DAMES & MOORE PTY LTD

A DAMES & MOORE COMPANY

DAMES & MOORE PTY LTD
A DAMES & MOORE COMPANY

RTE 26820.

REPORT

Kintyre Uranium Project
Baseline Soils Survey

for
Canning Resources Pty Limited

DAMES & MOORE
Ref: JCB:sor/15780-017-365/DK:302-B642.1/PER
12 May 1997

Level 3, Hyatt Centre
20 Terrace Road
East Perth WA 6004
Tel: 09 221 1630
Fax: 09 221 1639
A.C.N. 003 293 696

DAMES & MOORE PTY LTD
A DAMES & MOORE COMPANY

ORIGINAL
Level 3, Hyatt Centre
20 Terrace Road, East Perth
Western Australia 6004
61-9-221 1630 Tel
61-9-221 1639 Fax
per@dames.com E-mail

12 May 1997

Ref: 15780-017-365
JKB/DK:350-D046/DOC/PER

Canning Resources Pty Limited
!st Floor, 2 Mill Street
PERTH 6000

Circ Ltr	Original
BRU	BRU
CL	
BR.	BR
LIBT	
CL-W	14/5/97

copy 1

Attention: Mr Chris Leiner

Dear Sir,

FINAL REPORT
KINTYRE URANIUM PROJECT
BASELINE SOILS SURVEY

Dames & Moore is pleased to present two copies of the above final report presenting the results of the soil investigation undertaken at Kintyre during 1996 and incorporating your comments received on 2 April 1997.

Should you wish to discuss any aspect of the report please do not hesitate to contact Mr John Barnett or Ms Cathy Gupanis.

Yours faithfully
DAMES & MOORE

B I Bell

Brian Bell
Principal
Environmental Services

TABLE OF CONTENTS

Page N°

1. INTRODUCTION 1

2. PROCEDURE 1

2.1 GENERAL 1
2.2 AIR PHOTOGRAPH INTERPRETATION 2
2.3 SOIL PROFILES 2
2.4 PERCOLATION TESTING 2
2.5 ESTABLISHMENT OF SOIL MONITORING SITES 3
2.6 DISPERSION TESTING 4

3. RESULTS OF INVESTIGATIONS 5

3.1 SOIL MAPPING 5
3.2 PERCOLATION TESTING 6
3.3 SOIL ANALYSES 7
3.4 SLAKING AND DISPERSION 12

4. IMPLICATIONS FOR ENVIRONMENTAL MANAGEMENT 13

4.1 INFILTRATION AND WATER-HOLDING CHARACTERISTICS 13
4.2 SUSCEPTIBILITY TO EROSION 13
4.3 EASE OF HANDLING 14
4.4 SUITABILITY FOR REHABILITATION 14
4.5 NUTRIENT STATUS 14

5. REFERENCES 15

LIST OF TABLES

1	Soil Mapping Units	5
2	Percolation Test Results	6
3	Soil Analyses	8

LIST OF FIGURES

1	Soils

LIST OF APPENDICES

A	Soil Profiles
B	Grain Size Analyses
C	Percolation Test Results
D	Certificates of Analysis
E	Soil Monitoring Sites, Sample Locations
F	Modified Emerson Crumb Test Results

REPORT
KINTYRE URANIUM PROJECT
BASELINE SOILS SURVEY
for
Canning Resources Pty Limited

1. INTRODUCTION

This report presents the results of a baseline soils investigation programme carried out in May 1996 for the Kintyre Uranium Project. The objectives of the programme were as follows:

- to describe the soils of the project area; and
- to determine the baseline levels of trace elements in the soils of the project area.

The defined scope of work included the following:

- to prepare a soils map and description of the soils of the project area;
- to evaluate the susceptibility of the soil to erosion, to assess the water-holding and infiltration characteristics of the soil, and its ease of handling and suitability for use in rehabilitation;
- to establish permanent soil monitoring sites across the project area; and
- to prepare a soils report, including the soil maps, and a description of the physical and nutrient status of soils in the project area.

2. PROCEDURE

2.1 GENERAL

The procedure for soil investigation and mapping was as follows:

- initial interpretation of distribution of soil units from air photographs;
- field investigation, including ground truthing of soil distribution, description of typical soil profiles, sampling of representative soil profiles for physical and chemical characterisations and percolation testing;
- establishment of 20 permanent soil monitoring points and sampling for baseline chemical analysis; and
- dispersion testing.

Each of the above items is described in detail below.

2.2 AIR PHOTOGRAPH INTERPRETATION

The distribution of soil units was delineated on colour air photographs.

Air photography of 1:5,000 scale was available for most of the mapped area, namely Kintyre Series ASA-C1052, flown 11 November 1988. In the northern part of the mapped area, beyond the coverage of the 1:5000 scale air photography, 1:10,000 scale air photography was used, namely Miles Ridge Series KC363, flown 29 October 1986.

2.3 SOIL PROFILES

Eleven pits were dug by backhoe to refusal depth, ranging from 0.9m to 2.2m. Sites were apportioned according to the relative prevalence of the various soil units.

The soil profiles in each of these pits were described in detail, and classified according to their principal profile from Northcote (1971) and the Great Soil Group classification (Stace *et al.* 1968). The soil profile descriptions are included as Appendix A.

Seven of the profiles were sampled at 500mm depth intervals for grain size analysis; testing was carried out by Western Geotechnics. The results are given in Appendix B.

2.4 PERCOLATION TESTING

Percolation testing was undertaken by the falling head method, according to AS1547-1994, in 60mm diameter hand-auger holes, excavated to 450mm depth.

At each site the bore was topped up with water and the rate of water level decline was measured.

This step was repeated up to 4 times until the rate of decline was constant, indicating that the soil was saturated. The hole was then refilled and the time recorded for the depth of water in the hole to fall from 250mm to 225mm.

The continuing drop in level was then measured for a further 100-150mm, for analysis by the inverted auger hole (Porchet) method. This is based on the same formula as the AS1547-1994 method, but uses data from a longer test duration.

For the AS1547-1994 method, the permeability of the soil was calculated from the following relationship:

$$P = \frac{2.14}{t}$$

where: P = permeability, m/day
t = time in minutes for the fall of 25mm in water depth from 250mm

For the Porchet method, analysis is based on the relationship:

$K = 1.15r \tan \alpha$

where: K = hydraulic conductivity (cm/sec)
r = radius of auger hole (cm)

and:

$$\tan \alpha = \frac{\log(h(t_i) + r/2) - \log(h(t_n) + r/2)}{t_n - t_i}$$

where: $h(t_1)$ = water level in the auger hole at time t_1 (cm)

The analysis is performed by plotting log ($h(t_1) + r/2$) against t_1 on semi-logarithmic graph paper which gives a straight line of tan α.

The Porchet method, being based on a longer test duration, is expected to give a more accurate estimate of permeability than the AS1547-1994 method.

The field data relating to the percolation testing are included as Appendix C; the field permeability values are included in Table 2.

2.5 ESTABLISHMENT OF SOIL MONITORING SITES

Twenty soil monitoring sites were established, and samples taken for chemical analysis to determine background levels of heavy metals, and major ion and nutrient content of the soils. The sites were selected to cover downwind and downstream locations from the proposed mining and processing areas, so that any future changes as a result of mining activities can be identified. The predominant wind direction throughout most of the year is from the south-southeast and southeast, with a subsidiary northwesterly component in spring. The predominant directions of surface drainage from the mining and processing areas are towards the northwest and northeast. The sites are shown on Figure 1.

A star picket was driven firmly into the ground at each site as a permanent reference point. The top 300mm of the star picket has been spray-painted red, and marked with red flagging tape. Each location has been provisionally surveyed by Global Positioning System (GPS), and will be surveyed accurately in due course. The locations have also been marked on air photographs.

Five samples were taken at random locations within a 10m radius of each star picket, the location of each sample being identified by bearing and distance from the reference peg.

For each sample, the surface 50mm of soil was loosened with a trowel, and a sample taken by hand to avoid metal contamination. The sample, of about 500g, was transferred to a plastic bag which was then sealed with tape.

The samples were submitted to Analabs Environmental, for the following analyses:

- Electrical Conductivity (EC)
- pH
- Total Soluble Salts (TSS)
- Major Cations: Sodium, Potassium, Calcium, Magnesium
- Nutrients: Total Nitrogen, Total Phosphorus
- Heavy Metals and Trace Elements: Iron, Manganese, Arsenic, Boron, Cadmium, Chromium, Copper, Lead, Zinc
- Radioactive Elements: Uranium, Thorium
- Calculated Parameters: Cation Exchange Capacity; Exchangeable Sodium, Exchangeable Potassium, Exchangeable Calcium and Exchangeable Magnesium as a percentage of Cation Exchange Capacity.

The certificates of analysis are included as Appendix D, and the locations of the soil monitoring and sampling sites as Appendix E.

2.6 DISPERSION TESTING

The potential of the soils for slaking or dispersion, as a result of water uptake, was evaluated by the Modified Emerson Crumb Test (after CSIRO Division of Applied Geomechanics Technical Memorandum 15).

Two small chips of each sample were placed in deionised water in a plastic beaker of 45mm diameter. The beaker was covered with plastic film to prevent evaporation and allowed to stand overnight.

For each sample it was recorded whether or not slaking occurred and the degree of dispersion was recorded following the standing of the sample overnight. The sample was then rated according to the appropriate Modified Emerson Class Number. The results of dispersion testing are included as Appendix F.

3. RESULTS OF INVESTIGATIONS

3.1 SOIL MAPPING

The distribution of soil units is shown on Figure 1. Seven units have been identified within the project area, as shown in Table 1 below. The corresponding simplified vegetation units mapped by Hart, Simpson and Associates Pty Ltd are also given in the table.

Table 1

Soil Mapping Units

Soil Mapping Unit	Vegetation Mapping Unit	Landform	Soil Material	Comments
Unit 1	Vetetation unit 1, part unit 3	Flat plains	Red, deep sand (>2m thick)	Featureless airphoto pattern with scattered trees
Unit 2	Part vegetation unit 2	Stony hills and scree slopes	Rock fragments in sandy loam, overlying weathered rock at 0.5 - 1.0m depth	Airphoto pattern generally light-coloured, vegetation concentrated in defined drainage lines. General cover of spinifex
Unit 3	Vegetation units 6 and 7	Claypan areas and old drainage lines	Red sandy loam and silty sand, sometimes with surficial layer of sand	Airphoto pattern mottled, with small light-coloured claypans and darker patches of vegetation
Unit 4	Part vegetation unit 3	Patches of aeolian sand and minor sand dunes	Red sand	Airphoto pattern similar to Unit 1, but slightly paler, and vegetation more evenly scattered
Unit 5	Part vegetation unit 5	Levee banks and alluvium marginal to major drainage lines	Red, loose sand	Airphoto pattern sinuous and linear zones, heavily vegetated, large trees
Unit 6	Vegetation unit 4	Active drainage lines. Alluvium	Sand with gravel bars and lenses	Airphoto pattern light-coloured with lines and islands of large trees
Unit 7	Part vegetation unit 2	Rocky hills and ridges	Rock outcrops with small patches of Unit 2 soils	Rock structure visible on airphotos

Soil Units 1, 4, 5 and 6 comprise siliceous sands with a PPF classification of Uc 1.23. Under the Australian Soil Classification (Isbell, 1996), Soil Unit 1 corresponds to Arenic and Stratic Rudosols, Soil Unit 4 to Arenic Rudosol, Soil Unit 5 to Stratic Rudosol, and Soil Unit 6 to Arenic Rudosol. Soil Unit 2 has a PPF classification of K-Uc 1.23, corresponding to Leptic Rudosol. Soil Unit 3 is an

earthy sand of Uc 5.21, corresponding to Orthic Tenosol. The Australian Soil Classifications are described in the glossary.

Detailed descriptions of soil profiles in backhoe pits are set out in Appendix A, and grain size analyses in Appendix B. The locations of the backhoe pits in which the soil profiles were described are shown on Figure 1.

3.2 PERCOLATION TESTING

The results of percolation tests are summarised in Table 2 below, and details of the tests are given in Appendix C.

Table 2

Percolation Test Results

Site	Soil Unit	Coordinates (GPS)		Permeability (m/day)		Remarks
		m East	m North	AS1547-1994	Porchet	
PT 01	1	0403917	7529700	8.6	6.0	20m north of soil profile No. SP2
PT02	3	0402797	7529246	0.32	0.25	12m north of soil monitoring site No. SM2
PT03	1	0401429	7532186	1.0	1.6	Adjacent to soil profile No. SP6
PT04	1	0401866	7532549	2.7	1.8	Near soil monitoring site No. SM11
PT05	3	0402629	7530975	0.64	0.46	Adjacent to soil monitoring point No. SM13
PT06	3	0402414	7530643	0.11	0.11	Adjacent to soil monitoring point No. SM5
PT07	5	0405010	7531302	1.6	1.5	Adjacent to soil profile No. SP8

The Porchet analysis results are probably more reliable, as discussed in Section 2.4.

The permeability for Soil Unit 1, deep sand, therefore shows a measured range of 1.6-6m/day, and Soil Unit 3, sandy loam and silty sand, a range of 0.1-0.5m/day. Soil Unit 5, loose sand, gave a value of 1.5m/day, similar to Soil Unit 1. Soil Units 4 and 6 although not measured are expected to be at least as permeable as Soil Unit 1, from their sandy lithology. Soil Unit 2 would be of varying

permeability, depending on the nature of the bedrock from which it is derived, but is expected to be generally similar to Soil Unit 3.

3.3 SOIL ANALYSES

The results of soil analysis are set out in Table 3, and Certificates of Analysis included as Appendix D.

For seventeen of the 20 monitoring sites, five samples were bulked and analysed as a composite. For three selected sites (SM10, SM12 and SM17), each of the five sub-samples was analysed separately to determine the degree of variation at individual sites. Five composite samples (SM21-SM25) were also submitted as duplicates (undisclosed to the laboratory), to determine the reliability of test results.

The samples were analysed by Analabs, but the sub-samples were analysed by a subsidiary of Analabs, namely Genalysis. Comparison of the results shows some differences between the two sets of samples, the Genalysis results being generally higher in pH (more alkaline), total soluble salts and iron; the other parameters are similar for both sets of analyses.

The soil monitoring sites are mainly located in Soil Units 1 and 3, with one site in Soil Unit 4.

Soil Unit 3 generally shows higher levels of total soluble salts, total nitrogen, total phosphorus, and higher capacity for cation exchange. Otherwise the levels for other constituents are in the same range. Values for Soil Unit 4 are within the same range as Soil Unit 1 except for the iron content, which is higher for Soil Unit 4.

