SOILS AND LAND-USE PLANNING IN THE HOWICK EXTENSION AREA

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APPENDIX and SOIL MAP

C O N T E N T S

Appendix 1 : Check-list of soils in the Howick Extension Area and the operative soil series and soil forms of the Tugela Basin (van der Eyk et al. 1969)

Soil series		Soil form
Howick Extension Area	Tugela Basin	
ALBANY	ALBANY	LONGLANDS
ARCADIA	ARCADIA	ARCADIA
ARROCHAR	ARROCHAR	CARTREF
AVALON	AVALON	AVALON
BALMORAL	BALMORAL	HUTTON
Bellevue*	GLENDALE	SHORTLANDS
BERGVILLE	BERGVILLE	AVALON
BLUEBANK	BLUEBANK	KROONSTAD
Broadmoor*	HUTTON	HUTTON
CHAMPAGNE	CHAMPAGNE	CHAMPAGNE
CLEVELAND	CLEVELAND	GRIFFIN
CLOVELLY	CLOVELLY	CLOVELLY
Cranwell*	BALGOWAN	WILLEMSDAL
Dell*	HARRIS	FERNWOOD
DOVETON	DOVETON	HUTTON
Emmaus*	KILLARNEY	KATSPRUIT
ESTCOURT	ESTCOURT	ESTCOURT
FARMHILL	FARMHILL	GRIFFIN
FARNINGHAM	FARNINGHAM	HUTTON
Frere*	WILLIAMSON	GEMVALE
GLENCOE	GLENCOE	GLENCOE
GRIFFIN	GRIFFIN	GRIFFIN
Helpmekaar*	GRIFFIN	GRIFFIN
HUTTON	HUTTON	HUTTON
IVANHOE	IVANHOE	CHAMPAGNE
Jagersdrift*	MSINGA	HUTTON
KATSPRUIT	KATSPRUIT	KATSPRUIT
KILLARNEY	KILLARNEY	KATSPRUIT
KIORA	KIORA	KIORA
KLIPFONTEIN	KLIPFONTEIN	MISPAH
Ladysmith*	ESTCOURT	ESTCOURT
LEKSAND	LEKSAND	AVALON
Lidgetton*	FARMHILL	GRIFFIN
LONGLANDS	LONGLANDS	LONGLANDS
Loskop*	DOVETON	HUTTON
Majuba*	GEMVALE	GEMVALE
Matiwane*	KILLARNEY	KATSPRUIT
Melrose*	AVALON	AVALON
MISPAH	MISPAH	MISPAH
MSINGA	MSINGA	HUTTON
NEWPORT	NEWPORT	CLOVELLY
NORMANDIEN	NORMANDIEN	AVALON
OATSDALE	OATSDALE	CLOVELLY
PHOENIX	PHOENIX	RENSBURG
RENSBURG	RENSBURG	RENSBURG
RICHMOND	RICHMOND	SHORTLANDS
Rooikop*	MSINGA	HUTTON
RUSTON	RUSTON	AVALON
RYDALVALE	RYDALVALE	ARCADIA
Shandon*	ARROCHAR	CARTREF
SHORTLANDS	SHORTLANDS	SHORTLANDS
SOUTHWOLD	SOUTHWOLD	CLOVELLY
SPRINGFIELD	SPRINGFIELD	CLOVELLY
Tabamhlope*	FARNINGHAM	HUTTON
UMLAAS	UMLAAS	KIORA
VIMY	VIMY	HUTTON
WARRICK	WARRICK	WASBANK
WASBANK	WASBANK	WASBANK
WESSELSNEK	WESSELSNEK	GLENCOE
Weston*	DOVETON	HUTTON
WINTERTON	WINTERTON	LONGLANDS

* Redundant series names

Appendix 2 : Guide to the soil forms in the Howick Extension Area

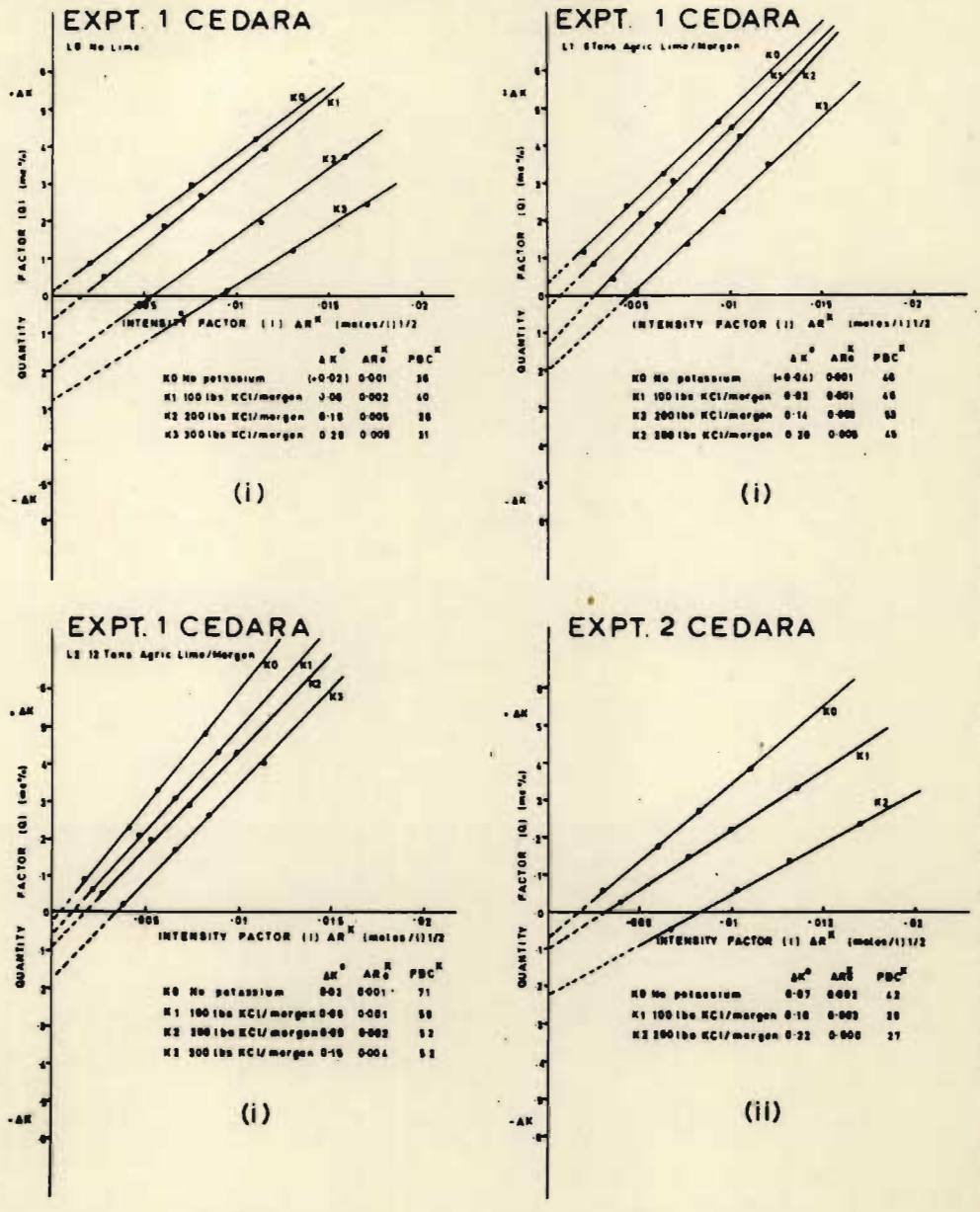
Profile	Diagnostic horizons	Soil forms																																
		RENSBURG	ARCADIA	WILLOWBROOK	STANGER	KIORA	BONHEIM	MILKWOOD	CHAMPAGNE	KATSPRUIT	INANDA	KRANSKOP	MAGWA	NOMANCI	HUTTON	SHORTLANDS	GRIFFIN	CLOVELLY	WILLEMSDAL	MISPAH	FERNWOOD	GERVALE	LONGLANDS	ESTCOURT	KROONSTAD	WASBANK	CARTREF	AVALON	GLENCOE	DUNDEE	MISPAH				
A HORIZON	VERTIC																																	
	MELANIC																																	
	ORGANIC																																	
	HUMIC																																	
	ORTHIC																																	
	(a) RED																																	
	(b) DARK BROWN																																	
	(c) GREY BROWN									(X)																								
UPPER B HORIZON	FIRM GLEY	X		X					X	X																								
	FRIABLE GLEY																																	
	CUTANIC				X																	X												
	PERCHED GLEY																						X	X	X	X	X							
	RED STRUCTURED					X										X																		
	RED APEDAL										X				X																			
	DARK BROWN STRUCTURED						X																											
	YELLOW APEDAL											X	X				X	X										X	X					
	YELLOW STRUCTURED																		X															
	REGIC SAND								(X)												X													
	STRATIFIED ALLUVIUM																													X				
LOWER B HORIZON	PRISMATIC TEXTURAL																							X										
	CUTANIC																								X									
	SOFT PLINTHIC																						X					X						
	HARD PLINTHIC																									X			X					
	RED APEDAL											X			X		X																	
C or R	C or R		X					X						X						X							X						X	

Appendix 3 : Q/I relations, energies of exchange (ΔF) and lime potential values for selected experimental sites on the Loskop series

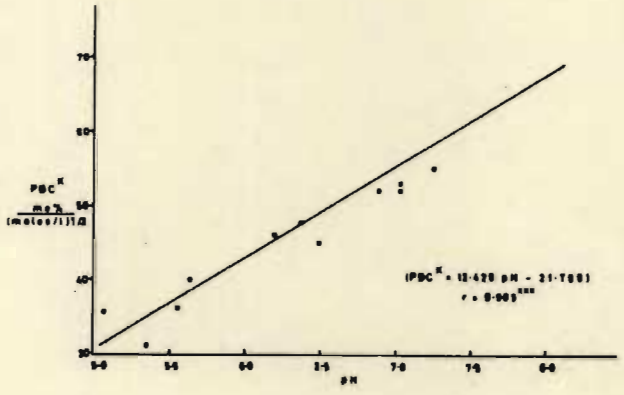
Treatment	Q/I relations				Energies of exchange ΔF	Lime potential	Yield of maize bags/ acre
	ΔK^o adjusted value	ΔK^o	AR_e^K	PBC^K			
	Site 1 - All plots received 300 lb superphosphate and 100 lb ammonium sulphate per acre. Lime treatments applied annually up to 1956/57. No lime for 9 years prior to sampling.						
L0 - no lime							
K0 - no K	0.04	(+0.02)	0.001	36	-4160	4.1	12.5
K1 - 50 lb KCl/acre	0.17	0.06	0.002	40	-3870	4.2	23.1
K2 - 100 " "	0.30	0.19	0.005	36	-3489	3.7	22.8
K3 - 150 " "	0.39	0.28	0.009	31	-3210	3.9	22.3
						4.0	
L1 - 3 tons Agric. lime/acre/ annum							
K0	0.02	(+0.04)	0.001	46	-4330	4.8	13.9
K1	0.15	0.03	0.001	48	-4035	5.0	25.1
K2	0.25	0.14	0.003	53	-3643	5.8	24.9
K3	0.32	0.20	0.005	45	-3473	5.1	26.1
						5.1	
L1 - 6 tons Agric. lime/acre/ annum							
K0	0.07	0.02	0.001	71	-4183	5.9	10.6
K1	0.14	0.06	0.001	55	-3898	5.8	17.6
K2	0.19	0.09	0.002	52	-3810	5.6	21.7
K3	0.25	0.18	0.004	52	-3628	5.5	14.8
						5.6	
	Site 2 - Basal dressing of ½ ton dolomitic lime, 250 lb nitromoncal and 250 lb superphosphate per acre applied.						
K0 - 50 lb KCl/acre	0.15	0.07	0.002	42	-3984	4.6	17.4
K1 - 100 " "	0.20	0.10	0.003	33	-3738	4.1	21.0
K2 - 150 " "	0.34	0.22	0.008	27	-3229	4.5	25.2
						4.3	

* Yield calculated as 5-year average

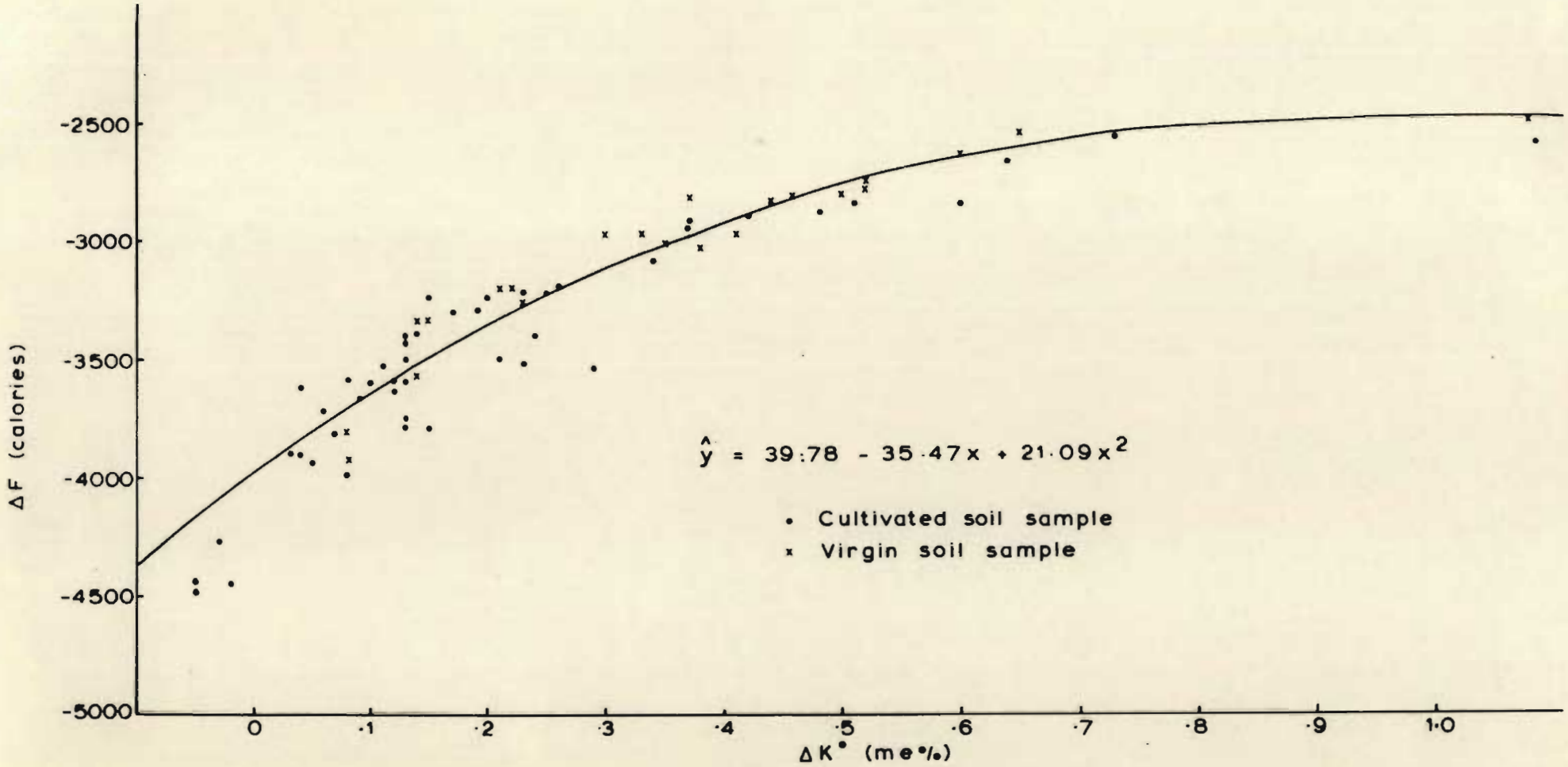
APPENDIX 3 (cont.)



3(a). The effect of fertilizer application on Q/I relations



3(b). Relationship between PBC^K and pH, Expt. 1 - Cedara (Loskop series)



Appendix 4: Relationship between energies of exchange (ΔF) and the pool of labile K (ΔK). The quadratic regression was significant at the 0·1 percent level.

