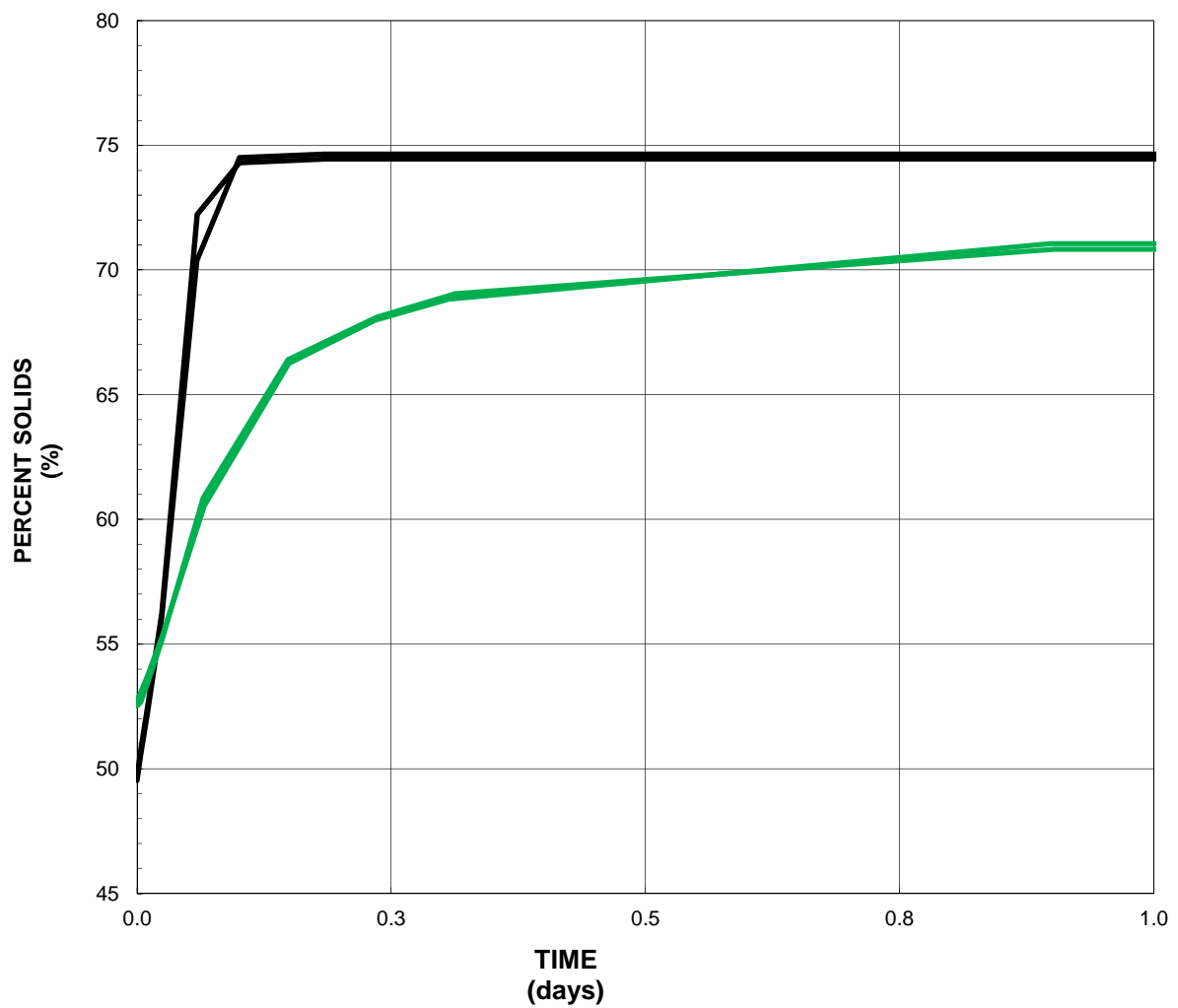
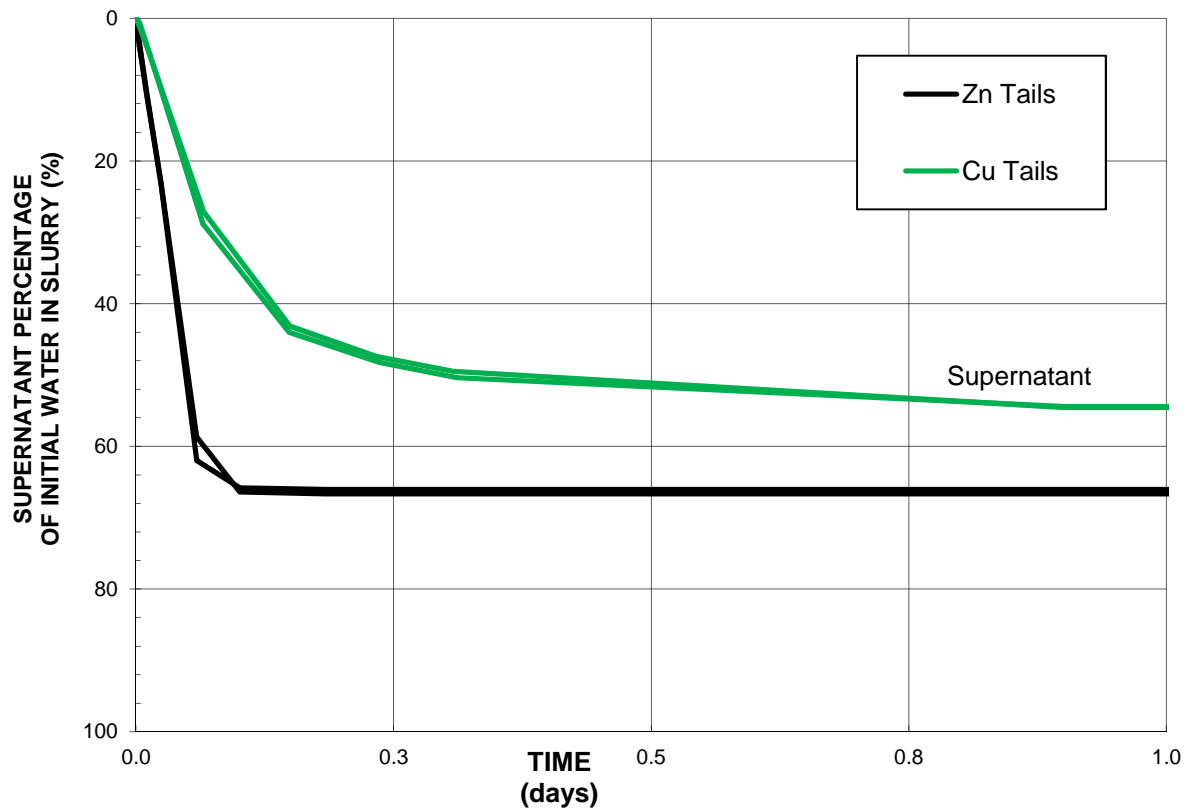
CLAY FRACTION		SILT FRACTION			SAND FRACTION			GRAVEL FRACTION				
		Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse		
0.0001	0.001	0.002	0.006	0.02	0.075	0.2	0.6	2.36	6	20	63	100
PARTICLE SIZE - mm												