TABLE 3

SOIL ANALYSES

Sample No.	Soil Unit	pH	TSS (mg/kg)	Major Ions (mg/kg)				Cation Exchange Capacity (meq/100g)*					Fe (mg/kg)
				Ca	K	Mg	Na	Ca	K	Mg	Na	Total	
SM1	1	6.15	45	200	220	290	12	1.0	0.06	0.38	<0.01	1.4	5,300
SM2	3	6.25	96	360	390	520	70	1.2	0.13	0.50	<0.01	1.8	7,200
SM21	3	6.20	83	390	390	540	64	1.3	0.11	0.53	0.03	2.0	7,800
SM3	1	6.20	35	340	320	360	9	1.3	0.08	0.49	0.04	1.9	6,600
SM4	1	6.00	50	140	260	190	<5	0.60	0.08	0.20	0.02	0.90	5,100
SM5	1	5.90	20	110	260	200	30	0.50	0.06	0.17	0.04	0.77	8,000
SM6	1	5.80	17	86	240	180	8	0.33	0.02	0.13	<0.01	0.48	8,000
SM22	1	5.75	19	80	230	180	20	0.32	0.04	0.15	<0.01	0.51	7,500
SM7	1	6.05	44	130	220	180	<5	0.52	0.06	0.16	<0.01	0.74	7,500
SM8	3	5.80	400	360	510	390	120	1.4	0.21	0.49	0.05	2.2	7,400
SM23	3	5.85	490	360	460	410	64	1.3	0.20	0.47	0.03	2.0	9,100
SM9	1	6.30	58	160	210	120	<5	0.76	0.10	0.18	0.03	1.1	5,200
SM24	1	6.05	44	160	180	110	<5	0.71	0.05	0.17	0.05	0.98	5,100
SM10a	1	5.60	23	240	320	150	35	0.30	<0.01	0.12	0.10	0.52	7,300
SM10b	1	5.30	26	440	470	220	48	0.30	0.02	0.09	0.05	0.46	9,700
SM10c	1	5.50	24	140	340	140	35	0.22	0.03	0.09	0.03	0.37	8,800
SM10d	1	5.50	16	180	600	210	40	0.22	<0.01	0.08	<0.01	0.30	12,000
SM10e	1	5.70	19	140	530	180	27	0.31	0.02	0.12	<0.01	0.45	13,000
SM11	1	5.90	28	86	160	110	10	0.34	0.03	0.13	0.06	0.56	4,500
SM12a	1	6.25	24	330	670	280	57	0.60	0.04	0.27	<0.01	0.91	11,000

TABLE 3 (*cont'd*)

Sample No.	Soil Unit	pH	TSS (mg/kg)	Major Ions (mg/kg)				Cation Exchange Capacity (meq/100g)*					Fe (mg/kg)
				Ca	K	Mg	Na	Ca	K	Mg	Na	Total	
SM12b	1	5.90	21	170	640	270	27	0.50	0.06	0.24	0.03	0.83	13,000
SM12c	1	6.05	25	220	750	310	47	0.58	0.09	0.26	0.06	0.99	13,000
SM12d	1	6.15	45	320	610	300	38	0.84	0.22	0.23	0.03	1.3	14,000
SM12e	1	6.10	21	240	690	340	41	0.65	0.08	0.27	0.17	1.2	12,000
SM13	3	5.90	170	170	290	230	16	0.97	0.19	0.22	0.03	1.4	6,100
SM14	1	6.25	24	120	320	390	<5	0.63	0.04	0.24	<0.01	0.91	5,700
SM25	1	5.85	50	120	300	360	21	0.45	0.04	0.22	0.06	0.77	5,600
SM15	1	5.80	47	210	440	570	22	0.80	0.06	0.30	0.01	1.2	6,300
SM16	1	6.05	54	210	560	830	18	0.67	0.06	0.33	<0.01	1.1	5,300
SM17a	1	5.90	19	180	450	220	26	0.38	0.03	0.16	0.10	0.67	11,000
SM17b	1	5.90	38	280	470	220	33	0.64	0.15	0.19	<0.01	0.98	11,000
SM17c	1	5.95	18	170	410	210	19	0.42	0.04	0.16	<0.01	0.62	12,000
SM17d	1	6.00	37	160	590	280	15	0.52	0.14	0.30	<0.01	0.96	14,000
SM17e	1	5.90	17	170	420	200	36	0.32	0.02	0.16	<0.01	0.50	13,000
SM18	1	6.15	77	260	410	910	12	0.83	0.10	0.41	<0.01	1.3	5,800
SM19	1	5.80	17	70	240	230	42	0.24	0.03	0.13	0.02	0.42	7,800
SM20	4	6.10	55	140	160	130	160	0.57	<0.01	0.11	<0.01	0.68	10,000

Note: * Results from Analabs in-house method of analysis of 1:50 extraction in 1m ammonium acetate at pH 7.

TABLE 3 (*cont'd*)

Sample No.	Mn (mg/kg)	Heavy Metals and Trace Elements (mg/kg)							Radioactive Elements (mg/kg)		Nutrients (mg/kg)		Remarks
		As	B	Cd	Cr	Cu	Pb	Zn	U	Th	Total N	Total P	
SM1	160	1.5	57	<0.5	15	<5	<5	9	0.68	5.3	140	51	
SM2	180	1.4	44	<0.5	17	6	<5	18	0.81	6.3	180	76	
SM21	180	1.8	59	<0.5	16	6	<5	13	0.84	6.3	230	71	Duplicate of SM2
SM3	140	1.6	40	<0.5	19	7	<5	13	0.84	6.4	140	60	
SM4	120	1.3	31	<0.5	16	5	<5	7	0.77	6.4	170	50	
SM5	190	1.4	48	<0.5	18	5	<5	8	0.94	8.0	100	48	
SM6	130	1.4	44	<0.5	17	<5	<5	9	0.96	8.4	110	46	
SM22	160	1.5	67	<0.5	21	6	<5	6	0.88	6.9	110	39	Duplicate of SM6
SM7	99	1.4	29	<0.5	17	5	<5	7	0.88	6.6	120	48	
SM8	180	2.2	29	<0.5	20	6	5	20	1.2	8.6	380	99	
SM23	170	1.4	54	<0.5	19	7	7	18	1.2	8.5	350	94	Duplicate of SM8
SM9	73	1.4	42	<0.5	16	<5	<5	8	1.1	7.7	180	46	
SM24	82	1.3	43	<0.5	15	<5	<5	6	0.75	6.5	170	33	Duplicate of SM9
SM10a	64	5.0	<50	<0.5	16	8	<5	<5	0.7	4.7	180	32	
SM10b	61	83	<50	<0.5	20	28	<5	6	0.8	6.0	280	42	
SM10c	79	4.3	<50	<0.5	17	9	<5	5	0.5	4.0	170	32	
SM10d	120	27	<50	<0.5	21	16	<5	<5	0.6	5.8	180	36	
SM10e	130	4.1	<50	<0.5	22	10	<5	<5	0.6	5.4	180	35	

TABLE 3 (*cont'd*)

Sample No.	Mn (mg/kg)	Heavy Metals and Trace Elements (mg/kg)							Radioactive Elements (mg/kg)		Nutrients (mg/kg)		Remarks
		As	B	Cd	Cr	Cu	Pb	Zn	U	Th	Total N	Total P	
SM11	49	1.3	28	<0.5	16	<5	<5	11	0.70	6.2	110	37	
SM12a	100	15	<50	<0.5	21	11	<5	7	0.8	5.6	240	60	
SM12b	140	3.6	<50	<0.5	23	11	6	7	0.8	6.4	200	89	
SM12c	130	7.2	<50	<0.5	24	11	<5	7	0.8	6.0	210	87	
SM12d	120	2.7	<50	<0.5	22	11	<5	6	0.7	5.2	260	64	
SM12e	110	3.3	<50	<0.5	24	9	<5	7	0.9	6.0	220	83	
SM13	42	1.1	31	<0.5	17	<5	<5	10	0.97	7.7	200	65	
SM14	65	0.8	40	<0.5	16	<5	<5	8	0.81	6.4	90	51	
SM25	62	1.0	37	<0.5	16	5	<5	7	0.81	6.0	130	46	Duplicate of SM14
SM15	86	1.1	26	<0.5	18	<5	<5	12	1.0	7.8	240	59	
SM16	79	0.5	44	<0.5	16	<5	<5	10	1.1	8.3	100	47	
SM17a	120	1.9	<50	<0.5	22	8	<5	<5	0.7	4.5	280	53	
SM17b	94	2.8	<50	<0.5	19	8	<5	5	0.6	3.3	230	<10	
SM17c	106	1.6	<50	<0.5	22	7	<5	<5	0.7	4.3	130	53	
SM17d	140	4.8	<50	<0.5	26	9	<5	7	1.0	5.6	200	66	
SM17e	110	1.3	<50	<0.5	22	7	<5	5	0.6	3.8	160	48	
SM18	96	0.8	45	<0.5	20	5	<5	17	1.0	7.7	100	61	
SM19	33	0.8	59	<0.5	18	5	9	14	0.91	4.7	70	36	
SM20	210	1.5	52	<0.5	20	5	120	18	0.99	5.0	180	36	

In summary, the general range of baseline values for each parameter are as follows:

- pH: 5.8 - 6.3
- Total Soluble Salts: Soil Units 1 and 4: 17-77mg/kg
  Soil Unit 3: 83-490mg/kg
- Cation Exchange Capacity: Soil Units 1 and 4: 0.4 - 1.3meq/100g
  Soil Unit 3: 1.4 - 2.2meq/100g
- Iron: Soil Units 1 and 3: 4,500 - 8,000mg/kg
  Soil Unit 4: 10,000mg/kg
- Manganese: 33 - 210mg/kg
- Arsenic: 0.8 - 2.2mg/kg
- Boron: 26 - 67mg/kg
- Cadmium: <0.5mg/kg
- Chromium: 15 - 21mg/kg
- Copper: <5 - 7mg/kg
- Lead: <5 - 9mg/kg
- Zinc: <5 - 20mg/kg
- Uranium: 0.5 - 1.2mg/kg
- Thorium: 5.0 - 8.6mg/kg
- Total Nitrogen: Soil Units 1 and 4: 70 - 240mg/kg
  Soil Unit 3: 180 - 380mg/kg
- Total Phosphorus: Soil Units 1 and 4: 33 - 61mg/kg
  Soil Unit 3: 65 - 99mg/kg

3.4 SLAKING AND DISPERSION

Twenty-nine samples from profiles excavated in Soil Units 1, 3, 4 and 5 were tested for slaking and dispersion by the Modified Emerson Crumb Test. (CSIRO Tech. Memo 15). The test details are included as Appendix F.

Most samples showed immediate or rapid slaking, except for a few surface samples, and two samples of sandy loam from Soil Unit 3.

Most samples did not disperse. Four deeper (40-50cm and 90-100cm) samples of Unit 3 soils showed moderate to slight (Class 2) dispersion, as did two deeper samples (90-100cm and 140-150cm) from Soil Unit 1 in Soil Profile No. 7.

The soils therefore generally correspond to Modified Emerson Class 4/7M or 8M, and should cause no problems during mining. The samples which show moderate to slight dispersion correspond to Class 2M. Such materials could give problems due to erosion if exposed and unprotected from surface runoff. They may also create stability problems if present at the base of spoil piles.

4. IMPLICATIONS FOR ENVIRONMENTAL MANAGEMENT

4.1 INFILTRATION AND WATER-HOLDING CHARACTERISTICS

Soil Units 1, 4, 5 and 6 are essentially permeable sands, with measured permeability in the range 1.5-6m/day. These soils will allow rapid infiltration, and have poor water-holding characteristics.

Soil Unit 2 consists of colluvial soils on steeper slopes, where runoff coefficients are high. The infiltration and water-holding characteristics vary with the rock type from which these soils are derived. They generally have a loamy matrix, with slow infiltration and fair water-holding characteristics.

Soil Unit 3, which consists of sandy loam and silty sand, is less permeable than Soil Units 1, 4, 5 and 6, with measured permeability in the range 0.1-0.5m/day. Infiltration is therefore slow, and ponding occurs at the surface after heavy rains, leading to the formation of superficial clay pans. Water-holding characteristics are fair.

Soil Unit 7 is essentially bare rock, with poor infiltration and water-holding characteristics.

4.2 SUSCEPTIBILITY TO EROSION

Soil Units 1, 4, 5 and 6 generally have cohesionless or low cohesive soil structure, and are thus susceptible to erosion by water or wind. Soil Units 1, 4 and 5 are generally protected by vegetation under natural conditions and are located topographically on low-lying plains. They are thus located in generally stable areas. These units are also permeable, so that little runoff is generated, and potential rates of erosion are low. Soil Unit 6, being within active drainage channels, is highly mobile during each flood event.

Soil Unit 3 is more cohesive, and is thus resistant to erosion, unless broken up by vehicle traffic.

Soil Unit 2, although generally quite cohesive, is commonly more subject to erosion because of its topographic position on steeper slopes. If the cover of vegetation is removed by fire or other causes, then erosion is likely to result.

Soil Unit 7 is highly resistant to erosion, as it consists mainly of bare rock, with only small patches of skeletal soil.

The subsoil and deeper soil horizons in Soil Units 1 and 3 may be slightly to moderately dispersive (see Section 3.4). Where dispersive soil layers occur, they may be prone to gully erosion if they are exposed as a result of earthworks and remain unprotected from the effects of concentrated surface/subsurface runoff.

4.3 EASE OF HANDLING

Soil Units 1, 4, 5 and 6 can be readily excavated by backhoe and are consequently easy to handle.

Soil Unit 3 is more cohesive and although it can still be excavated by backhoe, such excavation is slower and requires more effort.

Soil Unit 2 is difficult to excavate by backhoe, particularly with increasing depth, because of the high content of rock fragments.

Soil Unit 7 can generally not be excavated without preliminary blasting.

4.4 SUITABILITY FOR REHABILITATION

Soil Units 1, 3, 4 and 5, although predominantly of sandy texture in the surficial soil horizons, are suitable for use in rehabilitation. The top 150mm of the profile in each case should be excavated, stored and replaced separately, to preserve seedstock, organic matter and any soil nutrients in the uppermost part of the soil profile. Subsoil material to depths of 300-500mm should also be retained and stockpiled separately for use in rehabilitation.

Soil Unit 6 consists of sand and gravel in active drainage channels and is generally unsuitable for use in rehabilitation. Soil Units 2 and 7 are unsuitable for rehabilitation.

4.5 NUTRIENT STATUS

Exchangeable cations are an important source of plant nutrients. Although the absolute values of exchangeable cations are not good indicators of availability (Baker, 1991), in general the following levels are sufficient for plant nutrition:

Ca: 2meq/100g
Mg: 2meq/100g
K: >0.25meq/100g in sands and sandy loams
>0.30meq/100g in loams and clay loams

Soil analyses for the study area show low levels of Cation Exchange Capacity, below the sufficiency levels listed above. Recorded levels in the study area are as follows:

Soil Units 1 and 4:	Ca:	0.22 - 1.3meq/ 100g
	Mg:	0.08-0.49meq/100g
	K:	<0.01 - 0.22meq/100g
Soil Unit 3:	Ca:	0.97 - 1.4meq/100g
	Mg:	0.22 - 0.53meq/100g
	K:	0.11 - 0.21meq/100g

The major nutrient content of Soil Units 1 and 4, as measured at surface monitoring sites, ranges from 70-280mg/kg Total Nitrogen, and from less than 10 to 89mg/kg Total Phosphorus. Soil Unit 5 would be expected to be similar.

Soil Unit 3 has a slightly higher nutrient content, ranging from 180-380mg/kg Total Nitrogen, and 65-99mg/kg Total Phosphorus.

The content of minor nutrients is moderate for copper, high for boron and manganese, and very high for iron, as shown in Table 3.

5. REFERENCES

Baker, D.E. (1991). Interpreting Soil Analyses from Soil Surveys Conducted in Queensland. Queensland Department of Primary Industries, Agricultural Chemistry Branch, Bulletin QB91001.

Emerson, W.W. and Seedsman, R.W. A Field Test to Predict the Behaviour of Overburden Materials during Mining: Modified Emerson Crumb Test. CSIRO Technical Memorandum No. 15.

Isbell, R.F. (1996). Australian Soil and Land Survey Handbook: The Australian Soil Classification. CSIRO Publishing.

Northcote, K.H. (1971). A Factual Key for the Recognition of Australian Soils. Rellim, Glenside S.A.

Stace *et al.* (1968). A Handbook of Australian Soils. Rellim, Glenside S.A.