Appendix 5 : Analytical data for lime, phosphorus and potassium response studies on selected soil series

Soil series	Lime treatment	pH H_2O	pH N KCl	Lime reqt. SMP (pH 6.0) tons $CaCO_3$/acre	Exchangeable cations me% (oven dry basis) Ca	Mg	K	Na	H	S	T	BS %	Exch Al me%	Mn ppm	C %	Mechanical analysis % Sand	Silt	Clay
	(a) COMPONENT T-A - Highly leached soils																	
BALMORAL	1)	5.5	4.3	4.81	1.93	1.60	1.02	0.04	9.11	4.59	13.70	33.50	0.33	10.0	3.15	24	22	54
	2) L0 (nil)	5.1			1.45	1.67	0.84	0.07	10.85	4.03	14.88	27.08	0.45					
	L1 (1t/a)	5.5			3.37	1.68	0.86	0.07	9.36	5.98	15.34	38.98	0.15					
	L2 (2t/a)	5.7			7.61	1.33	0.94	0.04	6.74	9.92	16.66	59.54	0.05					
	L3 (4t/a)	6.0			8.80	1.33	0.93	0.11	5.14	11.17	16.31	68.19	0.02					
HUTTON	1)	5.3	4.2	5.6	0.94	0.82	0.40	0.02	10.91	2.18	13.09	16.7	1.03	7.50	3.10	53	16	31
	2) L0	4.77			0.79	0.93	0.32	0.07	11.04	2.11	13.15	16.05	1.20					
	L1	4.98			2.37	0.8	0.28	0.05	9.41	3.58	12.99	27.56	0.45					
	L2	5.17			4.40	0.95	0.31	0.09	7.74	5.75	13.49	42.12	0.14					
	L3	5.68			7.42	0.84	0.29	0.05	5.05	8.60	13.65	63.0	0.04					
FARMHILL	1)	5.6	4.4	5.2	2.06	1.42	0.98	0.02	9.72	4.48	14.20	31.50	0.10	7.50	4.78	24	21	55
	2) L0	5.45			1.76	1.74	1.03	0.11	11.29	4.64	15.93	29.13	0.21					
	L1	5.58			3.76	1.73	1.02	0.09	9.96	6.56	16.52	39.71	0.08					
	L2	5.69			5.56	1.78	1.01	0.13	8.42	8.48	16.90	50.18	0.04					
	L3	5.98			8.99	1.73	1.02	0.15	4.92	11.89	16.81	70.73	0.02					
Lidgetton	1)	5.20	4.00	6.5	2.06	1.42	0.77	0.07	13.30	4.32	17.62	24.50	1.11	7.50	4.30	23	23	54
	2) L0	4.95			1.68	2.08	0.70	0.10	17.10	4.56	21.66	21.05	1.16					
	L1	-			3.56	2.06	0.76	0.12	17.27	6.50	23.77	27.35	0.50					
	L2	5.30			5.38	2.13	0.70	0.13	10.9	8.34	19.24	43.35	0.20					
	L3	5.63			8.75	2.12	0.70	0.09	11.98	11.66	23.64	49.32	0.05					
GRIFFIN	1)	5.4	4.2	4.8	0.44	0.41	0.12	0.04	8.64	1.01	9.65	10.5	0.57	2.50	3.67	51	18	31
	2) L0	4.80			0.39	0.71	0.14	0.13	9.50	1.37	10.87	12.60	0.74					
	L1	5.23			2.10	0.67	0.16	0.11	7.25	3.04	10.29	29.54	0.21					
	L2	5.35			4.01	0.67	0.15	0.15	6.11	4.98	11.09	44.91	0.05					
	L3	5.74			6.76	0.61	0.13	0.12	3.93	7.62	11.55	65.97	0.03					
GRIFFIN (humic)	1)	5.60	4.50	5.2	0.81	0.41	0.19	0.07	12.42	1.48	13.90	10.60	0.32	4.38	5.19	51	25	24
	2) L0	4.91			0.77	0.92	0.30	0.15	17.02	2.14	19.16	11.17	0.47					
	L1	5.08			2.38	0.90	0.21	0.12	15.64	3.61	19.25	18.75	0.31					
	L2	5.35			4.20	0.93	0.24	0.19	16.58	5.56	22.14	25.11	0.12					
	L3	5.59			7.52	0.94	0.25	0.19	12.29	8.90	21.19	42.00	0.07					
CLOVELLY	1)	5.20	4.00	4.8	1.68	1.42	0.39	0.07	10.75	3.56	14.31	24.90	1.12	6.88	3.07	31	27	42
	2) L0	4.57			1.62	1.71	0.38	0.07	10.26	3.87	14.13	27.39	1.13					
	L1	4.81			3.31	1.75	0.37	0.07	9.17	5.67	14.84	38.21	0.43					
	L2	5.05			4.93	1.84	0.38	0.07	7.64	7.47	15.11	49.44	0.13					
	L3	5.55			7.68	1.72	0.37	0.05	5.52	10.20	15.74	64.80	0.04					
CLEVELAND	1)	5.30	4.20	3.9	0.25	0.10	0.11	0.07	5.87	0.53	6.43	8.30	0.74	3.75	2.67	69	15	16
	2) L0	4.43			0.20	0.30	0.11	0.03	7.58	0.64	8.22	7.79	1.13					
	L1	5.00			1.81	0.30	0.10	0.03	4.96	2.24	7.20	31.11	0.31					
	L2	5.33			3.67	0.30	0.11	0.04	3.34	4.12	7.46	55.23	0.07					
	L3	5.93			6.24	0.22	0.11	0.05	1.08	6.62	7.70	86.97	0.05					
	(b) COMPONENT - B - Partially leached soils																	
SHORTLANDS	1)	5.90	4.80	3.1	7.34	5.39	0.76	0.05	9.36	13.54	22.90	51.10	-	20.00	3.56	19	20	61
	2) L0	5.33			7.83	5.97	1.22	0.15	2.68	15.17	17.85	84.99	-					
	L1	5.36			8.18	6.49	1.19	0.14	6.47	16.00	22.47	71.21	-					
	L2	5.55			9.22	6.21	1.19	0.13	5.92	16.75	22.67	73.89	-					
	L3	5.88			10.89	6.48	1.21	0.14	4.13	18.72	22.85	81.93	-					
Bellevue	1)	6.20	5.00	1.0	5.74	3.25	0.76	0.07	2.78	9.82	12.60	77.9	-	82.00	2.03	45	16	39
	2) L0	5.85			5.68	3.06	0.70	0.08	2.49	9.52	12.01	79.27	-					
	L1	5.85			5.94	3.19	0.67	0.08	2.04	9.88	11.92	82.89	-					
	L2	6.23			7.30	3.13	0.70	0.07	1.11	11.20	12.31	90.98	-					
	L3	6.52			8.67	3.07	0.71	0.07	0.12	12.72	12.84	99.07	-					
Jagersdrift	1)	6.90	5.80	-	2.37	1.42	0.51	0.01	0.70	4.30	5.00	86.2	-	1.50	0.75	77	4	19
	2) L0	6.26			2.08	1.46	0.45	0.03	-	4.02	5.63	71.40	-					
	L1	6.75			2.52	1.50	0.45	0.03	-	4.50	3.75	120.00	-					
	L2	7.50			3.72	1.44	0.43	0.02	-	5.61	4.03	139.31	-					
	L3	7.76			5.61	1.43	0.43	0.02	-	7.49	4.13	181.36	-					
AVALON	1)	6.50	5.10	-	3.31	1.44	0.12	0.13	1.85	5.00	6.85	89.2	-	2.50	0.65	62	13	25
	2) L0	5.96			3.23	2.07	0.10	0.18	0.41	5.58	5.99	93.16	-					
	L1	6.36			3.62	2.00	0.10	0.18	0.38	5.90	6.28	93.95	-					
	L2	7.08			4.82	1.86	0.10	0.17	-	6.95	6.69	103.89	-					
	L3	7.63			6.29	1.72	0.10	0.17	-	8.28	6.68	123.95	-					
ARROCHAR	1)	5.70	4.30	1.4	1.87	1.42	0.31	0.02	4.38	3.62	8.00	45.3	0.08	6.25	1.45	58	15	27
	2) L0	5.29			1.90	1.74	0.33	0.04	2.76	4.01	6.77	59.23	0.08					
	L1	5.13			2.22	1.67	0.32	0.03	2.40	4.24	6.64	63.86	0.05					
	L2	5.68			3.56	1.70	0.33	0.03	1.42	5.62	7.03	79.83	0.02					
	L3	6.08			4.97	1.57	0.30	0.03	-	6.87	6.28	109.39	0.01					
SOUTHWOLD	1)	5.50	4.20	3.1	2.25	1.81	0.58	0.04	5.62	4.88	10.50	46.50	0.18	3.75	1.78	50	16	34
	2) L0	4.90			2.31	2.13	0.55	0.08	4.39	5.07	9.46	53.59	0.20					
	L1	5.05			2.75	2.20	0.55	0.08	3.11	5.58	8.69	64.21	0.12					
	L2	5.28			4.09	2.22	0.55	0.13	2.35	6.99	9.34	74.84	0.03					
	L3	5.66			5.56	2.11	0.41	0.52	1.16	8.60	9.76	88.11	0.02					
SPRINGFIELD	1)	6.10	4.80	-	2.75	1.42	0.56	0.03	2.32	4.78	7.10	67.3	-	2.50	1.78	74	8	18
	2) L0	5.50			2.60	1.36	0.22	0.05	1.26	4.23	5.49	78.69	-					
	L1	5.85			2.97	1.29	0.51	0.03	1.30	4.80	6.10	78.69	-					
	L2	6.43			4.63	1.40	0.57	0.05	-	6.65	6.04	110.10	-					
	L3	7.10			5.89	1.36	0.51	0.03	-	7.79	6.19	125.85	-					
RENSBURG	1)	7.00	6.10	-	13.59	10.60	0.38	0.14	1.59	24.71	26.30	94.00	-	8.28	2.36	41	13	46
	2) L0	7.06			18.50	13.65	0.63	0.10	0.42	32.88	33.30	98.74	-					
	L1	6.97			18.61	14.59	0.61	0.12	-	33.93	32.52	104.34	-					
	L2	7.28			19.32	13.73	0.63	0.09	-	33.77	33.12	101.96	-					
	L3	7.47			23.99	13.26	0.64	0.10	-	37.99	33.70	112.73	-					

1) Field samples
2) After equilibration

Appendix 6 : Multiple regression analysis for studies of lime, phosphorus and potassium on selected soil series
(Analytical data for unameliorated highly and partially leached soils after equilibration.)

CORRELATION COEFFICIENTS (LSD's 0.497 (P 0.05); 0.623 (P 0.01))

	X_1 Clay %	X_2 Carbon %	X_3 pH	X_4 exch. Al me%	X_5 Ca me%	X_6 Mg me%	X_7 K me%	X_8 Na me%	X_9 H me%	X_{10} S me%	X_{11} T me%	X_{12} BS %	X_{13} Mn ppm
X_1 Clay %	-												
X_2 Carbon %	0.493	-											
X_3 pH	0.051	-0.451	-										
X_4 EAI me%	0.005	0.460	-0.733**	-									
X_5 Ca me%	0.336	-0.158	0.767**	-0.460	-								
X_6 Mg me%	0.403	-0.080	0.714**	-0.390	0.989**	-							
X_7 K me%	0.877*	0.360	0.197	-0.277	0.349	0.384	-						
X_8 Na me%	0.072	-0.059	-0.114	-0.179	0.012	0.037	0.098	-					
X_9 H me%	0.252	0.838**	-0.645**	0.722**	-0.499*	-0.413	0.056	-0.061	-				
X_{10} S me%	0.398	-0.106	0.742**	-0.436	0.997**	0.997**	0.401	0.028	-0.453	-			
X_{11} T me%	0.623**	0.537*	0.296	0.093	0.682**	0.749**	0.475	-0.018	0.291	0.722**	-		
X_{12} BS %	0.055	-0.631**	0.830**	-0.841**	0.677**	0.602*	0.232	0.089	-0.864**	0.646**	0.023	-	
X_{13} Mn ppm	0.227	-0.060	0.199	-0.239	0.223	0.134	0.335	-0.095	-0.194	0.197	0.061	0.281	-
Y (1)	-0.293	-0.706**	0.622*	-0.714**	0.452	0.392	-0.078	0.139	-0.817**	0.416	-0.188	0.815**	-0.306
Y (2)	-0.151	-0.660**	0.605*	-0.696**	0.537*	0.537*	-0.003	0.261	-0.831**	0.558*	-0.047	0.844**	0.033

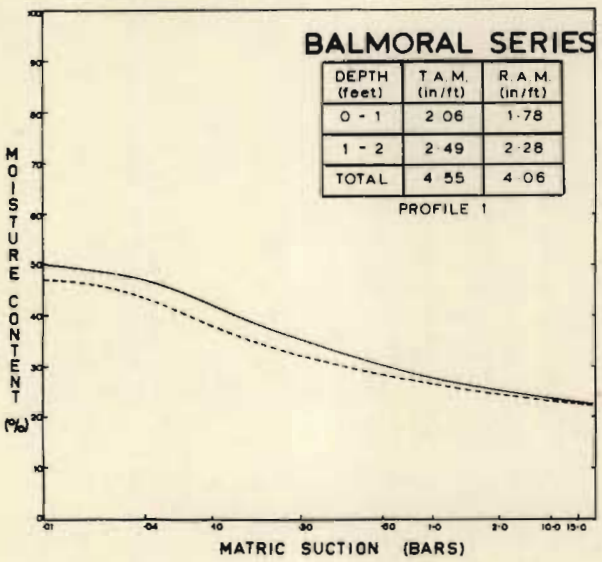
(1) Y-variate represents yield data for L0 treatment over all levels of P
(2) Y-variate represents yield data for L0P4 treatment
S - sum of bases; T - total exchange capacity; BS - base saturation

APPENDIX 7 : Moisture characteristics of selected soils in the Howick Extension Area

BALMORAL SERIES

DEPTH (feet)	T.A.M. (in/ft)	R.A.M. (in/ft)
0 - 1	2·06	1·78
1 - 2	2·49	2·28
TOTAL	4·55	4·06

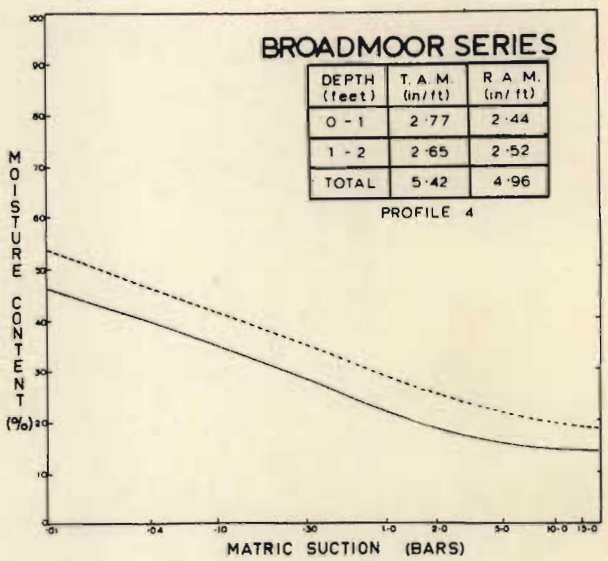
PROFILE 1



BROADMOOR SERIES

DEPTH (feet)	T.A.M. (in/ft)	R.A.M. (in/ft)
0 - 1	2·77	2·44
1 - 2	2·65	2·52
TOTAL	5·42	4·96

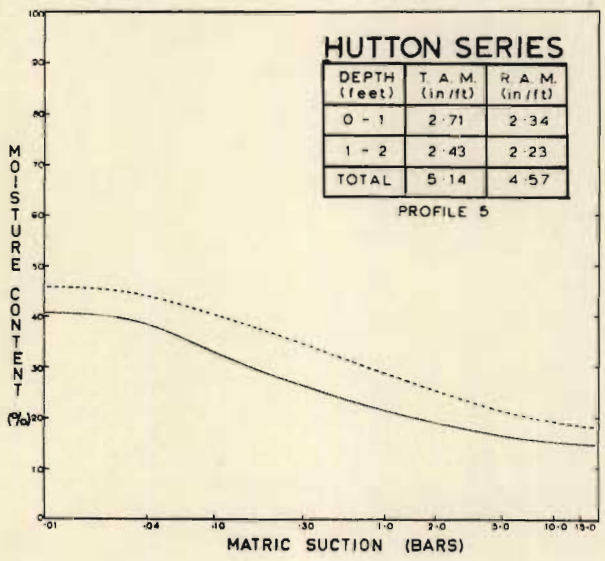
PROFILE 4



HUTTON SERIES

DEPTH (feet)	T.A.M. (in/ft)	R.A.M. (in/ft)
0 - 1	2·71	2·34
1 - 2	2·43	2·23
TOTAL	5·14	4·57

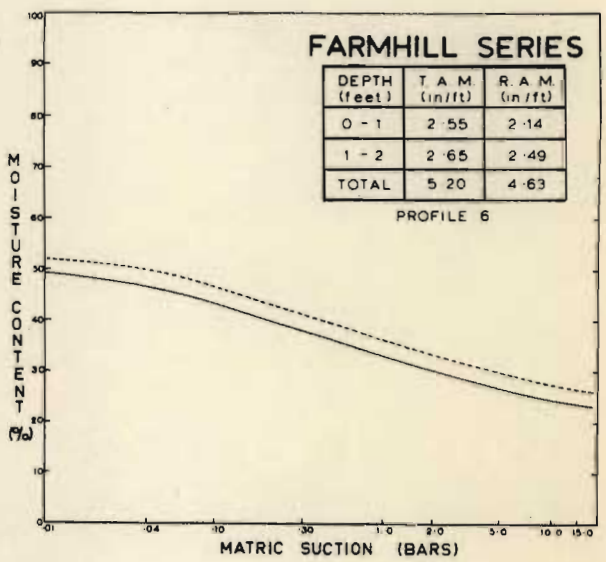
PROFILE 5



FARMHILL SERIES

DEPTH (feet)	T.A.M. (in/ft)	R.A.M. (in/ft)
0 - 1	2·55	2·14
1 - 2	2·65	2·49
TOTAL	5·20	4·63

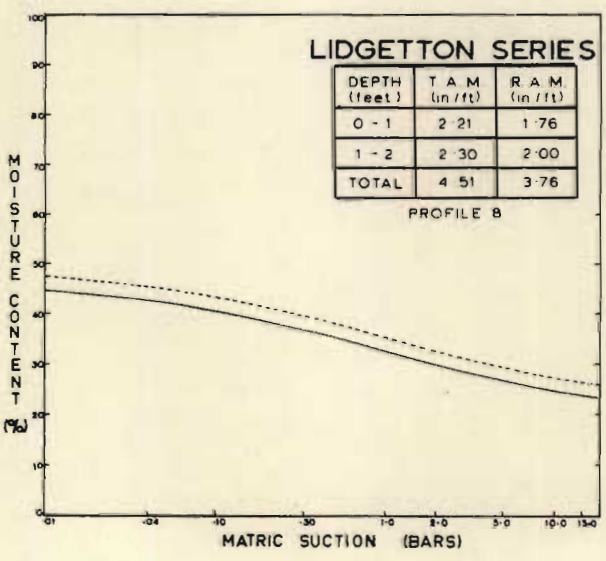
PROFILE 6



LIDGETTON SERIES

DEPTH (feet)	T.A.M. (in/ft)	R.A.M. (in/ft)
0 - 1	2·21	1·76
1 - 2	2·30	2·00
TOTAL	4·51	3·76