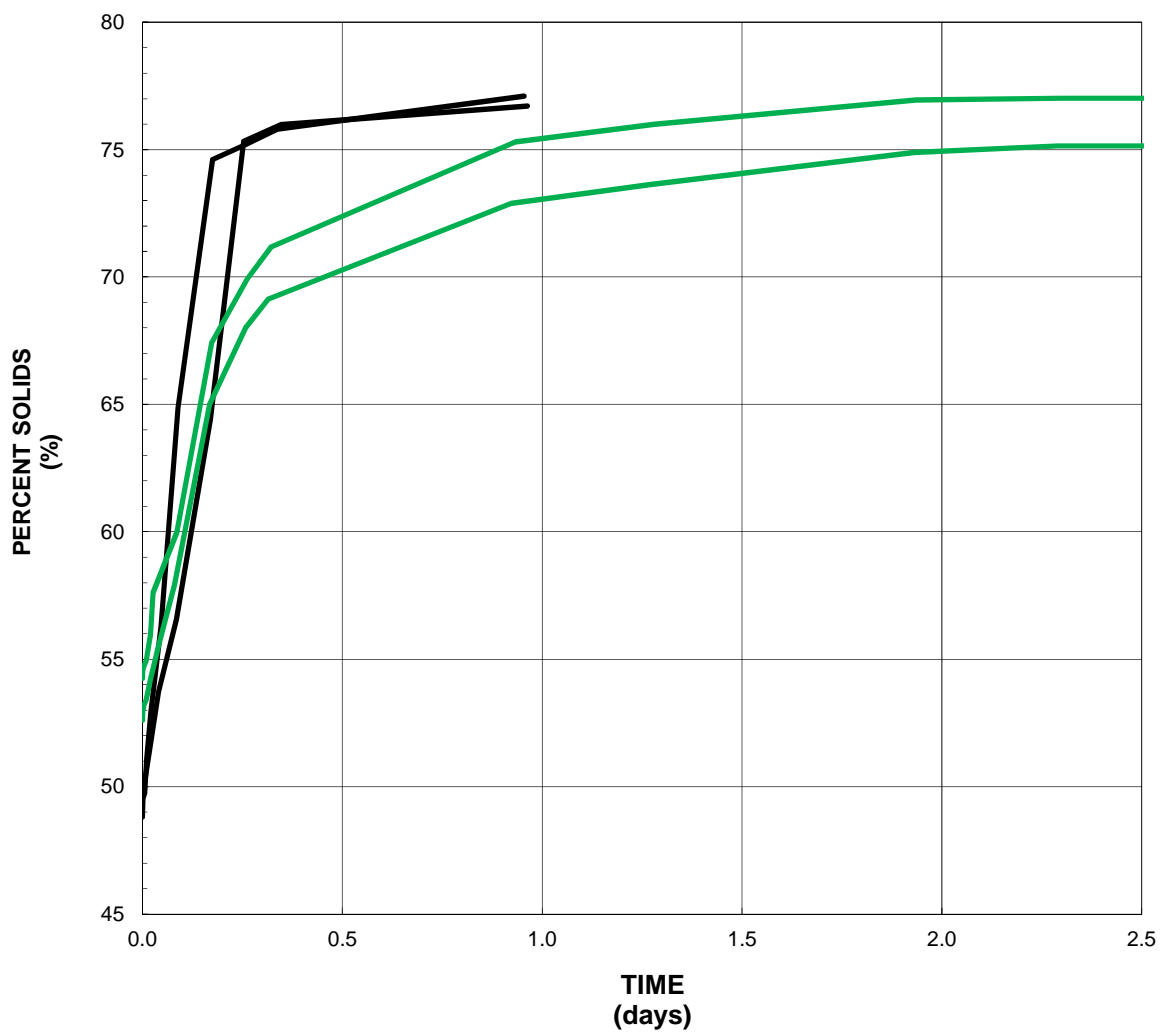
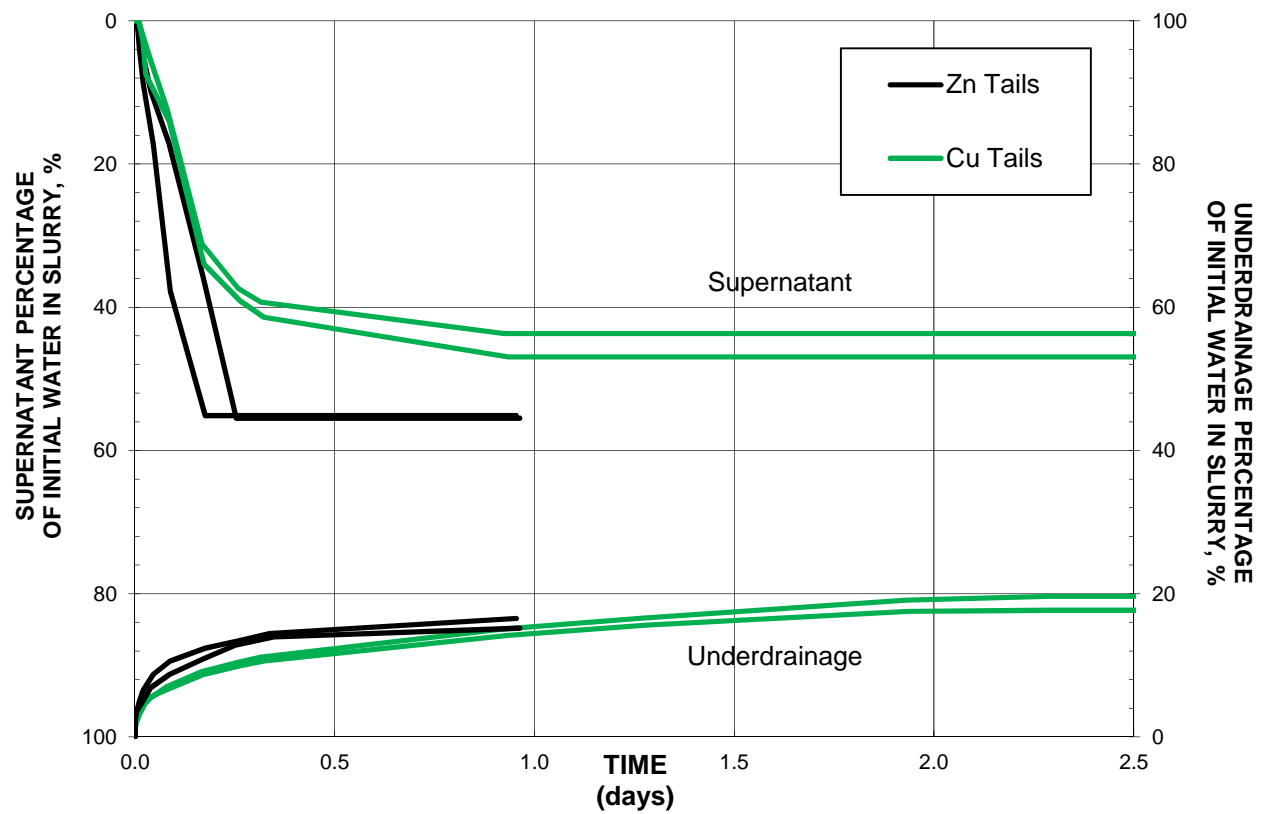
SYMBOL	SOIL DESCRIPTION	LIQUID LIMIT	PLASTICITY INDEX	SPECIFIC GRAVITY
—	Zn Tails	N.O.	N.P.	3.72
—	Cu Tails	N.O.	N.P.	3.53