* * *

Respectfully submitted
DAMES & MOORE

for J.C. Barnett
Consultant Hydrogeologist

GLOSSARY

Rudosol — Soils with negligible (rudimentary) pedologic organisation apart from (a) minimal development of an A1 horizon which does not meet the requirement for a **Leptic Tenosol**, or (b) the presence of less than 10% of B *horizon* material (including pedogenic carbonate) in fissures in the parent rock or saprolite. There is little or no texture or colour change with depth unless stratified, or buried soils are present. The soils are apedal or only weakly structured in the A1 horizon and show no pedological colour changes apart from the darkening of an A1 horizon. Hydrosols are excluded on the basis that these will normally show some pedological development, e.g. mottling.

Arenic — Soils in which at least the upper 0.5 m of the profile is non-gravelly (<2%>2mm) throughout, either loose or only weakly coherent both moist and dry, and the texture is sandy (i.e. S-LS-CS, up to 10% clay). Aeolian cross-bedding may be present but there is little if any evidence of other stratification or buried soils.

Stratic — Soils in which at least the upper 0.5m of the profile consists dominantly of *unconsolidated mineral materials* which are distinct, not or only slightly gravelly (<10%>2mm) sedimentary layers or buried soils but salinity is not high (EC <2 dS m^{-1}; 1:5 H_2O).

Leptic — Other soils that are underlain within 0.5m of the surface by a *calcrete pan; hard* unweathered rock or other *hard* materials; or partially weathered or decomposed rock or saprolite.

Tenosol — Soils other than Organasols, Hydrosols and Calcarosols with one or more of the following:

- A peaty horizon;
- A humose, melacic or melanic horizon which overlies hard unweathered rock, partially weathered or decomposed rock or saprolite, or unconsolidated mineral materials;

- A horizons which meet all the conditions for a peaty, humose, melacic or melanic horizon except the depth requirement, and which overlie hard unweathered rock, partially weathered or decomposed rock or saprolite, or unconsolidated mineral material;
- A1 horizons which have more than a weak development of structure and which directly overlie hard unweathered rock, partially weathered or decomposed rock or saprolite, or unconsolidated mineral materials;
- An A2 horizon which directly overlies hard unweathered rock or other hard materials, of partially weathered or decomposed rock or saprolite or, of unconsolidated mineral materials;
- Either a tenic B horizon, or a B2 horizon with 15% clay (SL-) or less, or a transitional horizon (C/B) occurring in fissures in the parent rock or saprolite which contains between 10 and 50% of B horizon material (including pedogenic carbonate).

Orthic

Other soils with a tenic B horizon, or a B2 horizon with 15% clay (SL-) or less, or a transitional horizon (C/B) occurring in fissures in the parent rock or saprolite which contains between 10 and 50% of B horizon material (including pedogenic carbonate).

400 000mE 402 000mE 404 000mE 406 000mE

7 532 000mN

7 530 000mN

7 528 000mN

0 500 1000

SCALE 1 : 25 000

SM 1 Soil Monitoring site

SP 1 Soil Profile site

Tracks

Limit of survey

SOIL UNIT No.	SOIL DESCRIPTION
1	Red, deep sand on flat plains
2	Rock fragments in sandy loam matrix, on stony hills and scree slopes
3	Red sandy loam and silty sand on claypan areas and old drainage lines
4	Red sand, aeolian, in scattered patches and minor dunes
5	Red loose sand, alluvial, levee banks and marginal to major drainage lines
6	Loose sand with gravel bars and lenses, in active drainage lines
7	Rock outcrops, minor colluvium

Airstrip

Camp Tracy

SM 1 SM 2 SM 3 SM 4 SM 5 SM 6 SM 7 SM 8 SM 9 SM 10 SM 11 SM 12 SM 13 SM 14 SM 15 SM 16 SM 17 SM 18 SM 19 SM 20

SP 1 SP 2 SP 3 SP 4 SP 5 SP 6 SP 7 SP 8 SP 9 SP 10 SP 11

Canning Resources Pty Limited
KINTYRE URANIUM PROJECT
BASELINE SOILS SURVEY

SOILS

DAMES & MOORE

FIGURE 1

Appendix A

Soil Profiles

DAMES & MOORE	Project: Canning Resources - Kintyre		Job No: 15780-017-365	Site No: SP1	Map Unit: 3
Landform: Flat plain, toe of long colluvial slope		Surface Slope: Very gentle	Local Relief: Level plain	Location (GPS): 51K 0402675 UTM 7528885	
Vegetation: Tussock, patches of hummock spinifex		Erosion: Stabilised		Date: 15/5/96	Logged by: JCB & SVC
Geology: Cainozoic alluvial plain	Micro-relief: Very uneven	Surface Drainage: Well drained		Groundwater: -	
Substrate: Quartz colluvium	Surface Stone: Scattered patches of gravel and pebbles	Profile Drainage Slowly permeable		Permeability:	
Exposure Type: Backhoe pit	Surface Condition: Soft, surface crust	Soil Classification:	GSG Earthy Sand / PPF Uc 5.21 / Aust. Soil Class Orthic Tenosol		

Soil Profile Description — **Comment:** — **Photo No:** Kintyre 4/6086

Depth	Soil Horizon	Texture (USG, plasticity, moisture, consistency)	Colour	Mottles	Structure	Coarse fragments	Segregations/ Inclusions	Field Tests: pH	Field Tests: EC (mS)	Field Tests	Samples
0-10cm	A	Coarse sand, dry, weak, slightly sticky, non-plastic, slight layering and partings in top 3cm, rest is structureless	Red 10R 4/6	None	Very massive	Rare quartz pebbles	Nil				-
10-30cm	B	As above	Red 10R 4/6	None	Massive	Rare quartz pebbles	Nil				-
30-50cm		Clayey sand, dry, very firm, slightly sticky, slightly plastic	Red 10R 4/6	None	Very massive	Rare quartz pebbles	Nil				-
50-85cm		As above	Red 10R 4/6	None	Massive	Rare quartz pebbles	Nil				-
85-110cm		Angular quartz up to 50mm in a matrix as above; matrix 10% quartz pebbles	Red 10R 4/6	None	Very massive	Angular quartz up to 50mm diameter	Nil				-

DAMES & MOORE	Project: Canning Resources - Kintyre		Job No: 15780-017-365	Site No: SP2	Map Unit: 1
Landform: Alluvial plain mid slope		**Surface Slope:** Gently inclined	**Local Relief:** Level plain	**Location (GPS):** 51K 0403833 UTM 7529663	
Vegetation: Hummock (spinifex)		**Erosion:** Stabilised		**Date:** 15/5/96	**Logged by:** JCB & SVC
Geology: Cainozoic alluvial plain	**Micro-relief:** Mounds around hummocks	**Surface Drainage:** Rapidly draining		**Groundwater:** -	
Substrate: ?	**Surface Stone:** Nil	**Profile Drainage** Moderately permeable		**Permeability:**	
Exposure Type: Backhoe pit	**Surface Condition:** Soft, surface crust	**Soil Classification:**	**GSG** Siliceous Sand / **PPF** Uc 1.23	**Aust. Soil Class** Arenic Rudosol	

Soil Profile Description				Comment:							Photo No: Kintyre 3/6070
Depth	**Soil Horizon**	**Texture (USG, plasticity, moisture, consistency)**	**Colour**	**Mottles**	**Structure**	**Coarse fragments**	**Segregations/ Inclusions**	**Field Tests**			**Samples**
								pH	**EC (mS)**		
0-10cm		Coarse sand, dry, non-plastic, non-sticky, weak	Red 10R 4/6	None	Massive	Nil	Nil				-
10-30cm		As above	Red 10R 4/6	None	Massive	Nil	Nil				-
30-50cm		As above	Red 10R 4/6	None	Massive	Nil	Nil				-
50-100cm		As above	Red 10R 4/6	None	Massive	Nil	Nil				-
1.0m-1.5m		As above, 1.0m down to base of pit at 2.0m; 5% quartz gravel	Red 10R 4/6	None	Massive	Nil	Nil				-
2.0m		Base of pit	Red 10R 4/6	None	Massive	Nil	Nil				-

DAMES & MOORE	**Project:** Canning Resources - Kintyre		**Job No:** 15780-017-365	**Site No:** SP3	**Map Unit:** 4
Landform: Sand dune, base of sand dune		**Surface Slope:** Moderately inclined	**Local Relief:** Mid slope	**Location (GPS):** 51K 0403934 UTM 7530094	
Vegetation: Hummock (spinifex)		**Erosion:** Stabilised		**Date:** 15/5/96	**Logged by:** JCB & SVC
Geology: Quaternary sand dune	**Micro-relief:** Mounds around hummocks	**Surface Drainage:** Rapidly draining		**Groundwater:** -	
Substrate: Scree	**Surface Stone:** Nil	**Profile Drainage** Moderately permeable		**Permeability:**	
Explosure Type: Backhoe pit	**Surface Condition:** Soft, surface crust	**Soil Classification:**	**GSG** Siliceous Sand / **PPF** Uc 1.23	**Aust. Soil Class** Arenic Rudosol	

Soil Profile Description				**Comment:**							**Photo No:** Kintyre 3/6070
Depth	**Soil Horizon**	**Texture (USG, plasticity, moisture, consistency)**	**Colour**	**Mottles**	**Structure**	**Coarse fragments**	**Segregations/ Inclusions**	**Field Tests**			**Samples**
								pH	**EC (mS)**		
0-10cm		Coarse sand, dry, non-plastic, non-sticky, loose	Red 10R 4/6	None	Single grain	Nil	Nil				0-10cm
10-30cm		As above	Red 10R 4/6	None	Single grain	Rare quartz	Nil				-
30-50cm		As above, rare quartz fragments	Red 10R 4/6	None	Single grain	Rare quartz	Nil				40-50cm
50-100cm		As above	Red 10R 4/6	None	Single grain	Rare quartz	Nil				90-100cm
100-135cm		As above	Red 10R 4/6	None	Single grain	Rare quartz	Nil				-
135-160cm		As above, 10% quartz gravel up to 30cm in diameter, subangular to subrounded	Red 10R 4/6	None	Single grain	Rare quartz	Nil				140-150cm
160-190cm		Gravel up to 60mm, quartz, some ironstone, subangular with approx. less than 5% sand matrix as above; loose	Red 10R 4/6	None	Single grain	Rare quartz	Nil				-

DAMES & MOORE	Project: Canning Resources - Kintyre		Job No: 15780-017-365	Site No: SP4	Map Unit: 3
Landform: Flat plain	**Surface Slope:** Level	**Local Relief:** Level plain		**Location (GPS):** 51K 0401986 UTM 7530391	
Vegetation: Tussock grass	**Erosion:** Stabilised			**Date:** 15/5/96	**Logged by:** JCB & SVC
Geology: Cainozioc alluvial plain	**Micro-relief:** Sparse mounds around tussocks	**Surface Drainage:** Imperfectly drained		**Groundwater:** -	
Substrate: ?	**Surface Stone:** Nil	**Profile Drainage** Moderately permeable		**Permeability:**	
Explosure Type: Backhoe pit	**Surface Condition:** Surface flake	**Soil Classification:**	**GSG** Earthy Sand / **PPF** Uc 5.21	**Aust. Soil Class** Orthic Tenosol	

Soil Profile Description — **Comment:** — **Photo No:** Kintyre 2/6048

Depth	Soil Horizon	Texture (USG, plasticity, moisture, consistency)	Colour	Mottles	Structure	Coarse fragments	Segregations/ Inclusions	Field Tests: pH	Field Tests: EC (mS)	Field Tests	Samples
0-10cm		Sandy loam, dry, moderately plastic, slightly sticky, firm	Red 10R 4/6	None	Massive	Nil	Nil				0-10cm
10-30cm		Sandy loam, dry, slightly sticky, moderately plastic, firm - as above	Red 10R 4/6	None	Massive	Nil	Nil				-
30-50cm		Sandy loam, dry, very firm to strong, slightly sticky, moderately plastic	Red 10R 4/6	None	Massive	Nil	Nil				40-50cm
50-100cm		Sandy loam, dry, slightly sticky, moderately plastic, strong	Red (weak) 10R 4/4	None	Massive	Nil	Nil				90-100cm
100-160cm		As above	Red (weak) 10R 4/4	None	Massive	Nil	Nil				140-150cm

DAMES & MOORE	**Project:** Canning Resources - Kintyre		**Job No:** 15780-017-365	**Site No:** SP5	**Map Unit:** 3
Landform: Flat plain	**Surface Slope:** Level	**Local Relief:** Level plain		**Location (GPS):** 51K 0402414 UTM 7530643	
Vegetation: Tussock grass	**Erosion:** Stabilised			**Date:** 15/5/96	**Logged by:** JCB & SVC
Geology: Cainozoic alluvial plain	**Micro-relief:** Flat, sparse mounds around tussocks	**Surface Drainage:** Imperfectly drained		**Groundwater:** -	
Substrate: ?	**Surface Stone:** Nil	**Profile Drainage** Moderately permeable		**Permeability:**	
Explosure Type: Backhoe pit	**Surface Condition:** Surface flake	**Soil Classification:**	**GSG** Earthy Sand / **PPF** Uc 5.21	**Aust. Soil Class** Orthic Tenosol	

Soil Profile Description				**Comment:**							**Photo No:** Kintyre 2/6048
Depth	**Soil Horizon**	**Texture (USG, plasticity, moisture, consistency)**	**Colour**	**Mottles**	**Structure**	**Coarse fragments**	**Segregations/ Inclusions**	**Field Tests**			**Samples**
								pH	**EC (mS)**		
0-20cm		Sandy loam, dry, slightly plastic, slightly sticky, very firm	Dusky Red 2.5YR 4/4	None	Massive	Nil	Nil				0-10cm
20-30cm		Sandy loam, dry, moderately plastic, slightly sticky, very strong manganese staining	Dusky Red 2.5YR 4/4	None	Massive	Nil	Nil				-
30-50cm		Sandy loam, dry, moderately plastic, slightly sticky, very firm, slight manganese staining	Red 2.5YR 5/6	None	Massive	Nil	Nil				40-50cm
50-100cm		Sandy loam, dry, slightly plastic, slightly sticky, strong manganese staining, buff mottling from 90cm down	Red 2.5YR 5/6	None	Massive	Nil	Nil				90-100cm
100-150cm		As above	Red 2.5 YR 5/6	Rare buff coloured	Massive	Nil	Nil				140-150cm

DAMES & MOORE	**Project:** Canning Resources - Kintyre		**Job No:** 15780-017-365	**Site No:** SP6	**Map Unit:** 3
Landform: Flat plain	**Surface Slope:** Level	**Local Relief:** Level plain		**Location (GPS):** 51K 0402634 UTM 7530952	
Vegetation: Tussock grass	**Erosion:** Stabilised			**Date:** 15/5/96	**Logged by:** JCB & SVC
Geology: Cainozoic alluvial plain	**Micro-relief:** Flat, sparse mounds around tussocks	**Surface Drainage:** Imperfectly drained		**Groundwater:** -	
Substrate: ?	**Surface Stone:** Rare scattered quartz	**Profile Drainage** Moderately permeable		**Permeability:**	
Explosure Type: Backhoe pit	**Surface Condition:** Crust, clay slick on top	**Soil Classification:**	**GSG** Earthy Sand / **PPF** Uc 5.21 / **Aust. Soil Class** Orthic Tenosol		

