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GOVERNMENT OF FIJI
MINISTRY OF OVERSEAS DEVELOPMENT, LONDON

NAVUA PRE-INVESTMENT STUDY

VOLUME 2a
APPENDICES

DECEMBER 1969

HUNTING TECHNICAL SERVICES LTD.
Land Use & Agricultural Consultants,

SIR M. MACDONALD & PARTNERS.
Consulting Engineers,

GOVERNMENT OF FIJI
MINISTRY OF OVERSEAS DEVELOPMENT, LONDON

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APPENDIX V

DETAILED ESTIMATED COSTS OF IRRIGATION AND DRAINAGE

ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL COST
1	sq ft	100	0.10	10.00
2	sq ft	200	0.10	20.00
3	sq ft	300	0.10	30.00
4	sq ft	400	0.10	40.00
5	sq ft	500	0.10	50.00
6	sq ft	600	0.10	60.00
7	sq ft	700	0.10	70.00
8	sq ft	800	0.10	80.00
9	sq ft	900	0.10	90.00
10	sq ft	1000	0.10	100.00
11	sq ft	1100	0.10	110.00
12	sq ft	1200	0.10	120.00
13	sq ft	1300	0.10	130.00
14	sq ft	1400	0.10	140.00
15	sq ft	1500	0.10	150.00
16	sq ft	1600	0.10	160.00
17	sq ft	1700	0.10	170.00
18	sq ft	1800	0.10	180.00
19	sq ft	1900	0.10	190.00
20	sq ft	2000	0.10	200.00
21	sq ft	2100	0.10	210.00
22	sq ft	2200	0.10	220.00
23	sq ft	2300	0.10	230.00
24	sq ft	2400	0.10	240.00
25	sq ft	2500	0.10	250.00
26	sq ft	2600	0.10	260.00
27	sq ft	2700	0.10	270.00
28	sq ft	2800	0.10	280.00
29	sq ft	2900	0.10	290.00
30	sq ft	3000	0.10	300.00
31	sq ft	3100	0.10	310.00
32	sq ft	3200	0.10	320.00
33	sq ft	3300	0.10	330.00
34	sq ft	3400	0.10	340.00
35	sq ft	3500	0.10	350.00
36	sq ft	3600	0.10	360.00
37	sq ft	3700	0.10	370.00
38	sq ft	3800	0.10	380.00
39	sq ft	3900	0.10	390.00
40	sq ft	4000	0.10	400.00
41	sq ft	4100	0.10	410.00
42	sq ft	4200	0.10	420.00
43	sq ft	4300	0.10	430.00
44	sq ft	4400	0.10	440.00
45	sq ft	4500	0.10	450.00
46	sq ft	4600	0.10	460.00
47	sq ft	4700	0.10	470.00
48	sq ft	4800	0.10	480.00
49	sq ft	4900	0.10	490.00
50	sq ft	5000	0.10	500.00
51	sq ft	5100	0.10	510.00
52	sq ft	5200	0.10	520.00
53	sq ft	5300	0.10	530.00
54	sq ft	5400	0.10	540.00
55	sq ft	5500	0.10	550.00
56	sq ft	5600	0.10	560.00
57	sq ft	5700	0.10	570.00
58	sq ft	5800	0.10	580.00
59	sq ft	5900	0.10	590.00
60	sq ft	6000	0.10	600.00
61	sq ft	6100	0.10	610.00
62	sq ft	6200	0.10	620.00
63	sq ft	6300	0.10	630.00
64	sq ft	6400	0.10	640.00
65	sq ft	6500	0.10	650.00
66	sq ft	6600	0.10	660.00
67	sq ft	6700	0.10	670.00
68	sq ft	6800	0.10	680.00
69	sq ft	6900	0.10	690.00
70	sq ft	7000	0.10	700.00
71	sq ft	7100	0.10	710.00
72	sq ft	7200	0.10	720.00
73	sq ft	7300	0.10	730.00
74	sq ft	7400	0.10	740.00
75	sq ft	7500	0.10	750.00
76	sq ft	7600	0.10	760.00
77	sq ft	7700	0.10	770.00
78	sq ft	7800	0.10	780.00
79	sq ft	7900	0.10	790.00
80	sq ft	8000	0.10	800.00
81	sq ft	8100	0.10	810.00
82	sq ft	8200	0.10	820.00
83	sq ft	8300	0.10	830.00
84	sq ft	8400	0.10	840.00
85	sq ft	8500	0.10	850.00
86	sq ft	8600	0.10	860.00
87	sq ft	8700	0.10	870.00
88	sq ft	8800	0.10	880.00
89	sq ft	8900	0.10	890.00
90	sq ft	9000	0.10	900.00
91	sq ft	9100	0.10	910.00
92	sq ft	9200	0.10	920.00
93	sq ft	9300	0.10	930.00
94	sq ft	9400	0.10	940.00
95	sq ft	9500	0.10	950.00
96	sq ft	9600	0.10	960.00
97	sq ft	9700	0.10	970.00
98	sq ft	9800	0.10	980.00
99	sq ft	9900	0.10	990.00
100	sq ft	10000	0.10	1000.00

APPENDIX I

Where monthly rainfall totals were previously calculated by P. W. D. or Ministry of Natural Resources, the values given have been accepted as correct.

Where possible, missing monthly rainfall records at one station are supplemented using correlations developed between that station and surrounding stations.

Records Available from Raianganga

	APPENDIX I	readings from	taken to
a)	Automatic Raianganga		
	i) Waiyantu	1961	1965
	ii) Access road, Navua water supply catchment	1962	1966
b)	Daily samplings		
	i) Nahaulevu, Nasawa Rd.	Oct. 1964	Dec. 1965
	ii) Raiteaga, Waiyantu Rd.	May 1966	Dec. 1968
	iii) Reservoir, Navua water supply catchment	Oct. 1966	Nov. 1968
	iv) Naitonitoni	1917	1968
	v) Nenumarua	May 1967	Nov. 1968
	vi) Nahaitelevu	June 1967	Nov. 1968
	vii) Tamakua	1965	1968
	viii) Waiyantu (weekly check on a) i))	1961	1966
	ix) Access road, Navua water supply catchment (weekly check on a) iii))	1962	1966
	x) Namoni Mission	1966	1968

CLIMATE

APPENDIX I

CLIMATE

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Where monthly rainfall totals were previously calculated by P. W. D. or Ministry of Natural Resources, the values given have been accepted as correct.

Where possible, missing monthly rainfall records at any station are supplemented using correlations developed between that station and surrounding stations.

Records Available from Raingauges

	readings from	taken to
a) Automatic raingauges		
i) Waiyanitu	1962	1966
ii) Access road, Navua water, supply catchment	1962	1966
b) Daily manuals		
i) Nakaulevu, Nasasa Rd.	Oct. 1964	Dec. 1968
ii) Raiwaqa, Waiyanitu Rd.	May 1964	Dec. 1968
iii) Reservoir, Navua water supply catchment	Oct. 1964	Nov. 1968
iv) Naitonitoni	1917	1968
v) Namuamua	May 1967	Nov. 1968
vi) Nabukelevu	June 1967	Nov. 1968
vii) Tamanua	1935	1968
viii) Waiyanitu (weekly check on a) i))	1962	1966
ix) Access road, Navua water supply catchment (weekly check on a) ii))	1962	1966
x) Namosi Mission	1936	1955

Notes on Siting of Raingauges

Naitonitoni

Gauge - 5" dia. daily recording gauge

Elevation - 10' approx.

Position - shielded by

a) Palm tree at 20' to NE.

b) 40' high tree at 40' to S.

c) Building 20' high at 20' to W.

d) Encircled by small shrubs at 4' from the gauge.

The gauge is 30 yds. from the coast and is clear to winds coming from the SE.

Tamanua

In April 1966 the gauge was moved from close to the farm manager's house to the factory $\frac{1}{2}$ mile to the east.

Prior to April 1966:

Gauge - 5" dia. daily recording gauge

Elevation - 20' approx.

Position - shielded to E by 50' high hill.

After April 1966:

Gauge - 5" dia. daily recording gauge

Elevation - 16' approx.

Position - in open field on post 6' from the ground.

Raiwaqa

Gauge - 8" dia. daily recording gauge

Elevation - approx. 25' above mean sea level

Position - clear.