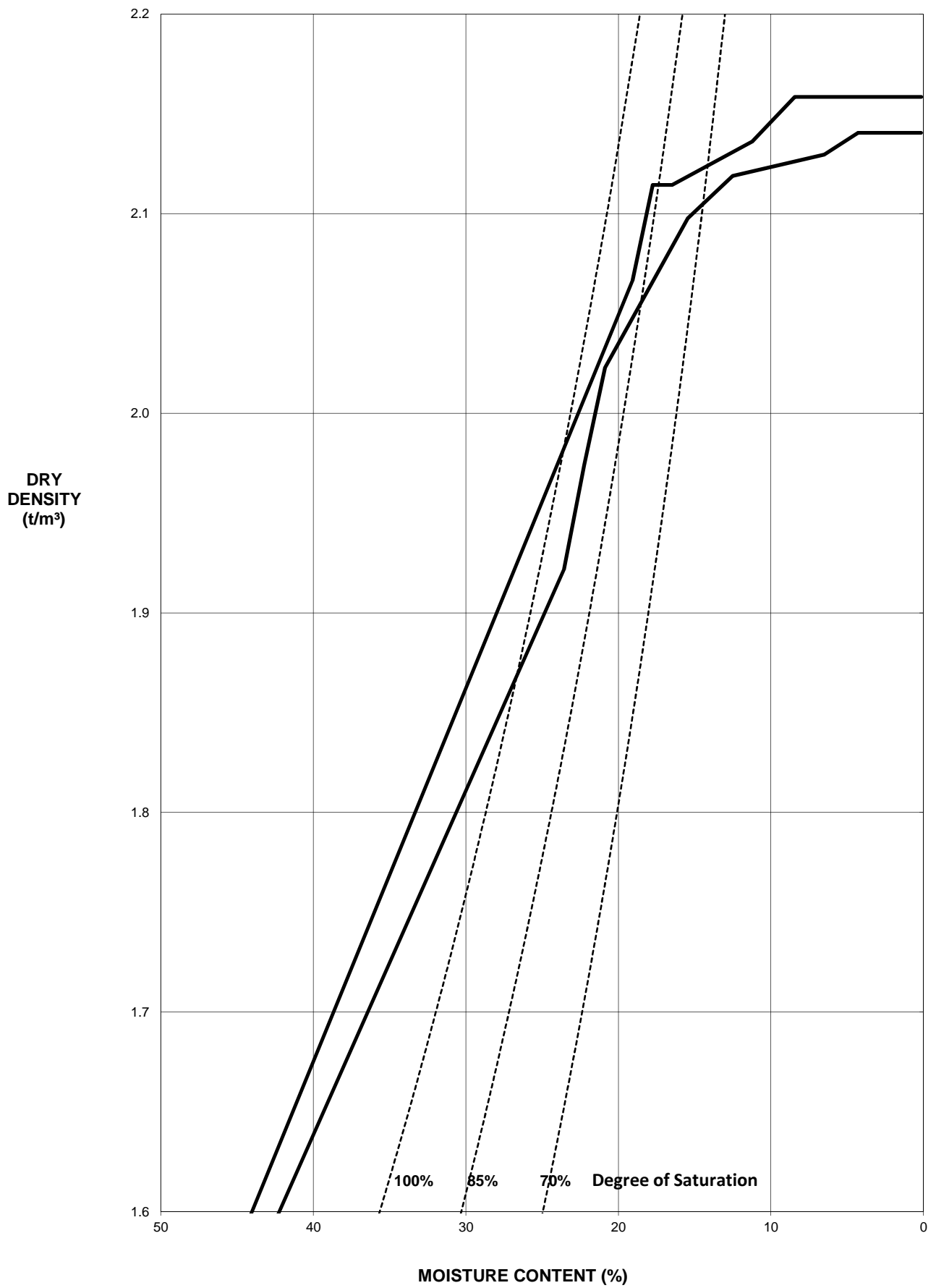
Note:

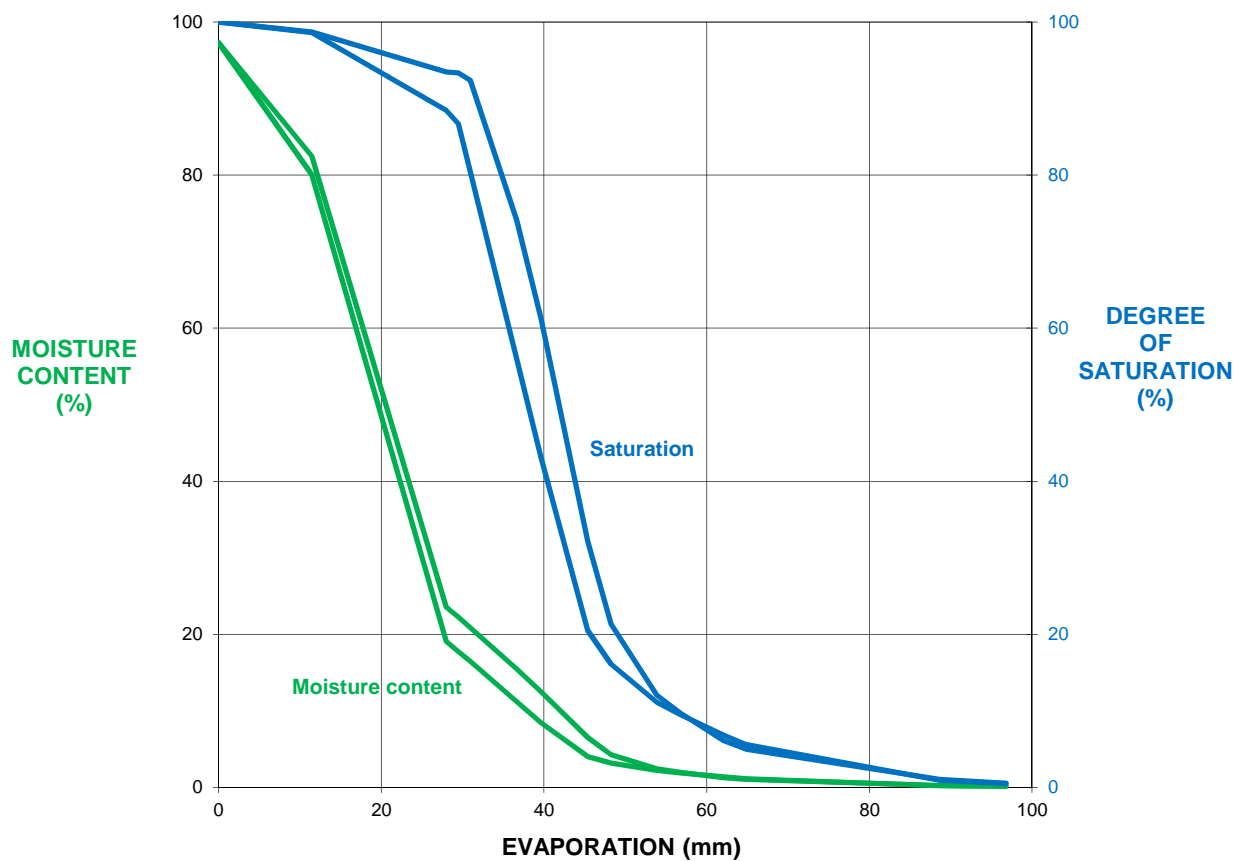
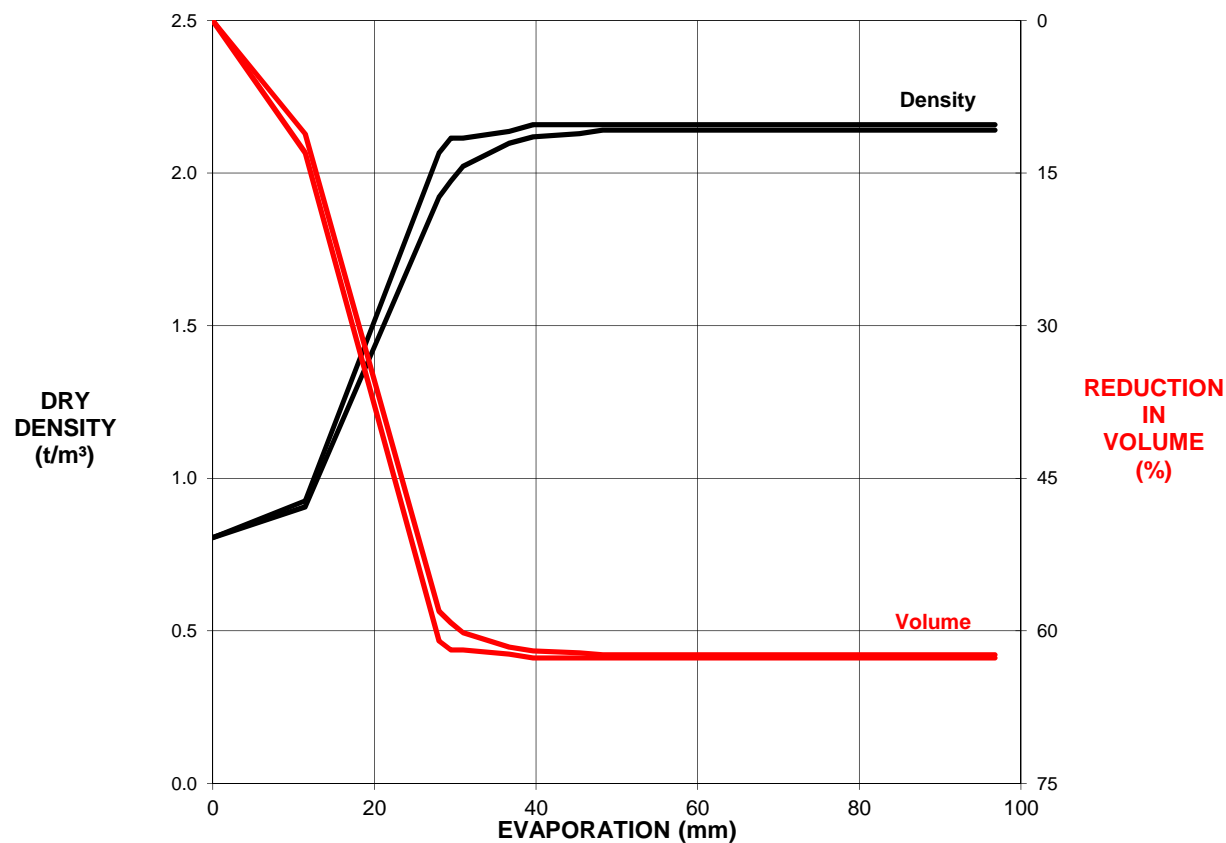
Liquefiable and potentially liquefiable soil limits suggested by USNRC 1985.