Soil Profile Description				**Comment:**							**Photo No:** Kintyre 2/6048
Depth	**Soil Horizon**	**Texture (USG, plasticity, moisture, consistency)**	**Colour**	**Mottles**	**Structure**	**Coarse fragments**	**Segregations/ Inclusions**	**Field Tests**			**Samples**
								pH	**EC (mS)**		
0-10cm		Fine sand, loose, non-sticky, non-plastic, dry	Red 10R 4/6	None	Single grain	Nil	Nil				0-10cm
10-30cm		As above	Red 10R 4/6	None	Single grain	Nil	Nil				-
30-50cm		Sandy loam, moderately plastic, moderately sticky, firm, moderately moist	Weak Red 10R 4/4	None	Massive	Nil	Nil				40-50cm
50-100cm		Sandy loam, moderately moist, moderately plastic, moderately sticky, firm	Weak Red 10R 4/4	None	Massive	Nil	Nil				90-100cm
100-160cm		As above	Weak Red 10R 4/4	None	Massive	Nil	Nil				140-150cm

DAMES & MOORE	**Project:** Canning Resources - Kintyre		**Job No:** 15780-017-365	**Site No:** SP7	**Map Unit:** 1
Landform: Flat plain		**Surface Slope:** Level	**Local Relief:** Level plain	**Location (GPS):** 51K 0405720 UTM 7531317	
Vegetation: Hummock, spinifex		**Erosion:** Stabilised		**Date:** 15/5/96	**Logged by:** JCB & SVC
Geology: Cainozoic alluvial plain	**Micro-relief:** Mounds around hummocks	**Surface Drainage:** Well drained		**Groundwater:** -	
Substrate: ?	**Surface Stone:** Rare quartz gravels, sandy	**Profile Drainage** Moderately permeable		**Permeability:**	
Explosure Type: Backhoe pit	**Surface Condition:** Soft surface crust	**Soil Classification:**	**GSG** Siliceous Sand / **PPF** Uc 1.23	**Aust. Soil Class** ? Stratic Rudosol	

Soil Profile Description — **Comment:** — **Photo No:** Kintyre 1/6038

Depth	Soil Horizon	Texture (USG, plasticity, moisture, consistency)	Colour	Mottles	Structure	Coarse fragments	Segregations/ Inclusions	Field Tests: pH	Field Tests: EC (mS)	Field Tests:	Samples
0-10cm		Sand, medium, dry, non-plastic, non-sticky, loose, subangular to well rounded quartz, slightly iron stained	Weak Red 10R 4/4	None	Single grain	Nil	Nil				0-10cm
10-30cm		As above	Weak Red 10R 4/4	None	Massive	Nil	Nil				-
30-50cm		Sand, medium, dry, non-sticky, non-plastic, very weak	Weak Red 10R 4/4	None	Massive	10% quartz gravel	Nil				40-50cm
50-70cm		As above	Weak Red 10R 4/4	None	Massive	10% quartz gravel	Nil				-
70-100cm		Sand, medium grained, dry, non-sticky, non-plastic, firm	Weak Red 10R 4/4	None	Massive	10% quartz gravel	Hil				90-100cm
100-150cm		As above, moderately moist	Weak Red 10R 4/4	None	Massive	10% quartz gravel	Nil				140-150cm
150-220cm Base 220cm		Sand, as above, moderately moist	Weak Red 10R 4/4	None	Massive	Nil, no gravel below 150cm	Nil				-

DAMES & MOORE	**Project:** Canning Resources - Kintyre		**Job No:** 15780-017-365	**Site No:** SP8	**Map Unit:** 5
Landform: Flood plain		**Surface Slope:** Level	**Local Relief:** Levee bank	**Location (GPS):** 51K 0405010 UTM 7531302	
Vegetation: Tussock grass		**Erosion:** Stabilised		**Date:** 15/5/96	**Logged by:** JCB & SVC
Geology: Quarternary flood plain	**Micro-relief:** Flat surface	**Surface Drainage:** Well drained		**Groundwater:** -	
Substrate: ?	**Surface Stone:** Rare quartz gravels, sandy	**Profile Drainage** Moderately permeable		**Permeability:**	
Explosure Type: Backhoe pit	**Surface Condition:** Surface crust/soft	**Soil Classification:**	**GSG** Siliceous Sand / **PPF** Uc 1.23 / **Aust. Soil Class** ? Stratic Rudosol		

Soil Profile Description				**Comment:**							**Photo No:** Kintyre 1/6036
Depth	**Soil Horizon**	**Texture (USG, plasticity, moisture, consistency)**	**Colour**	**Mottles**	**Structure**	**Coarse fragments**	**Segregations/ Inclusions**	**Field Tests**			**Samples**
								pH	**EC (mS)**		
0-10cm		Sand, medium grained, dry, non-plastic, non-sticky, very weak	Dusky Red 10R 3/4	None	Massive	Nil	Nil				0-10cm
10-30cm		As above, sand, medium grained, dry, non-plastic, non-sticky, very weak	Dusky Red 10R 3/4	None	Massive	Nil	Nil				-
30-50cm		As above, medium sand, dry, non-plastic, non-sticky, very weak	Dusky Red 10R 3/4	None	Massive	Nil	Nil				40-50cm
50-100cm		As above, weak, dry, non-plastic, non-sticky	Dusky Red 10R 3/4	None	Massive	5% quartz gravel	Nil				90-100cm
100-150cm		As above, firm, dry, non-plastic, non-sticky	Dusky Red 10R 3/4	None	Massive	5% quartz gravel	Nil				140-150cm
150-200cm		As above, firm, moderately moist, non-sticky, non-plastic	Dusky Red 10R 3/4	None	Massive	5% quartz gravel	Nil				-

DAMES & MOORE	Project: Canning Resources - Kintyre		Job No: 15780-017-365	Site No: SP9	Map Unit: 1
Landform: Flat plain		**Surface Slope:** Level	**Local Relief:** Flat plain	**Location (GPS):** 51K 0401429 UTM 7532186	
Vegetation: Spinifex grass/hummocks around vegetation rejuvenating after burning		**Erosion:** Stabilised		**Date:** 15/5/96	**Logged by:** JCB & SVC
Geology: Cainozoic alluvial plain	**Micro-relief:** Mounds around tussocks/hummocks	**Surface Drainage:** Well drained		**Groundwater:** -	
Substrate: ?	**Surface Stone:** Nil	**Profile Drainage** Moderately permeable		**Permeability:**	
Explosure Type: Backhoe pit	**Surface Condition:** Soft	**Soil Classification:**	**GSG** Siliceous Sand / **PPF** Uc 1.23	**Aust. Soil Class** Arenic Rudosol	

Soil Profile Description

Comment:

Photo No: Miles Ridge 3/7550

Depth (m)	Soil Horizon	Texture (USG, plasticity, moisture, consistency)	Colour	Mottles	Structure	Coarse fragments	Segregations/ Inclusions	Field Tests: pH	Field Tests: EC (mS)	Field Tests:	Samples
0-10cm		Sand, medium grained, non-plastic, weak, non-sticky, dry	Red 10R 4/8	None	Massive	Nil	Nil				0-10cm
10-30cm		Sand, medium grained, non-plastic, non-sticky, very weak, dry	Red 10R 4/6	None	Massive	Nil	Nil				-
30-50cm		Sand, medium grained, non-plastic, non-sticky, weak, dry	Red 10R 4/6	None	Massive	Nil	Nil				40-50cm
50-100cm		Sand, medium grained, non-plastic, non-sticky, very firm, dry	Red 10R 4/6	None	Massive	Nil	Nil				90-100cm
100-150cm		Sand, medium grained, non-plastic, non-sticky, weak, dry	Red 10R 4/8	None	Massive	Nil	Nil				140-150cm
150-210cm		Sand, medium grained, non-plastic, non-sticky, weak, moderately moist	Red 10R 4/8	None	Massive	from 160cm 5% quartz gravel	Nil				190-210cm

DAMES & MOORE	**Project:** Canning Resources - Kintyre		**Job No:** 15780-017-365	**Site No:** SP10	**Map Unit:** 2
Landform: Scree slope		**Surface Slope:**	**Local Relief:** Scree slope	**Location (GPS):** 51K 0404041 UTM 7530991	
Vegetation: Spinifex		**Erosion:** Stabilised		**Date:** 16/5/96	**Logged by:** JCB & SVC
Geology: Proterozoic schist	**Micro-relief:** Scree slope	**Surface Drainage:** Rapidly drained		**Groundwater:** -	
Substrate: Proterozoic schist	**Surface Stone:** Schist, some quartz	**Profile Drainage** Well drained/moderately permeable		**Permeability:**	
Explosure Type: Backhoe pit	**Surface Condition:** Scree	**Soil Classification:**	**GSG** Skeletal Lithosol / **PPF** K-Uc 1.23 / **Aust. Soil Class** Leptic Rudosol		

Soil Profile Description				**Comment:**							**Photo No:** Kintyre 2/6052
Depth	**Soil Horizon**	**Texture (USG, plasticity, moisture, consistency)**	**Colour**	**Mottles**	**Structure**	**Coarse fragments**	**Segregations/ Inclusions**	**Field Tests**			**Samples**
								pH	**EC (mS)**		
0-10cm		Rock fragments, up to 70mm in a matrix of sandy loam, non-plastic, non-sticky, dry. Scree makes up 80% of profile	Dusky Red 2.5YR 4/4	None	Massive	80% dispersed	Nil				-
10-30cm		As above	Dusky Red 2.5YR 4/4	None	Massive	80% dispersed	Nil				-
30-50cm		40cm weathered rock with joints and fractures filled with matrix as above (5%)	Dusky Red 2.5YR 4/4	None	Massive	greater than 95% dispersed	Nil				-
50-90cm		As above	Dusky Red 2.5YR 4/4	None	Massive	greater than 95% dispersed	Nil				-

DAMES & MOORE	Project: Canning Resources - Kintyre		Job No: 15780-017-365	Site No: SP11	Map Unit: 2
Landform: Base of scree slope	**Surface Slope:** Moderately inclined	**Local Relief:** Toe of scree slope		**Location (GPS):** 51K 0403256 UTM 7530700	
Vegetation: Hummocky spinifex	**Erosion:** Stabilised/minor natural gullying			**Date:** 16/5/96	**Logged by:** JCB & SVC
Geology: Proterozoic schist	**Micro-relief:** Minor natural gullying	**Surface Drainage:** Rapidly drained		**Groundwater:** -	
Substrate: Proterozoic schist	**Surface Stone:** Quartz pebbles	**Profile Drainage** Moderately permeable		**Permeability:**	
Explosure Type: Backhoe pit	**Surface Condition:**	**Soil Classification:**	**GSG** Skeletal Lithosol / **PPF** K-Uc 1.23 / **Aust. Soil Class** Leptic Rudosol		
Soil Profile Description		**Comment:**			**Photo No:** Kintyre 16050

Depth	Soil Horizon	Texture (USG, plasticity, moisture, consistency)	Colour	Mottles	Structure	Coarse fragments	Segregations/ Inclusions	Field Tests			Samples
								pH	EC (mS)		
0-10cm		Quartz pebbles up to 50mm in diameter in a matrix of sand, medium grained, dry, non-plastic, non-sticky	Dark Red 2.5YR 4/6	None	Massive	80% dispersed quartz pebbles	Nil				-
10-30cm		As above	Dark Red 2.5YR 4/6	None	Massive	90% dispersed quartz pebbles	Nil				-
30-40cm		As above	Dark Red 2.5YR 4/6	None	Massive	90% dispersed quartz pebbles	Nil				-
40-90cm		Scree, large fragments of schist in a matrix of sandy loam, non-plastic, non-sticky, dry	Dark Red 2.5YR 4/6	None	Massive	70% dispersed schist	Nil				-

Appendix B

Grain Size Analyses

WESTERN GEOTECHNICS

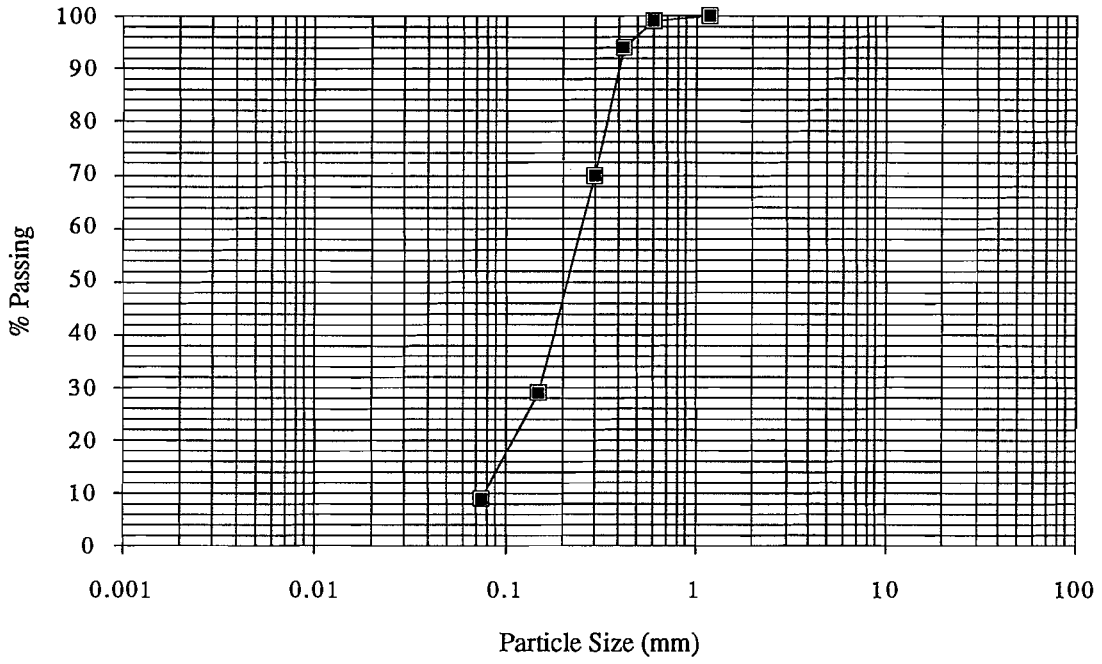
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP3
Depth (cm): 0-10

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32886
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
1.18	100
0.600	99
0.425	94
0.300	70
0.150	29
0.075	9

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 4-7-96

WESTERN GEOTECHNICS

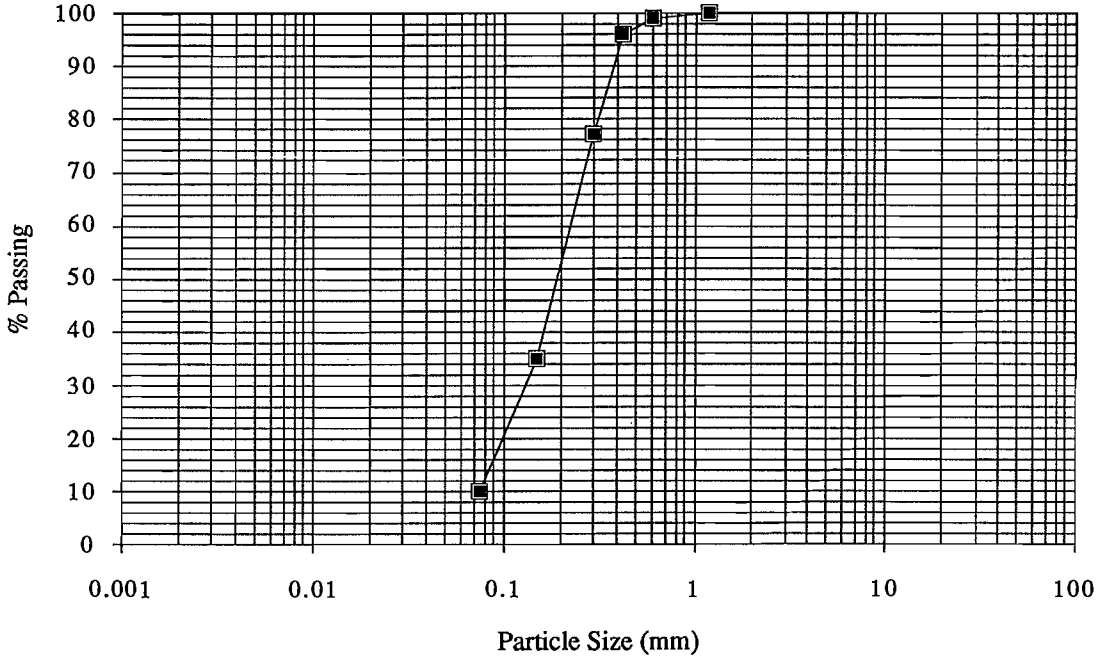
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP3
Depth (cm): 40-50