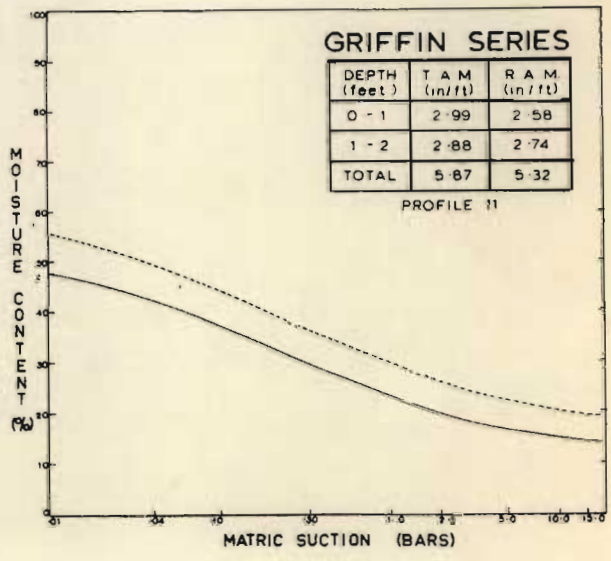
PROFILE 8



GRIFFIN SERIES

DEPTH (feet)	T.A.M. (in/ft)	R.A.M. (in/ft)
0 - 1	2·99	2·58
1 - 2	2·88	2·74
TOTAL	5·87	5·32

PROFILE 11



------- surface samples (6 inches)

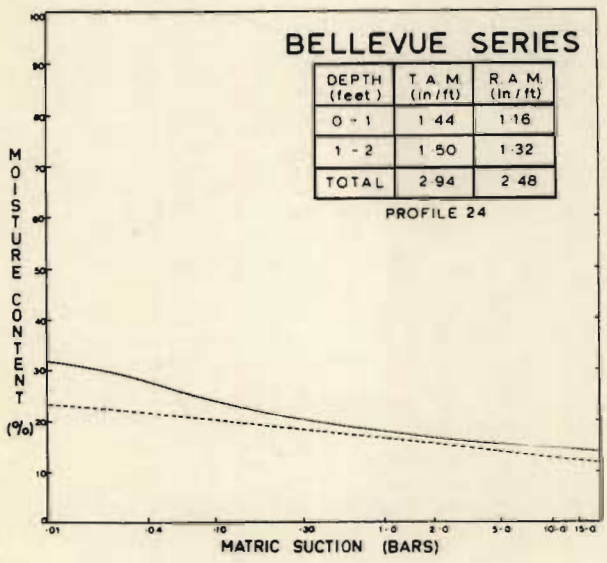
——— sub surface samples (18 inches)

APPENDIX 7 contd

BELLEVUE SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	1 44	1 16
1 - 2	1 50	1 32
TOTAL	2 94	2 48

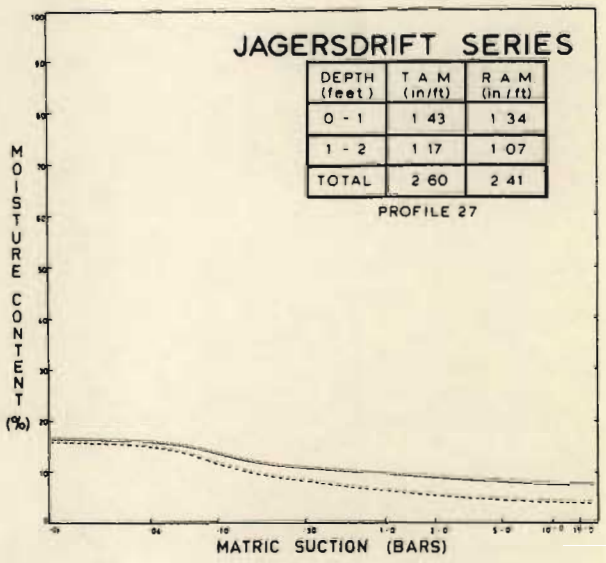
PROFILE 24



JAGERSDRIFT SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	1 43	1 34
1 - 2	1 17	1 07
TOTAL	2 60	2 41

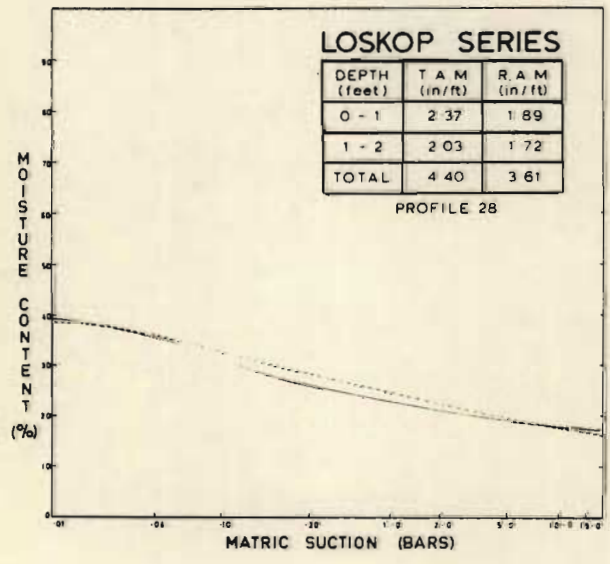
PROFILE 27



LOSKOP SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	2 37	1 89
1 - 2	2 03	1 72
TOTAL	4 40	3 61

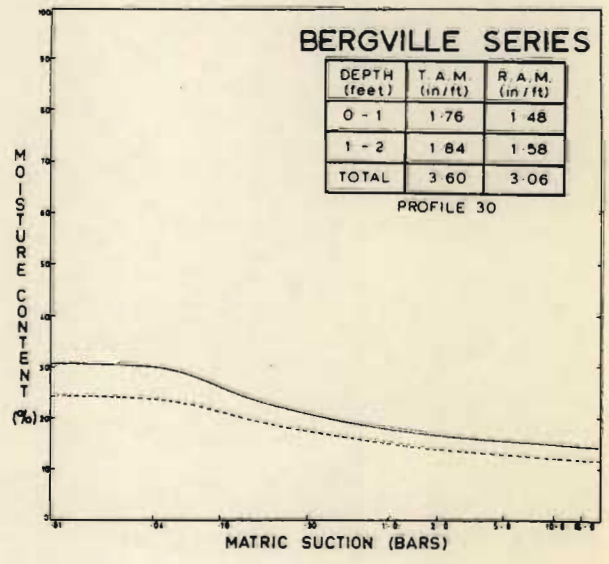
PROFILE 28



BERGVILLE SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	1 76	1 48
1 - 2	1 84	1 58
TOTAL	3 60	3 06

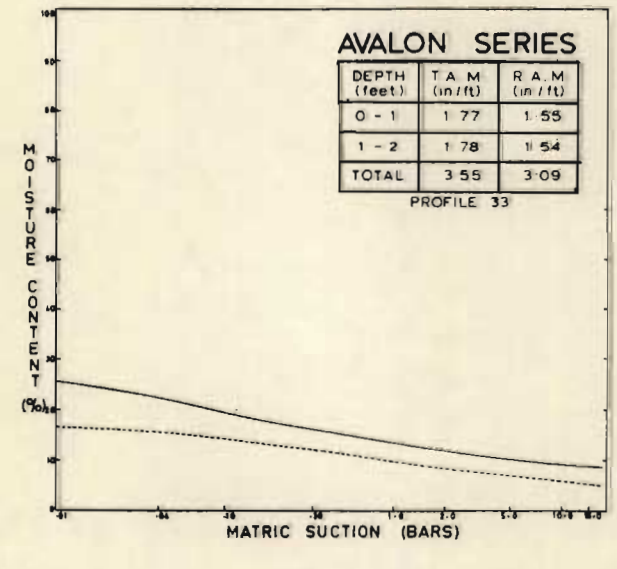
PROFILE 30



AVALON SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	1 77	1 55
1 - 2	1 78	1 54
TOTAL	3 55	3 09

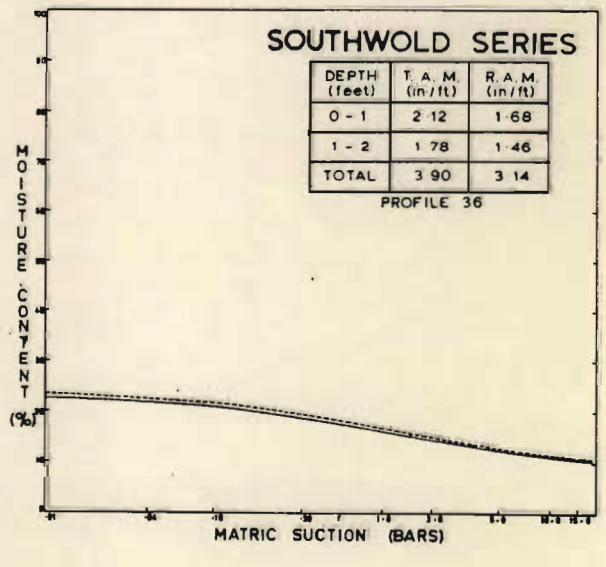
PROFILE 33



SOUTHWOLD SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	2 12	1 68
1 - 2	1 78	1 46
TOTAL	3 90	3 14

PROFILE 36



– – – – – – surface samples (6 inches)

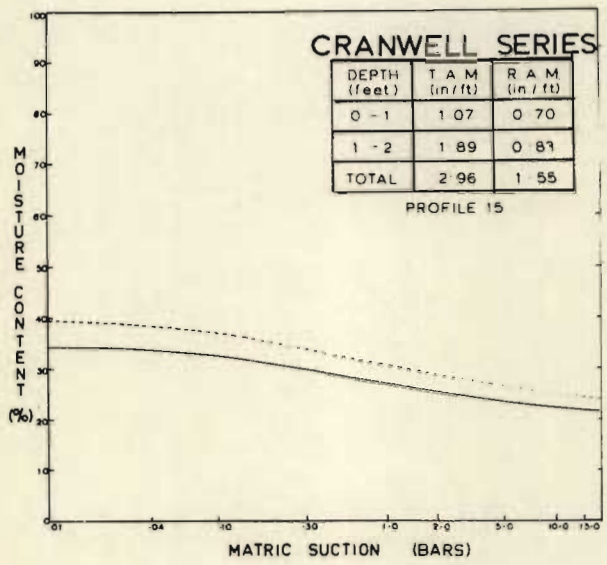
——— sub surface samples (18 inches)

APPENDIX 7 contd

CRANWELL SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	1 07	0 70
1 - 2	1 89	0 87
TOTAL	2 96	1 55

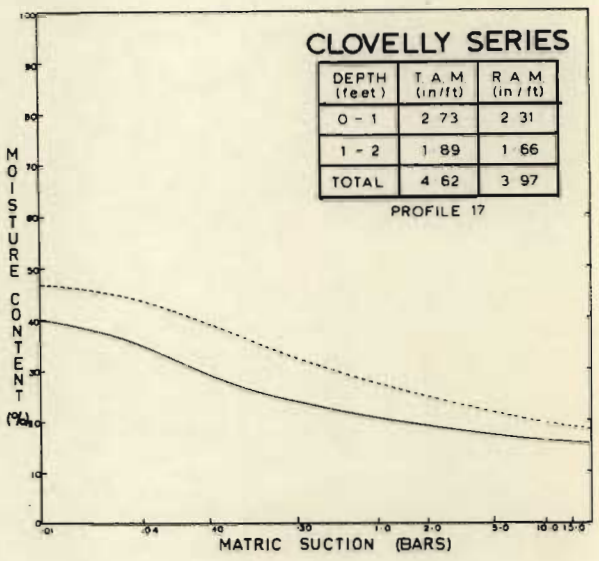
PROFILE 15



CLOVELLY SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	2 73	2 31
1 - 2	1 89	1 66
TOTAL	4 62	3 97

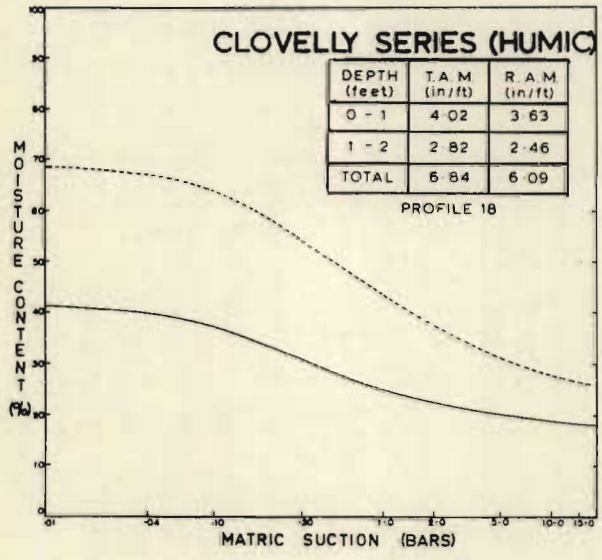
PROFILE 17



CLOVELLY SERIES (HUMIC)

DEPTH (feet)	T.A.M (in/ft)	R.A.M (in/ft)
0 - 1	4 02	3 63
1 - 2	2 82	2 46
TOTAL	6 84	6 09

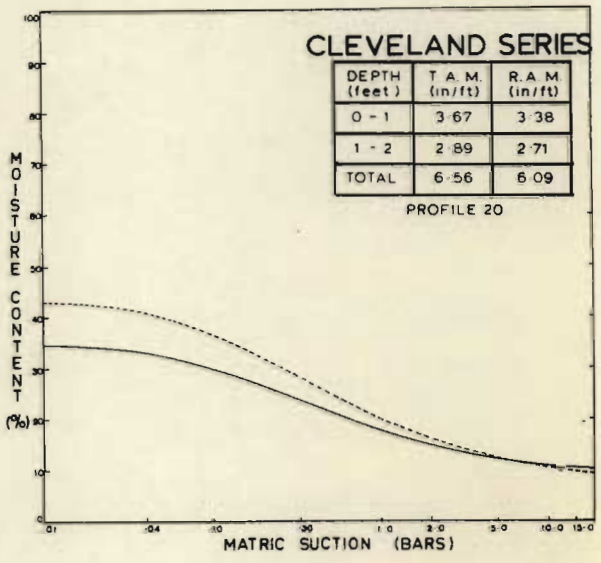
PROFILE 18



CLEVELAND SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	3 67	3 38
1 - 2	2 89	2 71
TOTAL	6 56	6 09

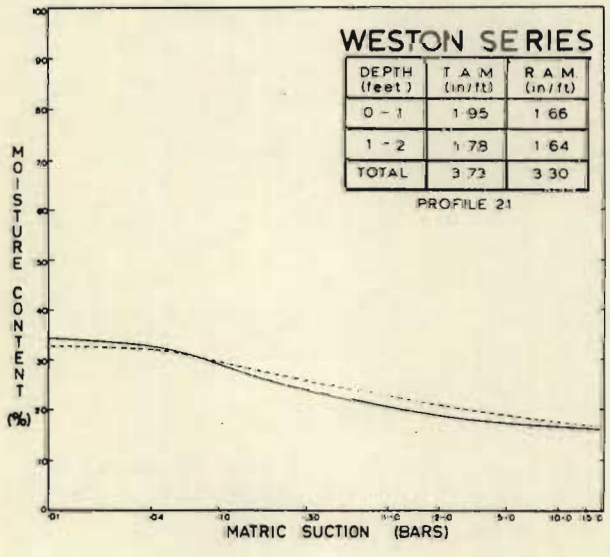
PROFILE 20



WESTON SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	1 95	1 66
1 - 2	1 78	1 64
TOTAL	3 73	3 30

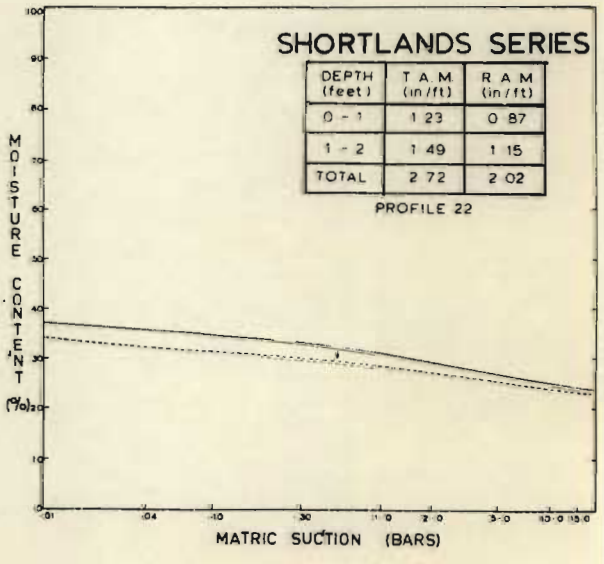
PROFILE 21



SHORTLANDS SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	1 23	0 87
1 - 2	1 49	1 15
TOTAL	2 72	2 02

PROFILE 22



- - - - - - - surface samples (6 inches)

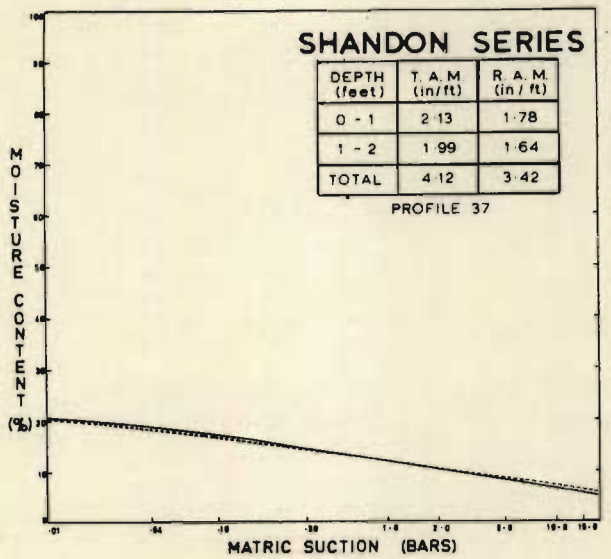
——————— sub surface samples (18 inches)

APPENDIX 7 contd

SHANDON SERIES

DEPTH (feet)	T. A. M. (in/ft)	R. A. M. (in/ft)
0 - 1	2·13	1·78
1 - 2	1·99	1·64
TOTAL	4·12	3·42