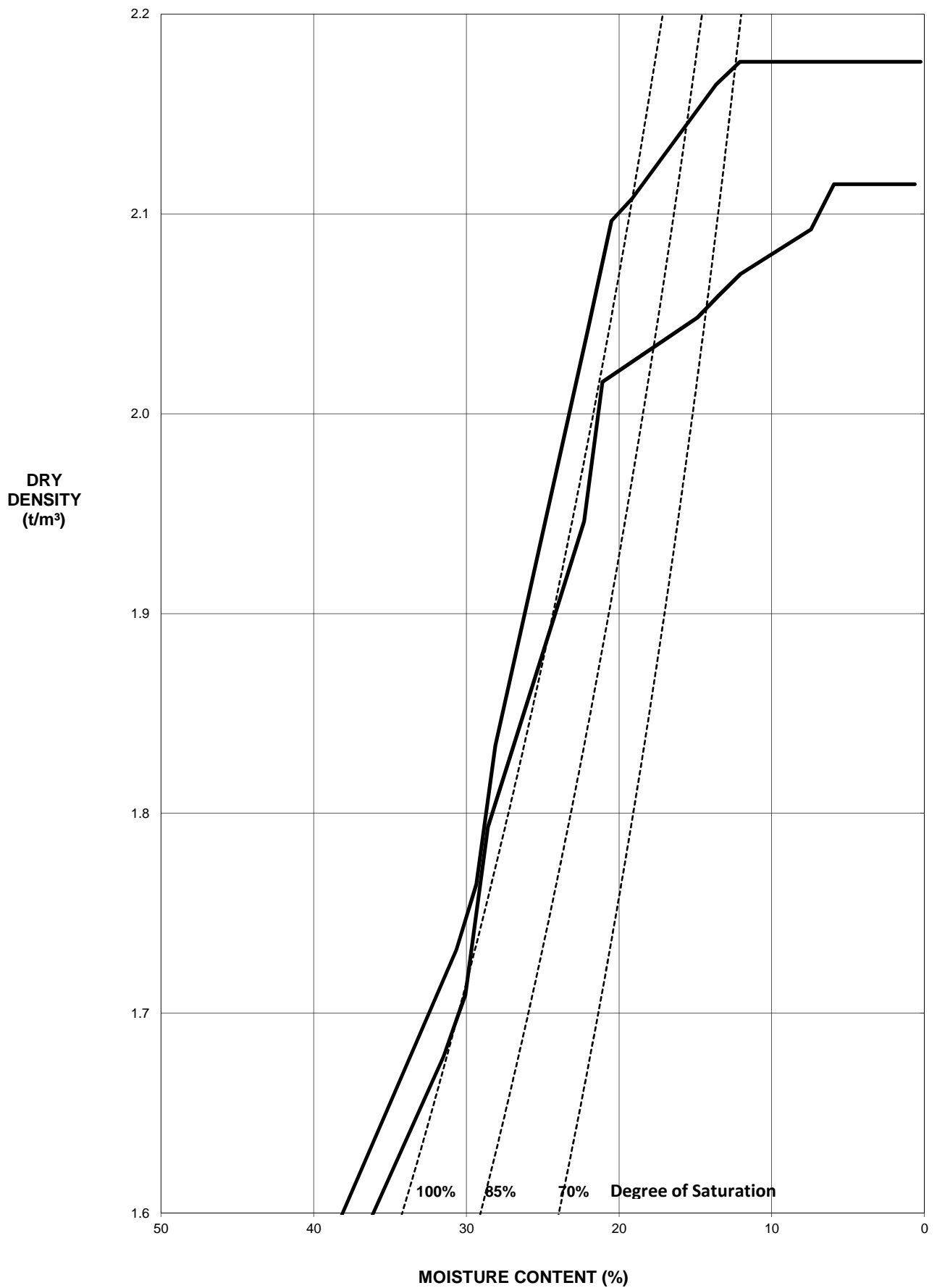
Data obtained from Figure 12.15 and 12.16 of Geotechnical Engineering of Dams, Fell 2005