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32887
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
1.18	100
0.600	99
0.425	96
0.300	77
0.150	35
0.075	10

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 4-7-96

WESTERN GEOTECHNICS

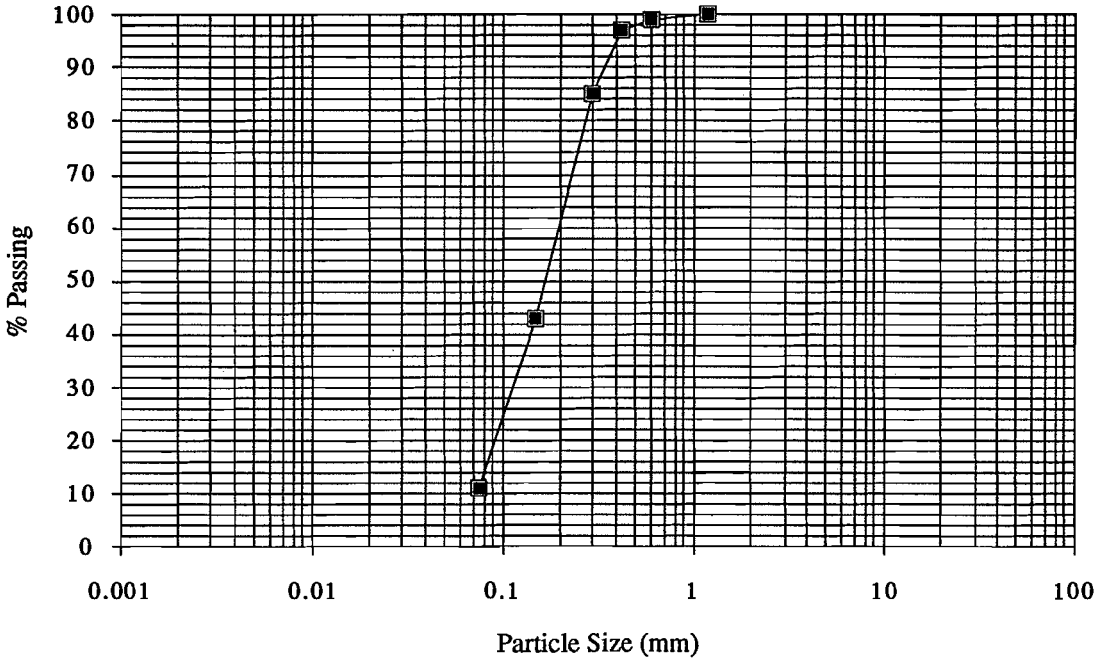
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP3
Depth (cm): 90-100

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32888
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
1.18	100
0.600	99
0.425	97
0.300	85
0.150	43
0.075	11

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

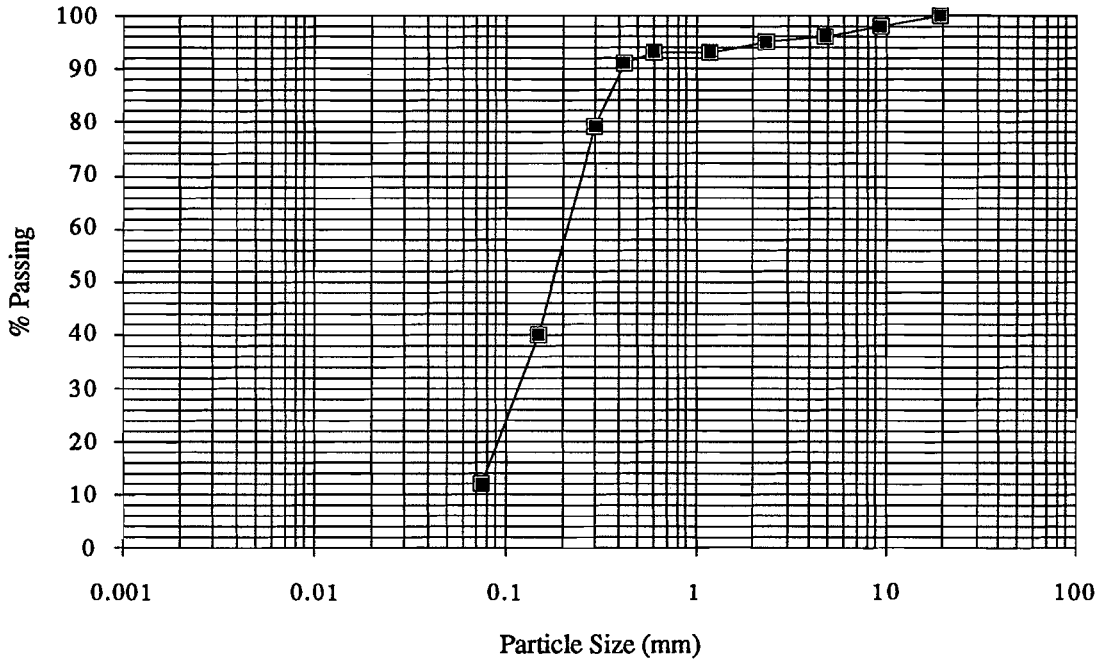
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP3
Depth (cm): 140-150

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32889
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
19.0	100
9.5	98
4.75	96
2.36	95
1.18	93
0.600	92
0.425	91
0.300	79
0.150	40
0.075	12

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

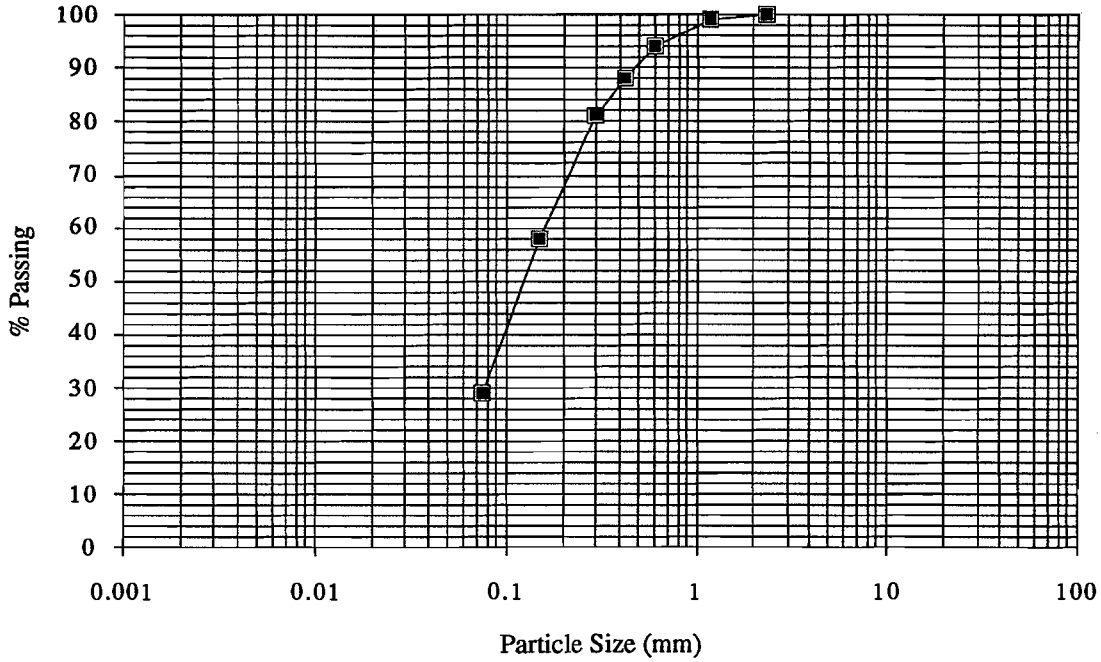
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP4
Depth (cm): 0-10

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32890
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	99
0.600	94
0.425	88
0.300	81
0.150	58
0.075	29

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

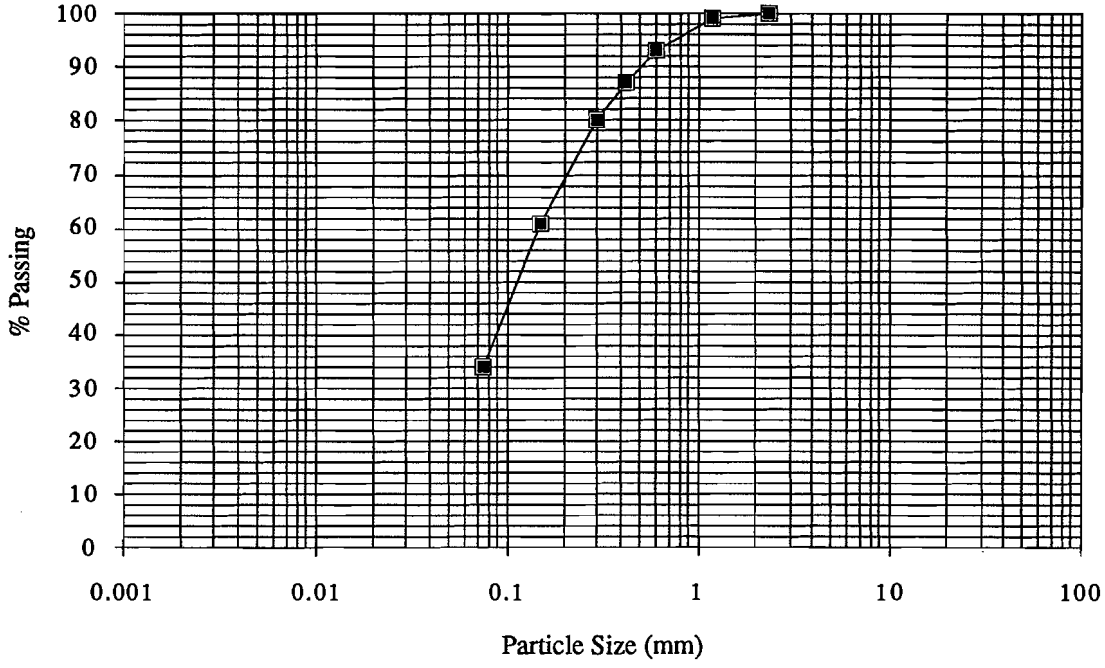
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP4
Depth (cm): 40-50

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG32891
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	99
0.600	93
0.425	87
0.300	80
0.150	61
0.075	34

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

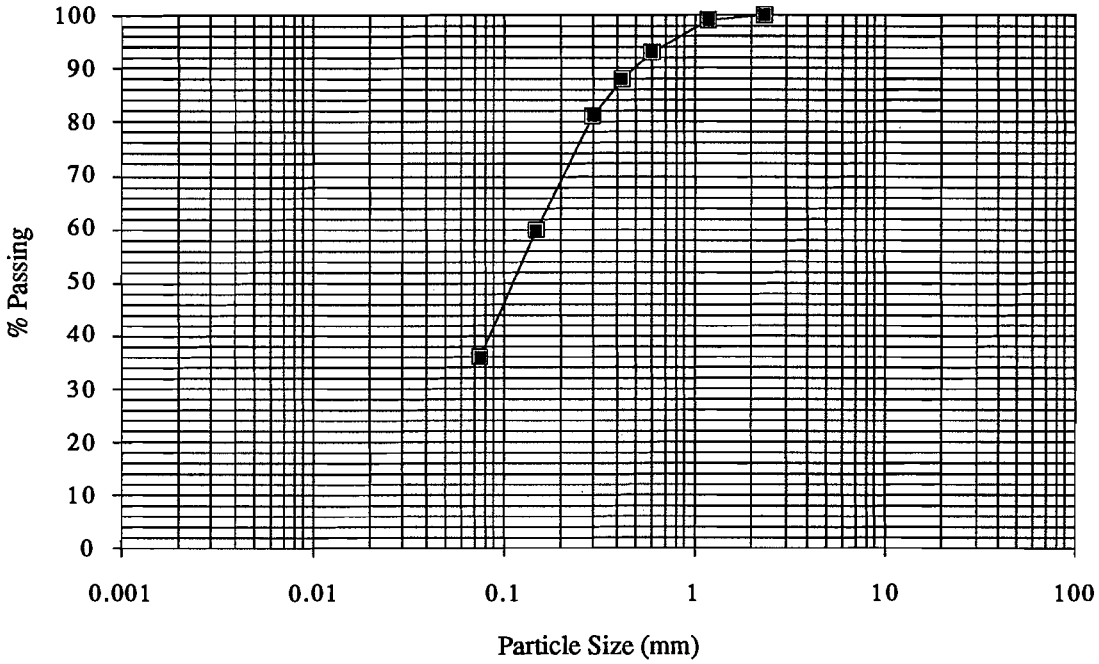
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP4
Depth (cm): 90-100

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32892
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	99
0.600	93
0.425	88
0.300	81
0.150	60
0.075	36

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

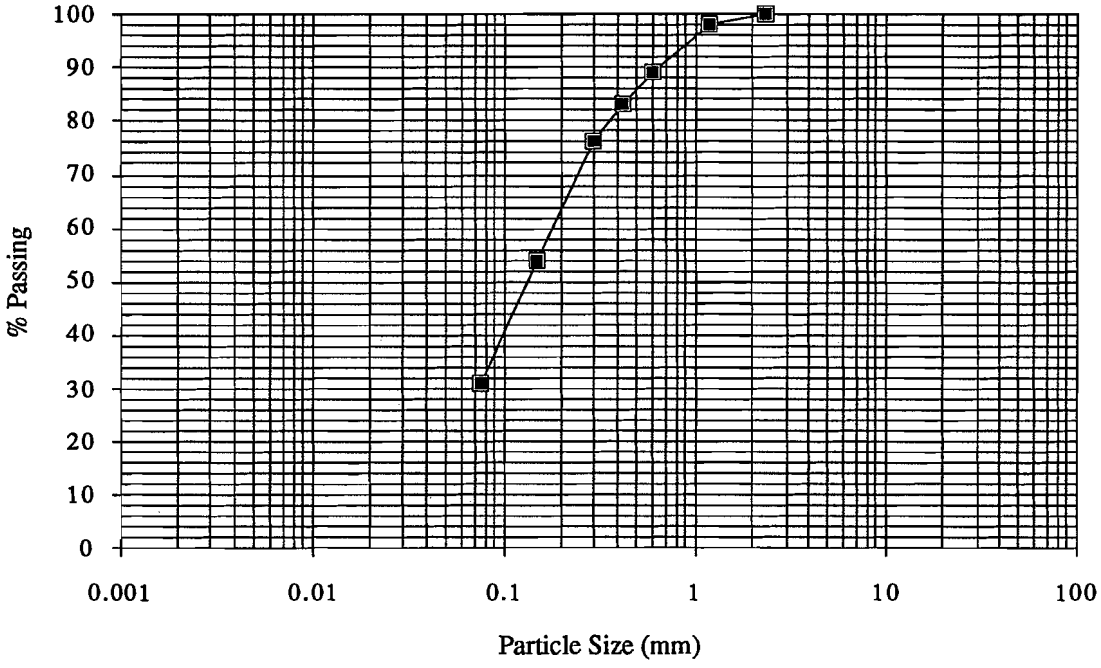
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP4
Depth (cm): 140-150