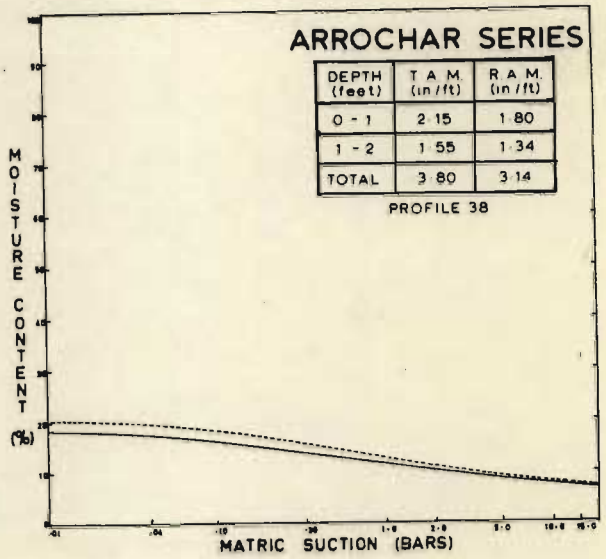
PROFILE 37



ARROCHAR SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	2·15	1·80
1 - 2	1·55	1·34
TOTAL	3·80	3·14

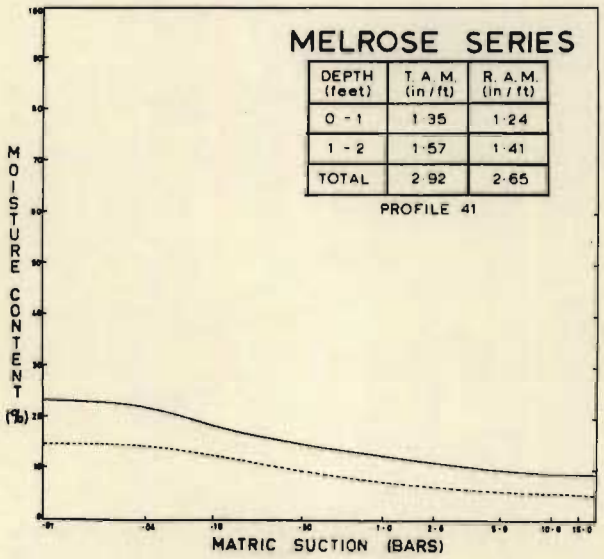
PROFILE 38



MELROSE SERIES

DEPTH (feet)	T. A. M. (in/ft)	R. A. M. (in/ft)
0 - 1	1·35	1·24
1 - 2	1·57	1·41
TOTAL	2·92	2·65

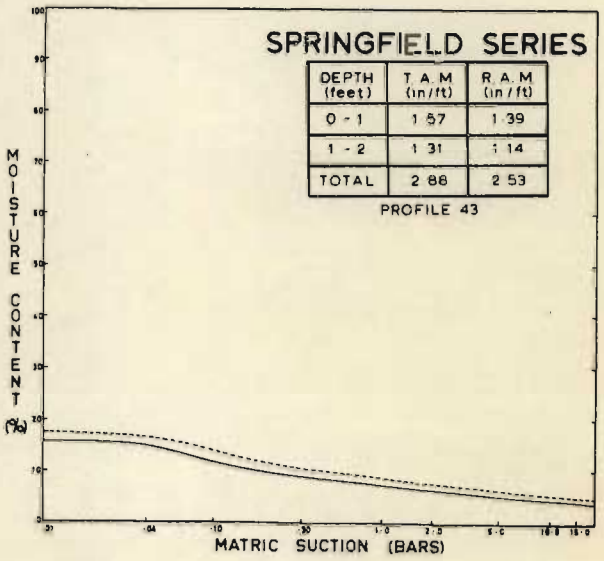
PROFILE 41



SPRINGFIELD SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	1·57	1·39
1 - 2	1·31	1·14
TOTAL	2·88	2·53

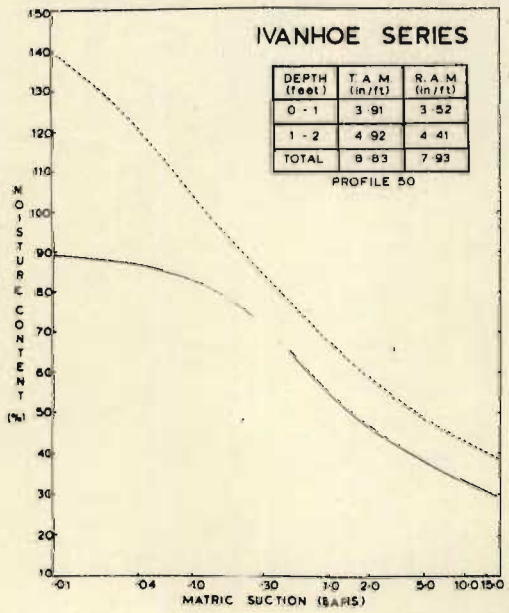
PROFILE 43



IVANHOE SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	3·91	3·52
1 - 2	4·92	4·41
TOTAL	8·83	7·93

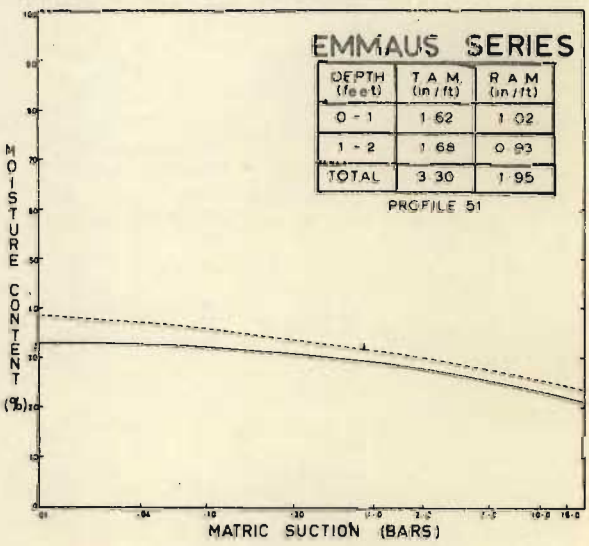
PROFILE 50



EMMAUS SERIES

DEPTH (feet)	T A M (in/ft)	R A M (in/ft)
0 - 1	1·62	1·02
1 - 2	1·68	0·93
TOTAL	3·30	1·95

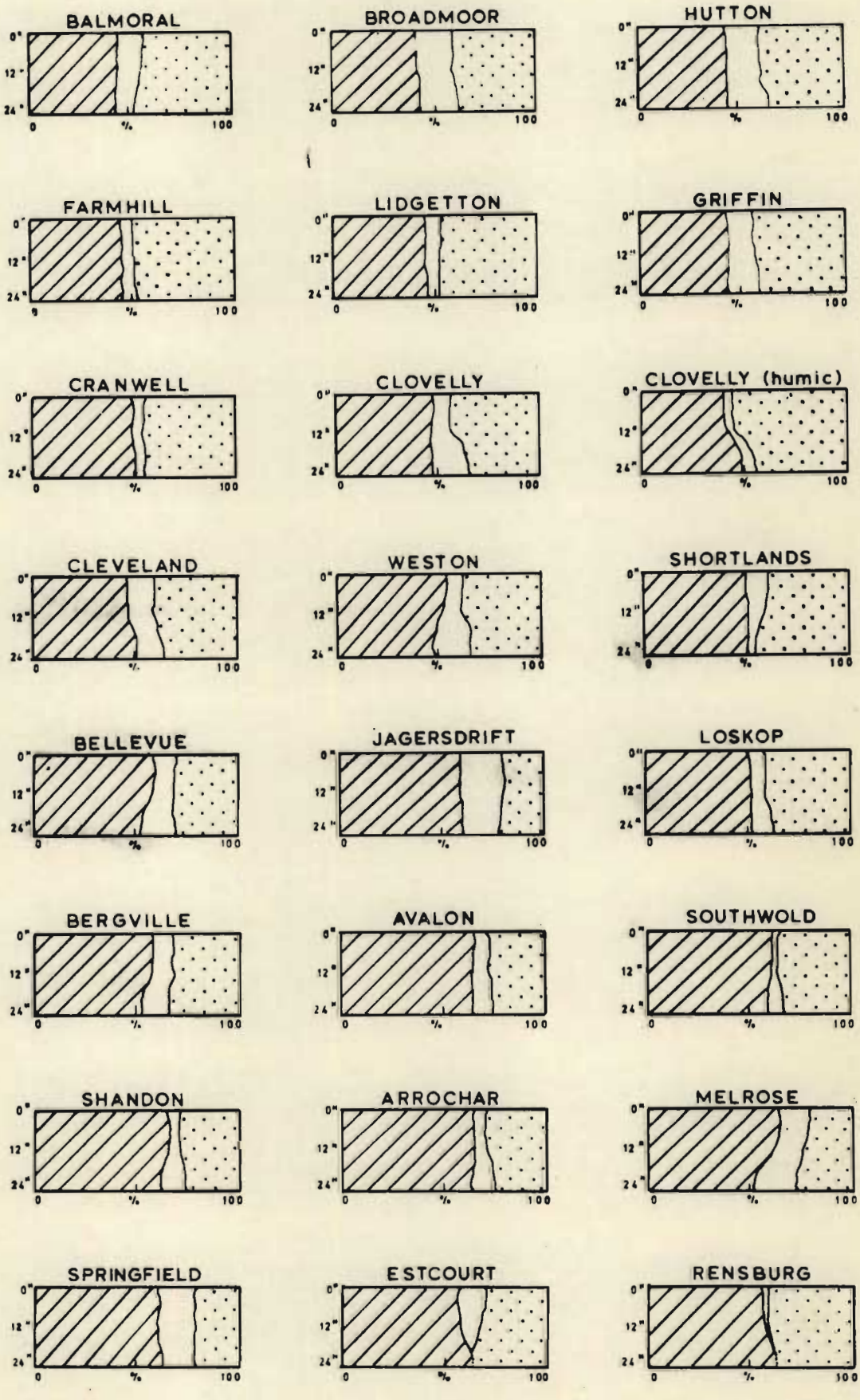
PROFILE 51



------- surface samples (6 inches)

——— sub surface samples (18 inches)

APPENDIX 8



TOTAL POROSITY AND PORE-SIZE DISTRIBUTION OF SELECTED SOIL SERIES.

Appendix 9 : Criteria for soil assessment

A list of the main soil criteria (and sundry other properties) and the various classes for each is presented below. The accompanying table indicates the writer's assessment of the selected criteria series by series. For the sake of convenience numerical symbols corresponding to the particular classes have been used in the table. The lowest value generally reflects the most favourable assessment. High values thus reflect properties which adversely affect soil capability. Positive and negative signs are used where an excess or deficiency of a particular soil property occurs.

In making these assessments the appraisals presented by van der Eyk et al. (1969) were consulted and the findings reported in Chapter 2 taken into account.

Effective depth: Effective depth may vary considerably within a particular soil series. For this reason, a range is given for certain soils. Effective depth is not as restrictive among highly leached soils as with partially leached soils because of the highly weathered nature of the parent material and rock. The five classes specified by Loxton (1962) are used:

1 Deep (> 60 inches)
2 Moderately deep (36 - 60 inches)
3 Moderately shallow (20 - 36 inches)
4 Shallow (10 - 20 inches)
5 Very shallow (< 10 inches)

Overall drainage: Seven main classes are used in accordance with those defined by Soil Survey Staff (1951) and van der Eyk (1965c). Values bracketed in the table indicate the possible range.

0 Well-drained
+1 Somewhat excessively drained
+2 Excessively drained
-1 Moderately well-drained
-2 Somewhat poorly drained
-3 Poorly drained
-4 Very poorly drained

Available moisture capacity: Assessment of available moisture capacity is based mainly on the results of the soil moisture study reported in Chapter 2. The five classes already defined are retained.

1 Very high (TAM > 5 inches/2 feet)
2 High (TAM 4-5 inches/2 feet)
3 Moderate (TAM 3-4 inches/2 feet)
4 Low (TAM 2-3 inches/2 feet)
5 Very low (TAM < 2 inches/2 feet)

Erosion hazard: Five classes are used to assess erosion hazard. This is defined by Loxton (1962) as the natural erodibility or susceptibility of a particular soil to erosion.

1 Very low
2 Low
3 Moderate
4 High (severe)
5 Very high (very severe)

Soil climate: Soil climate refers to the pedo-climate or moisture regime of the soil (Loxton, 1962). Considerable difficulty may be experienced in assessing the soil climate of imperfectly drained, partially leached soils. These soils, although generally somewhat droughty, are subject to periods of waterlogging when they are wet to very wet. To accommodate this, values have been presented to indicate the overall appraisal of soil climate together with values in brackets reflecting the degree of wetness.

The five classes used coincide with those defined by Loxton (1962).

0	Moist	-1	Somewhat droughty
+1	Wet	-2	Droughty or dry
+2	Very wet		

Mechanical limitations: The four classes defined by Loxton (1962) are used but limitations of slope are excluded. The following qualifying suffixes refer to the nature of the limitation:

r - surface stones; c - consistence; p - puddling, crusting or cloddiness and difficult to work when wet; t - subsurface limitations affecting tillage; w - limitations resulting in excessive wear and tear on machinery.

1	Nil	3	Moderate
2	Slight	4	Severe

Degree of leaching: The five classes defined in Chapter 1 are used.

0	Moderately leached	-1	Slightly leached
+1	Considerably leached	-2	Hardly leached
+2	Highly leached		

Infiltration capacity: Five simple classes are used to indicate the assessed infiltration capacity.

1	Very high	4	Low
2	High	5	Very low
3	Medium		

Swell-shrink potential: Five classes similar to those used by van der Eyk et al. (1969) are used. The bracketed suffixes t and s refer to assessments in respect of topsoil or subsoil respectively.

1	Very low	4	High
2	Low	5	Very high
3	Moderate		

Permeability of lower subsoil: Five classes are used to indicate the assessed permeability of the lower subsoil horizons. Similar assessments were presented by van der Eyk et al. (1969). This criterion is also reflected in the overall drainage values.

1	Very rapid	4	Slow
2	Rapid	5	Very slow
3	Moderate		

Porosity: The total porosity ratings presented in Chapter 2 form the basis of this assessment. The five classes established on the basis of percentage total porosity are retained.

1	Very high (> 60 percent)	4	Low (30-40 percent)
2	High (50-60 percent)	5	Very low (< 30 percent)
3	Moderate (40-50 percent)		

Organic matter content: The usual organic carbon content (percent) of the topsoil is used to define the following six classes:

1	Extremely high	(> 10	percent	organic	carbon)
2	Very high	(5-10	percent	"	")
3	High	(2-5	percent	"	")
4	Moderate	(1-2	percent	"	")
5	Low	(0.5-1.0	percent	"	")
6	Very low	(< 0.5	percent	"	")

Surface soil reaction: Six classes are defined on the basis of normal pH values (water).

0	Neutral (pH 6.5-7.0)	-1	Slightly acid (pH 5.5-6.5)
+1	Slightly to moderately alkaline (pH 7.0-8.0)	-2	Moderately acid (pH 5.0-5.5)
+2	Strongly alkaline (pH > 8.0)	-3	Strongly acid (pH < 5.0)

Textural classes: The usual textural classes of the A1-, upper B- and lower B-horizons are also indicated. These classes are in accordance with the modified triangular chart designed by Loxton (1961).

Structure and colour of upper subsoil: These two criteria were also considered when making the assessments since they (especially colour) are important co-varying factors. The values for these properties are not tabulated along with the other criteria since they are clearly indicated in table 2.

