OCEANIA TASMANIA

Comstock Mine
Zeehan Tasmania

Clay Reserve

(Permeability and Homogeneity)

Author – Paul Heath B.Sc. (Hons)

Tuesday, 23 October 2001

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Qualifications and Disclaimers

This report has been prepared by Paul Heath. Paul currently is employed as a geologist at the Comstock Mine for Oceania Tasmania Pty. Ltd, and has a BSc (Hons) in geology that was completed at the end of 1999 from the University of Tasmania. During 1993, he completed his Advanced Certificate of Horticulture at Burnley, Victoria.

The information contained in this report was drawn from the authors field observations and permeability and homogeneity results. All samples were collected by the author and analysed at BFP Consultants Pty Ltd, Prospect Vale, Tasmania. Paul accepts no liability to any person for errors or omissions, for losses or damages claimed as a result, directly or indirectly, of opinions or data produced in this report.

Contents

Aim

To identify a homogeneous and impermeable clay reserve to cap the existing Central and Swansea waste dumps.

Background

Oceania Tasmania Pty Ltd submitted a Development Proposal and Environmental Management Plan (DPEMP) for the establishment of a mineral processing plant for milling and flotation of lead and zinc minerals earlier this year. Permit conditions were granted by the Department of Primary Industries, Water and Environment on July, 2001. These permit conditions were granted under the Environmental Management and Pollution Act, 1994.

Section 13 of these conditions involves submission of a clay reserve that would cap existing waste dumps to stop the production of acid producing material creating acid mine drainage. This report will cover conditions listed below from Schedule 2 of the Comstock mine environmental permit.

(13) The person responsible for the activity must submit a report to the Director no later than 90 days after the issuing of this permit containing the following information:

(a) The results of investigations into the availability of clay resources for use in the management of waste rock and tailings as detailed in conditions (23) (24) and (25).
(b) The location, quantity and quality of the clay. Specifically, the permeability and homogeneity of the clay must be reported.
(c) If the clay resource is not at the lease site, proposed arrangements for accessing the clay must be reported.
(d) If no clay resource is identified at the land, alternative arrangements to meet the requirements of this permit must be reported.

Four permeability and compaction tests have been carried out prior to this investigation. These include three samples from Comstock; one each from the Swansea waste dump, Central waste dump and the third the near old workings along the main lode. The fourth sample was collected from the clay used to cap and rehabilitate Queen Hill by Mineral Resources Tasmania. This data is tabulated in the results section.

Regional Prospects/Geology

The Comstock Lease consists primarily of 3 main geological Formations;1) Precambrian Oonah, 2) Cambrian and the 3) Crimson Creek Formation. The Oonah Formation comprises altered limestones, sandstones and mudstones and forms the oldest rock unit on the lease. The Cambrian group of rocks consist mainly of gabbro and basalts. The Crimson Creek Formation lies north of the Balstrup Fault and comprises mudstone, greywacke and gabbro dykes (Figure 1).

Basesd on geological rock types, terrain and vegetation, the author's main area of prospectivity was along the northern side of the Balstrup Fault within the Crimson Creek Formation. The area of interest occurs on a flat lying area, typically swampy and covered by button grass. Undulating hills to the south, contain patches of vegetation, primarily *Eucalyptus*.

Access to the site is via the old tramway that extends in an east-west orientation (Figure 2). This access track runs parallel to the Balstrup Fault, approximately 150m south. This area is proposed for the stage 2 mine development and waste dumps as per Coffey Geosciences design (Figure 2).

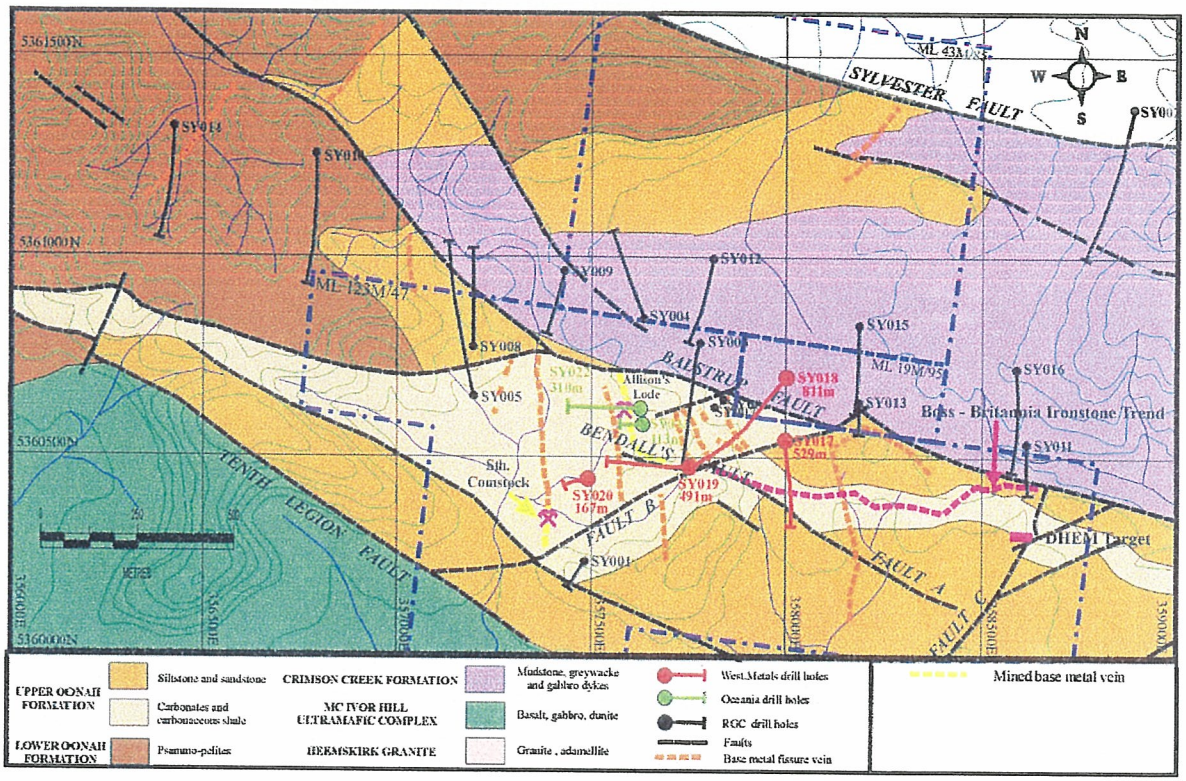


Figure 1. Geological map of the Comstock area adapted from Richardson (2000)

Methods

Twenty-four test pits (Figure 2) were dug over an approximate area of 400m by 300m with depths of 0.7m to 3.5m. Eight representative samples were collected for analysis, each sample weighing approximately 15kg. Samples were analysed at BFP Consultants for standard compaction, permeability, particle distribution size and Emerson tests (Table 1).