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32893
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	98
0.600	89
0.425	83
0.300	76
0.150	54
0.075	31

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

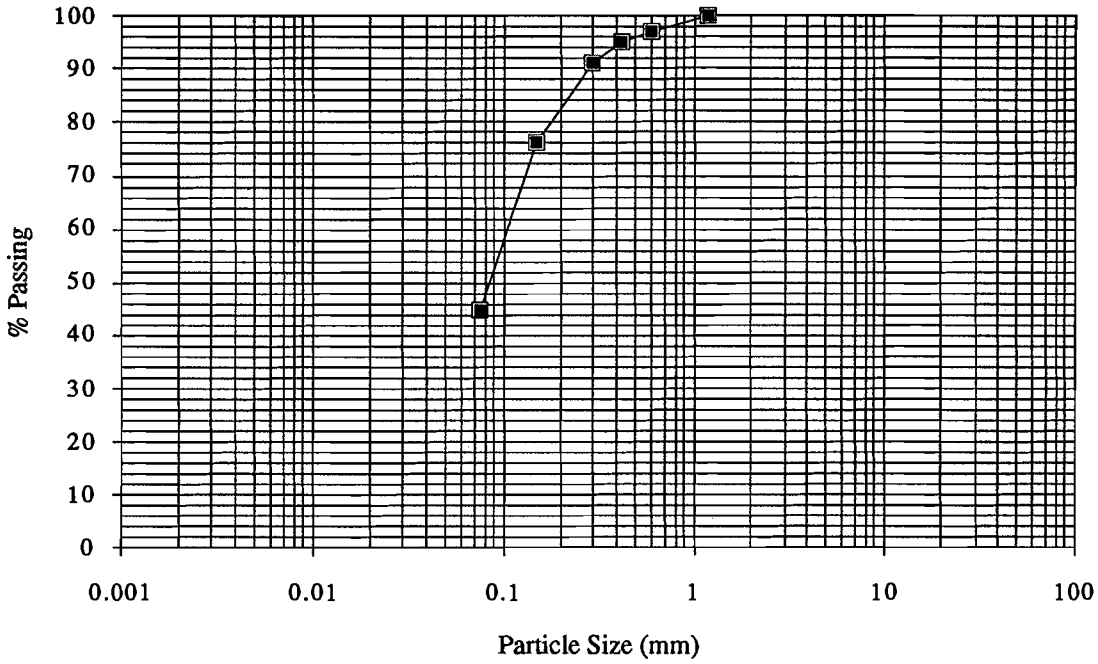
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP5
Depth (cm): 0-10

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32894
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
1.18	100
0.600	97
0.425	95
0.300	91
0.150	76
0.075	45

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

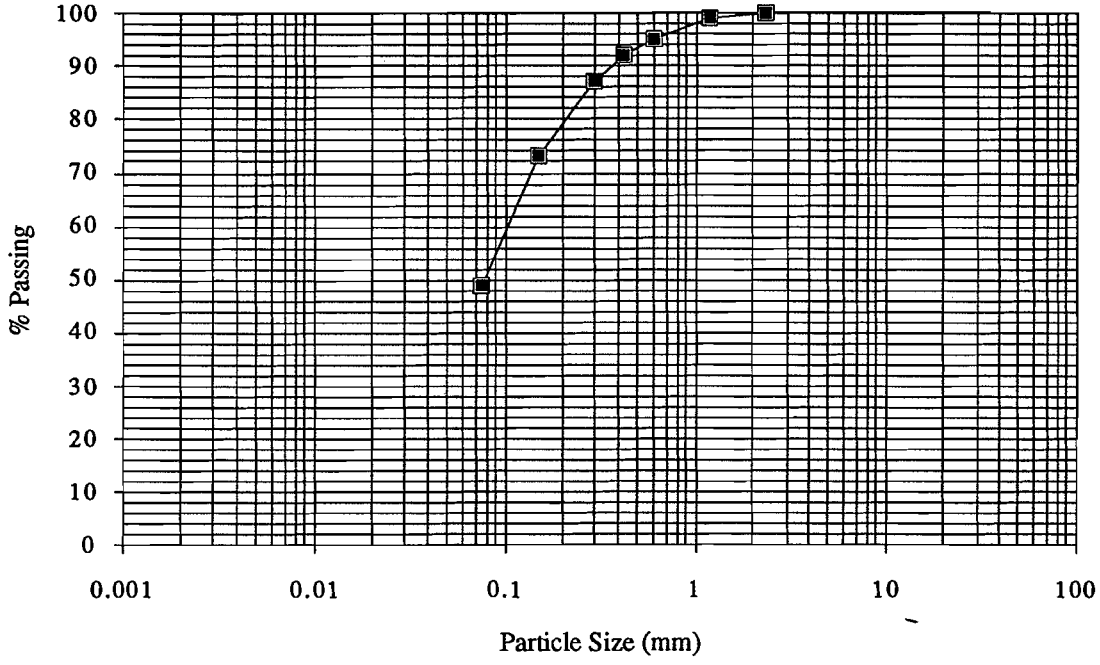
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP5
Depth (cm): 40-50

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG32895
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	99
0.600	95
0.425	92
0.300	87
0.150	73
0.075	49

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

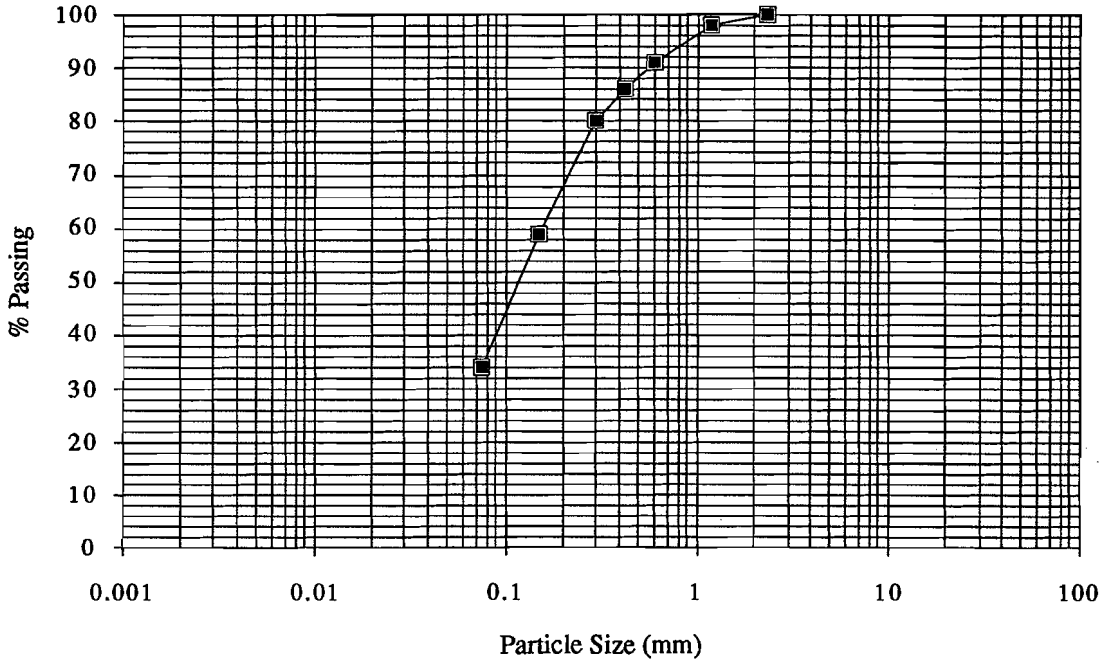
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP5
Depth (cm): 90-100

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32896
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	98
0.600	91
0.425	86
0.300	80
0.150	59
0.075	34

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

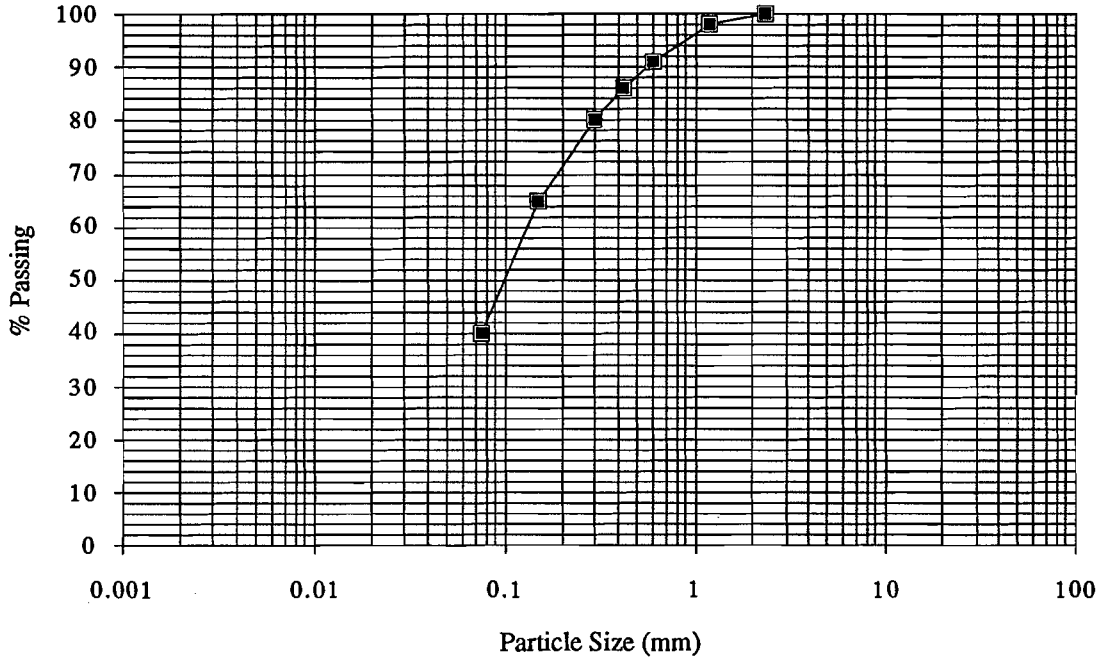
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP5
Depth (cm): 140-150

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32897
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	98
0.600	90
0.425	86
0.300	80
0.150	64
0.075	40

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

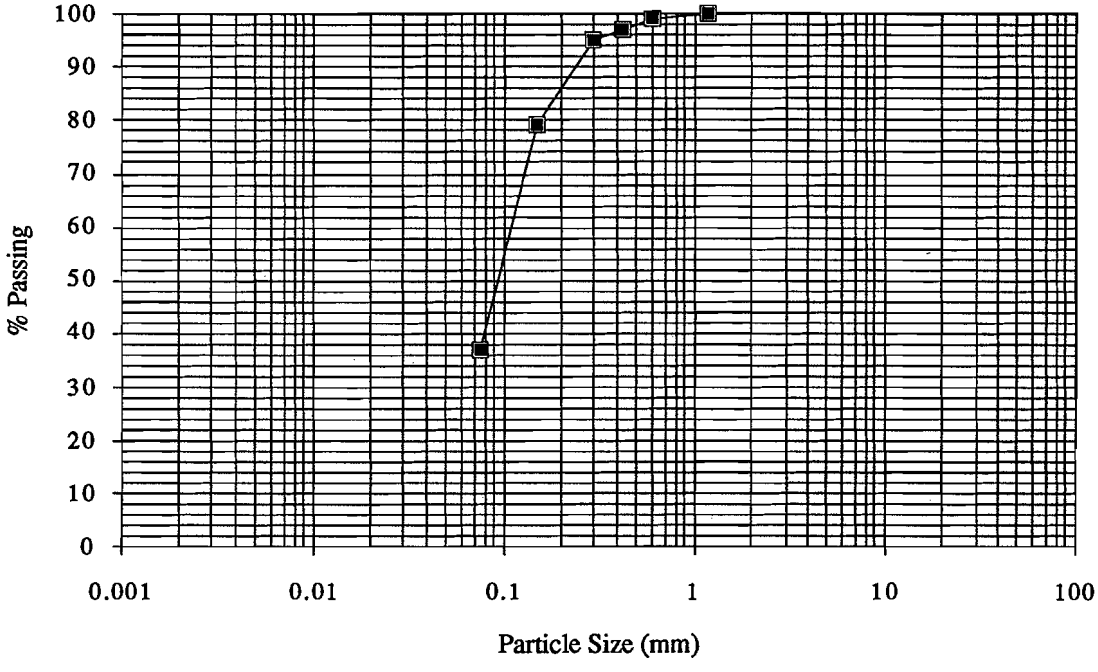
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP6
Depth (cm): 0-10

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG32898
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
1.18	100
0.600	99
0.425	97
0.300	95
0.150	79
0.075	37

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

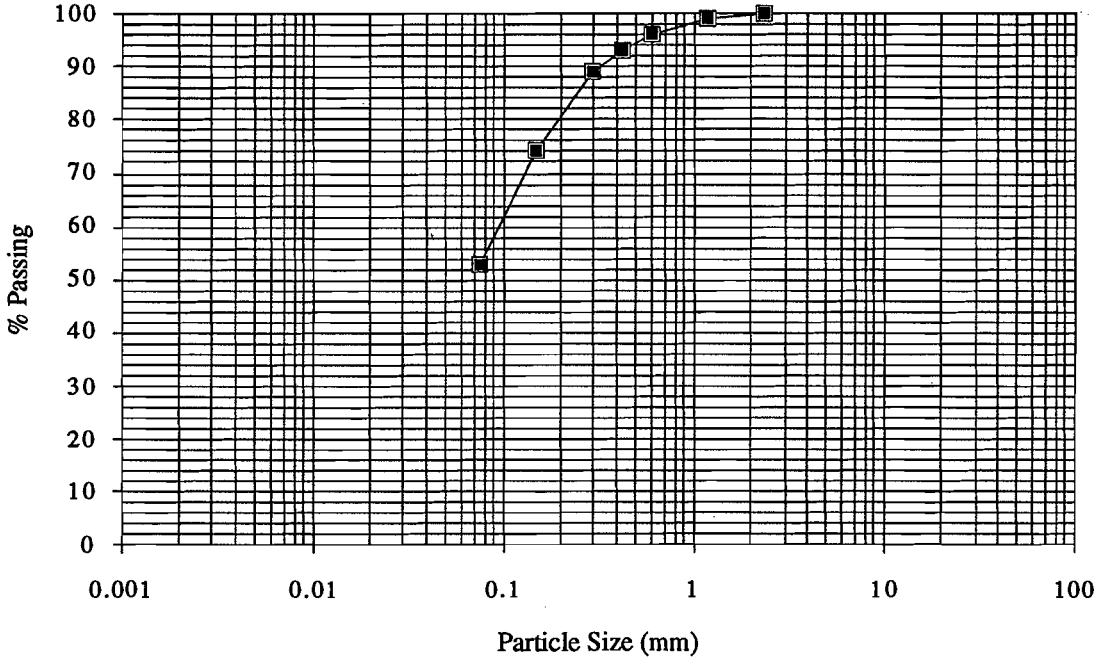
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP6
Depth (cm): 90-100

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32900
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	99
0.600	96
0.425	93
0.300	89
0.150	74
0.075	53