Appendix 9 : Criteria for soil assessment

Soil asstn.	Soil series	Criteria														
		Effective depth	Overall drainage	Available moisture capacity	Erosion hazard	Soil climate	Mechanical limitations	Degree of leaching	Infiltration capacity	Swell-shrink potential	Permeability of lower subsoil	Porosity	Organic matter content	Surface soil reaction	Textural class		
															A1	Upper B	Lower B
	(a) UPLAND SOILS																
A1	BALMORAL	1	0	2(1)	1	0	1(1-4r)	+2	1	2	1	2	3	-2	Cl	Cl	Cl
	Tabamhlope	1	0	2(1)	1	0	1	+2	1	2	1	2	3(4)	-2	SiClLm	SiCl	SiCl
	FARNINGHAM	1-4	0	2(1)	1(2)	0	1(1-4r)	+2	1	2	1(2)	2	3	-2	SiClLm	Cl	Cl
A2	Broadmoor	1	0	1	2	0	1	+2	1	1	1	2	3	-3	ClLm	fSaLm	fSaCl
	HUTTON	1-4	0(+1)	1	3(2)	0(-1)	1	+2	1	1	1	2	3	-3	ClLm	fSaClLm	fSaClLm
B1	FARMHILL	1	0	1(2)	1	0	1	+2	1(2)	2	2	2	3(2)	-2	Cl	Cl	Cl
	Helmekaar	1	0	1	1	0	1	+2	1	2	1	2	3	-2	ClLm	Cl	Cl
	Lidgetton	1-3	0	2	1	0	1	+2	1(2)	2	2	2	3(2)	-2(-3)	SiCl	Cl	Cl
	GRIFFIN	1-3	0	1	1	0	1	+2	1	2	1	1(2)	3(2)	-2(-3)	ClLm	Cl-ClLm	Cl
	Cranwell	2-4	1(-1)	3(4)	2(1)	0	1(2t)	+2	2	2	2(3)	3(2)	3	-2(-3)	SiCl	Cl	Cl
	CLOVELLY	2-4	0(-1)	2	2(1)	0	1(2t)	+2	1	2	2	2	3(2)	-2(-3)	ClLm	ClLm	Cl
	MISPAH (clayey)	4-5	-1	4	4(3)	0(-1)	2t	+2	2	2	3(4)	3	3	-2(-3)	SiCl-Cl	-	-
	Humic phase		0(-1)	1	2(3)	0(+1)	1	+2	1(2)	2(3t)	2(3)	1(2)	1	-2	SiClLm	Cl	Cl
B2	CLEVELAND	1-2	0(+1)	1	3	0(-1)	1	+2	1	1	1	2	3	-2(-3)	fSaLm	fSaClLm	SaClLm
	OATSDALE	2-4	0(+1)	3	4	0(-1)	1	+2	1	1	2	2	4	-3	fSaLm	fSaClLm	SaClLm
	MISPAH (loamy)	4-5	+1	4(5)	4	-1	2t	+2	1	1	2(3)	2	4	-2	fSaClLm	-	-
D1	VIMY	1	0	3(2)	1	0	1(1-4r)	+1	1	2	1	2(3)	3(4)	-2	Cl	Cl	Cl
	Weston	1	0	3(2)	1	0	1(1-4r)	+1	1	2	1	2(3)	3(4)	-2	ClLm	ClLm	Cl
	DOVETON	1-4	0	3(2)	1(2)	0(-1)	1	+1	1	2	1(2)	2(3)	3(4)	-2	Cl-ClLm	Cl-ClLm	Cl
	MSINGA	1-2	+1	4	3	-1	1	+1	1	2	1	3	4(5)	-2(-1)	SaClLm	SaClLm	SaCl
	Mona	3-4	0(-1)	4	3	-1(-2)	1	0	1(2)	3	2	3	5	-1	SaClLm	SaClLm	SaClLm
	RICHMOND	1	0	3	1	0	1(1-4r)	+1	1	2	1(2)	2(3)	3	-2	Cl	Cl	Cl
	SHORTLANDS	1-2	0(-1)	4(3)	2	-1	1(1-4r)	0	1(2)	3	2(3)	3	4	-1	Cl	Cl	Cl
	Bellevue	1-3	0	4(3)	2	-1	1(1-4r)	0	1(2)	3	2	3	4(5)	-1	ClLm	Cl	Cl
D2	Jagersdrift	1	0	4	3(2)	-1	1	0	1	2	1	3	5	-1	SaClLm	SaClLm	SaClLm-SaCl
D3	Laskop	2	0(-1)	3(2)	2	0	1	+1	1	2	2	2	3(4)	-2(-1)	ClLm	Cl	Cl
	Rooikop	2	0(-1)	4(3)	3	-1	1	+1	1	2	2	2(3)	4(5)	-1	SaClLm	SaClLm	SaClLm
E1	NORMANDIEN	2	-1	3	2	-1	2p	+2	2(3)	2	3	3	3	-2	ClLm	Cl-ClLm	Cl
	BERGVILLE	2	-1	3	2	-1(+1)	2p	+1	2(3)	2	3	3	4	-1(-2)	ClLm-Cl	Cl-ClLm	Cl
	RUSTON	2	-1	3	2(3)	-1	2p	+2	2(3)	2	3	3(4)	4	-2	fSaClLm	fSaClLm	fSaClLm
	AVALON	2	-1	3	2(3)	-1(+1)	2p	+1	2(3)	2	3	3(4)	4(5)	-1(-2)	fSaClLm	fSaClLm	fSaClLm
	NEWPORT	2-3	-1	3	2(3)	-1(+1)	2p	+1	2(3)	2	3	4(3)	4(5)	-1	ClLm	Cl-ClLm	Cl-ClLm
	SOUTHWOLD	2-3	-1	3	3	-1(+1)	2p	+1	2(3)	2	3	4(3)	4(5)	-1	fSaClLm	fSaClLm	fSaClLm
	Shandon	3	-2	3	3	-1(+1)	2pt	+1	3	2	3(4)	4	4(5)	-1	fSaClLm	fSaClLm	fSaClLm
	ARROCHAR	3-4	-2(-1)	4	3(4)	-1(+1)	2pt	+1(0)	3	2	3(4)	4	4(5)	-1	fSaClLm	fSaClLm	fSaClLm
	MISPAH (clayey)	4-5	-1	4	4	-2	3t	+1(0)	3	2	4	4	4(5)	-1	ClLm-Cl	-	-
	Majuba	3	-2	4(3)	3	-2(+1)	2p	0	3	2(3s)	4	4	4	-1	ClLm	ClLm-Cl	ClLm-Cl
	Frere	3	-1(-2)	4(3)	4	-2(+1)	2p	0	2	2(3s)	4	4	5	-1	Lm	Lm	ClLm

Appendix 9 contd

Soil assctn.	Soil series	Criteria														
		Effective depth	Overall drainage	Available moisture capacity	Erosion hazard	Soil climate	Mechanical limitations	Degree of leaching	Infiltration capacity	Swell-shrink potential	Permeability of lower subsoil	Porosity	Organic matter content	Surface soil reaction	Textural class		
															A1	Upper B	Lower B
	(a) UPLAND SOILS																
E3	Melrose	2	-1	4	4	-1(+1)	2w	+1	1	1	3	4(3)	5(6)	-1	SaLm	SaClLm	SaCl
	LEKSAND	2	-1	4	4	-2(+1)	2w	+1	1	1	3	4(3)	5(6)	-1	LmSa	SaLm	SaClLm
	SPRINGFIELD	2-3	-1	4	4(5)	-2	2w	+1	1	1	3	4(3)	5(6)	-1	LmSa-SaLm	SaLm	SaClLm
	LONGLANDS	2	-3(-2)	4	4(5)	+1(-1)	2pw	+1(0)	1	1	3(4)	4(3)	5(6)	-1	SaLm	SaLm	SaClLm
	MISPAH (sandy)	4-5	+2	5	5	-2	3tw	+1(0)	1	1	3(4)	4	5(6)	-1	LmSa-SaLm	-	-
E5	GLENCOE	2-3	-2(-1)	3	3	-1(+1)	2p	+1	2	2	4	3(4)	4(5)	-1(-2)	ClLm-fSaClLm	ClLm-fSaClLm	-
	WESSELSNEK	2-3	-2(-1)	4	4	-2(+1)	2w	+1	1	1	4	3(4)	5(6)	-1(-2)	LmSa	LmSa	-
	WARRICK	3	-3(-2)	3	4(5)	+1(-1)	2p	+1(0)	3	2	4(5)	3(4)	5	-1	SaClLm	ClLm	-
	WASBANK	3	-3(-2)	4	5	+1(-2)	2w	+1(0)	2	1	4(5)	3(4)	6(5)	-1	SaLm	LmSa	-
	MISPAH (clayey)	4-5	-3	4	4(5)	-1(+1)	3pt	+1(0)	3	2	5	4	5	-1	ClLm-Cl	-	-
	MISPAH (sandy) (KLIPFONTEIN)	4-5	-3	5	5	-2(+2)	3t	+1(0)	2	1	5	4(3)	6(5)	-1	LmSa-SaLm	-	-
E6	WINTERTON	2-3	-3	3	3	+1(-1)	3p	+1(0)	3	2(3)	4(5)	3	3(4)	-1(-2)	ClLm	Cl	Cl
	ALBANY	2-3	-3	3	4(3)	+1(-1)	3p	+1(0)	2	2(3)	4(5)	3	4	-1	Lm	ClLm	ClLm
F1	ESTCOURT	3-4	-3(-2)	4	5	-2(+1)	3p	0(-1)	3(4)	1t 4s	5	4	5(6)	-1	Lm-ClLm	ClLm	Cl
	Bluebank	3	-2	4	5	-2(+1)	2p	0(-1)	3	1t 4s	5	4	5(6)	-1	SaClLm	SaClLm	SaCl
G2	RYDALVALE	2-4	0(-1)	4	3(4)	-2	3cp	-1	3(4)	4(5)	4	3	3(4)	0	Cl	Cl	Cl
	ARCADIA	2-4	0(-1)	4	3(4)	-2	3cp	-1	3(4)	4(5)	4	3	3(4)	0	Cl	Cl	Cl
	UPLAAS	1-3	0	3	3(2)	-1	2cp	0	3	3(4)	3	3	4(3)	-1	ClLm-Cl	Cl	Cl
	KIORA	1-3	0	3	3	-1	2cp	0	3	3(4)	3	3	4(3)	-1	SaClLm-ClLm	ClLm	Cl
	RENSBURG	2-3	-2(-3)	4	4(5)	-2(+1)	3cp	-1	3(4)	5	5	3(4)	3(4)	0(+1)	Cl	Cl	Cl
	PHOENIX	2-3	-2(-3)	4	4(5)	-2(+1)		-1	3(4)	5	5	3(4)	3(4)	0(+1)	Cl	Cl	Cl
	Ladysmith	3-4	-2(-3)	4	5	-2(+1)	3p	-1(0)	3(4)	3t 5s	5	4	4	-1	ClLm-Cl	Cl	Cl
	(b) BOTTOMLAND SOILS[1]																
C1	IVANHOE	3-5	1-4[2]	1	2(3)	+2	3cp	+1(0)	3(4)	3	5	1t(2)	1	-2	SiCl	Cl	Cl
	CHAMPAGNE	3-5	1-4[2]	1	3(2)	+2	3cp	+1(0)	3(4)	3	5	1t(2)	1	-2	SiClLm	Cl-ClLm	Cl
	KATSPRUIT	3-5	1-4[2]	2	2(3)	+2	3cp	+1(0)	4	3	5	2	2(3)	-2	ClLm-Cl	Cl	Cl
	Estcourt	3-5	1-4[2]	2	2(3)	+2	3cp	0	4	3	6	2	3	-2	ClLm-Cl	Cl	Cl
	Dall	3-5	1-4[2]	2	3(2)	+2	3cp	+1(0)	4	3	5	2	3(4)	-2	SaClLm	SaClLm	SaCl
M1	KILLARNEY	2-4	1-4[2]	3	3	+2(-1)	3cp	0(-1)	4(5)	4	5	3	3(4)	0(-1)	ClLm-Cl	Cl	Cl
	Estcourt(alkaline)	2-4	1-4[2]	3	3	+2(-1)	3cp	0(-1)	4(5)	4	5	3	3(4)	-1	ClLm-Cl	ClLm-Cl	Cl
	Rietvlei	2-4	1-4[2]	4	4	+2(-2)	3cp	-1	4(5)	4(5)	5	4	3(4)	0(+1)	ClLm-Cl	Cl	Cl

[1] Alluvial soils of 11-association not included

[2] Dependent on water table

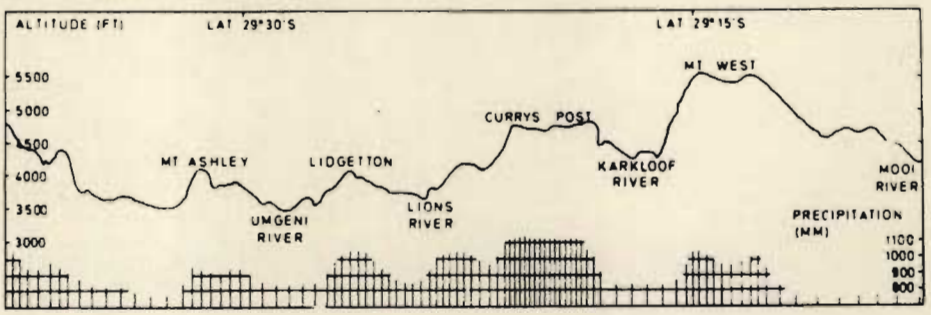
[3] Very high erosion hazard (5) if cultivated and injudiciously drained

Appendix 10 : Rainfall data for the Howick Extension Area

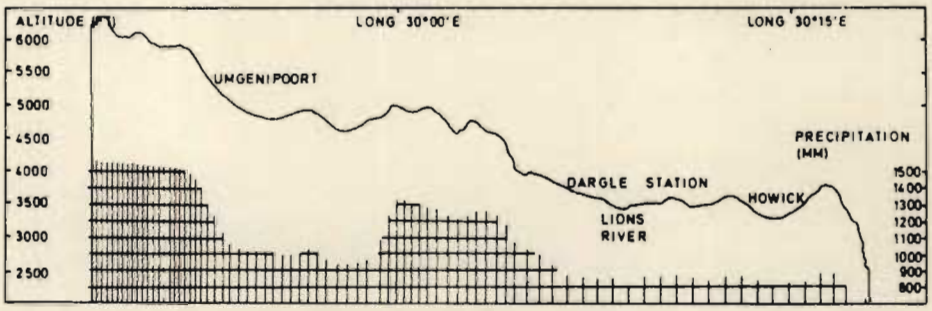
Station	Latitude (S)	Longitude (E)	Altitude (meters)	Period (years)	Average monthly rainfall (mm) and number of days with rain												Average annual rainfall	
					July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	mm	inches
Highdown	29 28	29 55	1470 4820ft	6	10 -	16 -	56 -	87 -	128 -	142 -	157 -	160 -	119 -	59 -	51 -	10 -	995 -	39.2
*Fort Nottingham	29 25	29 54	1661 5448ft	6	10 1	20 3	65 7	93 17	91 17	174 19	138 17	125 13	196 16	47 8	32 3	16 1	1007 122	39.2
Glenfern	29 26	29 57	1470 4820ft	10	8 2	26 4	49 8	64 13	114 17	178 20	162 18	151 15	107 13	60 9	33 4	4 2	956 125	37.6
*Stay Brae	29 24	30 02	1311 4300ft	12	20 4	24 4	31 9	88 17	138 18	155 19	147 18	136 15	122 15	63 8	40 4	22 3	986 134	38.8
*Nottingham Road (Strathearn)	29 32	29 59	1438 4716ft	51	13 3	20 5	38 9	72 17	113 17	146 18	129 18	138 16	107 16	50 10	24 5	10 3	860 137	33.9
Stanmore	29 18	30 02	1524 5000ft	16	18 2	38 3	48 4	84 8	107 12	132 12	152 11	119 9	97 8	61 6	25 3	10 1	891 79	35.1
Mansfield	29 17	30 05	1433 4700ft	12	5 1	20 2	43 5	82 8	107 9	135 11	109 10	143 10	97 8	44 4	19 2	14 1	818 71	32.2
Gowan Brae	29 37	30 08	1387 4550ft	12	20 2	25 2	58 5	94 10	125 13	152 13	147 13	132 11	109 11	84 6	31 3	20 2	997 91	29.3
*Wahroonga	29 36	30 08	1219 4000ft	17	23 3	21 4	43 8	77 13	108 14	143 16	122 16	122 14	115 14	57 8	32 3	25 2	888 115	35.0
Maritzdaal	29 29	30 02	1219 4000ft	30	13 -	28 -	43 -	84 -	117 -	163 -	163 -	147 -	125 -	66 -	23 -	10 -	982 -	38.7
Hopedale	29 32	30 02	1219 4000ft	28	14 -	21 -	39 -	82 -	116 -	151 -	145 -	136 -	114 -	66 -	29 -	12 -	925 -	36.4
*Dargle Forestry	29 32	30 01	1450 4756ft	7	6 2	20 5	52 8	86 14	117 18	162 21	179 17	147 13	96 13	72 10	49 6	5 2	987 129	38.9
Bainn Mheadon	29 30	30 03	1204 3950ft	26	15 -	28 -	46 -	97 -	122 -	173 -	173 -	152 -	135 -	74 -	31 -	10 -	1056 101	41.6
Kilgobbin	29 28	30 04	1326 4350ft	44	16 -	28 -	56 -	122 -	156 -	213 -	203 -	181 -	171 -	74 -	32 -	15 -	1267 155	49.9
*Lidgetton	29 26	30 06	1204 3950ft	32	16 2	21 3	56 7	98 13	143 15	178 17	167 15	153 13	144 14	54 7	30 3	16 2	1076 111	42.2
Michaelhouse	29 24	30 03	1295 4250ft	36	18 3	25 5	51 9	94 15	132 17	170 17	168 17	160 15	137 14	66 8	31 4	15 2	1067 126	42.0
Kwa Heri	29 22	30 05	1356 4450ft	14	8 2	36 4	64 7	94 12	137 15	198 18	168 15	203 13	119 12	79 8	33 3	8 2	1147 111	45.2
Spencer Farm	29 22	30 06	1301 4270ft	39	18 2	20 2	53 5	84 9	119 12	160 13	155 12	152 11	132 10	66 6	31 2	18 2	1008 86	39.7
Farm Hill	29 21	30 12	1301 4270ft	5	7 2	17 5	71 11	93 17	118 19	148 19	134 16	155 16	92 14	65 10	29 6	6 2	935 137	36.8
Aldora	29 23	30 14	1112 3650ft	14	15 3	28 4	53 8	89 14	135 18	158 19	178 17	137 15	107 13	69 11	31 4	20 2	1020 128	40.2
Elderslie	29 26	30 12	1240 4070ft	13	15 3	28 4	64 9	94 16	125 18	158 20	173 18	135 14	104 13	69 10	31 4	18 2	1014 131	39.9
Everdon	29 27	30 16	1097 3600ft	49	11 2	27 4	63 8	113 14	153 16	179 17	174 17	152 14	151 14	59 8	31 4	12 2	1125 120	44.3
Pumula	29 28	30 08	3520ft	16	10 -	30 -	43 -	70 -	107 -	148 -	162 -	116 -	92 -	61 -	22 -	11 -	872 -	34.3
Hilton College	29 29	30 19	1067 3500ft	63	15 -	25 -	51 -	94 -	125 -	137 -	135 -	137 -	112 -	53 -	28 -	15 -	927 -	36.5
The Start	29 26	30 18	1067 3500ft	24	15 2	38 4	74 7	140 10	163 13	218 13	193 12	178 11	145 9	97 7	38 3	10 2	1309 93	51.5
Yarrow	29 20	30 18	1097 3600ft	32	27 3	36 5	69 8	124 14	162 15	206 18	197 15	200 13	167 13	93 8	39 4	18 2	1333 124	52.5
*Markloof (Brsco)	29 19	30 19	1219 4000ft	27	25 4	36 4	66 9	111 15	156 15	208 17	188 15	210 15	186 15	83 9	87 5	25 3	1331 126	52.4
Shawswood	29 19	30 18	1112 3650ft	18	20 3	40 5	78 8	145 14	177 15	223 18	207 16	241 15	164 13	117 10	49 4	25 3	1486 124	58.5
Bewdley	29 29	30 08	1060 3480ft	11	10 2	23 4	48 8	80 15	120 18	131 18	144 17	130 14	98 14	68 10	27 4	6 2	883 126	34.8
Craigmethan	29 30	30 09	1112 3650ft	15	9 2	26 3	49 7	71 11	116 15	148 16	146 14	136 13	102 11	76 8	28 3	6 1	913 103	35.9
*Howick	29 29	30 14	1092 3450ft	52	14 2	19 3	43 7	81 13	110 15	121 16	128 16	129 13	117 13	54 8	24 4	15 2	855 113	33.7
*Cedara	29 32	30 17	1076 3530ft	50	16 4	24 6	44 10	82 16	112 18	129 21	123 19	127 17	118 17	53 11	31 6	15 4	882 149	34.7
Thurlow	29 31	30 11	1042 3420ft	13	9 -	31 -	41 -	64 -	94 -	119 -	125 -	124 -	86 -	56 -	26 -	4 -	779 -	30.7
Mt Ashley	29 33	30 07	1103 3620ft	18	5 2	20 3	46 5	66 11	101 13	121 12	127 13	129 10	102 10	55 8	22 2	5 1	799 90	32.1
*Merrivale	29 31	30 15	1045 3427ft	46	15 2	21 3	34 5	75 10	105 12	121 13	116 12	119 11	101 10	51 5	27 3	13 1	798 87	31.4
Fairview	29 14	30 04	1479 4850ft	9	8 -	33 -	53 -	86 -	86 -	140 -	155 -	132 -	75 -	51 -	13 -	3 -	856 -	33.7
*Torwood	29 17	30 08	1594 5097ft	24	19 3	24 4	45 7	79 13	117 14	144 16	136 16	147 14	119 12	62 8	27 3	16 2	934 112	36.8
Home Farm	29 16	29 58	1487 4720ft	16	8 1	23 3	43 6	64 9	97 13	137 15	124 13	112 11	102 11	64 7	25 3	5 1	804 93	31.7
Springfield	29 14	30 01	4880ft	25	10 1	23 2	41 5	97 8	104 11	137 14	122 12	130 10	104 10	61 6	20 3	8 1	857 83	33.7
Weston	29 13	30 02	1470 4820ft	34	13 1	15 2	33 4	66 7	91 10	107 11	109 10	104 10	86 9	48 5	20 2	10 1	702 72	27.6
*Saregrove	29 11	30 04	1372 4500ft	34	11 1	17 2	36 4	65 7	90 9	114 11	112 10	111 9	94 9	43 5	21 2	9 1	723 70	28.5
Vorentoe	29 08	30 13	1256 4120ft	16	15 1	14 1	25 2	53 4	81 6	102 7	114 8	102 7	71 5	33 3	15 1	13 1	669 46	25.9
Stations situated outside the Area																		
*Impendhle	29 30	29 52	1600 5248ft	45	16 2	21 3	39 6	71 10	119 12	147 15	159 14	150 12	139 13	61 7	30 3	17 2	969 99	38.1
*Vaucluse	29 43	30 09	1372 4500ft	27	16 2	27 4	44 7	85 13	123 15	144 15	152 15	155 11	117 11	65 7	41 4	20 2	989 106	38.9
*Kamberg	29 22	29 42	1325 5002ft	7	8 2	17 3	54 6	73 11	109 13	131 18	180 15	165 15	121 13	58 8	55 4	6 2	1089 109	42.9
*East Meshlyn	29 21	29 45	1585 5196ft	35	16 2	20 2	39 5	69 9	109 10	166 14	177 14	191 12	134 11	55 6	31 3	12 2	978 91	38.5
*Estcourt	29 01	29 52	1181 3874ft	66	10 2	16 2	32 4	64 8	92 11	125 13	127 12	115 11	99 10	41 5	17 3	7 1	744 82	29.2
*Jeanen	28 51	30 05	845 2772ft	99	8 1	17 2	29 3	57 7	93 9	108 11	122 11	99 9	81 9	39 4	14 2	7 1	674 89	26.5
*Nietgedacht	28 57	30 21	792 2598ft	9	10 2	15 3	24 5	45 8	59 11	116 12	86 10	117 11	71 8	43 6	29 3	10 2	662 82	26.1