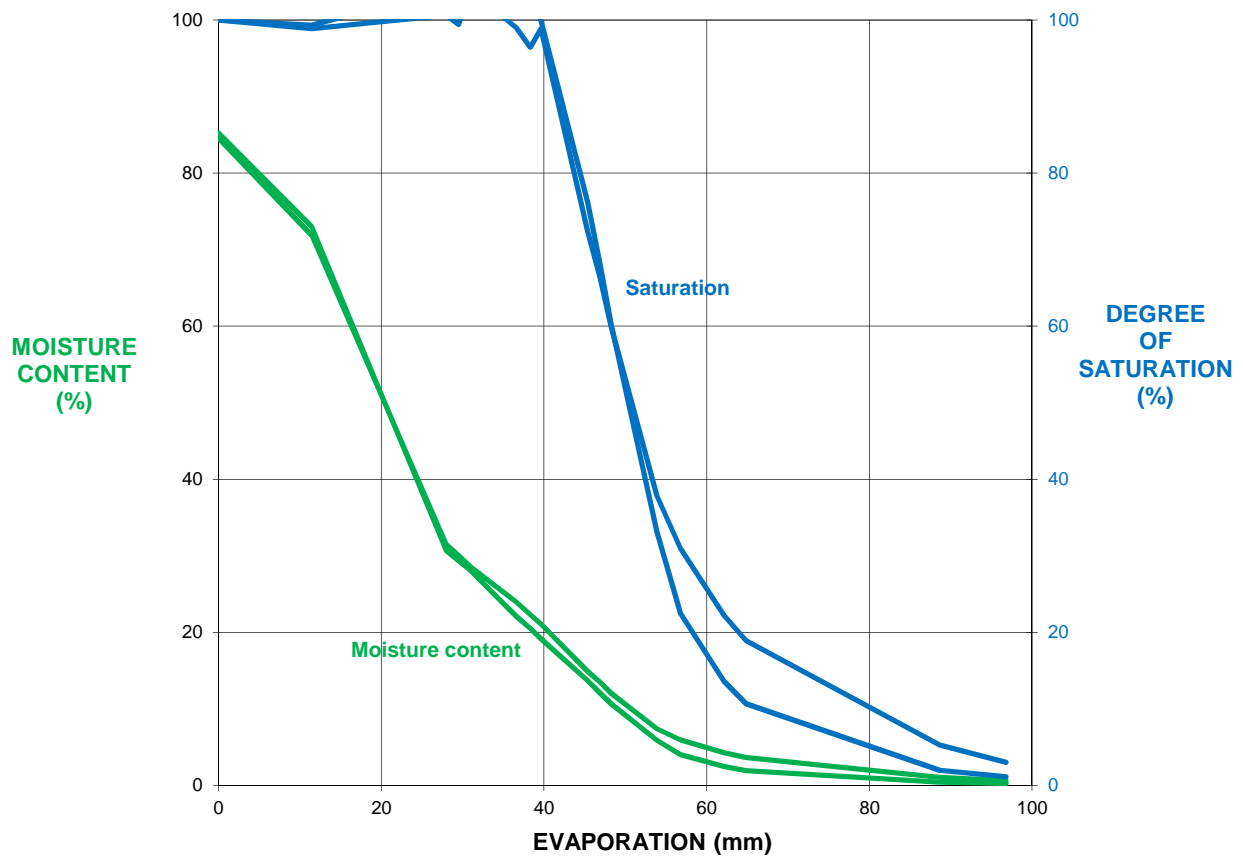
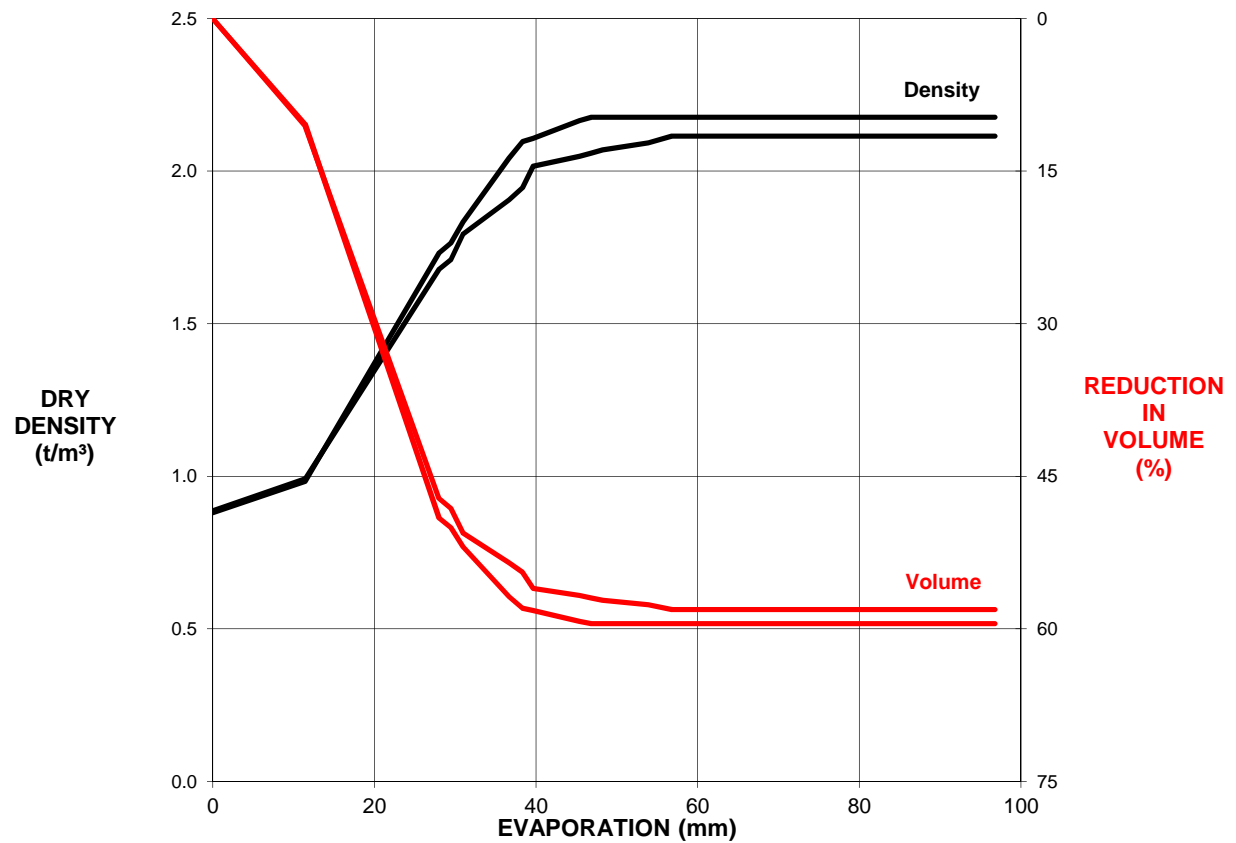