Nakaulevu - Nasasa Rd.

- Gauge - 8" dia. daily recording gauge
 Elevation - approx. 15' above mean sea level
 Position - Small tree, at present 3' high, at 20' to the west of the gauge. House, 15' high, 50' to 5. of the gauge. Clothes line almost over the gauge!

Waiyanitu

- Gauge - i) Recording gauge, changed weekly
 ii) 5" dia. check gauge read weekly
 Elevation - 50' approx.
 Position - clear top of small mound.

Navua water supply catchment gauge

- Gauge - i) Recording gauge changed weekly
 ii) 5" dia. check gauge read weekly
 Elevation - approx. 300' above mean sea level
 Position - set in clearing in wood. Shielded to the NE.

Navua reservoir gauge

- Gauge - 5" dia. daily recording gauge
 Elevation - 100'
 Position - set on top of the reservoir tank, partly shielded by 30' high trees at 50' from the gauge to the west.

Table I. 1 Monthly Rainfall Data (inches)

Raiwaga - Namosi

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1968	9.98	14.40	13.26	4.37	7.53	6.50	5.51	2.54	11.90	6.40	1.67	7.97	92.03
1967	26.83	8.94	8.43	-	8.67	6.80	5.14	9.22	12.96	33.48	6.07	14.17	-
1966	14.38	7.71	14.26	21.90	6.17	10.35	12.08	8.85	2.13	11.70	9.24	20.86	139.63
1965	14.37	23.61	32.10	20.03	-	-	-	8.77	14.74	-	-	-	-
1964	Gauge installed on 29th May 1964												
						13.49	7.47	12.14	21.05	16.43	9.52	9.19	-

Navua Reservoir

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1968	10.41	17.06	11.22	6.47	7.57	6.09	8.98	2.60	15.76	7.24	1.72	-	-
1967	21.54	9.96	5.32	18.14	9.10	6.83	4.96	8.58	9.38	31.08	5.63	14.35	144.87
1966	12.26	11.92	25.95	32.22	6.31	9.77	11.44	7.51	0.99	13.96	13.85	30.12	176.30
1965	21.83	36.67	35.63	35.63	35.59	5.45	2.40	7.88	18.55	8.29	9.86	5.35	253.13
1964	Gauge installed on 15th October 1964. Readings unreliable until 1965												

Nakaulevu - Nasasa Rd.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1968	8.98	8.26	11.37	5.84	6.38	6.14	5.77	2.86	4.57	9.93	2.02	4.54	76.66
1967	24.71	6.94	6.71	17.57	8.55	16.16	3.33	9.02	10.09	28.79	4.16	8.52	144.55
1966	15.80	11.71	9.37	27.49	4.56	7.98	5.00	3.92	0.67	13.62	11.71	18.19	130.02
1965	11.63	7.74	27.26	17.26	20.11	2.02	8.97	9.35	16.14	13.96	9.20	4.60	148.24
1964			Gauge installed on 15th October 1964										

Tamanua

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1968 *	8.27	14.72	11.08	5.08	10.01	7.81	5.46	2.16	12.26	6.58	1.88	4.70	90.01
1967	16.07	7.31	6.50	15.79	5.08	5.17	3.01	8.17	10.74	24.42	2.79	6.85	111.90
1966	14.65	6.94	12.82	15.70	7.95	5.81	8.43	7.39	1.64	7.41	5.87	15.58	110.22
1965 *	12.12	19.33	23.96	15.80	18.35	2.30	9.28	5.58	10.61	8.85	6.54	5.03	137.75
1964	7.47	11.78	19.01	*16.84	12.63	7.16	4.72	6.28	15.48	16.49	*9.70	7.21	134.77
1963	12.63	4.61	9.07	25.97	19.71	5.82	3.71	20.95	9.57	7.17	11.74	16.93	147.88
1962	20.16	30.40	17.87	10.77	4.75	12.87	7.67	1.48	9.83	5.87	11.56	4.96	138.19
1961	27.51	12.65	9.63	11.29	13.66	10.76	2.37	6.66	16.63	7.68	21.28	17.19	157.31
1960	10.84	13.42	21.04	14.45	6.21	6.40	12.41	4.22	8.28	8.10	24.75	8.27	134.75
1959	9.48	4.27	10.10	14.86	7.75	14.33	4.73	16.51	15.70	9.75	9.67	4.88	122.03
1958	4.49	12.01	15.35	36.57	12.35	1.28	2.05	3.45	2.78	4.91	17.10	8.88	121.22
1957	20.99	8.33	12.30	18.71	9.31	7.14	2.46	4.01	6.12	4.49	10.15	5.84	109.85
1956	24.75	12.37	20.43	12.58	7.51	4.90	12.16	5.85	5.40	13.70	18.94	6.75	145.34
1955	16.20	14.44	14.02	15.82	15.59	17.66	10.05	12.17	24.44	10.95	23.35	16.65	191.34
1954	14.25	13.67	18.20	18.30	3.02	13.29	10.13	18.59	11.08	10.00	31.32	18.13	179.98
1953	18.15	20.52	15.97	12.42	6.81	5.37	11.86	6.56	2.51	5.47	1.87	6.86	114.87
1952	21.78	19.52	16.67	6.34	8.91	12.54	17.00	2.09	5.54	3.83	16.61	20.29	151.11
1951	9.90	13.22	13.04	12.59	4.85	12.17	3.65	2.84	12.66	6.98	1.05	9.26	102.71
1950	14.60	16.97	24.31	12.10	16.71	4.46	11.08	9.44	12.90	20.32	17.75	14.25	174.69
1949	12.09	14.31	16.10	11.61	17.13	4.65	12.64	14.28	22.41	16.31	6.52	10.38	158.43
1948	16.24	26.74	15.99	18.78	7.33	11.23	7.84	7.81	8.95	12.81	11.71	15.08	160.01

Tamanua cont'd

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1947	18.39	11.05	18.60	7.43	16.12	16.16	8.98	5.85	10.94	6.31	10.95	8.79	139.66
1946	12.42	24.79	23.42	6.16	10.04	0 8.52	3.78	7.35	4.23	10.93	10.36	8.20	129.60
1945	19.11	11.33	12.39	13.36	17.14	10.49	7.45	13.14	6.30	16.21	7.34	16.79	151.35
1944	9.70	11.81	35.67	14.82	6.26	10.87	3.39	10.49	17.51	5.24	2.71	14.86	143.33
1943	12.16	12.32	8.43	29.51	8.01	1.95	5.99	4.17	3.28	15.79	15.18	5.18	122.07
1942	13.76	13.94	8.52	26.25	15.50	11.20	7.94	11.58	8.01	11.73	3.51	11.93	133.87
1941	14.74	18.60	4.91	49.15	8.35	12.74	4.29	11.22	12.13	3.11	4.92	13.66	157.82
1940	7.87	5.42	21.07	15.39	6.04	6.61	5.27	7.53	7.46	14.56	6.78	21.09	124.69
1939	25.38	11.48	16.88	25.03	27.72	3.18	6.28	9.08	3.98	18.75	11.42	7.10	166.28
1938	12.68	8.60	7.50	3.08	17.28	6.80	15.14	14.39	18.28	10.48	18.24	20.42	152.89
1937	12.56	5.87	29.90	13.30	16.47	5.16	7.95	14.04	8.98	10.86	9.35	6.23	139.37
1936	24.47	8.32	25.99	13.14	28.66	7.04	4.82	5.81	7.85	20.40	3.93	19.68	170.11
1935	17.72	4.22	12.41	10.66	8.35	10.29	7.47	21.60	7.46	29.45	36.58	19.55	185.76