Results

Table 1 shows the twenty-four test pits north of the Balstrup Fault, near the Old Comstock railway. The table shows location, depth of hole, permeability (cm/sec and m/sec), maximum dry density, optimum moisture, particle analysis, Emerson class number and type of clay.

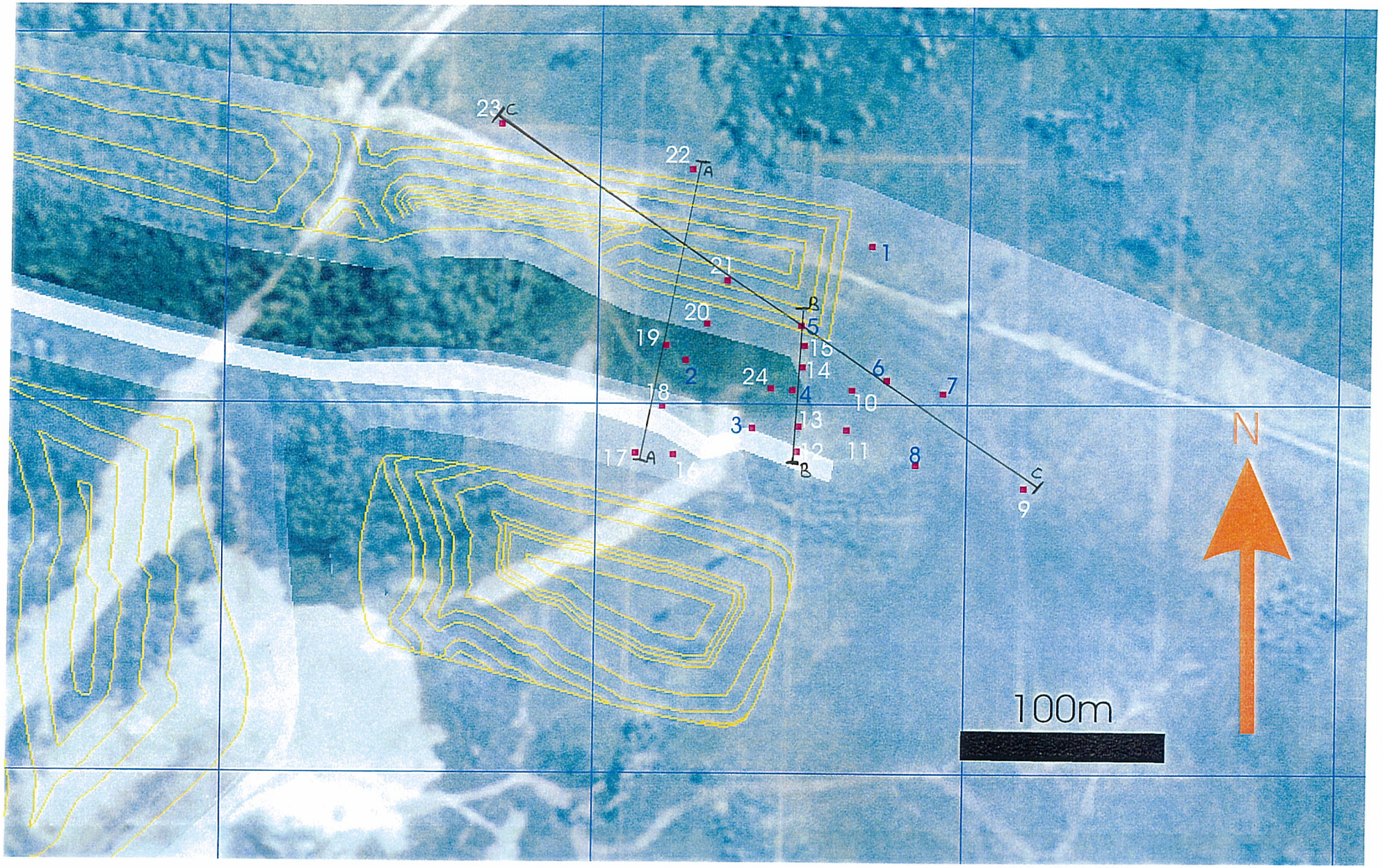


Figure 2. Proposed area for Stage 2 (Balstrup Fault) of the mine development plan with proposed dumps (adapted from Coffey 2000). Future dumps (yellow lines), Balstrup Fault (white sheet), representative samples analysed at BPF consultants (blue numbers), other test pits logged only (white numbers). Black lines indicate traverses of test pit cross-sections (Figure 3).