* Official records (Weather Bureau, 1968).

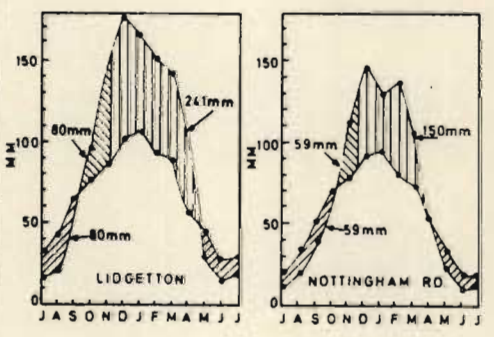
APPENDIX 11 Diagramatic representation of climatic data in the Howick Extension Area



11(a) Precipitation in relation to landform (cross section on longitude 30°07'30"E)

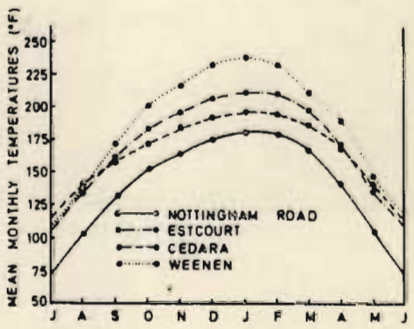


11(b) Precipitation in relation to landform (cross section on latitude 29°28'30"S)

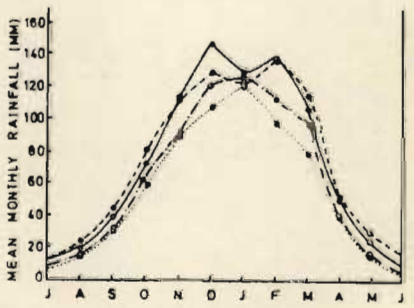


11(c) A comparison of the annual precipitation and water need at selected stations (after Thornthwaite, 1948)

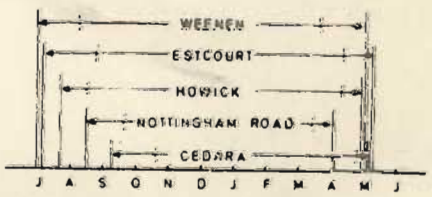
PRECIPITATION
WATER SURPLUS
WATER DEFICIENCY
WATER NEED
SOIL MOISTURE UTILIZATION
SOIL MOISTURE RECHARGE



11(d)i Annual temperature at selected stations



11(d)ii Annual rainfall at selected stations



11(d)iii Period between first and last frost at selected stations

DENOTES EXTREME FROST DATES

Appendix 12 : Temperature data for the Howick Extension Area

12a : Mean annual and daily maximum (Tx) and minimum (Tn) temperatures (^{o}C) for selected stations

Station		Month												Year
		J	A	S	O	N	D	J	F	M	A	M	J	
Nottingham Road*	Tx	17.1	19.8	21.7	22.4	22.8	23.7	23.7	23.7	22.7	21.3	19.4	17.2	21.3
	Tn	-2.5	0.7	4.8	8.1	9.8	11.3	12.3	12.2	10.5	6.7	1.5	-2.3	6.1
	Mean	7.3	10.3	13.3	15.3	16.3	17.5	18.0	17.9	16.6	14.0	10.5	7.5	13.7
Cedara*	Tx	19.0	21.5	22.7	23.0	23.6	24.7	24.9	24.9	24.0	22.8	21.0	19.1	22.6
	Tn	4.2	6.8	8.6	10.6	12.1	13.4	14.3	14.5	13.5	11.0	7.4	4.5	10.1
	Mean	11.6	14.1	15.7	16.8	17.9	19.1	19.6	19.7	18.7	16.9	14.2	11.8	16.3
Howick*	Tx	19.2	21.8	23.4	24.6	25.4	26.1	27.1	27.2	25.9	24.6	22.1	19.5	23.9
	Tn	1.8	4.6	7.7	10.7	11.4	13.7	14.3	14.3	13.1	9.7	5.4	1.9	9.1
	Mean	10.7	10.5	13.2	15.6	17.6	18.4	20.7	20.7	19.5	17.2	13.8	10.7	16.5
Estcourt*	Tx	18.7	21.4	24.1	25.4	26.1	27.1	27.3	26.9	25.6	24.0	21.2	18.9	23.9
	Tn	2.4	5.1	8.1	11.3	12.8	14.3	15.0	14.9	13.7	10.4	6.0	2.6	9.7
	Mean	10.7	10.5	13.3	16.1	18.3	19.5	20.7	21.1	20.9	19.7	17.2	13.6	16.8
Weenen*	Tx	21.0	23.9	26.3	28.1	28.9	30.4	31.2	30.2	29.0	27.0	24.2	21.3	26.8
	Tn	0.8	4.2	7.9	12.2	14.2	15.8	16.2	16.1	14.8	10.8	5.2	0.8	9.9
	Mean	16.9	14.1	17.2	20.2	21.6	23.1	23.7	23.1	21.9	18.9	14.7	11.1	18.4
Nietgedacht*	"	11.3	13.8	16.3	19.6	20.9	22.2	23.0	22.3	21.0	18.4	15.1	11.8	18.0
Lidgetton	"	12.3	14.3	17.5	17.9	19.1	20.4	21.0	21.4	20.4	16.7	15.1	12.2	17.4
Hopedale	"	10.9	12.0	14.3	15.0	16.6	18.0	18.9	18.8	17.0	15.6	12.8	10.1	15.0
Bewdley	"	11.2	13.9	17.3	18.5	19.8	21.1	21.6	22.0	20.6	17.5	13.9	10.6	17.3
Torwood	"	8.9	11.8	14.2	16.1	16.8	18.2	18.4	18.2	17.1	14.8	12.2	9.1	14.7
Weston	"	9.9	12.3	15.4	16.6	16.7	18.5	19.9	19.4	17.9	14.3	11.2	7.8	15.0

* Official records (Weather bureau, 1954)

12b : Highest (Tx) and lowest (Tn) temperature extremes (^{o}C) for selected stations (Weather bureau, 1954)

Station		Month												
		J	A	S	O	N	D	J	F	M	A	M	J	
Nottingham Road	Tx	26.1	30.6	32.2	35.0	33.9	34.4	33.3	32.8	30.0	28.3	28.3	26.1	
	Tn	-9.4	-10.0	-6.7	-2.8	0.0	1.1	5.6	5.0	2.2	-3.3	-6.7	-9.4	
Cedara	Tx	28.2	31.0	35.3	36.9	36.6	38.3	35.8	36.9	33.6	31.2	30.4	28.2	
	Tn	-5.8	-3.1	-1.2	0.0	3.2	4.4	6.1	4.7	5.9	0.6	-2.2	-3.3	
Howick	Tx	38.3	32.8	36.9	40.6	37.8	40.1	40.0	37.9	38.3	33.3	32.2	35.0	
	Tn	-6.1	-4.4	-3.9	0.3	2.9	4.4	6.0	6.4	3.3	0.5	-4.4	-6.6	
Estcourt	Tx	26.7	29.4	34.4	37.8	37.8	37.2	38.9	36.7	35.0	31.9	30.0	27.2	
	Tn	-6.7	-5.0	-2.2	1.1	3.3	4.4	7.2	7.2	6.6	0.6	-1.7	-5.0	
Weenen	Tx	28.9	34.4	38.3	42.8	41.1	41.7	42.2	40.6	37.8	40.6	35.0	31.1	
	Tn	-6.7	-5.0	-0.6	0.6	2.2	7.2	6.7	6.7	6.1	0.0	-3.9	-5.6	
Nietgedacht	Tx	28.3	31.7	37.8	40.0	40.6	39.4	41.1	38.3	36.9	33.3	32.5	27.8	
	Tn	-4.2	-2.5	-0.6	3.1	1.7	1.9	7.8	0.3	2.8	1.1	-1.0	-2.8	

Appendix 13 : Water balance and moisture indices for selected station in the Howick extension area

Station	Mean annual temperature °C	Annual water balance (mm)					Moisture index	Summer (Oct.-March) water balance (mm)			
		Precip-itation	Water need	Surplus	Deficiency	Soil moisture utilization		Precip-itation	Water need	Surplus	Deficiency
Lidgetton	17.4	1075	834	241	-	80	29	882	561	321	-
Nottingham Road*	13.7	857	707	150	-	59	21	701	493	208	-
Hopedale	15.0	927	738	189	-	79	26	747	487	260	-
Cedara*	16.3	880	780	100	-	86	13	697	512	185	-
Howick*	16.3	854	796	58	-	83	7	686	546	140	-
Bewdley	17.3	887	837	50	-	75	6	704	494	210	-
Weston	15.0	704	765	-	61	54	-4	564	519	45	-
Estcourt*	16.8	742	816	-	74	67	-5	619	569	50	-
Nietgedacht*	18.0	661	869	-	208	15	-14	531	620	-	89
Weenen*	18.4	673	904	-	232	-	-15	559	658	-	99

(* Official weather stations)

Appendix 14 : Monthly and annual run-off data (mm) for the main river catchments in the Howick Extension Area

River catchment	Umgeni	Lions	Karkloof	Mooi
Ganging station	Howick 273	Allerton 463	Shafton 458	Mooi River 401
Record period (yrs)	13	7	8	11
Catchment size (km^2)	932	347	305	1025
October	8	12	12	8
November	12	15	27	13
December	19	32	60	51
January	25	36	51	79
February	26	34	80	79
March	26	23	83	42
April	14	18	36	18
May	11	16	24	16
June	6	9	10	6
July	5	7	7	5
August	4	5	5	4
September	5	8	12	9
Annual run-off (mm)	161	215	407	330

Appendix 15 : Average 1) daily silt load (tons), 2) percentage silt (wt/wt) and 3) discharge (cusecs) for rivers in the Howick Extension Area

River		Umgeni	Lions	Mooi
Gauging station Record (yrs) Catchment (sq. miles)		Corrie Lynn 537 3 (1958-61) 129	Allerton 463 2 (1958-60) 134	Middelrus 525 2 (1961-63) 610
October	1	1.3	0.9	27.8
	2	0.006	0.001	0.016
	3	7.7	27.5	63.8
November	1	9.2	8.6	92.9
	2	0.008	0.008	0.023
	3	40.1	37.8	149.6
December	1	29.6	40.8	391.1
	2	0.007	0.017	0.037
	3	148.9	87.7	389.7
January	1	23.6	12.7	915.5
	2	0.008	0.004	0.038
	3	108.5	114.5	881.0
February	1	19.3	39.6	18.9
	2	0.005	0.009	0.001
	3	137.0	169.1	469.2
March	1	13.8	7.3	40.9
	2	0.004	0.002	0.002
	3	119.7	142.1	628.9
April	1	4.8	6.3	67.9
	2	0.001	0.003	0.009
	3	118.1	88.2	288.9
May	1	24.9*	10.5*	4.6
	2	0.006	0.004	0.001
	3	151.8	105.8	147.1
June	1	0.57	2.7	2.1
	2	0.0008	0.001	0.0009
	3	24.4	81.4	85.2
July	1	0.16	1.4	10.1
	2	0.0007	0.0009	0.003
	3	8.8	58.5	110.4
August	1	0.04	1.0	1.6
	2	0.0004	0.001	0.001
	3	3.5	35.6	52.2
September	1	0.01	0.3	0.6
	2	0.00007	0.0004	0.0005
	3	4.9	27.8	40.0
Annual silt load (tons)		3873	3958	48574
Annual soil loss 1) tons/sq.mile 2) tons/acre		29.9 0.046	29.5 0.046	79.6 0.124

(* - includes flood of May, 1959)

Appendix 16 : Definitions of land capability classes

1. UPLAND CLASSES

1.1 Upland arable class

Class I

Class I land has very high potential for long term intensive crop production. Ordinary good farming practice will normally ensure safe use. It has the widest range of alternative uses, no permanent limitations and a very low erosion hazard. The land is nearly level (slope group A) and the soils are deep (> 36 inches), well-drained, of medium texture and have very favourable moisture characteristics. They are either well supplied with plant nutrients, or, are highly responsive to inputs of lime and fertilizer. The improvement and maintenance of soil fertility and organic matter are, however, essential for sustained production. Class I land is well-suited to flood and sprinkler irrigation. Soils exhibiting slight hydromorphism can be included in this class provided the impeded drainage does not affect plant growth.

Class II

Class II land has high potential for intensive crop production but requires easily applied conservation measures for safe use. Its range of alternative uses is slightly restricted and the main limitation is a moderately low erosion hazard. The land is usually level to gently sloping but does not exceed slope group B. The soils should be at least moderately well-drained. A fairly wide range of texture is permitted but light textured soils should not be less than 36 inches deep or steeper than slope group A. Available moisture capacity should be moderately high. Very slight mechanical limitations are permitted although stoniness must be overcome at low cost. Class II land is suitable for irrigation.

Class III

Class III land has moderate potential for crop production and requires special conservation practices for safe use. Rotations including long term leys and the application of efficient agronomic practice ensuring maximum soil cover are required. The range of alternative uses is considerably restricted by the main limitations which may include a moderately high erosion hazard, imperfect drainage, low available moisture capacity and moderate surface soil limitations. The land is usually gently to strongly sloping but should not exceed slope group C, or slope group B where moderately deep, sandy soils occur. Moderately shallow clayey soils are permitted. Although somewhat poorly drained soils are included in Class III the duration of the temporary waterlogging period must be short. The land may be sprinkler irrigated with careful planning and management but the costs are generally high.

Class IV

Class IV land has low potential for crop production and requires the rigid application of intensive conservation measures for safe use.