* Rainfalls calculated from surrounding raingauges

Naitohitoni

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1968	5.60	11.54	11.13	3.94	3.51	4.44	2.90	3.66	10.11	-	1.36	4.40	-
1967	13.26	6.65	7.65	-	4.15	1.11	1.56	4.13	9.86	13.66	0.24	5.68	-
1966	10.54	5.88	12.16	17.96	6.56	6.19	5.68	4.11	-	1.06	-	9.68	-
1965	12.12	23.21	23.18	15.19	16.03	1.53	6.88	4.15	6.83	4.81	4.77	1.92	120.62
1964	7.71	10.77	23.01	16.84	15.75	0.66	9.69	15.35	6.75	4.83	9.70	13.77	134.83
1963	15.12	4.90	11.86	22.65	17.52	5.01	3.50	23.42	6.51	5.70	9.30	13.82	139.31
1962	15.25	22.28	15.93	8.02	3.89	13.98	4.98	00.87	7.89	4.10	11.79	6.73	115.71
1961	18.37	10.77	9.78	14.03	10.72	7.87	5.25	7.97	9.43	6.91	18.66	16.13	134.89
1960	11.13	11.19	18.63	9.06	4.86	6.44	8.44	3.40	2.94	5.50	22.47	8.51	112.97
1959	14.38	5.81	8.96	10.30	6.25	8.15	0.77	13.71	12.30	6.44	6.93	1.03	95.03
1958	3.35	10.55	0.70	25.72	9.69	0.00	1.50	2.30	0.86	3.40	11.90	6.30	76.27
1957	15.78	10.75	15.38	18.36	7.96	6.82	2.50	2.32	7.07	4.50	11.00	2.90	105.34
1956	11.92	14.32	22.53	15.92	5.73	3.74	8.50	4.79	3.78	12.87	17.87	2.32	124.29

Naitonitoni cont'd

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1955	12.92	11.20	17.91	9.83	14.04	8.20	6.45	14.18	21.48	6.16	21.92	18.86	162.97
1954	-	-	-	-	-	-	-	-	-	-	13.92	9.63	-
1953	21.87	14.38	16.97	13.63	6.78	4.28	-	-	-	-	-	-	-
1952	20.09	15.69	18.75	5.39	8.64	10.14	11.29	2.15	5.75	2.08	10.27	20.12	130.32
1951	10.06	8.82	10.91	11.03	8.49	7.94	4.06	3.01	8.31	6.76	0.88	9.18	89.46
1950	15.87	9.28	16.89	11.68	12.35	2.17	10.29	6.63	9.98	17.58	15.98	9.67	138.37
1949	10.15	11.62	11.23	8.72	14.94	3.53	7.31	9.31	15.55	9.87	5.73	7.77	115.73
1948	20.39	23.35	14.42	13.41	7.11	2.03	8.47	2.35	2.43	5.61	9.58	8.34	117.49
1947	14.48	9.42	19.10	9.12	18.27	10.67	9.19	3.53	8.17	3.15	6.10	6.15	117.35
1946	16.71	32.83	23.32	6.30	7.60	7.07	4.10	5.19	4.28	7.72	6.88	5.57	127.57
1945	7.83	12.65	8.92	4.44	8.00	14.51	4.66	11.56	3.94	15.41	6.83	12.76	111.51
1944	8.51	6.76	31.63	9.06	9.85	3.91	1.54	7.15	11.23	4.22	3.02	15.37	112.25
1943	10.07	10.82	6.33	17.13	7.42	1.13	2.48	3.09	3.20	10.85	10.13	4.44	87.09
1942	1.75	10.28	4.99	20.39	11.28	13.05	4.97	6.58	4.57	6.06	1.26	10.04	95.22
1941	10.13	13.90	4.50	35.23	6.25	10.27	4.07	8.38	7.71	2.03	2.67	8.96	114.10
1940	13.02	2.52	20.06	18.55	6.28	6.42	4.62	6.63	7.41	10.86	7.76	22.72	126.85
1939	30.62	9.22	21.47	29.20	25.79	1.99	4.70	8.84	3.47	11.26	12.57	5.86	165.49
1938	11.79	5.32	9.40	5.68	13.13	5.75	13.03	12.49	13.42	10.21	18.27	23.03	139.50
1937	9.49	7.91	19.96	10.00	12.49	3.86	11.80	9.48	17.20	10.86	7.61	4.26	124.92
1936	13.27	6.75	12.77	7.34	27.38	4.63	3.37	6.30	6.18	17.21	3.68	15.00	123.88
1935	16.52	5.03	9.12	10.37	7.62	8.67	7.51	16.43	6.51	16.13	19.74	12.19	135.84
1934	21.05	14.81	19.86	17.12	17.63	5.20	13.07	4.86	9.93	9.36	7.20	6.35	136.44
1933	9.24	11.98	20.20	43.51	8.25	6.94	2.66	2.56	6.77	10.26	23.97	33.18	179.52
1932	10.06	16.04	15.41	15.36	10.06	2.27	12.70	6.12	2.90	9.40	14.13	6.26	120.71
1931	8.65	19.72	12.66	5.42	9.17	5.10	4.70	3.59	8.18	9.84	10.24	13.45	110.72
1930	14.46	21.67	13.76	6.33	7.09	5.28	1.92	1.58	4.94	1.24	3.66	8.73	90.66
1929	8.05	14.62	10.50	8.12	6.39	21.18	3.47	8.38	7.88	4.17	11.56	23.06	127.32
1928	5.00	6.27	22.60	24.73	17.26	1.66	2.39	10.35	5.01	7.03	6.00	9.36	117.66
1927	26.69	18.24	8.08	6.07	17.15	13.88	3.98	4.66	11.96	17.15	12.59	24.64	165.09
1926	3.15	11.97	11.32	9.52	3.75	10.98	5.26	0.21	16.84	4.20	5.30	4.00	86.50
1925	9.26	5.70	4.76	17.89	6.46	1.94	5.06	4.50	5.68	8.04	3.32	4.29	76.90
1924	6.05	5.26	15.47	5.76	24.89	25.35	3.52	27.46	15.12	25.25	16.88	6.12	177.13
1923	11.76	14.27	13.33	4.06	7.97	4.89	8.25	3.73	5.16	5.22	15.45	7.39	101.48
1922	16.44	14.24	21.24	10.00	6.34	2.92	2.67	10.81	9.09	6.68	21.29	10.76	133.06

Naitonitoni cont'd

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1921	20.30	14.69	14.63	27.51	9.39	4.17	4.35	14.83	7.75	11.01	29.65	33.95	192.14
1920	8.67	9.55	8.85	22.65	13.18	6.80	6.17	4.41	10.01	3.81	4.35	12.56	111.01
1919	9.30	6.31	10.29	16.26	4.49	7.60	6.36	5.22	7.27	11.12	14.21	9.92	108.35
1918	4.18	11.91	7.13	11.02	24.07	13.32	11.10	8.53	2.70	9.50	4.46	16.68	124.60
1917	13.80	7.91	16.17	14.07	11.22	13.74	10.50	13.78	15.82	11.47	16.01	11.49	155.99

Nabukelevu (Serua)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1968	13.14	7.51	13.42	10.58	2.02	5.32	5.55	0.97	3.96	2.98	4.80	-	-
1967						1.38	1.11	1.57	1.93	14.79	2.39	17.33	-

Namuama (Namosi)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1968	13.87	9.97	15.68	4.36	5.14	3.40	5.24	1.28	4.87	3.20	3.05	-	-
1967						1.73	3.98	6.36	5.59	26.45	9.38	20.51	-