Table 1. Test pits, location, and classification

Sample Name	Easting	Northing	Z	Depth (cm)	P(cm/sec)	P(m/sec)	Maximum Dry Density	Optimum moisture content %	Passing 0.075mm sieve %	Emersion class number	Name	Description
SBA1	360776	357913	280	160	2.08E-07	2.08E-09	1.43	31	78	6	Dark grey sandy silty clay	Grey fine grained material, fragments
												weather zone of graphitic shale
SBA2	360714	357813	280	200	2.69E-07	2.69E-09	1.42	30.2	82	6	Grey silty clay some fine sand	Light grey material,
												very homogenous, no fragments
SBA3	360677	357849	280	200	1.09E-06	1.09E-08	1.65	21.2	62	6	Orange brown silty clayey sand	Orange weatherd material
												(similar to Queen Hill, Homogenous)
SBA4	360698	357871	280	160	6.29E-07	6.29E-09	1.45	29.6	76	6	Grey/brown sandy silty clay	Light tan material, fairly homogenous
											(filled with water)	contains minor oraganics
SBA5	360733	357875	280	150	1.82E-07	1.82E-09	1.54	24.8	39	6	Brown/grey silty clayey sand	
SBA6	360703	357922	280	75	1.52E-07	1.52E-09	1.34	35	76		Dark grey sandy clayey silt	Medium grey material,
											(filled with water)	smooth when rolled in hand
SBA7	360696	357952	280	80	1.05E-07	1.05E-09	1.43	30.6	76		Black sandy clayey silt	Dark grey organic rich material,
												smooth when rolled in hands, shale weathering zone
SBA8	360658	357938	280	190	5.9E-07	5.9E-09	1.27	38.6	42		Orange/Brown gravelly sandy clay	Tan to oranange material, fine sand,
												to pebbles with a clay matrix
SBA9	360645	357996	280	100							Orange brown sandy silty clay	Orange to brown material,
												fine particles of sand and pebbles within a clay matrix
SBA10	360698	357903	280	90							Dark grey sandy clayey silt	Dark grey material, silty material,
											(similar to 33) full of water	smooth when rolled in hand
SBA11	360676	357900	280	100							Orange/Brown gravelly sandy clay	Office - brown/orange rock, large pebbles
											(similar to SBA34 + SBA36) water	
SBA12	360665	357873	280	50							Silty Clay	Pink to red soil, fragments of sand within clay matrix
												crumbles in hand, minor organic matter
SBA13	360678	357874	280	160							Grey clayey silt	
SBA14	360710	357876	280	300							Sandy Gravel	Orange material, Orange sandy graval
											(Not suitable)	
SBA15	360722	357877	280	160							weatherd coarse pebble	Orange weathered rock, organic matter
											(Similar to SBA3)	crumbles in hands, no coherhance when added to water
SBA16	360663	357806	280	150							Fine sandy silt	Light tan, fine grained soil
												finely fragmented, crumbles in hand
SBA17	360664	357786	280	120							Gray clayey silt	
SBA18	360689	357800	280	180							Gravelly silt	Light tan to orange, weathered material,
												fragments within clay
SBA19	360722	357802	280	100							Fine silt	Light grey-green, organic matter 30%,
											(filled with water) same as SBA6	not homogeneous
SBA20	360734	357824	280	230							Silty clay	Light tan to light grey,
											(filled with water)	mottled appearance, forms a paste when wet
SBA21	360757	357835	280	100							Grey silty clay	Fine grained grey clay, 10% organics
											(hole filled up)	
SBA22	360817	357815	280	100							Dark grey graphitic clay	Dark grey graphitic material,
											(similar in composition to SBA1)	weatherd zone of graphitic shale? 5-10% organics
SBA23	360841	357712	280	100							Dark grey sandy silty clay	Organic matter, light green sticky material
											(similar in composition to SBA1)	sticks to hand when wet, 5-10% organics
SBA24	360699	357859	280	150							Sandy gravel	Orange weatherd rock, fragmented, coarse, fine sand,
											(Similar to SBA3)	

Sample Name	Sample Type	P(cm/sec)	P(m/sec)	Maximum Dry Density	Optimum moisture content %	Passing 0.075mm sieve %	Emersion class number	Name	Description
Swansea Waste	Surface sample	2.1E-06	2.1E-08	1.71	23.4			Grey silty sandy gravel	
Central Waste	Surface sample	8.4E-06	8.4E-08	2.03	14.2			Grey silty sandy gravel	
Comstock	8m from surface	4.2E-07	4.2E-09	1.32		82		Grey clayey silt, some fine sand	
Queen Hill	Surface sample	1.7E-06	1.7E-08	1.49		62		Grey silty clayey sand,	
								fine to coarse grained	