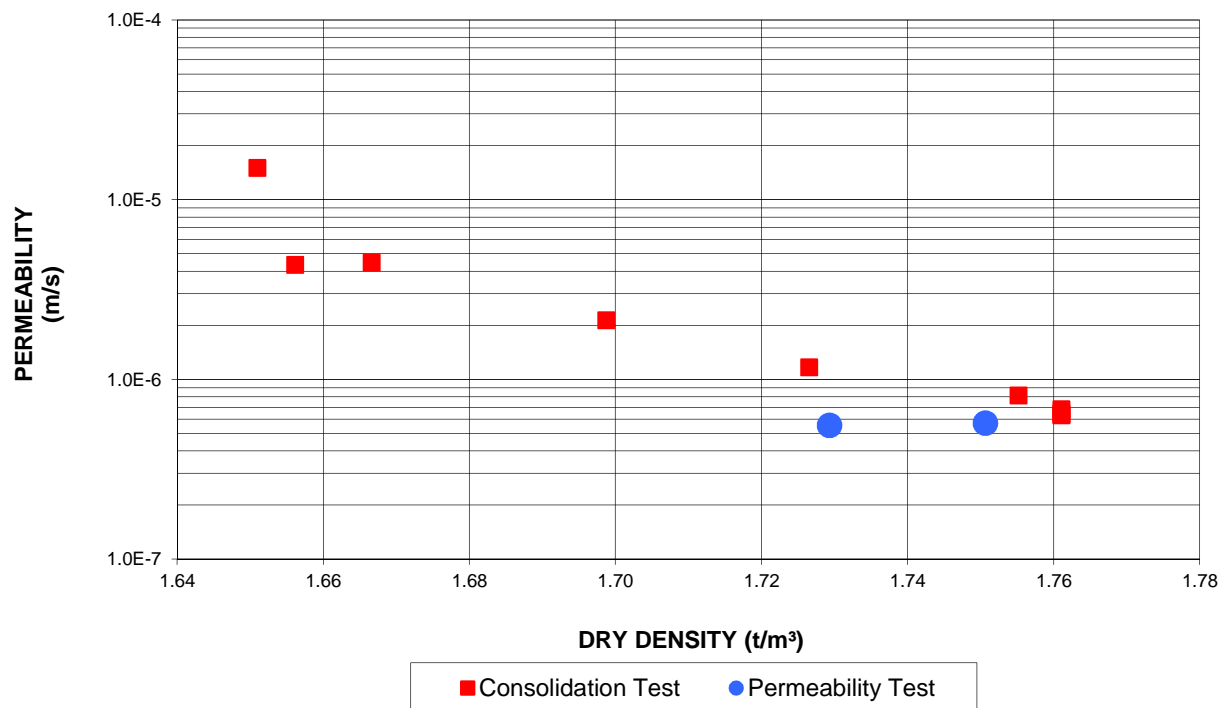
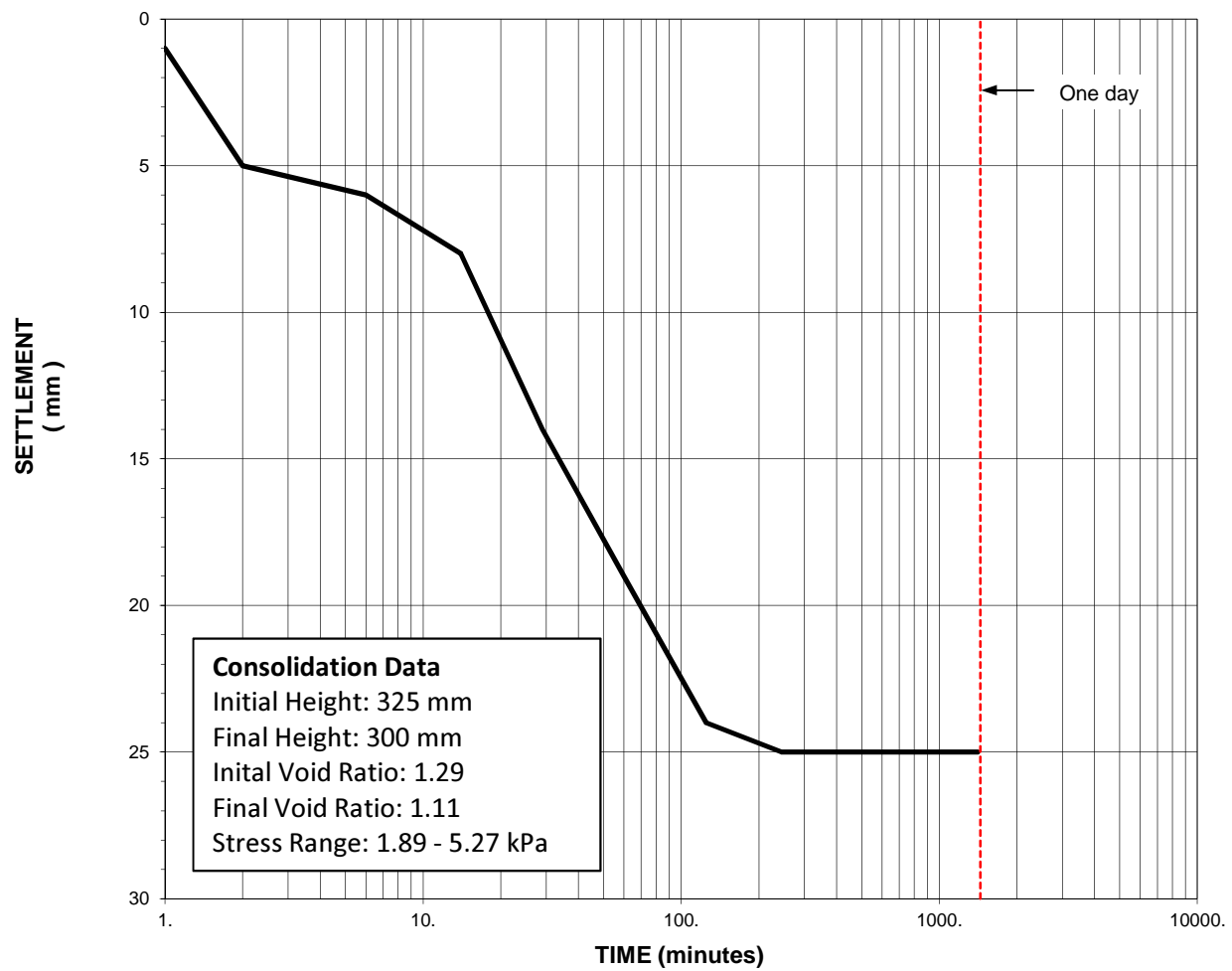