Gauge installed 24/5/67

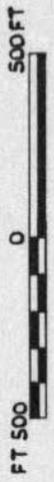
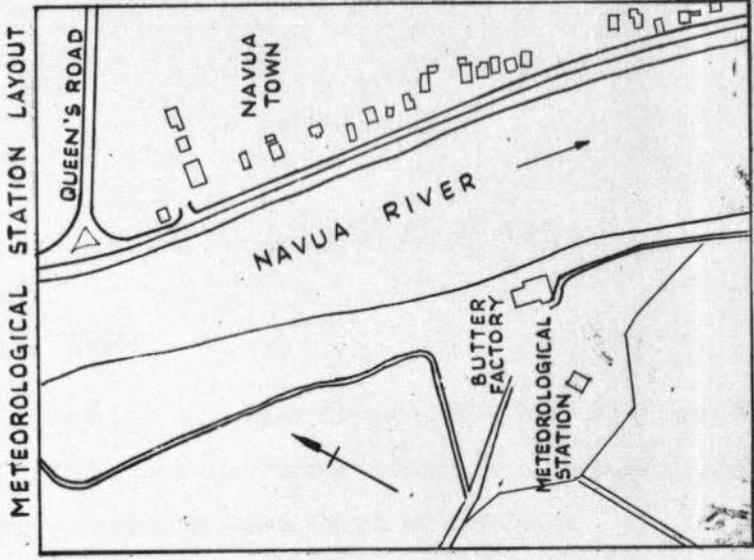
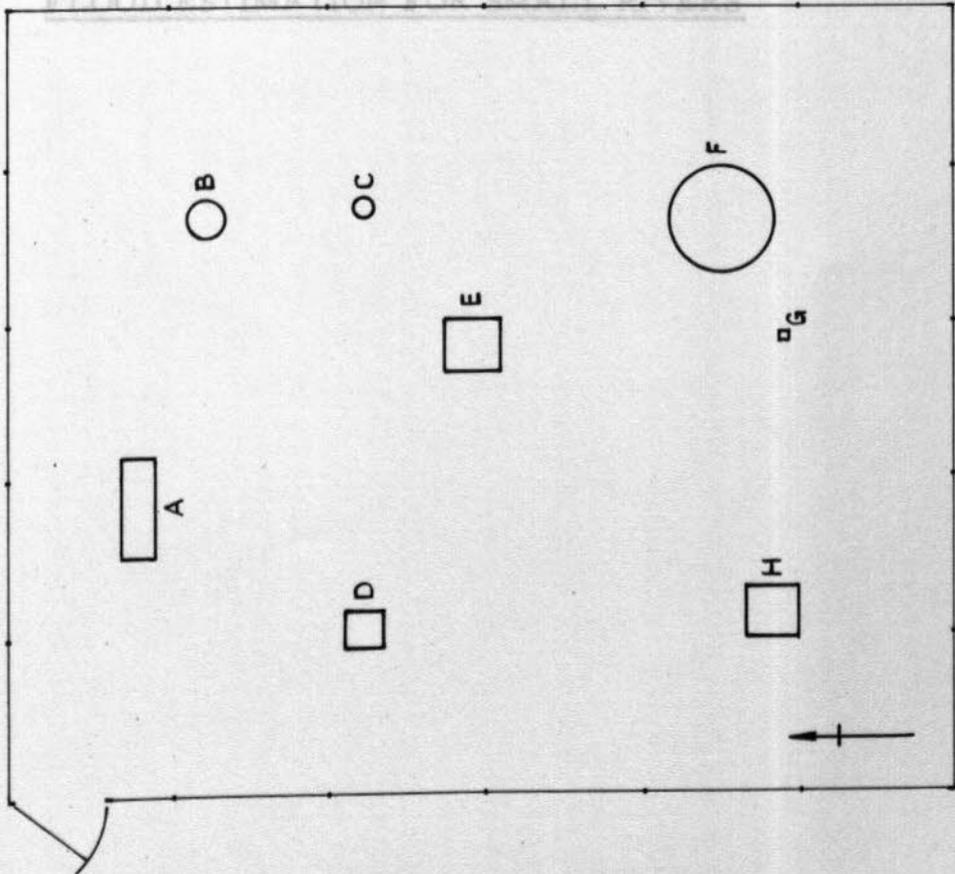
Namosi Mission

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1955	21.40	18.05	28.30	20.70	19.44	22.30	5.45	6.50	27.04	10.91	29.70	19.60	227.79
1954	29.54	20.40	92.80	16.83	3.07	19.30	8.99	Absent	15.22	12.26	29.90	36.38	202.00
1953	20.70	36.50	22.95	30.63	10.76	6.75	13.66	5.88	3.90	3.67	2.54	28.49	186.63
1952	22.74	25.40	20.38	7.92	5.96	7.77	15.14	1.42	10.05	6.46	19.93	14.80	157.97
1951	13.27	17.80	14.04	5.73	4.44	10.59	5.45	2.00	6.59	9.09	2.40	16.51	107.83
1950	14.61	25.31	25.61	21.00	14.92	3.14	7.10	(1.31)	(6.00)	17.13	24.76	(9.44)	-
1949	14.58	12.40	23.83	32.92	19.05	5.65	11.24	(6.70)	(17.55)	11.92	14.39	15.21	185.44
1948	17.98	40.00	20.20	21.50	7.80	2.15	7.85	4.43	3.20	19.17	15.79	29.23	189.30
1947	20.39	12.26	43.79	7.55	17.83	11.47	8.46	7.29	11.69	6.21	9.70	21.42	178.06
1946	16.36	22.29	22.07	8.40	4.09	3.73	4.77	3.15	2.38	6.37	10.76	19.05	123.42
1945	14.70	20.52	10.66	16.09	11.70	0.23	5.90	12.49	8.41	12.42	19.08	26.92	168.12
1944	9.91	9.75	56.58	19.87	4.71	6.57	3.39	5.36	21.79	7.94	3.73	22.81	172.41
1943	27.56	11.22	8.27	22.72	6.95	1.93	2.81	1.12	3.33	18.60	13.20	16.26	133.97
1942	12.21	20.21	12.48	25.46	15.55	11.67	9.35	8.38	5.96	11.73	4.27	13.50	150.77
1941	14.97	40.23	8.10	51.12	10.96	9.85	4.09	6.75	8.55	3.43	7.91	16.70	182.66
1940	12.69	20.65	26.95	17.91	5.43	5.59	8.64	3.88	8.15	20.98	6.08	25.70	162.65
1939	40.79	13.81	21.71	20.47	29.08	2.54	3.23	6.98	2.84	11.98	11.86	10.18	175.47
1938	16.81	13.12	10.24	5.14	9.48	4.58	8.35	11.88	13.83	13.20	24.56	30.12	161.31
1937	11.66	7.86	13.90	13.66	10.62	1.82	7.00	9.39	6.97	10.13	3.67	7.89	104.57

Figure 1-1

TAMANUA METEOROLOGICAL STATION

METEOROLOGICAL STATION LAYOUT



LEGEND

- A STEVENSON SCREEN
- B AUTOMATIC RAIN GAUGE
- C DAILY RAIN GAUGE
- D BENCH MARK
- E CAMPBELL STOKES SUNSHINE RECORDER
- F CLASS A TYPE EVAPORATION PAN
- G ANEMOMETER
- H BIMETALLIC ACTINOGRAPH

APPENDIX II

Flood Estimation for Small Rivers

Assumptions made

- i) All the above assumptions of the unit hydrograph
- ii) That the above storm measured is a typical storm and the rainfall pattern taken is correct.
- iii) That the rainfall intensity duration curve developed holds for storm durations of up to 16 hours - values taken beyond this are known to be of dubious accuracy
- iv) That runoff **APPENDIX II** rainfall intensity and curves
- v) That all catchments are of similar hydrologic type and that peak flows from each catchment are directly proportional to the catchment area.

FLOOD ESTIMATION FOR SMALL RIVERS

APPENDIX II

FLOOD ESTIMATION FOR SMALL RIVERS

APPENDIX II

Flood Estimation for Small Rivers

Assumptions made

- i) All the basic assumptions of the unit hydrograph.
- ii) That the one storm measured is a typical storm and the rainfall pattern taken is correct.
- iii) That the rainfall intensity duration curve developed holds for storm durations of up to 16 hours - values taken beyond this are known to be of dubious accuracy
- iv) That runoff is dependant on rainfall intensity and duration.
- v) That all catchments are of similar hydrologic type and that peak flows from each catchment are directly proportional to the catchment area.