SBA Cross Sections

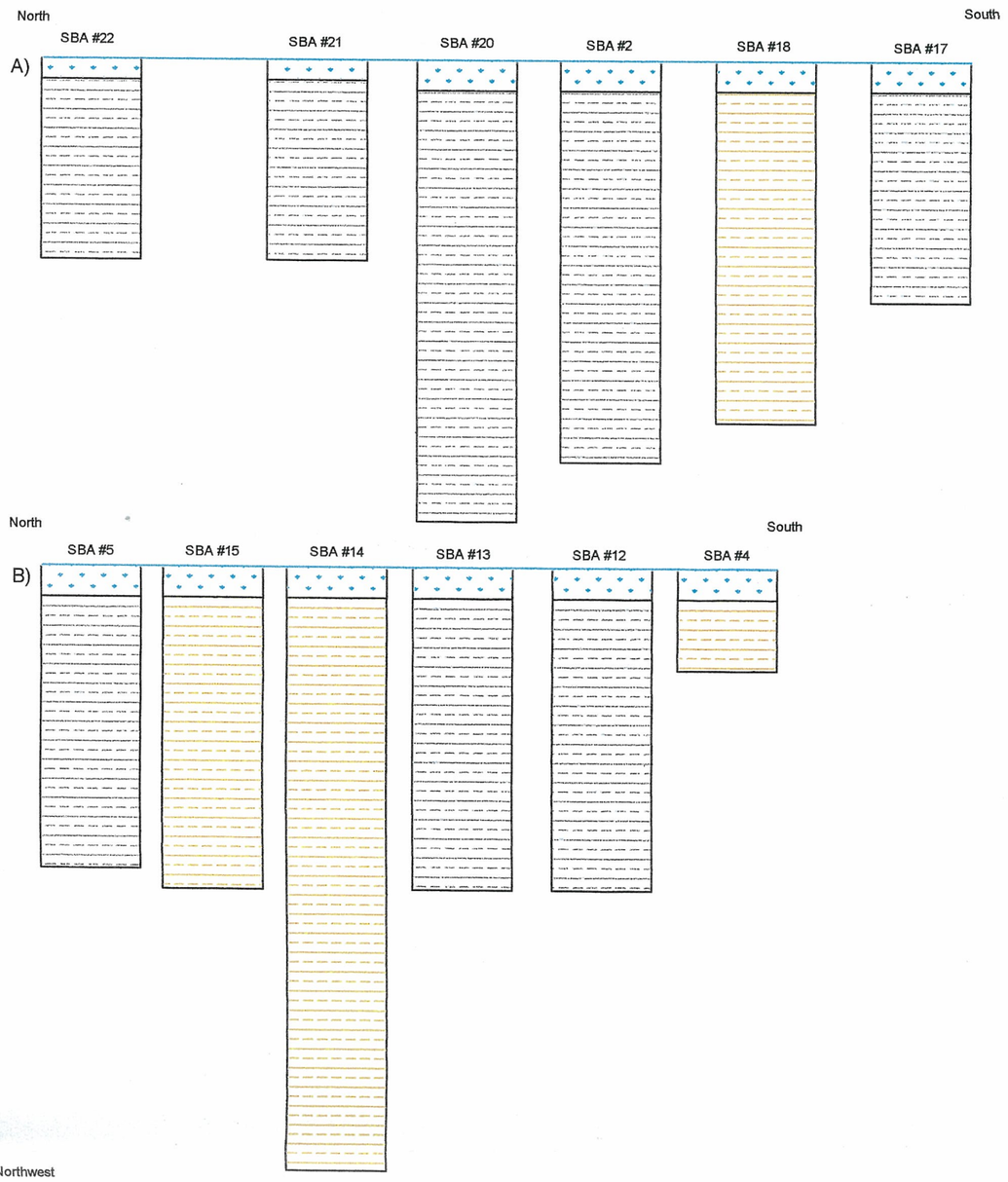


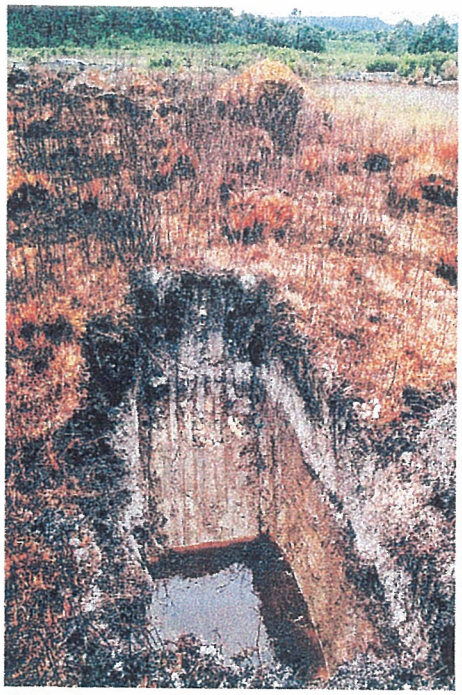
Figure 3.

Permeability

Eight representative samples from the 24 test pits were tested at BFP consultants. All permeability results were less than the required $1x10^{-8}$ m/sec (Table 1). All specimens were remoulded to 95% Standard Compaction at Optimum Moisture Content before permeability was tested. Note, both cm/sec and m/sec are documented in Table 1. Results in Appendix 1 are in cm/sec.

Homogeneity

The area under investigation comprises two main clay types; 1) an orange-brown-silty-clayey sand and 2) a grey-brown-sandy-silty clay (Figure 4). The orange clay forms part of the weathering zone of the Crimson Creek Formation. The dark-grey-clayey-silt is from the weathering zone of the shale. Figure 3 shows the categorised SBA test pits based on analysed data and observations. The top soil varies between 5 to 20 cm in thickness. This dark layer of top soil is rich in organic matter and extends in all the test pits. A subsoil horizon also occurs in some of the test pits, extending no more than 10 to 20cm (SBA4). All test pits still penetrated clay at the bottom of their hole.



SBA 4 – Grey/brown sandy silty clay

SBA3- Orange brown silty clayey sand

Figure 4. Test Pits SBA 3 and 4. This shows the two main types of clay within the area.

Particle grading tests were completed on samples SBA1 to 8 (Appendix 2). This test shows the percentage of particles that pass through a series of sieves. A good clay type material is indicated by the percentage of particles passing a 0.075mm sieve. All samples, except SBA5 and 8 showed more than 60% for the 0.075mm sieve.

Emerson Tests

Five samples (SBA1 to SBA5) were analysed for their Emerson class number. All samples resulted as being Class 6 (refer to Appendix 3 for results and notes on determining the

emersion class number). Class 6 represents a clay sample that will not disperse under constant rainfall.

Volume (estimated reserves of clay)

Volume 1 -
Approximate area containing the test pits @1m depth

400m x 300m x 1m

= 120, 000 m^3 clay reserve

Volume 2 -
Approximate area containing the test pits @2m depth

400m x 300m x 2m

= 240, 000 m^3 clay reserve

Volume 3 -
Approximate area containing the test pits @3m depth

400m x 300m x 3m

= 360, 000 m^3 clay reserve

Volume 4 -
Approximate area containing the test pits and an area of similar geology outside this area @2m depth

500m x 800m x 2m

= 800, 000 m^3 clay reserve

Summary

Several factors influenced the location of the clay reserve. These include access, location (i.e located in future planned stockpile areas which will be subject to stripping), indigenous clay (weed free), permeability, and homogeneity. All samples except for the Queen Hill, Swansea, Central and SBA3 returned permeability results less than the required $1x10^{-8}$m/sec. Sample SBA3 had a permeability of $1.08x\ 10^{-8}$ m/sec (Table 1).

Standard compaction, permeability, and particle size distribution tests were carried out on eight samples. Emerson tests were carried out on samples, which were all categorised as Class 6. Based on the area of investigation, it has been calculated a minimum reserve between 240, 000m^3 and 360, 000m^3.