The range of alternative uses is severely restricted by high erosion hazard, imperfect drainage, very low available moisture capacity and severe mechanical limitations. Preferably the land should remain under perennial vegetation for long periods and special protective measures should be applied during the short periods of cropping. Class IV land is mostly strongly sloping, but should not exceed slope group C, and includes shallow and very shallow soils. Shallow light textured soils and soils with ferruginous hardpans may be included provided the slope does not exceed group B. Claypan soils may be included under very special circumstances and only if the slope does not exceed group A. Poorly drained clayey soils on level terrain are included in this class. The land is not generally recommended for irrigation but under special conditions, and usually at considerable cost, sprinkler irrigation may be applied on a limited scale.

1.2 Upland non-arable classes

Land that cannot be regularly cultivated is included in these classes. A distinction is made between non-arable land that can be established to permanent swards (Class V) and that which should remain under natural grassland (Class VI). Sub-classes are used where soil class, or depth, may influence management practice. In this way soils of doleritic origin are separated from those derived from Karoo sediments since they affect the palatability and management of the natural sward. Depth phases are important in the planning of forestry projects.

Class V

Class V land is suitable for the production of perennial vegetation. Tillage for establishment purposes is permitted provided adequate protection is afforded during the establishment period. The slightly concave depressions which form the natural drainage ways for the surrounding uplands, yet are not typically bottomlands, can be included in this class provided sod-forming swards can be established with safety. Class V land is usually moderately steep to hilly but not exceeding slope group D and is rockfree. Gently sloping land should be included if soil characteristics preclude arable use. The land is suitable for permanent pasture, afforestation, plantation crops and orchards. It may, however, remain under natural veld (mowable) which can be reinforced by suitable species. Sprinkler irrigation cannot be recommended except under very exceptional circumstances.

Class VI

Class VI land is subject to such severe limitations that its use is restricted to the production of natural vegetation for grazing purposes, or, where suitable, afforestation established by pit-planting. The natural sward may be reinforced where conditions are suitable. The main limitations include excessive steepness and/or rockiness, very high erosion hazard and unfavourable characteristics of soil depth, texture and drainage. Very uneven land, land subject to special climatic limitations within a defined ecological area, or, severely eroded land requiring temporary withdrawal from grazing or cultivation should be included in this class. The land is usually steep to very hilly (slope group E). Class VI includes all rock outcrops and very shallow (less than 20 inches) sandy soils on slopes exceeding group B. Land with an abundance of termite mounds precluding mowing or tillage should also be included in Class VI.

1.3 Upland protected classes

Class VII

Class VII land is unsuitable for cultivation, grazing or afforestation owing to very severe limitation or the need for special conservation. It may, however, be used for wildlife or recreation. The main limitations include an exceptionally high erosion hazard, excessively steep and/or rocky land or very unfavourable soil characteristics. Severely eroded land requiring permanent withdrawal from use, land requiring special protection (e.g. indigenous forests, watersheds or recreational areas such as dams or waterfalls) and areas often too small to be shown on a farm map (e.g. road reserves, streambanks, deep gullies, etc.) should be included in Class VII.

Land requiring special management treatment such as the indigenous forests should be included in a special sub-class.

2. BOTTOMLAND CLASSES

The bottomland classes, although limited in extent, are among the most important. Definition of these classes is based mainly on soil characteristics and a distinction is made between soils of recent river alluvium and the hydromorphic 'vlei' soils.

The alluvial soils (L1-association) occur along all the major rivers and since their distribution is not greatly influenced by climate they may occur in any ecological area. Formed by natural cyclic erosion and being of recent sedimentation they exhibit a low degree of pedo-genetic development. The influence of calcification and gleyzation is, however, often apparent. Generally, drainage should not be worse than 'somewhat poor'. Matrix colours of values 3 or more and chromas 2 or more are required for soils to qualify for this class. The alluvial soils usually occur as narrow strips on either side of the river, or in level terrain occupying the inside of the meanders.

The hydromorphic bottomland soils (C1-, H1-, H2-associations) are strongly influenced by pedo-genetic development and are characterized by strong gleying and, in most cases, strong organic matter accumulation. By comparison with the alluvial soils they are very poorly drained as indicated by matrix colours with values of 4 to 6 and chromas of 0 to 1 (van der Eyk, 1965b).

The transition from river alluvium to 'vlei' soils is often gradual and difficult to locate. Only by careful inspection of the soil profile can the distinction be made. The 'vleis' are invariably the result of geological formations and even along the major rivers, river incision may be halted giving rise to large flood plains. Alluvial and 'vlei' soils are often intricately interwoven within one and the same flood plain, an example of which occurs at the confluence of the Umgeni and Lions rivers.

There are three main groups of 'vlei' soils. In ecological areas 1a and 1b the level, or nearly level (± 1% slope), well-defined and often narrow bottomlands comprise the acid hydromorphic soils of the C1-association (Type 1 vleis). They are usually submerged for the greater part of the year and are subject to occasional overflow. The soils are very poorly drained and are characterized by strong gleying, mottling and an accumulation of much organic matter. The organic matter content is, however, greatly reduced by artificial drainage and tillage.

In ecological areas 2a, 2b, 2c and 2d the bottomlands comprise neutral to alkaline hydromorphic soils of the H1-association (Type 2 vleis). These 'vleis' are often marshy and become submerged for short periods during summer. The accumulation of organic matter is, however, not as great as with the C1-association soils. Towards the drier parts (areas 2c and 2d) soils of the G2-association may occur and are mostly dry. Invariably the natural ground water table has been lowered by the presence of a deeply eroded drainage channel running the length of the bottomland.

The bottomlands in ecological areas 3a and 3b are not typical of wet 'vleis' and comprise margalitic and claypan soils of the G2- and F1-associations (Type 3 vleis). Extensive gully erosion is a common feature in these bottomlands and has led to widespread desiccation of the landscape. In the past, these bottomlands were probably moist and occasionally submerged. For the purpose of the land capability classification two sub-groups are recognized. These include:

1) the generally well defined bottomlands similar to those in ecological areas 2c and 2d; and

2) segments of bottomland which, because of ill-definition, are not typically bottomlands and occur in the upper reaches of the pediments. They extend out from the base of major escarpments in broad, slightly concave basins and emerge gradually into the uplands. Planimetrically they have a rounded triangular shape with the base of the triangle lying along the foot of the escarpment and at the apex the land meets the more typical narrow bottomlands of sub-group (1). Usually deep gullies with numerous tributaries have eroded back in fan-like manner to the base of the escarpment and into the bordering uplands leaving islands of the original land surface. Dense stands of thorntrees usually occur on these 'islands'.

Bottomland classes are separated into arable, non-arable and protected classes on the basis of the types of bottomland already described.

2.1 Bottomland arable classes

Class Ib

Class Ib land includes only the deep, highly productive alluvial soils of the L1-association. The potential of this land for intensive production of many crops, pastures and trees is high. Good farming practice, protection against erosion during flood periods and surface drainage will usually ensure safe use. This class of land is eminently suited to irrigation. The main limitations include periodic flooding, silt deposition, imperfect drainage, compaction of the clayey soils and the presence of poisonous weeds such as 'tulip' (Moraea spp.).

Three sub-classes, accommodate the wide range in texture and drainage.

Sub-class Ib (1): This sub-class includes the clayey, somewhat poorly drained soils (L1 - 1). Surface limitations and compaction are additional limitations. This sub-class is best suited to the production of pastures and may require surface and underground drainage.

Sub-class Ib (2): The loamy, well-drained to moderately drained soils (L1 - 2) are included in this sub-class. It has the highest potential for intensive cropping, pasture production and trees (poplars).

Sub-class Ib (3): This sub-class includes the sandy, well-drained to excessively drained soils (L1 - 3) usually lying adjacent to the river. A low moisture holding capacity of the soils is one of the chief limitations. Irrigation practice is essential for optimum yield and permits the production of a wide range of fodder and horticultural crops.

2.2 Bottomland non-arable classes

Class Vb

This is the most important bottomland class and includes the hydromorphic 'vlei' soils. The land is deemed 'non-arable' because of the unique management and conservation requirements. The replacement of natural vegetation by perennial mixed pasture swards or trees is, however, permissible under certain conditions. The requirements for land improvement and safe use of this class is discussed in Chapter 6. The main limitations include extremely poor drainage (especially in humid parts), potentially high erosion hazard (especially in drier parts), surface soil limitations restricting the use of machinery and the grazing of livestock, compaction and high costs of land improvement. Unfavourable moisture characteristics are important among the margalitic and claypan soils. Parasites and some poisonous weeds are also associated with this class of land. Despite the poor drainage, Class Vb can be irrigated (sprinkler) to advantage. Irrigation is, in fact, a prerequisite in the drier parts although the development of 'brak' conditions must be avoided.

The wide diversity of conditions requires that this class be treated separately for each ecological group.

1) Ecological areas 1a and 1b

With efficient land improvement techniques Class Vb land has a high potential for the production of pastures. However, if the safety of the bottomland or the water supplies are in doubt, the land should be excluded from the class. Four sub-classes are tentatively suggested, based on the organic carbon content and textural class of the soils.

Sub-class Vb (1a): includes soils in which the O-horizon is plastic and the clay content of the upper subsoil exceeds 35 percent (e.g. IVANHOE series).

Sub-class Vb (1b): includes soils in which the O-horizon is friable and the clay content of the upper subsoil is usually less than 35 percent (e.g. CHAMPAGNE series).

Sub-class Vb (1c): includes soils in which organic carbon content of the A-horizon is usually less than 5 percent and the clay content of the upper subsoil exceeds 35 percent (e.g. KATSPRUIT).

Sub-class Vb (1d): includes soils in which the organic carbon content of the A-horizon is less than 5 percent and the clay content of the upper subsoil is less than 35 percent (e.g. Dell series).

N.B. The narrow, usually steep, drainage ways characterized by 'vlei' soils are included in Class VIIb.

2) Ecological areas 2a, 2b, 2c and 2d

This land has moderately high potential for pastures or poplar but requires very intensive conservation practices for safe use, especially in areas 2c and 2d. Two sub-classes are defined.

Sub-class Vb (2a): includes wet vleis with neutral to alkaline soils (H1-association).

Sub-class Vb (2b): includes the usually narrow, dry bottomlands with margalitic soils. Because of the high erosion hazard this sub-class should be left under natural vegetation. Where the hazard of use reaches a high limit such bottomlands must be included in Class Vb.

3) Ecological areas 3a and 3b

Class Vb land in these areas has a very high erosion hazard and other limitations which generally restrict its use to the production of natural vegetation. The production of perennial swards of pasture or lucerne is permissible with irrigation and intensive conservation practice. Two sub-classes are defined.

Sub-class Vb (3a): includes the moderately well-defined rather narrow bottomlands including margalitic and claypan soils. It is similar to Class V (2b) and should be left under natural vegetation.

Sub-class Vb (3b): includes the broad ill-defined concave depressions comprising margalitic and claypan soils. Much of this sub-class has been severely eroded and requires reclamation. Perennial swards of pasture or lucerne are permissible with irrigation and stringent conservation practice.

2.3 Bottomland protected classes

Class VIIb

This class includes all bottomland that, because of severe limitations or the need for conservation of soil, water or wildlife, requires total protection. Important water sources such as the 'eyes' of springs, or severely eroded bottomlands requiring reclamation and the narrow, steep bottomlands subject to considerable overflow, should be included in this class. The limitations and needs are such that the class is suitable only for wildlife or recreation.

Appendix 17 : Economic data for 'GLENFERN'

Appendix 17a : Basic information for linear programme - 'GLENFERN'

Enterprize	Dairy		Sheep	Pigs	Potatoes		Cabbages	Maize	Timber	Pastures		Hay	
	Milk	Heifers			Table	Seed				Winter and silage	Summer	Farm	Selling
	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
Unit	A.U.	A.U.	A.U.	Baconer	Acre	Acre	Acre	Acre	Acre	Acre	Acre	Acre	Acre
Yield per unit	750 gals/ cow 410 gals/ A.U.	1	1	1	150 bags	150 bags	150 bags	20 bags	-	20 tons	20 tons	5 tons	5 tons
Price per unit (R)	32 cents	R110	R60	R26	R3	R7	R1.50	R3.15	R22	R1.50	R1.50	R14	R14
Total income per unit (R)	R131	R110	R60	R26	R450	R1050	R225	R63	R22	R30	R30	R70	R70
VARIABLE COSTS : PER UNIT (R)													
CROPS: Seed	-	-	-	-	176	176	5	2	12	30	30	42	42
Fertilizer	-	-	-	-	45	45	20	20	12	30	30	42	42
Spraying	-	-	-	-	15	39	10	2	12	30	30	42	42
Bags and other	-	-	-	-	15	15	20	1	12	30	30	42	42
LIVESTOCK: Bought feed	30	25	5	19	-	-	-	-	-	-	-	-	-
Dips and medicines	5	3	2	1	-	-	-	-	-	-	-	-	-
Total variable costs per unit	35	28	7	20	251	275	55	25	12	30	30	42	42
Gross profit per unit	96	82	53	6	199	775	170	38	10	-30	-30	-42	28

Appendix 17b : Summary of input data fed into electronic computer for linear programming solution - 'GLENFERN'

	Real activities													Disposal activities																Supply or activity level
	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}	X_{22}	X_{23}	X_{24}	X_{25}	X_{26}	X_{27}	X_{28}	X_{29}	X_{30}	
Capital	35	28	7	20	251	276	55	25	12	30	30	42	42		1																= 100,000
	1															1														= 212
		1															1													= 32
			1															1												= 300
				1															1											= 320
					1															1										= 32
						1															1									= 13
							1															1								= 5
								1															1							= 179
									1															1						= 150
									1					-1											1					= 73
Pasture	2.5	2.5	2.5							-1																1				= 0
Pasture	1.5	1.5	1.5								-1																1			= 0
Hay	3.0	3.0	3.0									-1																1		= 0
													1																1	= 150
Arable					1	1	1	1		1	1	1																	1	= 399
GROSS PROFIT ROW	96	82	53	6	199	775	170	38	10	-30	-30	-42	+28	-9999.9																

Appendix 17c : Activity level and gross profit for different enterprizes on 'GLENFERN' - selected by computure through linear programming technique

Enterprize	No. of units to be produced	Lower price limit	Upper price limit	Gross income from enterprize	Variable costs for enterprize	Gross profit per enterprize
Dairy	121 A.U.	R85.1	R99.2	R15,851	R4,235	R6,036*
Pigs	320 baconers	--	unlimited	8,320	6,400	1,920
Potatoes	32 acres	R35.7	"	14,400	8,032	6,368
Seed potatoes	13 acres	R35.7	"	13,650	3,575	10,075
Cabbages	5 acres	R35.7	"	1,125	275	850
Maize	179 acres	R35.7	"	11,277	4,475	6,802
Timber	73 acres	--	"	1,606	876	730
Winter and silage pastures	49 acres	-R57.1	-R22.1	--	1,470	--
Summer pastures	81 acres	-R46.2	-R25.3	--	2,430	--
Farm hay	40 acres	-R74.8	-R32.4	--	1,680	--
				R66,229	R33,448	R32,781

* Cost of home grown feed subtracted = R5,580

Appendix 17d : Profit and loss account for new versus old plan for 'GLENFERN'

Expenses					Receipts		
	Old plan		New plan			Old plan	New plan
VARIABLE COSTS:							
Crops: Seed	230		8,303		Dairy	21,917	15,851
Fertilizer	2,894		5,705		Pigs		8,320
Spraying fluids	-		1,395		Potatoes		14,400
Other	-		954		Seed potatoes		13,650
Livestock: Feed	5,142		9,710		Cabbages		1,125
Dips, medicine & vet.	442		925		Maize		11,277
Timber			876		Timber		1,606
Winter and silage pastures			1,470		Sheep	3,053	
Summer pastures			2,430				
Farm hay			1,680				
Sub-total		8,708		33,448			
OVERHEAD COSTS:							
European wages	2,400		3,600				
Bantu wages and rations	2,266		3,500				
Equipment repairs	950		1,500				
Fuel and lubricants	786		1,500				
Insurance and licences	162		300				
Railage and hired transport	389		600				
All other expenses	730		1,500				
Depreciation	762		1,500				
Sub-total		R8,445		R14,000			
Total farm expenses	17,153		47,448				
NET FARM INCOME	7,817		18,781				
	R24,970		R66,229			R24,970	R66,229

Appendix 18 : Simplified conversion tables

(SOUTH AFRICAN TO METRIC UNITS)

Rainfall

inches	millimetres
1	25
2	51
3	76
4	102
5	127
7.9	200
10	254
11.8	300
15	381
15.7	400
20	508
23.6	600
25	635
27.6	700
30	762
31.5	800
35	889
35.4	900
40	1016
45	1143
50	1270

Temperature

Centigrade	Fahrenheit
-10	14
- 5	23
0	32
5	41
10	50
15	59
20	68
25	77
30	86
35	95
40	104
$1^{o}C$	$1.8^{o}F$

Altitude

feet	metres
100	30
200	61
300	91
400	122
500	152
600	183
700	213
800	244
900	274
1000	305
2000	610
3000	914
4000	1219
5000	1524
6000	1829
7000	2134

LENGTH

metre	yards	feet	inches
1	1.0936	3.2808	39.3701
0.9144	1	3	36
0.3048	0.3333	1	12
0.0254	0.0278	0.0833	1