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

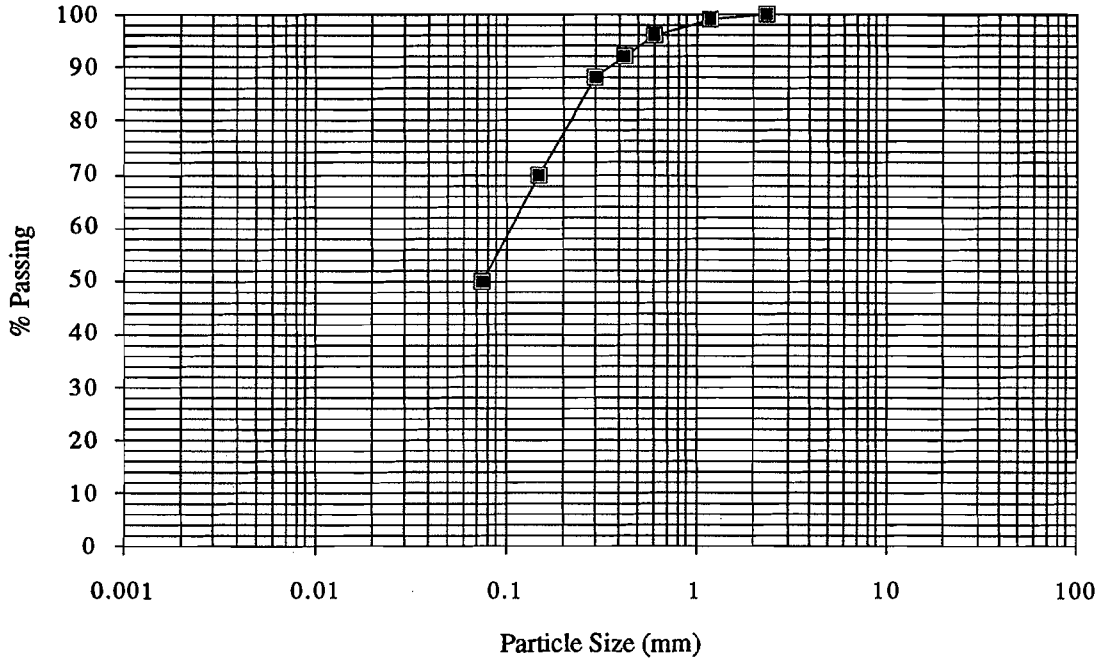
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP6
Depth (cm): 140-150

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32901
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	99
0.600	96
0.425	92
0.300	88
0.150	70
0.075	50

Notes. Sample supplied by Client.

Certificate No: WG 32886-32914

Approved Signatory: _____ (P. Brittan) **Date:** 6-6-96

This Laboratory is registered by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with its terms of registration. This document shall not be reproduced except in full.

Form No. AS 1289 3.6.1 94/1 R

WESTERN GEOTECHNICS

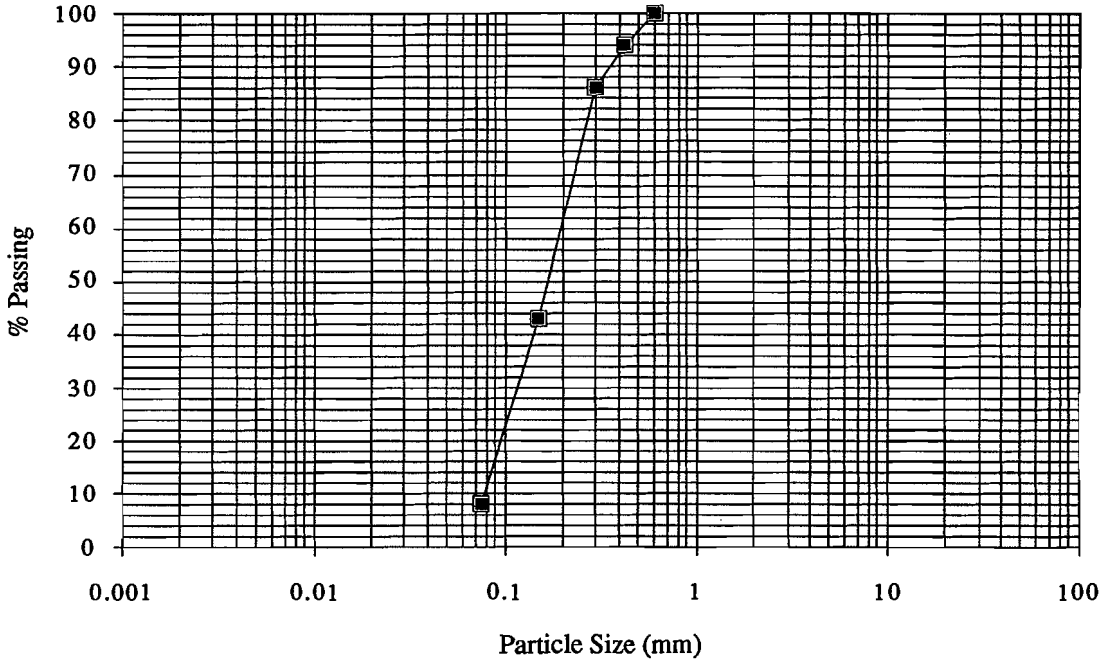
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP7
Depth (cm): 0-10

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32902
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
0.600	100
0.425	94
0.300	86
0.150	43
0.075	8

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

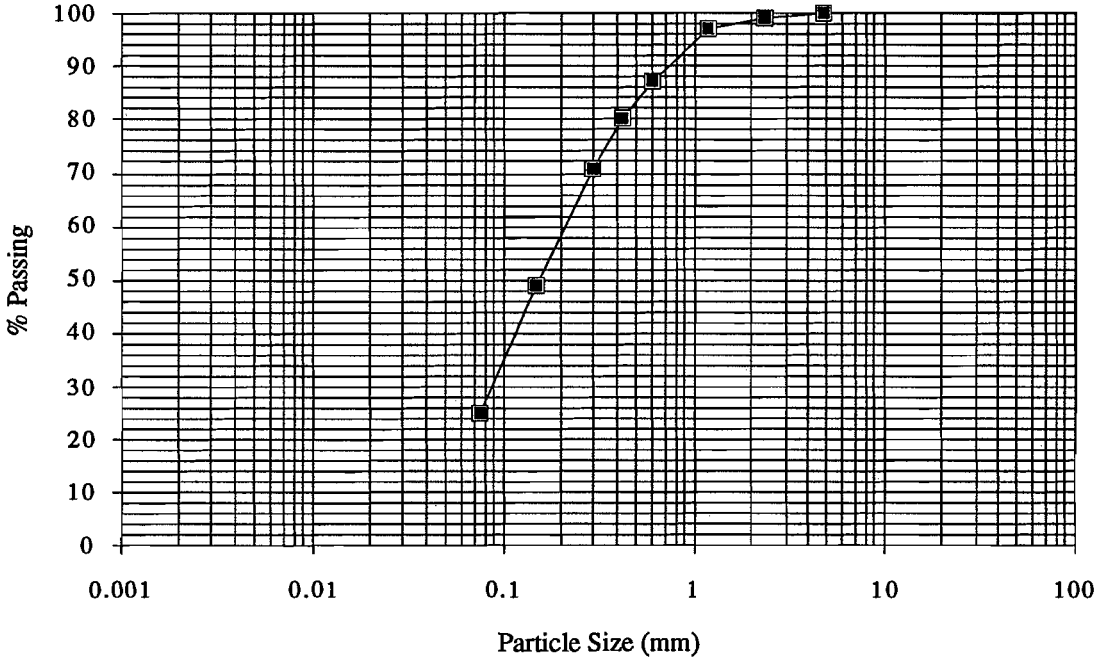
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP7
Depth (cm): 90-100

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32904
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
4.75	100
2.36	99
1.18	96
0.600	87
0.425	80
0.300	70
0.150	49
0.075	25

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

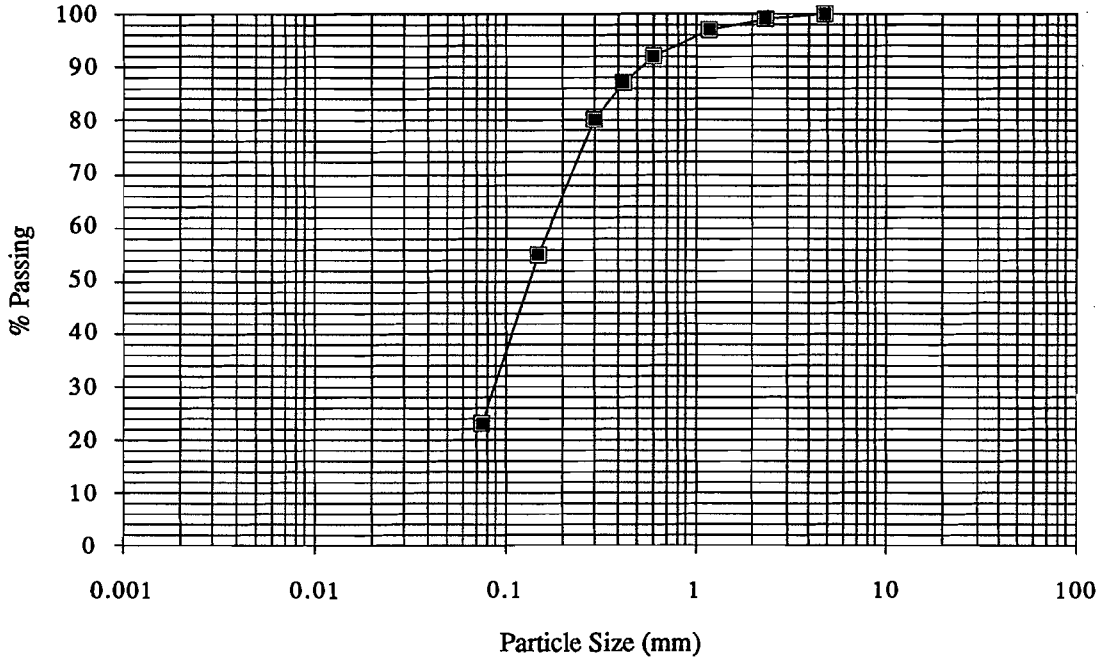
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP8
Depth (cm): 0-10

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32906
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
4.75	100
2.36	99
1.18	97
0.600	92
0.425	87
0.300	80
0.150	55
0.075	23

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

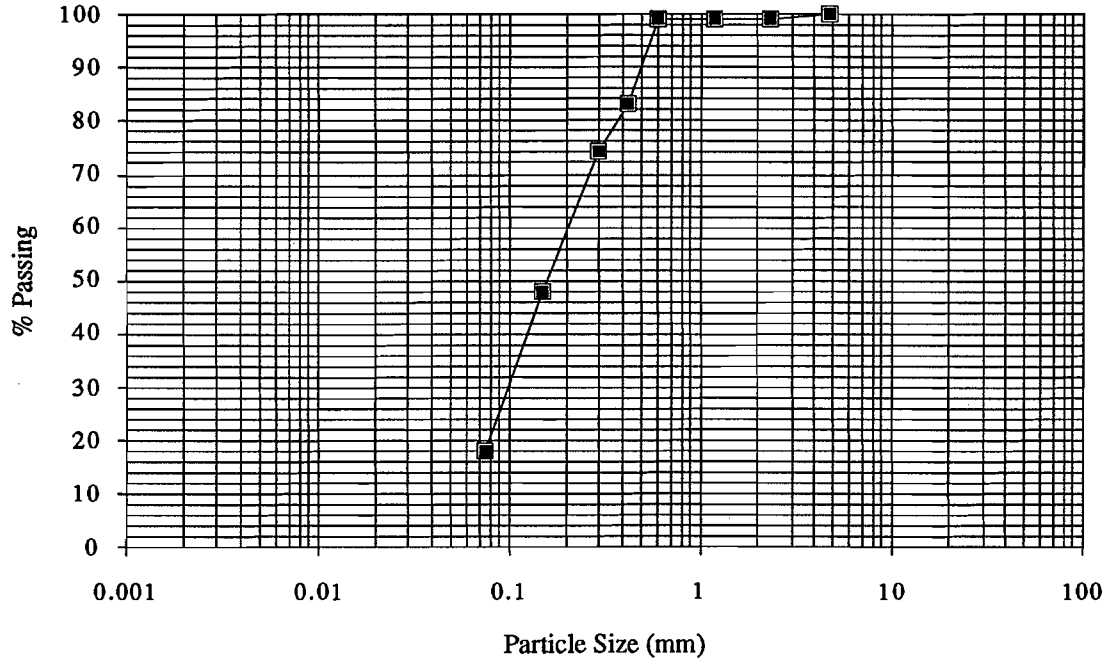
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP8
Depth (cm): 40-50

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32907
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
4.75	100
2.36	99
1.18	99
0.600	99
0.425	82
0.300	74
0.150	48
0.075	18

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

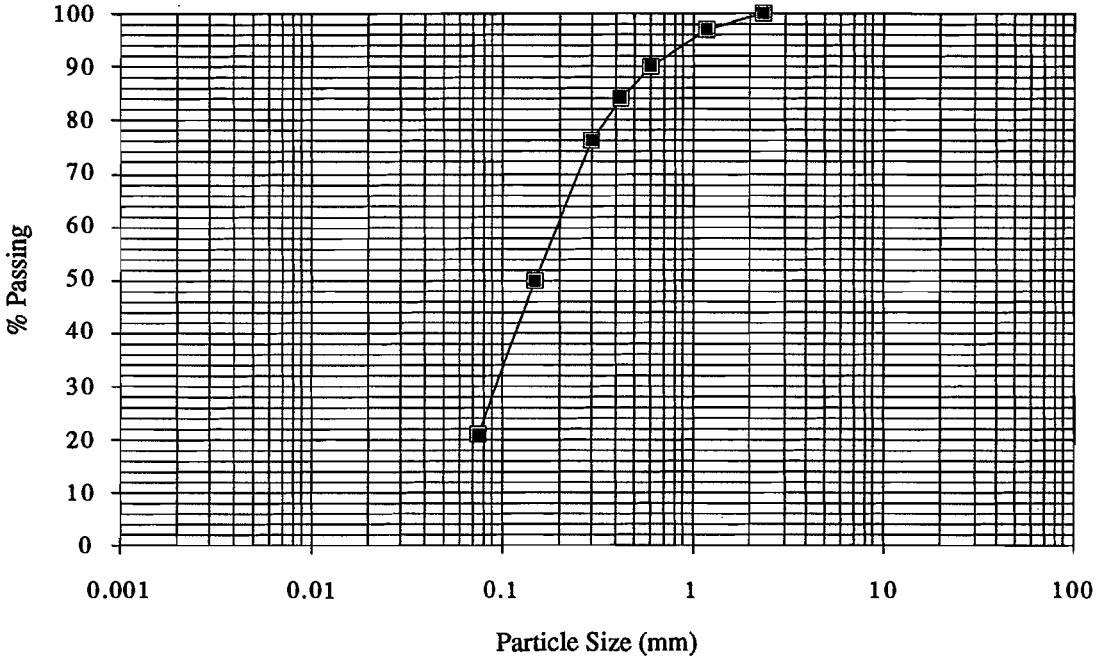
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP8
Depth (cm): 90-100

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32908
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	97
0.600	90
0.425	84
0.300	76
0.150	50
0.075	21

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

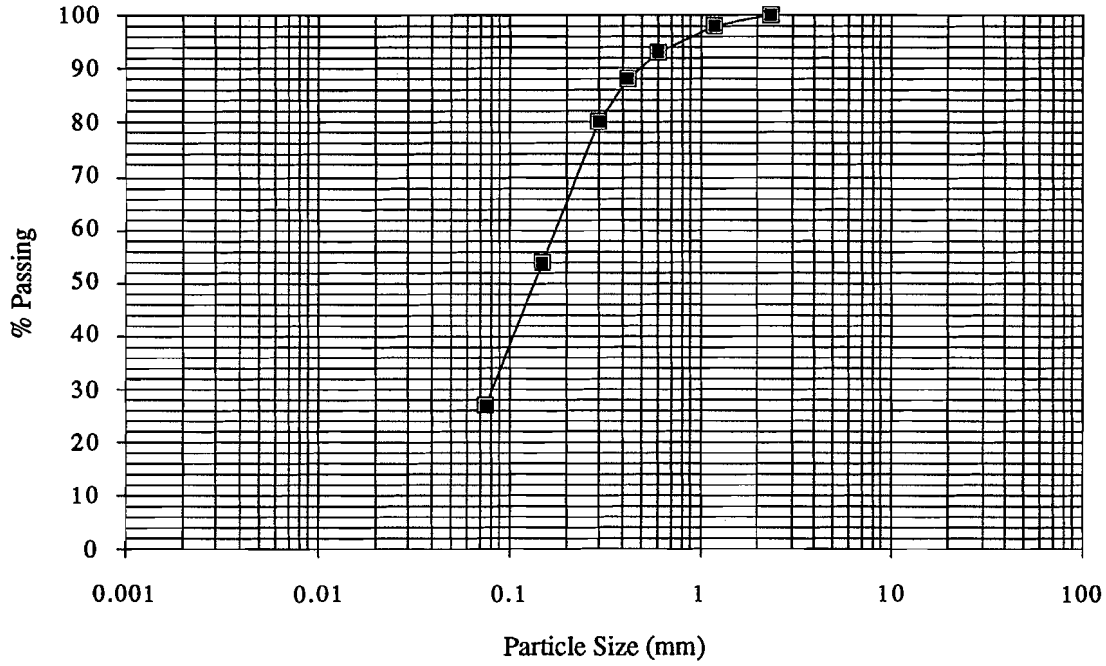
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP8
Depth (cm): 140-150

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32909
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	98
0.600	93
0.425	88
0.300	80
0.150	54
0.075	27

Notes. Sample supplied by Client.