Appendix 1

Falling Head Permeability & Compaction Certificates

BFP FALLING HEAD PERMEABILITY

materials testing laboratories
369A Bass Highway Prospect Vale Tas 7250
ACN 073 692 270

job No 26441

client **OCEANIA TASMANIA** date tested 12/9 - 26/9/01

project **COMSTOCK**

location **ZEEHAN ZINC**

sampled by: **Client** date received 7/09/01

Sample Identification	Sample Description	coefficient of permeability **cm/sec**	Maximum Dry Density t/m^3	Optimum Moisture Content %
L01/409/a SBA 1	Dark grey sandy silty clay	2.08×10^{-7}	1.43	31.0
L01/409/b SBA 2	Grey silty clay some fine sand	2.69×10^{-7}	1.42	30.2
L01/409/c SBA 3	Orange brown silty clayey sand	1.09×10^{-6}	1.65	21.2
L01/409/d SBA 4	Grey/brown sandy silty clay	6.29×10^{-7}	1.45	29.6

Note:

1 Launceston tap water used. Mean temperature 14^0 C.

2 Specimens remoulded to 95% Standard Compaction at Optimum Moisture Content.

3 Specimens saturated 5 days prior to test under a head equivalent to 1.5m.

3/10/01

BFP

FALLING HEAD PERMEABILITY

materials testing laboratories
369A Bass Highway Prospect Vale Tas 7250
ACN 073 692 270

job No 26441

client **OCEANIA TASMANIA** date tested 12/9 - 26/9/01

project **COMSTOCK**

location **ZEEHAN**

sampled by: **Client** date received 7/09/01

Sample Identification	Sample Description	coefficient of permeability **cm/sec**	Maximum Dry Density t/m^3	Optimum Moisture Content %
L01/409/e SBA 5	Brown/grey silty clayey sand	1.82×10^{-7}	1.54	24.8
L01/409/f SBA 6	Dark grey sandy clayey silt	1.52×10^{-7}	1.34	35.0
L01/409/g SBA 7	Black sandy clayey silt	1.05×10^{-7}	1.43	30.6
L01/409/h SBA 8	Orange/brown gravelly sandy clay	5.90×10^{-7}	1.27	38.6

Note:

1 Launceston tap water used. Mean temperature 14^0 C.

2 Specimens remoulded to 95% Standard Compaction at Optimum Moisture Content

3 Specimens saturated 5 days prior to test under a head equivalent to 1.5m.

3/10/01

BFP
Consultants Pty Ltd
materials testing laboratories
369a Bass Highway Prospect Vale
ACN 073 692 270

FALLING HEAD PERMEABILITY TEST

(Compaction to AS 1289 5.1.1)

job no 26394

client OCEANIA Pty Ltd

date tested 19 – 21/2/01

project COMSTOCK MINE

location ZEEHAN

Sample Identification	Sample description	passing 0.075mm sieve %	coefficient of permeability cm/sec	initial dry density t/m^3	moisture content %
L01/71 COMSTOCK	GREY CLAYEY SILT, some fine sand	82	4.2×10^{-7}	1.32	32.0
L01/72 QUEEN HILL	GREY SILTY CLAYEY SAND, fine to coarse grained	62	1.7×10^{-6}	1.49	26.6

PERMFH–C.WKS–SEPT 96

NOTE:

1. Launceston tap water used. Mean temperature 19°C
2. Specimen remoulded to 95% Standard Compaction at Optimum Moisture Content.
3. Specimens saturated 3 days under a head equal to 1.5m.

11 SEP 2000

BFP
Consultants Pty Ltd
materials testing laboratories
369a Bass Highway Prospect Vale
ACN 073 692 270

FALLING HEAD PERMEABILITY TEST

(Moisture Content to AS 1289 2.1.1)

Job no 26350
report no 350/AA

client ZEEHAN ZINC Pty Ltd

date tested 22–23/8/00

project COMSTOCK MINE WASTE

location WEST COAST TASMANIA

issue date 31/8/00

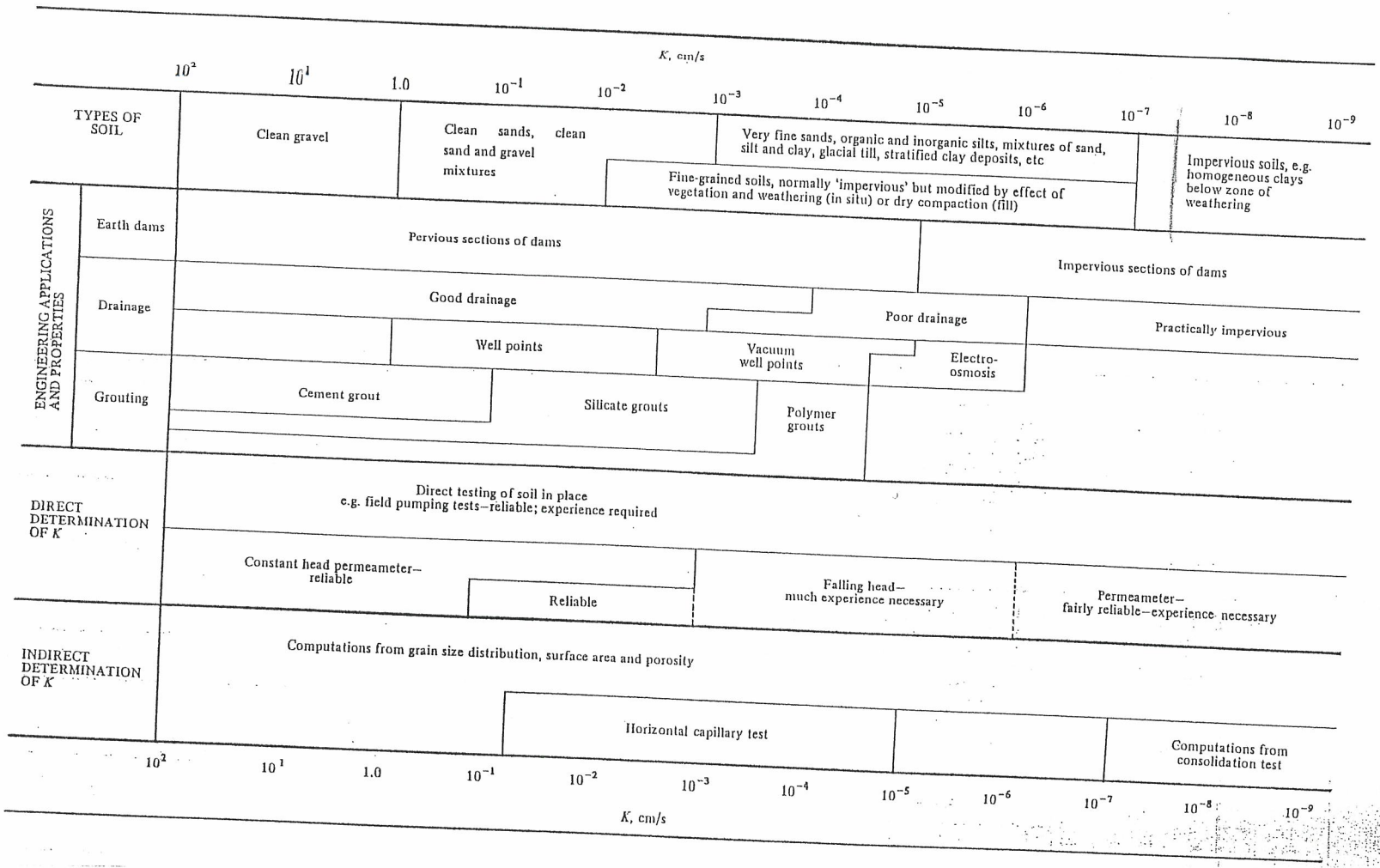
Sample Identification	Sample description	coefficient of permeability cm/sec	initial dry density t/m^3	moisture content %
L00/465 Swansea Waste	Grey silty sandy gravel	2.1×10^{-6}	1.71	23.4
L00/466 New/Central	Grey silty sandy gravel	8.4×10^{-6}	2.03	14.2