TABLE II. 1 Runoff Nos. for use in Central Africa

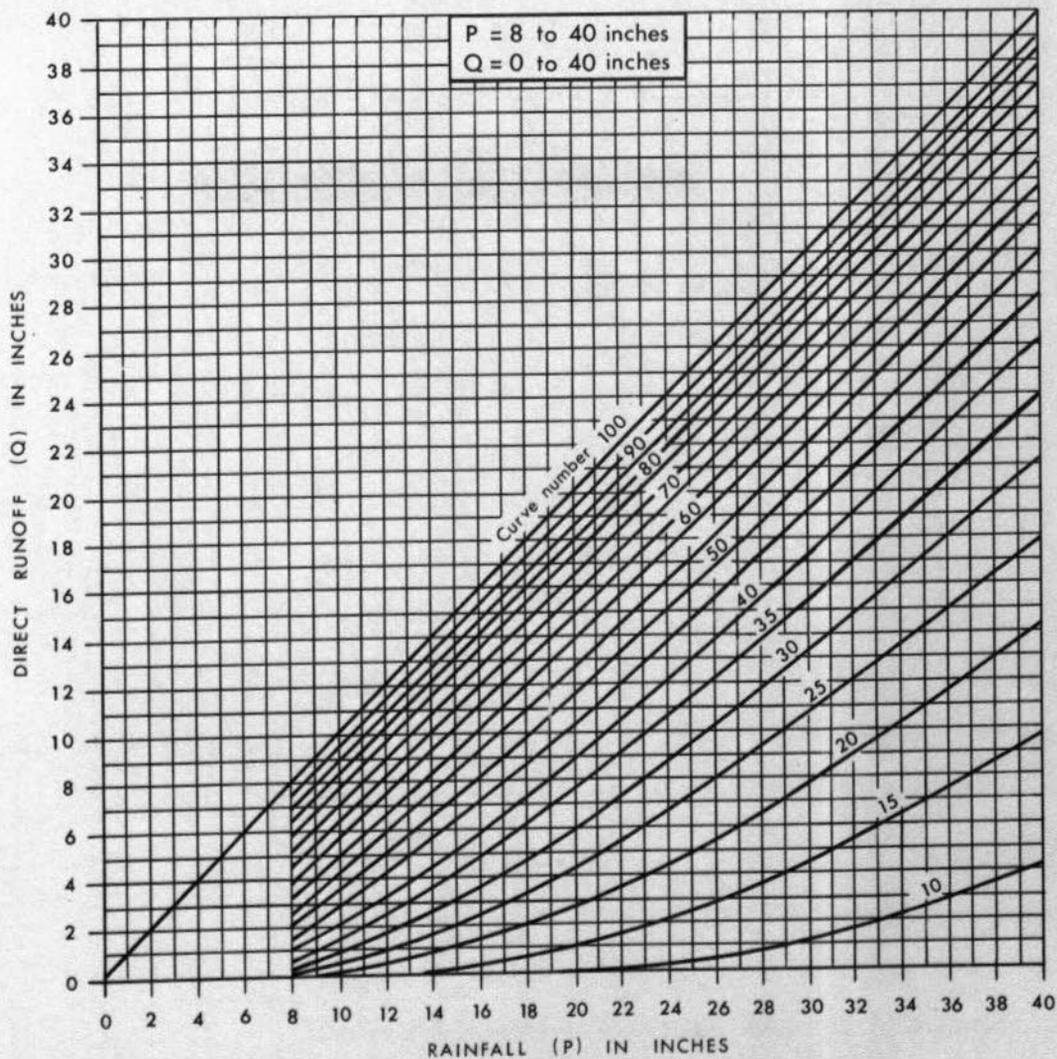
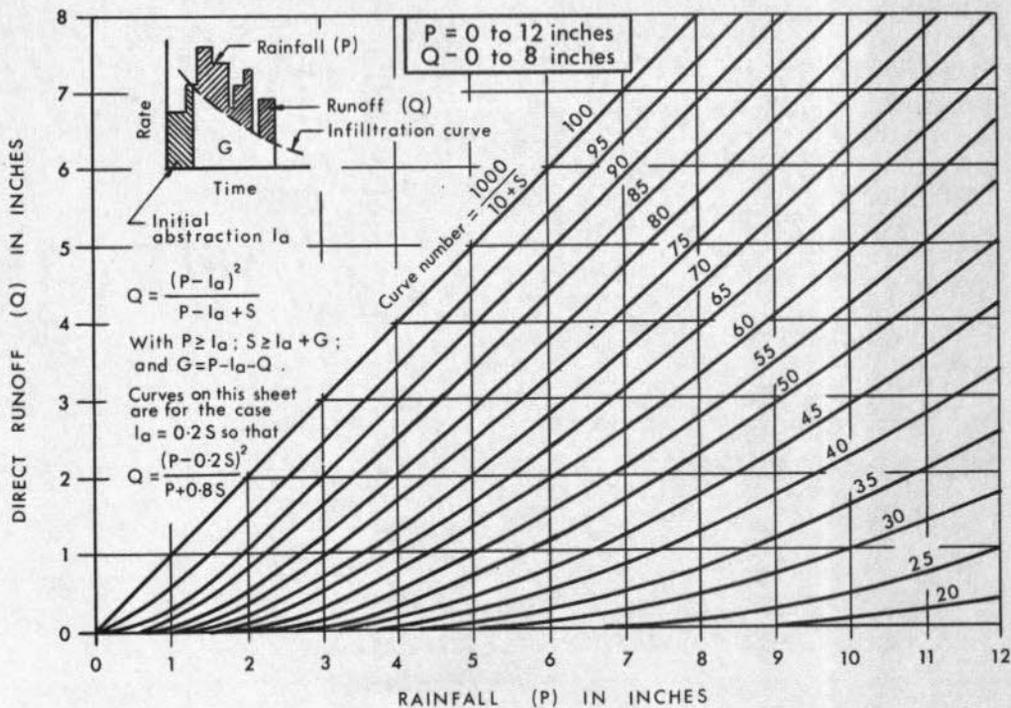
Runoff nos. to be used in U. S. Soil Conservation method for estimating runoff.

Land Use	Treatment	Hydrologic Condition	Hydrologic Soil Group			
			A	B	C	D
Fallow			77	86	81	81
Row crops (e. g. maize, tobacco, cotton and sugar)	S. R.	Poor	72	81	88	91
	C	Good	65	75	82	86
Small grain (e. g. wheat, rapoka)	S. R.	Poor	65	76	84	88
	C	Good	61	73	81	84
Close seeded legumes (e. g. lucerne peas, beans, ground nuts)	S. R.	Poor	66	77	85	89
	C	Good	55	69	78	88
Improved pasture		Poor	49	69	79	84
		Good	39	61	74	80
Natural veldt (grass)		Poor	68	79	86	89
		Good	49	69	79	84
Tree savanna			44	65	75	81
Woodland savanna			40	62	72	78
Woodland			35	59	69	75
Forest (various types of natural forest)			31	56	66	78
Wattle plantations			31	56	66	72
Coniferous forest			26	52	62	69
Meadow or golf courses			30	58	71	78
Gardens in housing areas			30	58	71	78
Roads (dirt)			72	82	87	89
			74	84	90	92
Houses & bitumen roads			100	100	100	100

- Notes: 1. This table is for Condition II
 2. S. R. - Straight Row
 C - Contoured