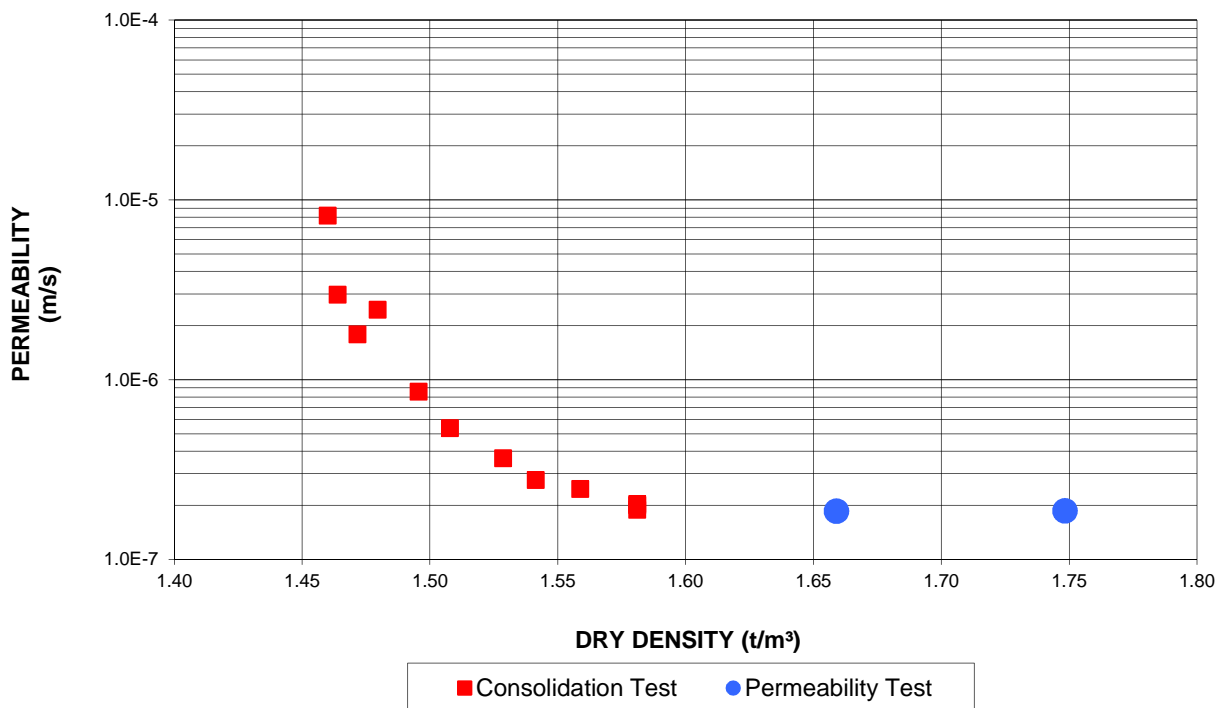
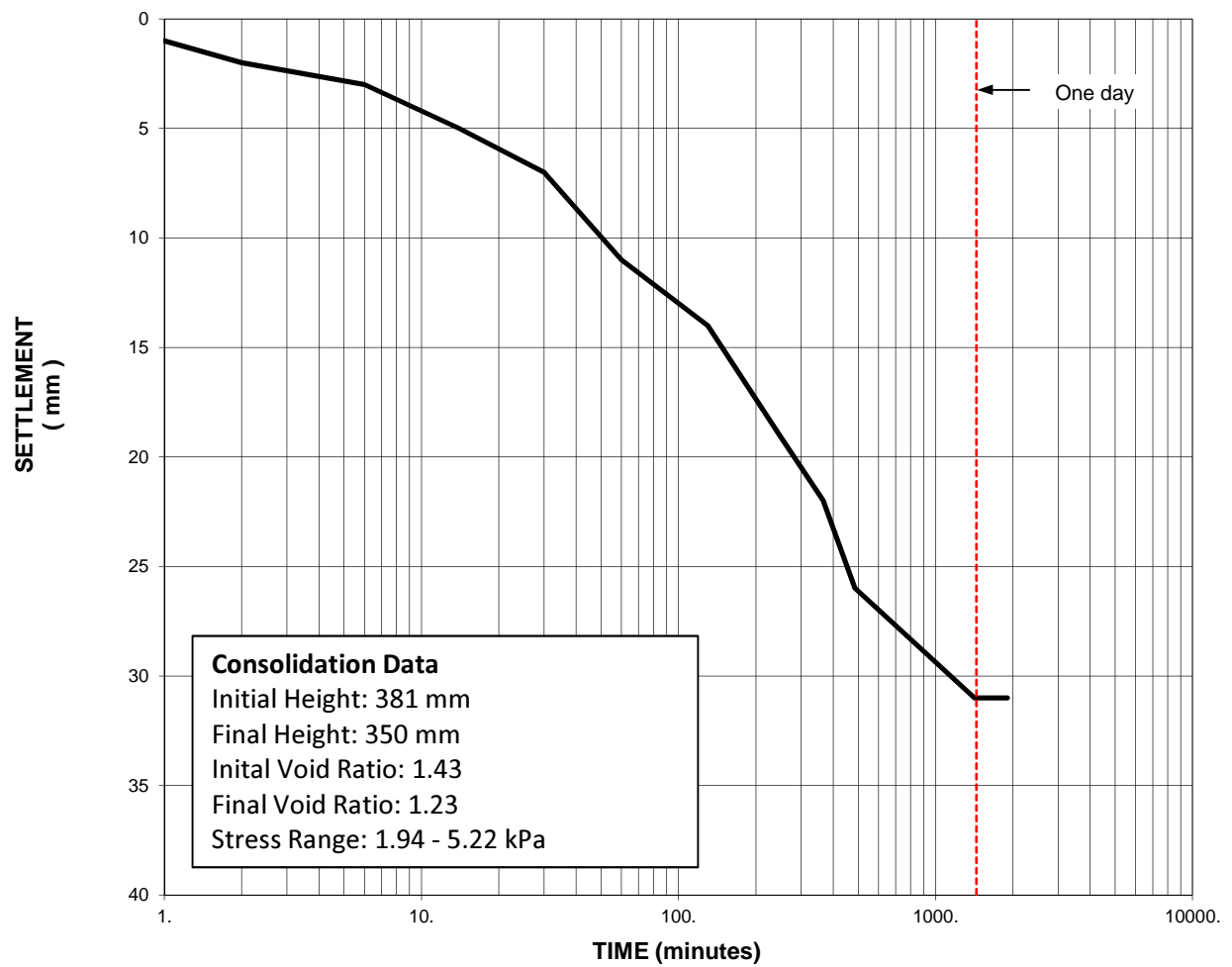












APPENDIX A
Trilab Laboratory Test Results

ATTERBERG LIMITS TEST REPORT

Test Method: AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

Client	Knight Piesold Pty Ltd Level 1	Report No.	P 18060047-AL
Address	184 Adelaide Terrace, EAST PERTH WA 6004		
Project	PE801-00300 Sulphur Springs Zinc - Copper Project	Test Date	14/06/2018
		Report Date	18/06/2018

Sample No.	18060047	18060048				
Client ID	A18701 Bulk #1 ZN CT + ROTAIL	A18701 Bulk #2 CU CT + ROTAIL				
Depth (m)	Not Supplied	Not Supplied				
Liquid Limit (%)	Not Obtainable	Not Obtainable				
Plastic Limit (%)	Not Obtainable	Not Obtainable				
Plasticity Index (%)	Non Platic	Non Platic				
Linear Shrinkage (%)	Not Obtainable	Not Obtainable				
Moisture Content (%)	64.1	85.6				

Sample No.						
Client ID						
Depth (m)						
Liquid Limit (%)						
Plastic Limit (%)						
Plasticity Index (%)						
Linear Shrinkage (%)						
Moisture Content (%)						

NOTES/REMARKS: The samples were tested oven dried, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client

* Cracking occurred

+ Curling occurred

Page 1 of 1

REP30101

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in
this document are traceable to Australian/National Standards.

Tested at Trilab Perth Laboratory.

Authorised Signatory



C. Channon



Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.

Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.