PERMFH–C.WK3–SEPT 95

NOTE:

1. Launceston tap water used. Mean temperature 14°C
2. Specimens remoulded to 95% Standard Compaction at Optimum Moisture Content.

7.8.1. HYDRAULIC CONDUCTIVITY (PERMEABILITY)[1]



1. From Australian Standard 1726-1981, by permission.

7.8.2. SUMMARY OF THE ARITHMETIC MEAN OF HYDRAULIC PROPERTIES FOR ALL ROCK TYPES[1]

Appendix 2

Particle Size Distribution Certificates

MATERIAL QUALITY
SUMMARY OF TEST RESULTS

BFP

materials testing laboratories

369A Bass Highway Prospect Vale Tas 7250

Ph (03) 6340 2155 Fax (03) 3640 2177

job No **26441**
certificate No **441/AA**

client **OCEANIA TASMANIA**
project **COMSTOCK**
location **ZEEHAN**

date tested **14/09/01**
tested by **DLM**
sample No **L01/409a**

sample identification **SBA 1**
sampled by **Client**
sample description **Dark grey sandy silty clay**

date received **7/09/01**

Test Description	test method AS 1141	results	units	remarks
Gradation finer than AS sieve mm	11			
9.5			%	
6.7			%	
4.75		**100**	%	
2.36		**96**	%	
1.18		**92**	%	
0.600		**90**	%	
0.425		**90**	%	
0.300		**89**	%	
0.150		**79**	%	
0.075		**78**	%	

aggregate.xls - Dec 98

Approved Signatory
M.A.Maundrill

28/9/01
date of issue

MATERIAL QUALITY
SUMMARY OF TEST RESULTS

BFP

materials testing laboratories

369A Bass Highway Prospect Vale Tas 7250

Ph (03) 6340 2155 Fax (03) 3640 2177

job No **26441**

certificate No **441/AB**

client **OCEANIA TASMANIA**

project **COMSTOCK**

location **ZEEHAN**

date tested **14/09/01**

tested by **DLM**

sample No **L01/409b**

sample identification **SBA 2**

sampled by **Client**

sample description **Grey silty clay, some fine sand**

date received **7/09/01**

Test Description	test method AS 1141	results	units	remarks
Gradation finer than AS sieve mm	11			
9.5			%	
6.7			%	
4.75		**100**	%	
2.36		**99**	%	
1.18		**98**	%	
0.600		**96**	%	
0.425		**95**	%	
0.300		**93**	%	
0.150		**88**	%	
0.075		**82**	%	

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Approved Signatory
M.A.Maundrill

14/9/01
date of issue

MATERIAL QUALITY
SUMMARY OF TEST RESULTS

BFP
materials testing laboratories
369A Bass Highway Prospect Vale Tas 7250
Ph (03) 6340 2155 Fax (03) 3640 2177

job No **26441**
certificate No **441/AC**

client **OCEANIA TASMANIA**
project **COMSTOCK**
location **ZEEHAN**

date tested **14/09/01**
tested by **DLM**
sample No **L01/409c**

sample identification **SBA 3**
sampled by **Client**
sample description **Orange brown silty clayey sand**

date received **7/09/01**

Test Description	test method AS 1141	results	units	remarks
Gradation finer than AS sieve				
mm	11			
9.5			%	
6.7		100	%	
4.75		96	%	
2.36		90	%	
1.18		84	%	
0.600		79	%	
0.425		77	%	
0.300		75	%	
0.150		70	%	
0.075		62	%	

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date of issue

MATERIAL QUALITY
SUMMARY OF TEST RESULTS

BFP

materials testing laboratories

369A Bass Highway Prospect Vale Tas 7250

Ph (03) 6340 2155 Fax (03) 3640 2177

job No **26441**

certificate No **441/AD**

client	**OCEANIA TASMANIA**
project	**COMSTOCK**
location	**ZEEHAN**

date tested **14/09/01**

tested by **DLM**

sample No **L01/409d**

sample identification	**SBA 4**
sampled by	**Client**
sample description	**Grey/brown sandy silty clay**

date received **7/09/01**

Test Description	test method AS 1141	results	units	remarks
Gradation finer than AS sieve mm	11			
9.5			%	
6.7			%	
4.75		**100**	%	
2.36		**98**	%	
1.18		**95**	%	
0.600		**91**	%	
0.425		**89**	%	
0.300		**87**	%	
0.150		**81**	%	
0.075		**76**	%	