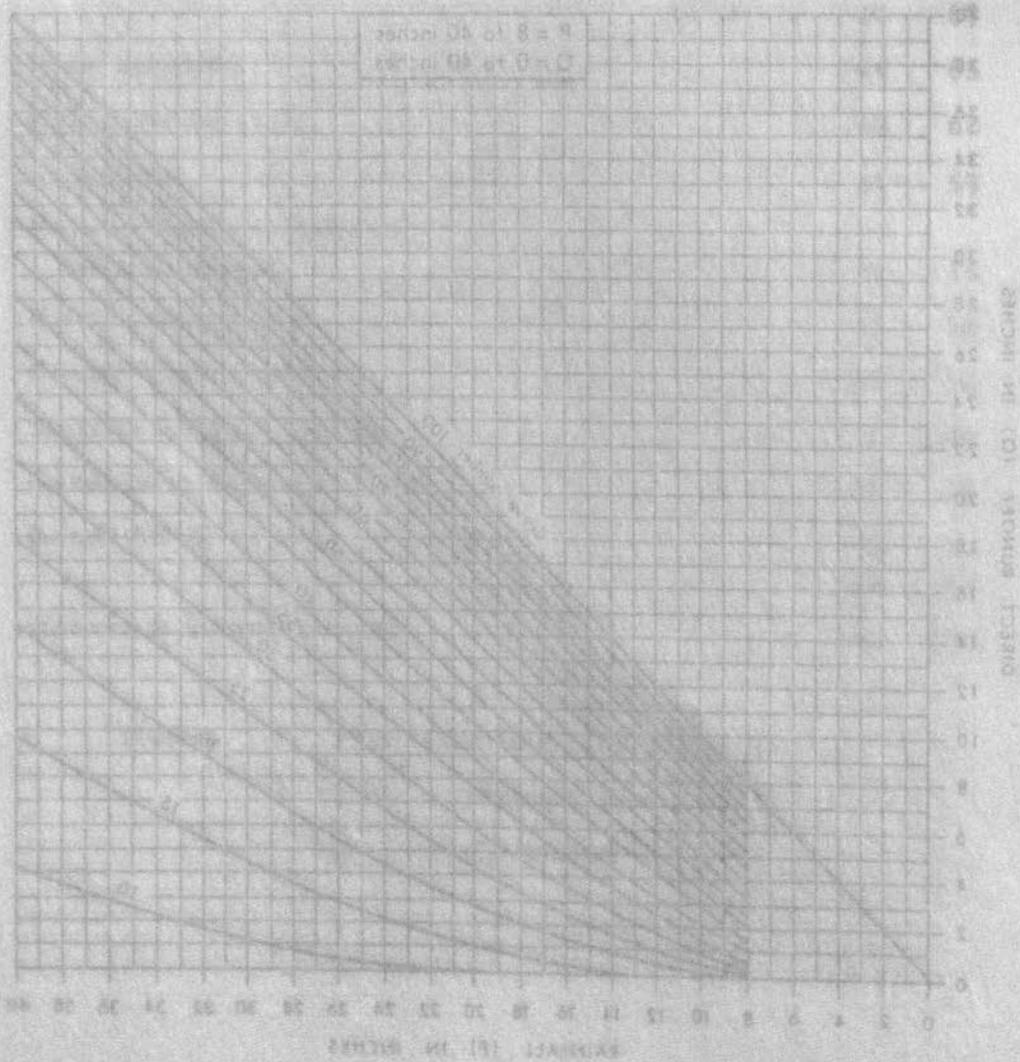
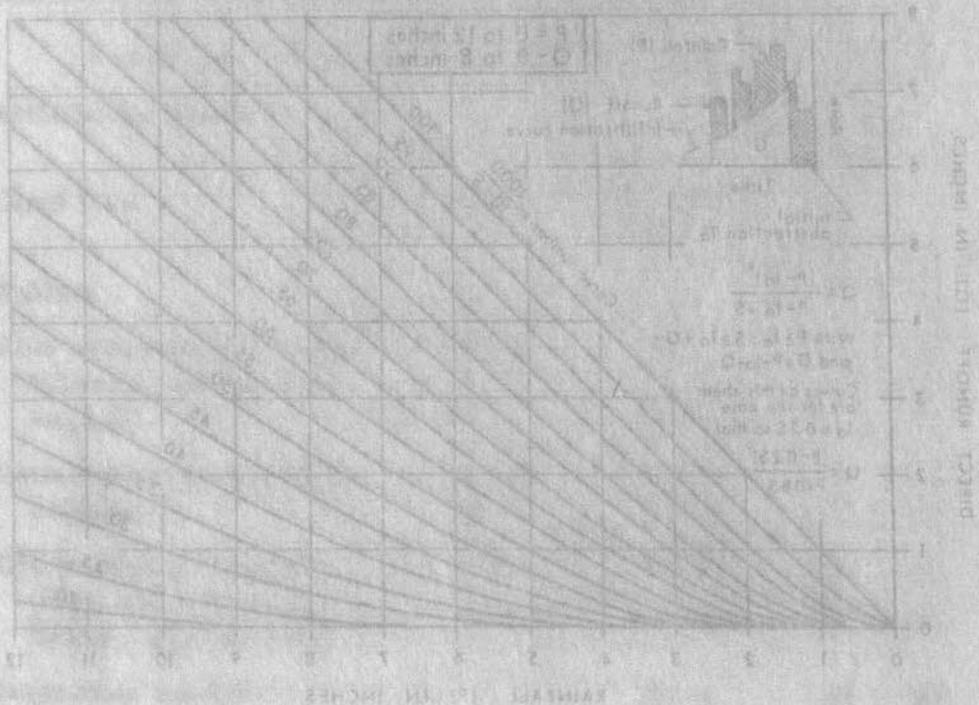
RELATIONSHIP BETWEEN RAINFALL AND RUNOFF AS GIVEN BY THE U.S. SOIL CONSERVATION SERVICE

(SOLUTION OF RUNOFF EQUATION, $Q = \frac{(P - 0.2 S)^2}{P + 0.8 S}$)



RELATIONSHIP BETWEEN RAINFALL AND RUNOFF AS GIVEN BY THE U.S. SOIL CONSERVATION SERVICE

(SOLUTION OF RUNOFF EQUATION $Q = \frac{R - 0.25I}{9 + 0.82I}$)



APPENDIX III

SOIL PROFILE DESCRIPTIONS

APPENDIX III

Soil Profile Descriptions

PIT NO.	:	D. 001
LOCATION	:	Run 276 : photo 31
TOPOGRAPHY	:	Flat, near bottom of levee slope
PARENT MATERIAL	:	Riverine alluvium of intermediate composition
VEGETATION	:	Grazed area, dominated by Navua sedge
DRAINAGE	:	Imperfect to poor
SOIL CLASS	:	Tamanua
DESCRIPTION		
0 - 9"		10YR 4/2 dark greyish brown, silty clay loam; many medium prominent red mottles; moderate medium sub-angular blocky breaking to moderate to strong granular; moist and firm; many roots; medium organic matter; earthworms; clear smooth boundary to:-
9 - 14"		10YR 5/1 grey, silty clay loam, abundant large prominent red mottles; moderate medium angular blocky; moist and firm to very firm; weak plough pan in upper 3 inches; few roots; low organic matter; clear wavy boundary to:-
14 - 19"		2.5Y 6/6 olive yellow, silty clay loam; many large prominent red mottles; thin lense of loamy coarse sand; weak coarse prismatic breaking to moderate angular blocky; polished faces on some peds; wet and sticky; few roots; diffuse smooth boundary to:-
19 - 35"+		2.5Y 6/2 light brownish grey and 6/4 light yellowish brown, variegated silty clay, moderate medium angular blocky; polishing on ped faces; few roots; charcoal fragments; water table at 36 inches.

III. 2.

PIT NO. : D.002
 LOCATION : Run 275 : photo 16
 TOPOGRAPHY : Flat, low lying with uneven micro-relief
 PARENT MATERIAL : Alluvium of riverine derivation overlying
 estuarine alluvium
 VEGETATION : Weed fallow after rice
 DRAINAGE : Poor
 SOIL CLASS : Naitonitoni - $\frac{Z}{C}$

DESCRIPTION

0 - 5" 5Y 4/1 dark grey, heavy silt loam; few medium distinct red mottles; medium sub-angular blocky; moist and firm; many roots; low organic matter; clear wavy boundary to:-

5 - 9½" 5Y 6/1 grey, heavy silt loam; few fine distinct red mottles; weak coarse angular blocky; wet and slightly sticky; few roots; low organic matter; diffuse smooth boundary to:-

9½ - 14" 2.5Y 5/2 greyish brown, heavy sandy loam; few diffuse red mottles; moderate medium sub-angular blocky; wet and sticky; few roots; medium organic matter; clear smooth boundary to:-

14 - 23" 10YR 3/2 very dark greyish brown, light sandy loam; no mottles; moderate medium sub-angular blocky; wet and sticky; medium to high organic matter; clear smooth boundary to:-

23 - 30" 10YR 3/1 very dark grey, heavy sandy loam; no mottles; moderate medium sub-angular blocky; wet and non-sticky; high organic matter; mainly mangrove swamp remnants;

Water table 29".

PIT NO. : D. 003
 LOCATION : Run 275 : photo 16
 TOPOGRAPHY : Flat, level; 12 yards from 3 ft. drain
 PARENT MATERIAL :: Alluvium of estuarine derivation
 VEGETATION : Former rice seedling bed
 DRAINAGE : Poor (Improved very poor)
 SOIL CLASS : Toguru - M
 DESCRIPTION

0 - 9" 10YR 3/1 very dark grey, heavy sandy loam;
 no mottles; moderate to strong medium
 sub-angular blocky; moist and friable; few
 roots; medium organic matter; worm
 channels; medium organic matter; clear wavy
 boundary to:-

9 - 18" 10YR 4/1 and 5/1, dark grey and grey, heavy
 sandy loam; weak coarse angular blocky; moist
 and very firm; few stones; medium organic
 matter; no roots; clear wavy boundary to:-

18 - 27" 2.5Y 4/1 dark grey, heavy sandy loam; medium
 coarse angular blocky; wet and slightly sticky;
 high organic matter; mangrove residue; no
 roots; clear smooth boundary to:-

27 - 36"+ 2.5Y 4/0 - 3/0 dark grey and very dark grey,
 heavy loam; weak coarse angular blocky; wet
 and sticky; abundant shell fragments; few
 stones of andesite; many coral fragments; high
 organic matter; water flowing into pit at 36".