Certificate No: WG 32886-32914

Approved Signatory: _____ (P. Brittan) **Date:** 6-6-96

WESTERN GEOTECHNICS

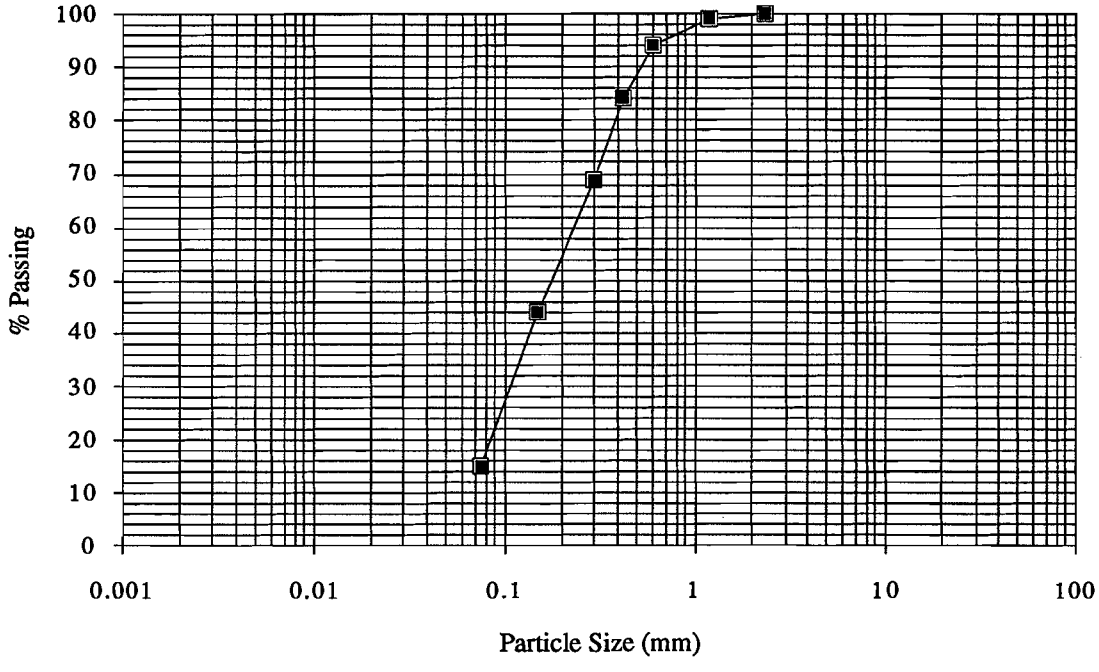
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP9
Depth (cm): 0-10

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32910
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	99
0.600	94
0.425	84
0.300	69
0.150	44
0.075	15

Notes. Sample supplied by Client.

Certificate No: WG 32886-32914

Approved Signatory: (P. Brittan) **Date:** 6-6-96

This Laboratory is registered by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with its terms of registration. This document shall not be reproduced except in full.

Form No. AS 1289 3.6.1 94/1 R

WESTERN GEOTECHNICS

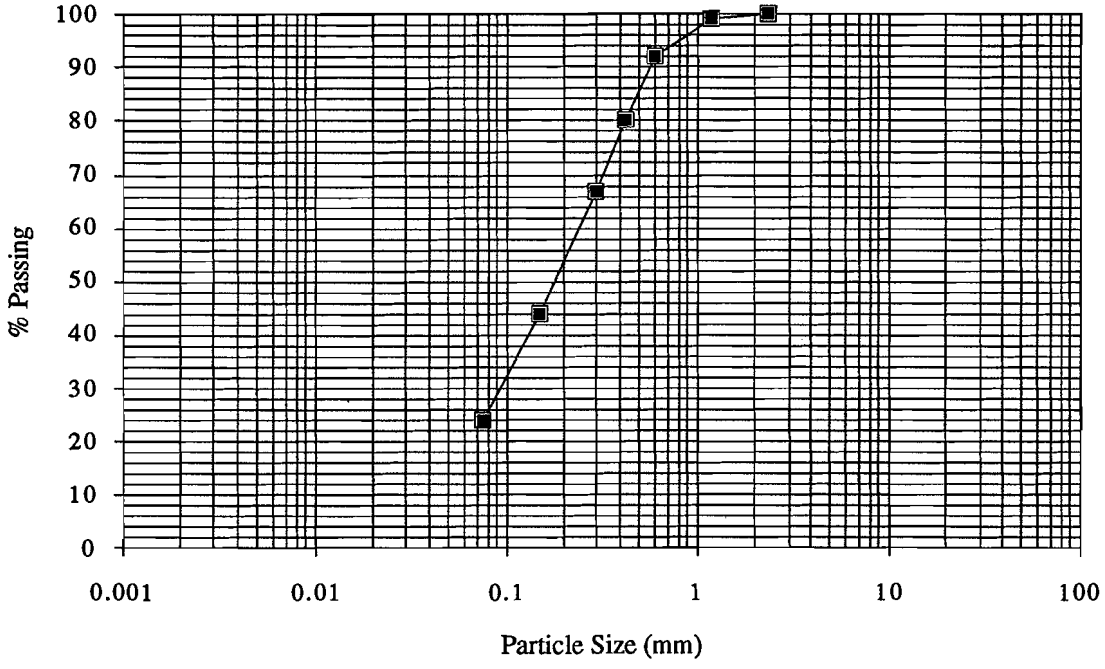
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP9
Depth (cm): 40-50

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32911
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	99
0.600	92
0.425	80
0.300	67
0.150	44
0.075	24

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

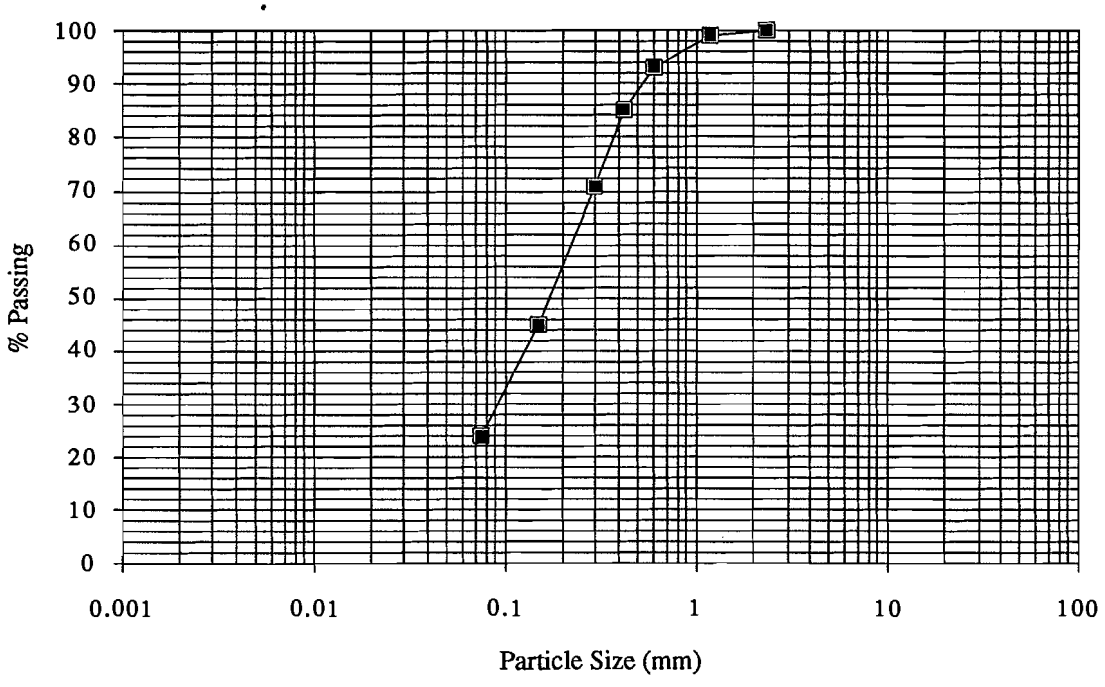
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP9
Depth (cm): 90-100

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG 32912
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	99
0.600	93
0.425	85
0.300	71
0.150	45
0.075	24

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

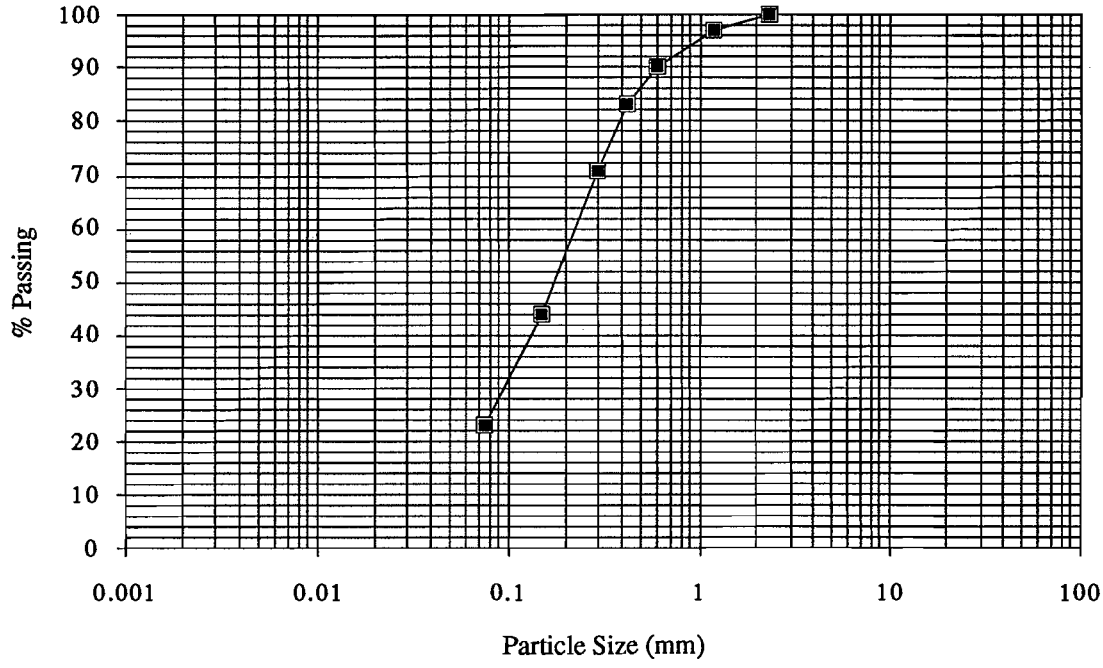
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP9
Depth (cm): 140-150

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG32913
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	97
0.600	90
0.425	83
0.300	71
0.150	44
0.075	23

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96

WESTERN GEOTECHNICS

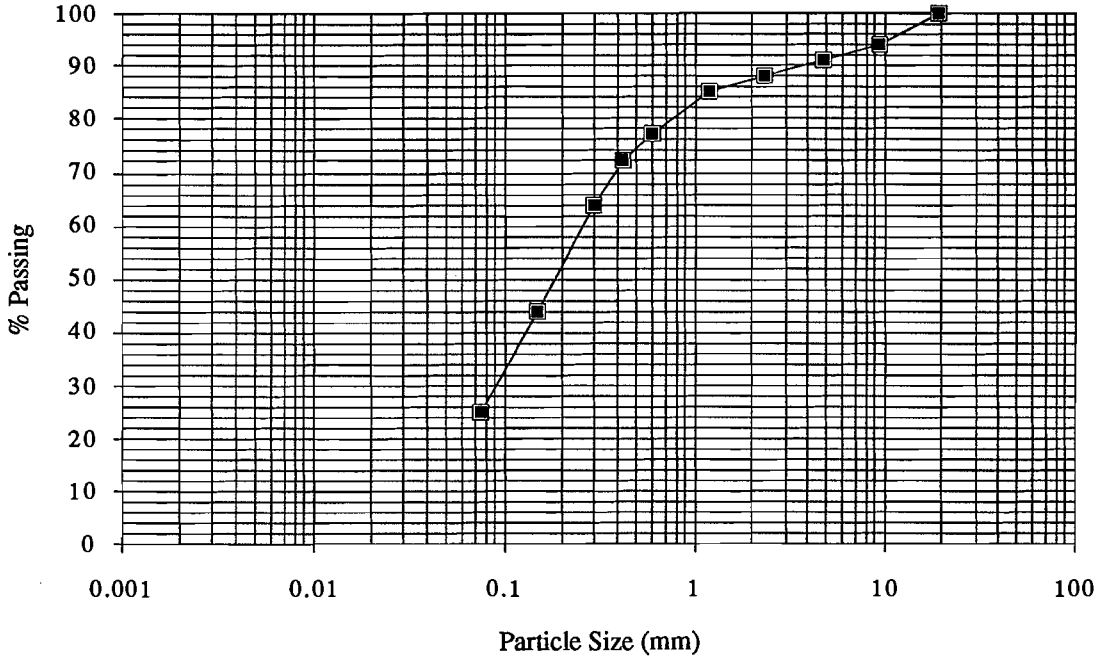
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: Kintyre
LOCATION: Kintyre Site
Sample Id: SP9
Depth (cm): 190-210

JOB No.: 001-01-282
Client Job No: 15780-017-5100-365
Lab Ref No: WG32914
Date Tested: 27.5.96

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
19.0	100
9.5	94
4.75	91
2.36	88
1.18	85
0.600	77
0.425	72
0.300	64
0.150	44
0.075	25

Notes. Sample supplied by Client.

Approved Signatory: _____ (P. Brittan) **Certificate No: WG 32886-32914** **Date:** 6-6-96