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MATERIAL QUALITY
SUMMARY OF TEST RESULTS

BFP
materials testing laboratories
369A Bass Highway Prospect Vale Tas 7250
Ph (03) 6340 2155 Fax (03) 3640 2177

job No **26441**
certificate No **441/AE**

client **OCEANIA TASMANIA**
project **COMSTOCK**
location **ZEEHAN**

date tested **14/09/01**
tested by **DLM**
sample No **L01/409e**

sample identification **SBA 5**
sampled by **Client**
sample description **Brown/grey silty clayey sand**

date received **7/09/01**

Test Description	test method AS 1141	results	units	remarks
Gradation finer than AS sieve mm	11			
9.5			%	
6.7		100	%	
4.75		98	%	
2.36		84	%	
1.18		74	%	
0.600		65	%	
0.425		61	%	
0.300		57	%	
0.150		48	%	
0.075		39	%	

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MATERIAL QUALITY
SUMMARY OF TEST RESULTS

BFP
materials testing laboratories
369A Bass Highway Prospect Vale Tas 7250
Ph (03) 6340 2155 Fax (03) 3640 2177

job No **26441**
certificate No **441/AF**

client **OCEANIA TASMANIA**
project **COMSTOCK**
location **ZEEHAN**

date tested **14/09/01**
tested by **DLM**
sample No **L01/409f**

sample identification **SBA 6**
sampled by **Client**
sample description **Dark grey sandy clayey silt**

date received **7/09/01**

Test Description	test method AS 1141	results	units	remarks
Gradation finer than AS sieve mm	11			
9.5			%	
6.7			%	
4.75		100	%	
2.36		98	%	
1.18		95	%	
0.600		91	%	
0.425		89	%	
0.300		86	%	
0.150		81	%	
0.075		76	%	

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MATERIAL QUALITY
SUMMARY OF TEST RESULTS

BFP
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369A Bass Highway Prospect Vale Tas 7250
Ph (03) 6340 2155 Fax (03) 3640 2177

job No **26441**
certificate No **441/AG**

client **OCEANIA TASMANIA**
project **COMSTOCK**
location **ZEEHAN**

date tested **14/09/01**
tested by **DLM**
sample No **L01/409g**

sample identification **SBA 7**
sampled by **Client**
sample description **Black sandy clayey silt**

date received **7/09/01**

Test Description	test method AS 1141	results	units	remarks
Gradation finer than AS sieve mm	11			
9.5			%	
6.7			%	
4.75			%	
2.36		**100**	%	
1.18		**95**	%	
0.600		**90**	%	
0.425		**88**	%	
0.300		**85**	%	
0.150		**80**	%	
0.075		**76**	%	

Approved Signatory
M.A.Maundrill

28/9/01
date of issue

MATERIAL QUALITY
SUMMARY OF TEST RESULTS

BFP
materials testing laboratories
369A Bass Highway Prospect Vale Tas 7250
Ph (03) 6340 2155 Fax (03) 3640 2177

job No **26441**
certificate No **441/AH**

client **OCEANIA TASMANIA**
project **COMSTOCK**
location **ZEEHAN**

date tested **14/09/01**
tested by **DLM**
sample No **L01/409h**

sample identification **SBA 8**
sampled by **Client**
sample description **Orange/brown gravelly sandy clay**

date received **7/09/01**

Test Description	test method AS 1141	results	units	remarks
Gradation finer than AS sieve mm	11			
9.5			%	
6.7		**100**	%	
4.75		**94**	%	
2.36		**84**	%	
1.18		**71**	%	
0.600		**62**	%	
0.425		**58**	%	
0.300		**55**	%	
0.150		**48**	%	
0.075		**42**	%	

aggregate.xls - Dec 98

Approved Signatory
M.A.Maundrill

28/9/01
date of issue

Appendix 3

Emersion Class Number Certificates

BFP
materials testing laboratories
369A Bass Highway Prospect Vale Tas 7250
ACN 073 692 270

Dispersion - Determination of Emerson class number of a soil
AS 1289.3.8.1

job No 26441

client **OCEANIA TASMANIA** date tested 19/10/01

project **COMSTOCK**

location **ZEEHAN ZINC**

sampled by: **Client** date received 7/09/01

Sample Identification	Sample Description	EMERSON CLASS NUMBER
L01/409/a SBA 1	Dark grey sandy silty clay	6
L01/409/b SBA 2	Grey silty clay some fine sand	6
L01/409/c SBA 3	Orange brown silty clayey sand	6
L01/409/d SBA 4	Grey/brown sandy silty clay	6
L01/409e SBA 5	Brown/grey silty clayey sand	6

Deionised water used. Temperature of water 17° C

Approved Signatory
M.A.Maundrill

22/10/01
date of issue

(d) If the soil slakes but does not disperse, obtain a few grams of air-dried soil and add distilled water to bring the soil to approximately the plastic limit. Remould at this moisture content with the spatula for 2 min. Roll three balls of this soil (six if reservoir or other contact water is also to be tested) about 3 mm in diameter. Repeat Step (b) with these remoulded balls (see Note 3).

(e) If the soil still does not disperse, check chemically for presence of calcium carbonate or calcium sulfate (see Note 4).

(f) If calcium carbonate or calcium sulfate is not present, prepare a 1:5 soil/water suspension by placing 2 g of original air-dried soil in the bottom of a test tube and adding 10 mL of water. Shake vigorously for 10 min. Record whether the suspension remains dispersed or flocculates, showing clear or almost clear water at the surface, within 5 min.