III.4.

PIT NO. : D. 004
 LOCATION : Run 276 ; photo 33
 TOPOGRAPHY : Flat with slightly uneven micro-relief
 PARENT MATERIAL : Alluvium of riverine derivation
 VEGETATION : Fallow padi field : Navua sedge and various weeds
 DRAINAGE : Poor
 SOIL CLASS : Navua - F
 DESCRIPTION

0 - 9" 2.5Y 5/2 greyish brown, silty clay to silty clay loam; many medium prominent red mottles; strong medium sub-angular blocky; moist and firm and many roots; medium organic matter; smooth diffuse boundary to:-

9 - 17" 5Y 4/1 dark grey, silty clay loam; abundant coarse prominent red mottles; moderate coarse angular-blocky; moist and very firm; weak polishing on ped faces; boundary to:-

17 - 27" 5Y 4/1 dark grey, silty clay; many fine prominent red mottles in root channels; weak coarse prismatic breaking to weak angular blocky; weak polishing on ped faces; wet and slightly plastic; clear wavy boundary to:-

27 - 34"+ 2.5Y 6/1 grey, silty clay; few fine prominent red mottles in root channels; weak coarse prismatic; wet and plastic; rare roots; very low organic matter;
 Water table at 30".

PIT NO. : D. 005
 LOCATION : Run 276: photo 33
 TOPOGRAPHY : Flat, slightly uneven micro-relief
 PARENT MATERIAL : Alluvium of riverine derivation
 VEGETATION : Padi field ploughed for rice planting
 DRAINAGE : Very poor
 SOIL CLASS : Tokotoko - F
 DESCRIPTION

0 - 13"

5Y 4/2 olive grey, clay to clay loam; few
 fine distinct red mottles in root channels;
 weak medium sub-angular blocky; moist
 and very firm; few roots; medium organic
 matter; smooth diffuse boundary to:-

13 - 20"+

2.5Y 5/2 greyish brown, clay moderate
 medium angular blocky; few fine distinct
 red mottles; wet and plastic; low organic
 matter; few roots;
 Water table 16".

III. 6.

PIT NO. : D.006
LOCATION : Run 276 : photo 33
TOPOGRAPHY : Flat, with uneven micro-relief
PARENT MATERIAL : Riverine alluvium overlying estuarine
alluvium
VEGETATION : Uncultivated area at edge of padi field :
Navua sedge, Para grass, Guava
DRAINAGE : Poor
SOIL CLASS : Naitonitoni - $\frac{F}{M}$
DESCRIPTION

0 - 12"

2.5Y 4/2 dark greyish brown, clay loam;
few fine distinct red mottles; moderate to
strong medium sub-angular blocky; moist
and firm; many roots; medium organic matter;
smooth clear boundary to:-

12 - 20"

2.5Y 6/0 grey, sandy clay loam; many fine
distinct red mottles in root channels; weak
coarse angular blocky; wet and sticky; few roots;
low organic matter; smooth diffuse boundary
to:-

20 - 34"

2.5Y 6/2 light brownish grey, sandy clay
loam with pockets of heavy sandy loam;
mottles as above; weak coarse angular blocky;
wet and sticky; few roots; low organic matter;
water table at 30".

PIT NO. : D. 007
 LOCATION : Run 276. : photo 31
 TOPOGRAPHY : Flat and very gently sloping to south
 PARENT MATERIAL : Alluvium of riverine derivation
 VEGETATION : Permanent grassland, Para grass
 DRAINAGE : Imperfect
 SOIL CLASS : Tamanua - F
 DESCRIPTION

0 - 10"

10YR 4/2 dark greyish brown, silty clay loam; few fine faint reddish mottles; moderate medium sub-angular blocky; moist and firm; many roots; medium organic matter; clear wavy boundary to:-

10 - 18"

2.5Y 5/6 light olive brown, clay; many medium distinct grey mottles; abundant manganese on ped faces and in small soft nodules; many roots; medium organic matter; moist and firm; smooth diffuse boundary to:-

18 - 30"

2.5Y 5/6 light olive brown and 6/2 light brownish grey, variegated silty clay; moderate coarse angular blocky; abundant manganese as above; wet and slightly plastic; few roots; low organic matter;
 Water table 30".

III. 8.

PIT NO. : D.008
LOCATION : Run 274 : photo 06
TOPOGRAPHY : Flat and level
PARENT MATERIAL : Alluvium of riverine derivation
VEGETATION : Grassland : Para grass : Navua sedge
DRAINAGE : Imperfect
SOIL CLASS : Tamanua - Z
DESCRIPTION

0 - 15"

10YR 4/2 - 4/3 dark greyish brown to dark brown, very fine sandyday loam; moderate medium sub-angular blocky breaking to moderate granular in top 5 inches; moist and firm; few manganese nodules; few roots, many in top 5 inches; medium organic matter

15 - 24"

10YR 4/4 dark yellowish brown, silty clay loam; few faint coarse grey mottles; moderate coarse angular blocky; moist and firm to very firm; many manganese mottles and soft nodules; few roots; medium organic matter; smooth diffuse boundary to:-

24 - 38"

10YR 5/6 yellowish brown, silty clay; many coarse distinct grey mottles; moderate coarse angular blocky; many manganese mottles and soft nodules; few roots; low organic matter; Water table at 36".

PIT NO. : D.009

LOCATION : Run 274 : Photo 03

TOPOGRAPHY : Flat and gently sloping on levee

PARENT MATERIAL : Alluvium of riverine derivation

VEGETATION : Grassland - Para grass - Navua sedge

DRAINAGE : Moderately well

SOIL CLASS : Rewa - Z

DESCRIPTION

0 - 3" 10YR 4/4 dark brown, loam; moderate fine sub-angular blocky; moist and friable; abundant roots; medium organic matter; earthworms; smooth diffuse boundary to:-

3 - 11 $\frac{1}{2}$ " 10YR 4/3 dark brown, very fine sandy loam; few fine faint grey mottles; moderate medium sub-angular blocky breaking to moderate granular; moist and firm; medium organic matter; few roots; few manganese mottles; clear wavy boundary to:-

11 $\frac{1}{2}$ - 31" 10YR 4/4 dark yellowish brown, very fine sandy loam; few fine faint grey mottles; moderate medium angular blocky; moist and firm; few roots; low organic matter; few manganese mottles; smooth diffuse boundary to:-

31 - 41" 7.5YR 4/4 dark brown, silt loam; many fine faint grey mottles; moderate medium angular blocky; moist and firm; few roots; low organic matter content; few manganese mottles; smooth diffuse boundary to:-

41 - 55" 7.5YR 4/4 dark brown, silt loam; mottling as above; weak medium angular blocky; moist and firm to very firm; few roots; low organic matter; few manganese stains; clear smooth boundary to:-

55 - 63" 10YR 4/4 dark yellowish brown, very fine sandy loam; moderate medium angular blocky; many medium distinct grey mottles; moist and firm; rare roots; low organic matter; few manganese stains.

Water table 63".

III. 10.

PIT NO. : D. 010
 LOCATION : Run 276 : photo 29
 TOPOGRAPHY : Near edge of low lying area : depressional
 PARENT MATERIAL : Riverine alluvium
 VEGETATION : Navua sedge - sedge - Guava
 DRAINAGE : Poor
 SOIL CLASS : Navua - F
 DESCRIPTION

0 - 7½"

10YR 3/3 dark brown, silty clay loam; many medium prominent red mottles; weak coarse sub-angular blocky breaking to moderate granular; moist and very firm; abundant roots; medium organic matter; smooth diffuse boundary to:-

7½ - 14"

5Y 4/2 olive grey, silty clay; abundant medium prominent red mottles; weak coarse sub-angular; moist and firm; many roots; medium to low organic matter; smooth clear boundary to:-

14 - 26"

2.5Y 6/0 grey, clay to clay loam; weak coarse angular blocky; wet and slightly plastic; abundant coarse prominent red mottles; especially in root channels; low organic matter; few roots; smooth clear boundary to:-

26 - 39"

2.5Y 5/0 grey, clay to clay loam; many prominent red mottles in root channels; very weak coarse angular blocky; wet and plastic; no roots; low organic matter; smooth diffuse boundary to:-

39 - 47" +

5Y 4/1 dark grey, clay loam; no mottles; very weak coarse angular blocky; wet and slightly plastic; no roots; medium organic matter;

Water table 26".