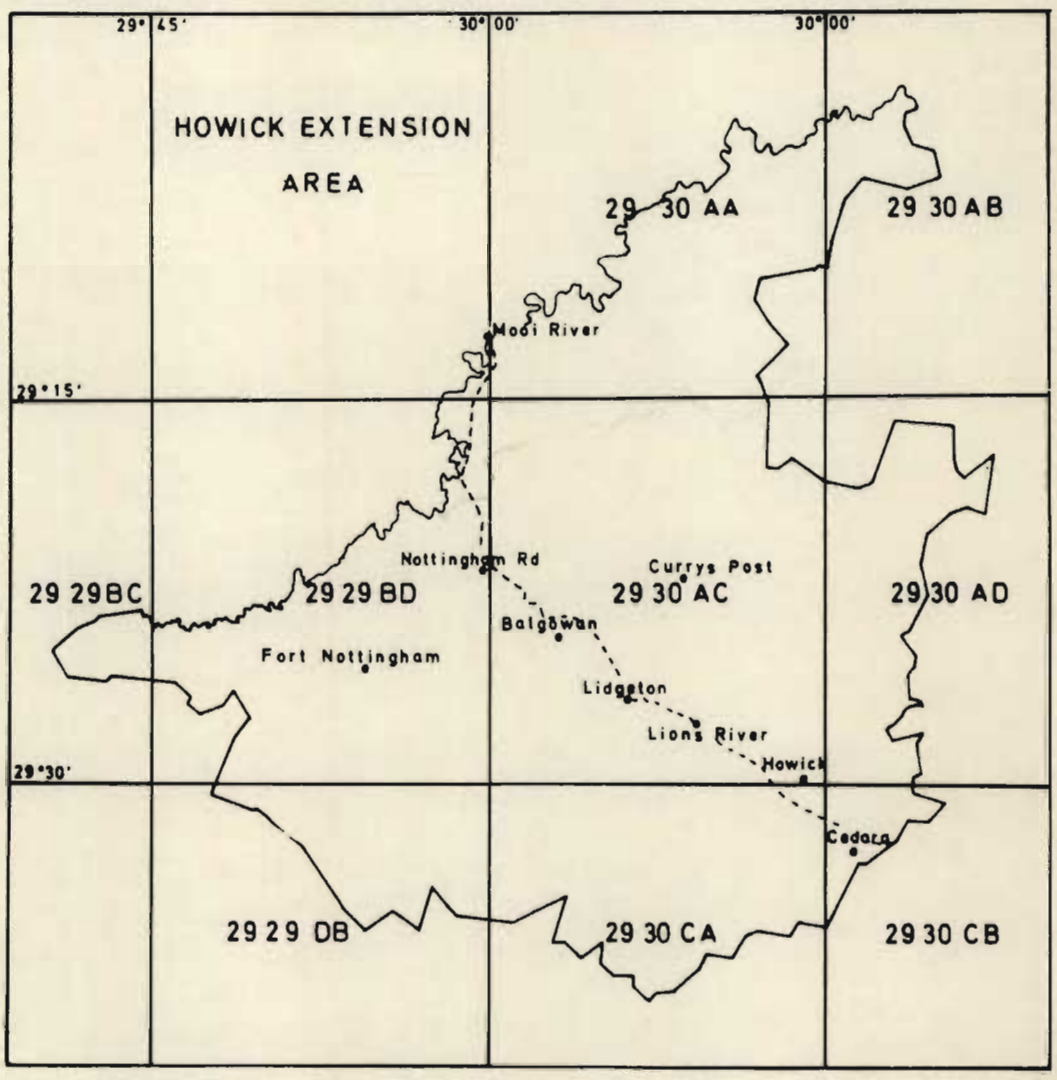
AREA

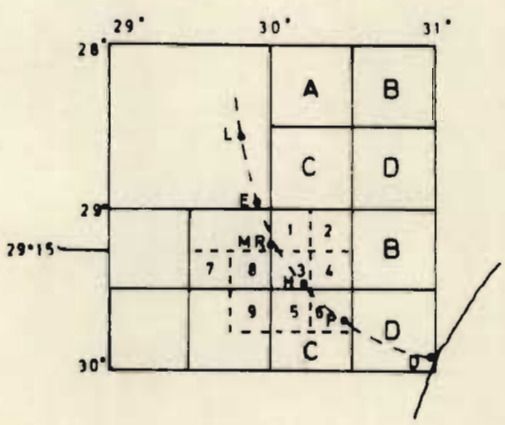
m^2	sq yd	sq ft	sq inch
1	1.1959	10.7639	1550.003
0.8361	1	9	1296
0.0929	0.1111	1	144
0.00064	0.00077	0.0069	1
aar	acre	sq yd	morgen
1	0.0247	119.599	0.01167
40.4686	1	4840	0.47247
0.0084	0.0002	1	0.000097
85.6532	2.1165	10244.0	1

OTHER EQUIVALENTS

1 mile = 1.6 kilometre
1 kilometre = 0.62 mile
1 sq. mile = 640 acre
= 258.99 hectares
1 acre = 0.472 morgan
= 0.405 hectares
1 morgen = 2.117 acre
= 0.857 hectares
1 hectare = 2.4711 acre
= 1.167 morgen
1 lb = 0.45359 gram
= 0.4536 kilogram
1 kilogram = 2.205 lbs
1 ton (2000 lb) =
907.185 kilgram
1000 kilogram = 1.1023 ton
1 gallon = 4.546 litre
1 litre = 0.2199 gallon
1 acre foot = 0.4725 morgen feet
= 1233.48 kilolitre
= 271,328 gallon

SOIL MAP





1 29 30 AA
2 29 30 AB
3 29 30 AC
4 29 30 AD
5 29 30 CA
6 29 30 CB
7 29 29 BC
8 29 29 BD
9 29 29 DB

1) Each Square degree is designated by values of Latitude and Longitude at its NW corner.

2) Each Square degree is divided into 16 1:50,000 sheets each 15' x 15'

KEY

HIGHLY LEACHED LANDSCAPES

- A1 Balmoral - Forningham Association
- A2 Broadmoor - Hutton Association
- B1 Farmhill - Griffin - Clovelly Association
- B2 Cleveland - Oatsdale Association
- C1 Katspruit - Dell Association

CONSIDERABLY TO MODERATELY LEACHED LANDSCAPES

- D1 Vimy - Shortlands Association
- D2 Jagersdrift Association
- D3 Loskop - Rooikop Association
- E1 Bergville - Avalon - Southwold Association
- E2 Avalon - Glencoe - Klipfontein Association
- E3 Leksand - Springfield Association
- E5 Glencoe - Klipfontein Association
- E6 Winterton - Albany Association
- H1 Emmaus - Killarney - Matiwane Association

SLIGHTLY LEACHED LANDSCAPES

- F1 Estcourt - Bluebank Association
- G2 Arcadia - Pepworth - Ladysmith Association
- H2 Rensburg - Ladysmith - Estcourt Association

IN ALL LANDSCAPES

- L1 River Alluvium
- M Hilly, Steep and/or Stony Land
- M F Indigenous Podocarpus Forests
- R Litholic Soils (< 10")

PHASES

- o Shallow Soils
- s Sloping Phase (>8% slope)
- h Humic Phase (>5% organic carbon)
- x Sheet Erosion
- y Gully Erosion

MOOI RIVER

TO JOHANNESBURG

TO RIETVLEI

05'

10'

29° 15'

30° 00'

30° 15'

29,30 AB

1:50000

15'

20'

29, 30 AC

1:50000

30° 00'
29° 15'
05'
10'
30° 15'
29° 15'
20'
25'
29° 30'
30° 00'
05
10'
30° 15'
29° 30'

LIONS RIVER
MOOI RIVER VALLEY AIS
LIONS RIVER AIS
NAT. ROAD
S.A.R.
EMICHAEL HOUSE
LIDGETTON
NAT. ROAD
S.A.R.
HOWICK
FALLS
DAM
MIDMAR DAM

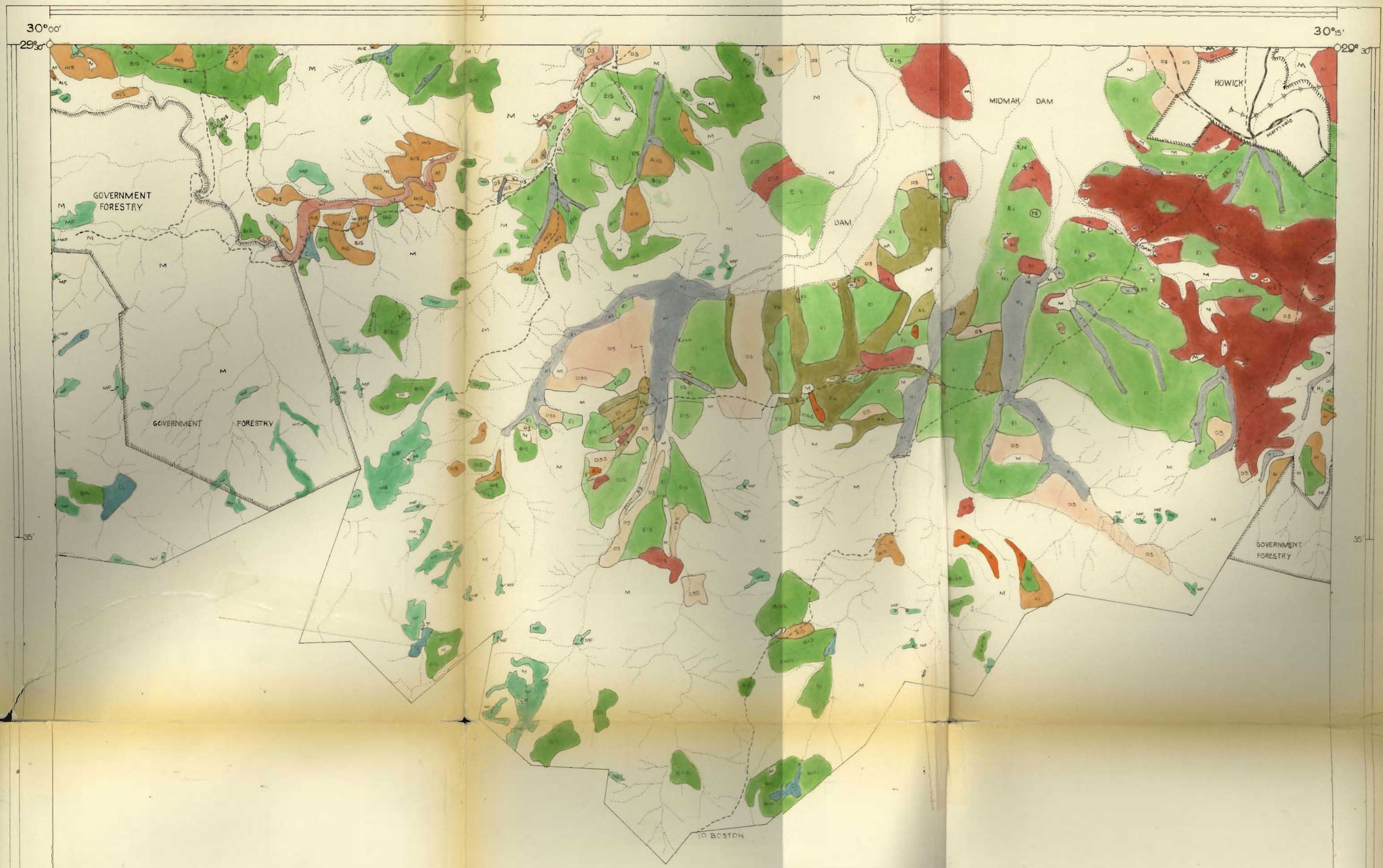
29, 30 AD

1:50000

30°15'
29°15'
20'
25'
TO RIETVLEI
TO ALBERT FALLS
HILTON COLLEGE
FALLS

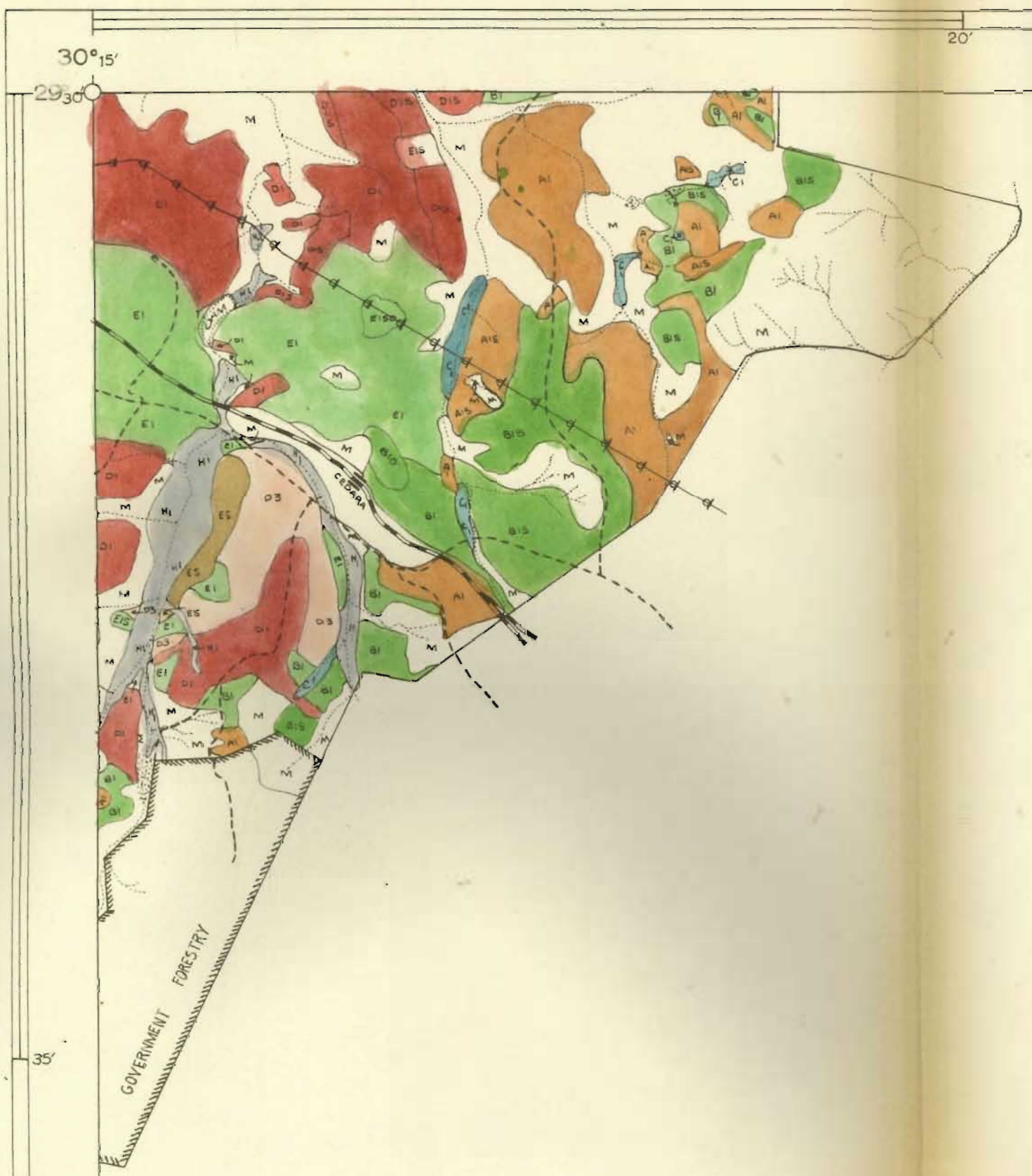
29, 30 CA

1:50000

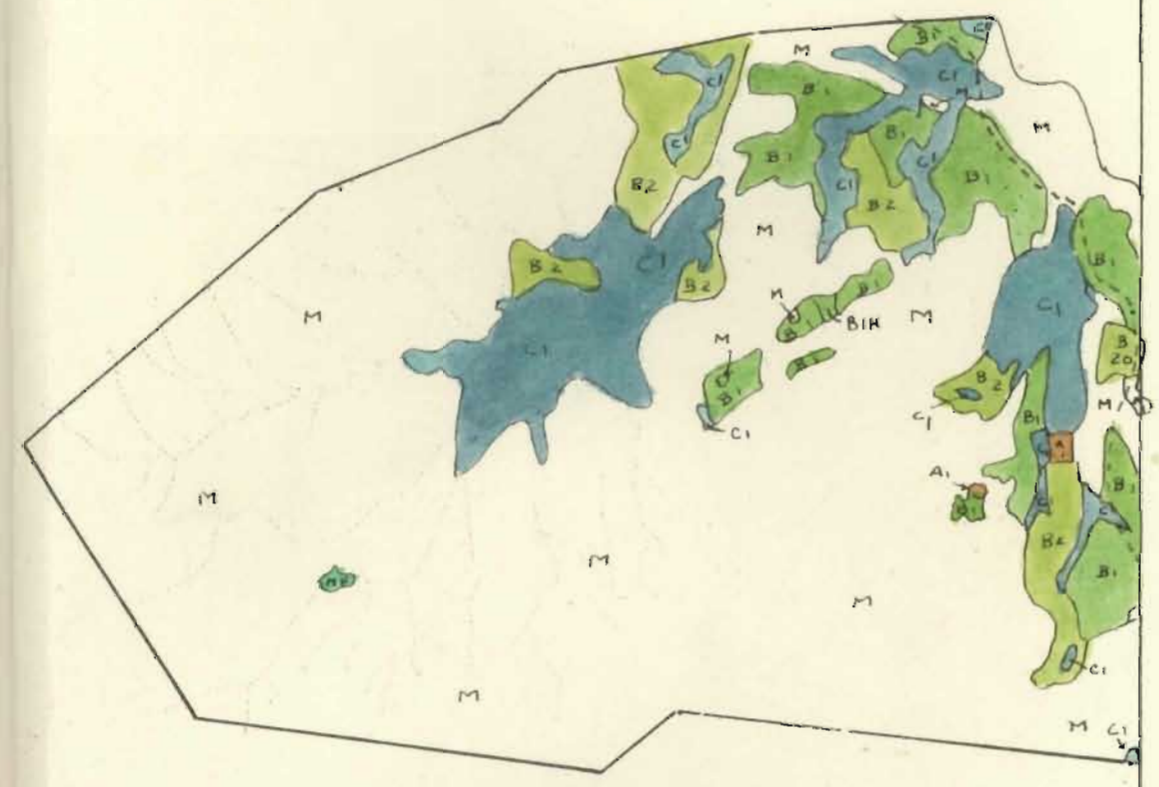


29, 30 C

1:50000



20'



25'

40'

29°30'

29°45'

29,29 BD

1 : 50000

29, 29 DB

1:50000