6 DETERMINATION OF EMERSON CLASS NUMBER If a soil slakes it belongs to one of Classes 1 to 6 (see Figure 1). If it does not slake it belongs to Class 7 or Class 8. The soil shall be classified as follows:

(a) *Class 1* Air-dried crumbs of soil shall show a strong dispersing reaction, i.e. a colloidal cloud shall cover nearly the whole of the bottom of the beaker, usually in a very thin layer. No fixed time can be set for observation of the dispersing reaction, but the reaction should be evident within about 10 min. In extreme cases all the water in the beaker becomes cloudy leaving only a coarse residue in a cloud of clay.

(b) *Class 2* Air-dried crumbs of soil shall show a moderate to slight reaction. A moderate reaction consists of an easily recognizable cloud of colloids in suspension usually spreading in thin streaks on the bottom of the beaker. A slight reaction consists of the bare hint of cloud in water at the surface of the crumbs.

(c) *Class 3* The soil remoulded at the plastic limit shall disperse in water.

(d) *Class 4* The remoulded soil shall not disperse in water and calcium carbonate nor shall calcium sulfate be present.

(e) *Class 5* The remoulded soil shall not disperse in water and the 1:5 soil/water suspension shall remain dispersed after 5 min.

(f) *Class 6* The remoulded soil shall not disperse in water and the 1:5 soil/water suspension shall begin to flocculate within 5 min.

(g) *Class 7* The air-dried crumbs of soil shall remain coherent in water and shall swell.

(h) *Class 8* The air-dried crumbs of soil shall remain coherent in water and shall not swell.

7 REPORTING OF RESULTS The following shall be reported:

(a) Emerson class number.

(b) Sample identification.

(c) Source of material.

(d) Date of sampling.

(e) Soil description.

(f) Type and temperature of water used for testing.

(g) Reference to this Standard, i.e. AS 1289.3.8.1.

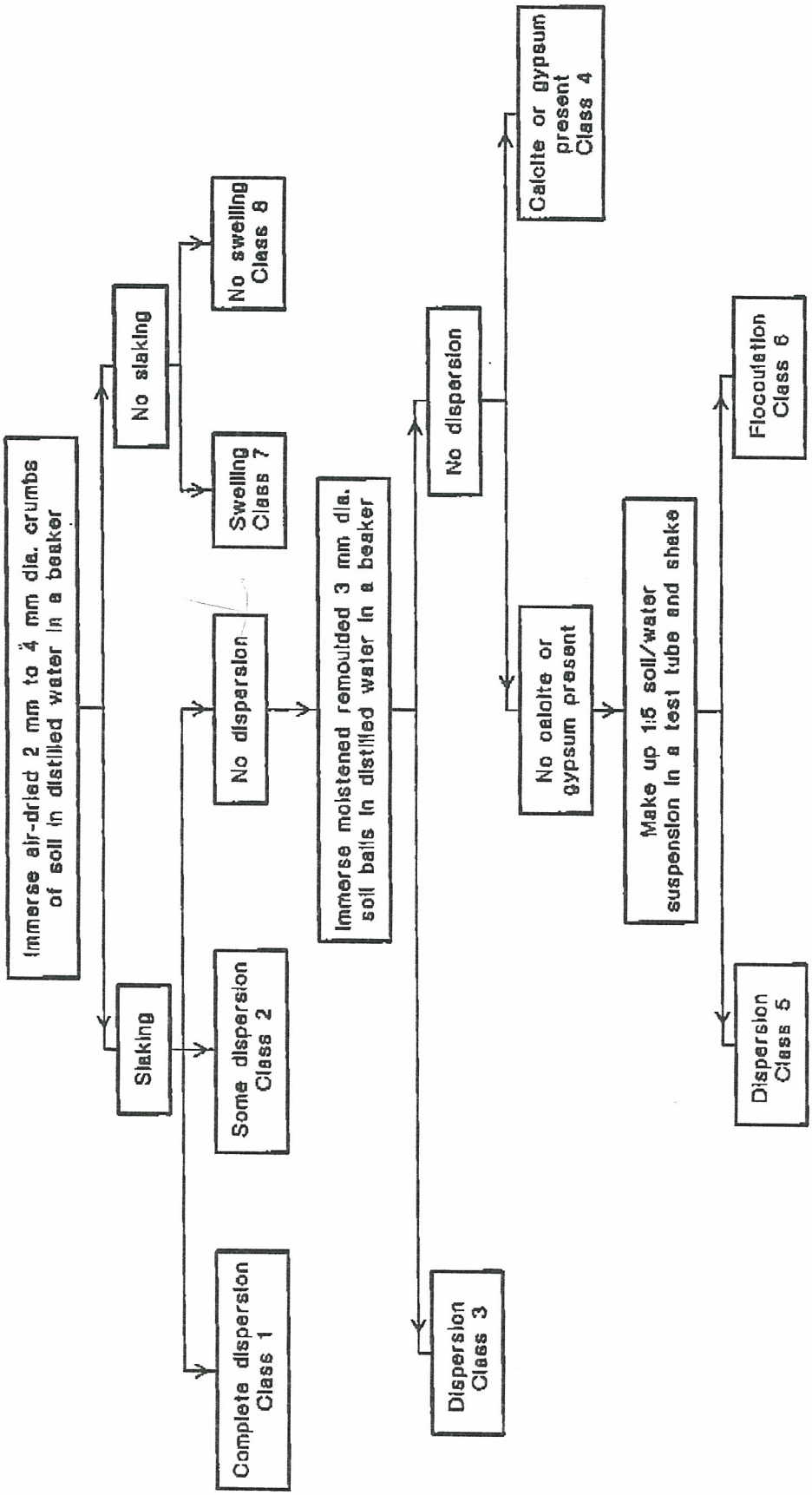

FIGURE 1 DETERMINATION OF THE EMERSON CLASS NUMBER OF A SOIL

NOTES:

1 *Slaking*—most dry soil crumbs slake (break up and run out along the bottom of the beaker in a flat pile) when immersed in water.

2 *Dispersion*—describes the tendency for the clay fraction of a soil to go into colloidal suspension in water.

3 *Calcite* is chemically calcium carbonate.

4 *Gypsum* is chemically calcium sulfate.