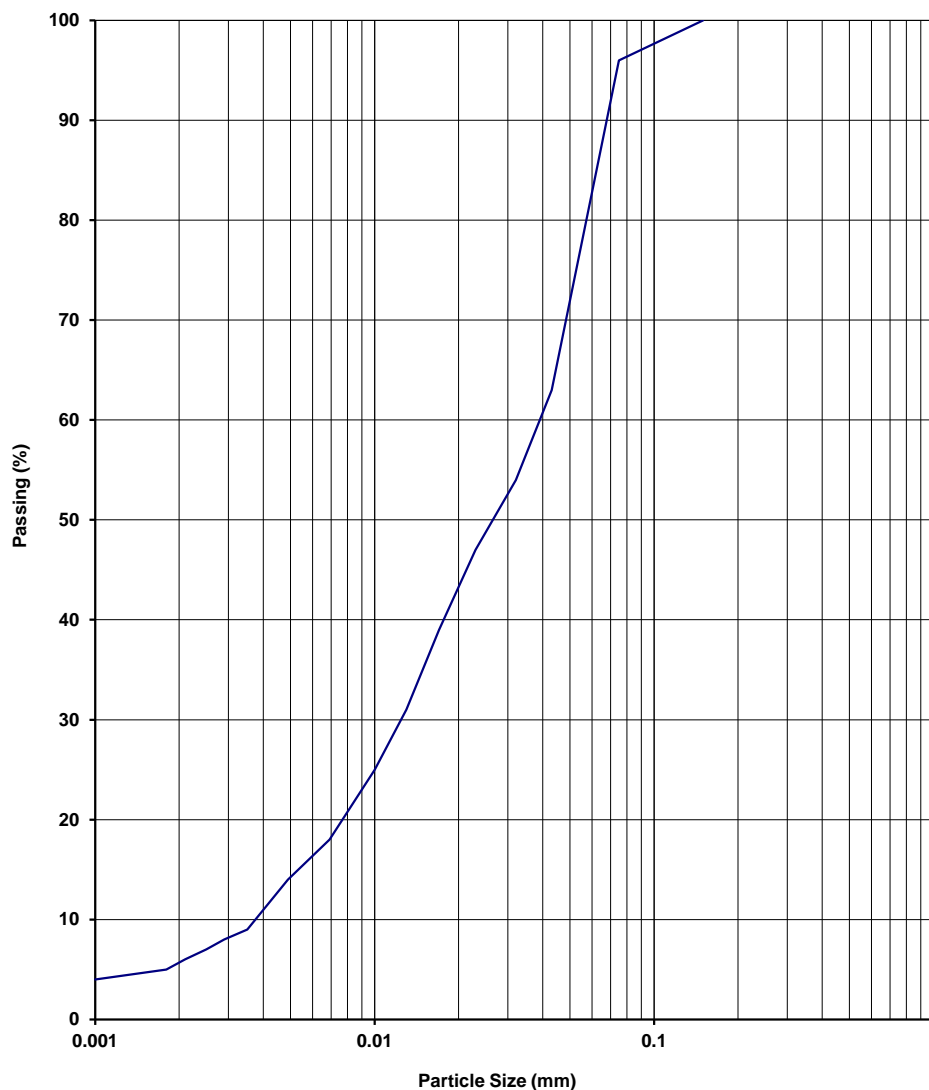
Trilab Pty Ltd ABN 25 065 630 506

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1

Client	Knight Piesold Pty Ltd Level 1	Report No.	P 18060047-G
Address	184 Adelaide Terrace, EAST PERTH WA 6004		
Project	PE801-00300 Sulphur Springs Zinc - Copper Project	Test Date	8/06/2018
		Report Date	15/06/2018
Client ID	A18701 Bulk #1 ZN CT + ROTAIL	Depth (m)	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
53.0	
37.5	
26.5	
19.0	
9.5	
4.75	
2.36	
1.18	
0.600	
0.425	
0.300	
0.150	100
0.075	96
0.043	63
0.032	54
0.023	47
0.017	39
0.013	31
0.01	25
0.007	18
0.005	14
0.004	9
0.003	8
0.003	7
0.002	6
0.002	5
0.001	4



NOTES/REMARKS:

Moisture Content 64.1%
Sample/s supplied by the client

-2.36mm Soil Particle Density(t/m³) 3.72

Page 1 of 1 REP33901

Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Perth Laboratory

Authorised Signatory



C. Channon



Laboratory No. 9926

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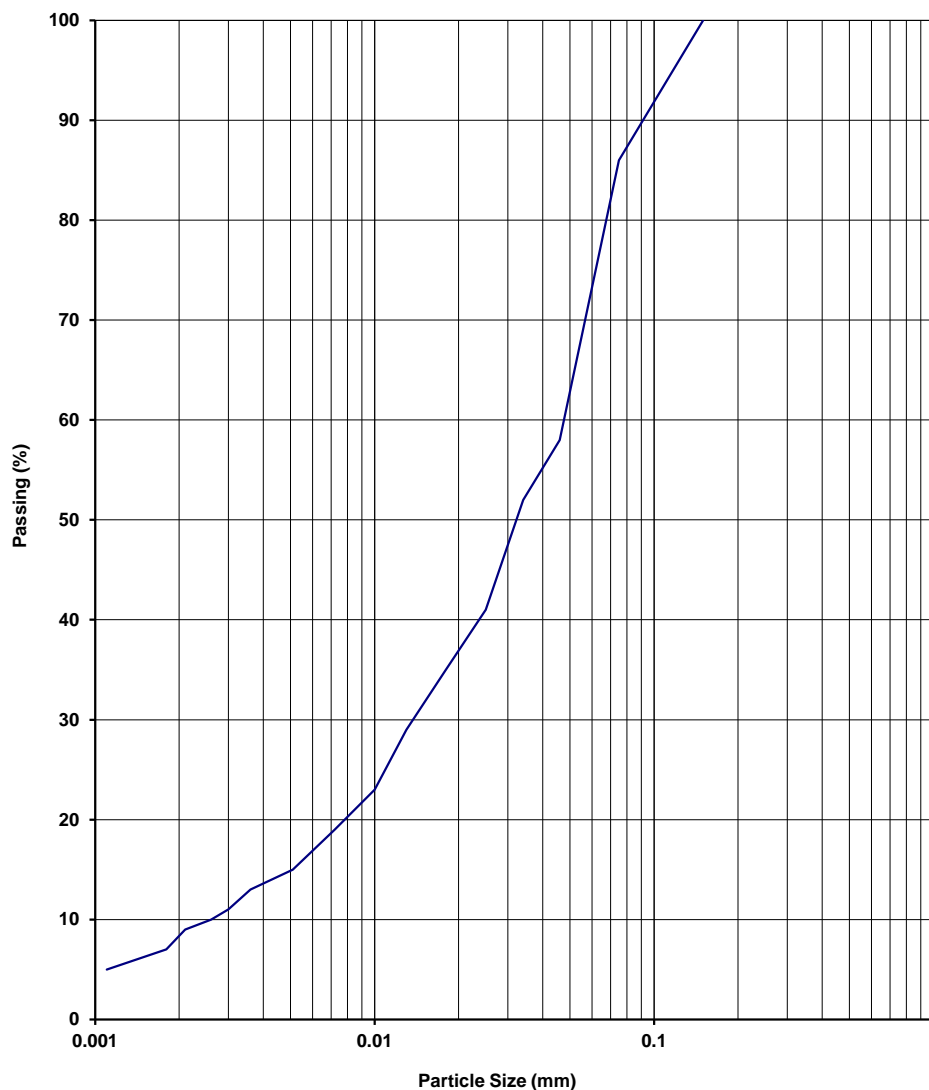
Trilab Pty Ltd ABN 25 065 630 506

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1

Client	Knight Piesold Pty Ltd Level 1	Report No.	P 18060048-G
Address	184 Adelaide Terrace, EAST PERTH WA 6004		
Project	PE801-00300 Sulphur Springs Zinc - Copper Project	Test Date	8/06/2018
		Report Date	15/06/2018
Client ID	A18701 Bulk #2 CU CT + ROTAIL	Depth (m)	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
53.0	
37.5	
26.5	
19.0	
9.5	
4.75	
2.36	
1.18	
0.600	
0.425	
0.300	
0.150	100
0.075	86
0.046	58
0.034	52
0.025	41
0.018	35
0.013	29
0.01	23
0.007	19
0.005	15
0.004	13
0.003	11
0.003	10
0.002	9
0.002	7
0.001	5



NOTES/REMARKS:

Moisture Content 85.6%
Sample/s supplied by the client

-2.36mm Soil Particle Density(t/m³) 3.53

Page 1 of 1 REP33901

Accredited for compliance with ISO/IEC 17025.
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Tested at Trilab Perth Laboratory

Authorised Signatory



C. Channon



Laboratory No. 9926

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Trilab Pty Ltd ABN 25 065 630 506