PIT NO. : D.011
 LOCATION : Run 277 : photo 48
 TOPOGRAPHY : Near bottom of small levee
 PARENT MATERIAL : Riverine alluvium
 VEGETATION : Grass land : Navua sedge : Batiki blue grass;
 mile-a-minute
 DRAINAGE : Imperfect
 SOIL CLASS : Tamanua - M
 DESCRIPTION :

0 - 7" 10YR 4/3 dark brown, loam; few fine distinct grey mottles; moderate medium sub-angular blocky; moist and firm; many roots; medium organic matter; smooth diffuse boundary to:-

7 - 14" 2.5Y 4/4 olive brown, fine sandy loam; many medium distinct grey mottles; moderate medium angular blocky; moist and firm; few roots; low organic matter; clear smooth boundary to:-

14 - 22" 10YR 4/3 dark brown, loamy sand; weak medium angular blocky; moist and firm; few coarse distinct grey mottles; low organic matter; no roots; diffuse manganese and iron bands at bottom of horizon; smooth clear boundary to:-

22 - 26" 5Y 5/2 olive grey, light sandy loam; many coarse prominent red mottles weak medium angular blocky; wet and slightly sticky; low organic matter; smooth clear boundary to:-

26 - 52" 2.5Y 4/0 dark grey, silty clay loam, moderate medium sub-angular blocky; wet and slightly plastic; medium organic matter; smooth clear boundary to:-

52 - 64" 5Y 4/1 dark grey, heavy fine sandy loam; weak coarse angular blocky; wet and sticky; many large pores; medium organic matter.
 Water table 64".

III. 12.

PIT NO. : D. 012
LOCATION : Run 270 : photo 66
TOPOGRAPHY : Flat and level
PARENT MATERIAL : Riverine alluvium overlying estuarine material
VEGETATION : Fallow padi field : grazed
DRAINAGE : Poor to very poor
SOIL CLASS : Naitonitoni
DESCRIPTION

0 - 8" 5Y 3/2 dark olive grey, loam; many medium prominent red mottles; moderate medium sub-angular blocky; moist and firm; many roots; medium organic matter; clear wavy boundary to:-

8 - 14" 2.5Y 2/0 black and 5Y 3/2 dark olive grey, silt loam and silty clay loam; few coarse prominent red mottles; medium to high organic matter; many dead roots; wet and plastic; weak smell of H₂S; clear wavy boundary to:-

14 - 26" 5Y 4/4 olive, heavy sand loam; no mottles; weak medium sub-angular blocky; wet and sticky; medium organic matter; very poorly decomposed; few fine gravel; clear smooth boundary to:-

26 - 39" 5Y 3/1 very dark grey, organic light sandy loam; massive; high organic matter; mainly woody tissue; wet and non-sticky; smooth diffuse boundary to:-

39 - 52" + 2.5Y 4/2 dark greyish brown, organic light sandy loam; massive; organic matter as above; wet and non-sticky; much fine gravel, mainly andesitic. Water table 14".

PIT NO. : D. 013
 LOCATION : Run 270 : photo 67
 TOPOGRAPHY : Area of long parallel ridges and narrow swales;
 pit on ridge
 PARENT MATERIAL : Marine sand
 VEGETATION : Grassland, grazed : Batiki blue grass
 DRAINAGE : Moderate to imperfect
 SOIL CLASS : Waikalou - C

DESCRIPTION

0 - 12"

10YR 3/1 very dark grey, light sandy loam;
 moderate medium sub-angular blocky breaking to
 medium crumbs; moist and friable; many roots;
 medium organic matter; faunal activity; clear
 wavy boundary to:-

12 - 17"

10YR 5/4 yellowish brown, sand; very weak medium
 angular blocky; moist and very friable; few roots;
 low organic matter; smooth clear boundary to:-

17 - 28½"

10YR 6/2 light brownish grey, sand; weak medium
 angular blocky; moist and friable; weakly cemented
 in patches by iron-humas compounds; low organic
 matter; clear wavy boundary to:-

28½ - 31"

10YR 5/6 yellowish brown, sand; weak coarse
 angular blocky; moist and very firm; cemented as
 above; few manganese mottles; clear wavy boundary to:-

31 - 37"

10YR 5/1 - 6/1 grey, sand; very weak coarse
 angular blocky; moist and firm; very low organic
 matter; clear smooth boundary to:-

37 - 41"

10YR 6/2 light brownish grey, sand; very weak
 coarse angular blocky; moist and very friable; few
 coarse red mottles; low organic matter; clear
 wavy boundary to:-

41 - 50"+

10YR 5/4 yellowish brown, sand; very weak coarse
 angular blocky; moist and very firm; manganese
 stains; very low organic matter.

Water table 40".

III.14

PIT NO.	:	D.014
LOCATION	:	Run 270 : photo 67
TOPOGRAPHY	:	Long parallel ridges and narrow swales; pit near bottom of ridge
PARENT MATERIAL	:	Marine sand
VEGETATION	:	Grassland, grazed : Batiki blue grass
DRAINAGE	:	Poor
SOIL CLASS	:	Deuba - C
DESCRIPTION		
0 - 7"		10YR 3/2 very dark greyish brown, light sandy loam; moderate to strong fine sub-angular blocky breaking to fine crumb; moist friable; medium organic matter; abundant roots; clear smooth boundary to:-
7 - 18"		7.5YR 5/6 strong brown, with patches of 10YR 5/1; sand; weak coarse angular blocky; moist and very friable; many roots in top 6 inches; few below; low organic matter; clear wavy boundary to:-
18 - 27"		2.5Y 5/2 greyish brown, sand; many coarse red patches; very weak coarse angular blocky; moist and firm; slightly cemented; low organic matter; few roots; smooth diffuse boundary to:-
27 - 35"		5Y 5/1 grey, sand; few coarse red mottles; structure as above; wet and non-sticky; low organic matter; few roots; clear wavy boundary to:-
35 - 39"		5Y 4/1 - 5/1 dark grey to grey, sand; weak coarse angular blocky; wet and hard; cemented; strongly bedded; iron staining in patches and bands; clear smooth boundary to:-
39 - 45"+		2.5Y 6/0 grey, sand; single grain; wet and non-sticky; slumping in pit; few coarse red mottles; Water table 29".

PIT NO. : D. 015
 LOCATION : Run 276 : photo 35
 TOPOGRAPHY : Flat and level
 PARENT MATERIAL : Estuarine alluvium
 VEGETATION : Navua sedge : Wainodoi grass : Desmodium heterophyllum
 DRAINAGE : Poor to very poor
 SOIL CLASS : Toguru - $\frac{M}{C}$

DESCRIPTION

0 - 7" 2.5Y 4/2 dark greyish brown, loam; many medium distinct red mottles; moderate medium sub-angular blocky; moist and friable; many roots; medium organic matter; smooth diffuse boundary to:-
 7 - 11" 2.5Y 5/2 greyish brown, heavy sandy loam; many iron stained root channels; weak coarse sub-angular blocky; moist and firm; few roots; low organic matter; smooth clear boundary to:-
 11 - 19" 2.5Y 6/2 - 6/4 light brownish grey to light yellowish brown, heavy sand loam; many medium distinct yellow mottles; moderate medium sub-angular blocky; wet and sticky; few roots; low organic matter; clear wavy boundary to:-
 19 - 28" 2.5Y 6/2 light brownish grey, light sandy loam; few red mottles in root channels; weak coarse angular blocky; wet and slightly sticky; few roots; low organic matter; clear wavy boundary to:-
 28 - 41" 2.5Y 5/0 grey, loamy sand; no mottles; weak medium angular blocky; wet and slightly sticky; medium organic matter; poorly decomposed woody tissue; no roots; smooth diffuse boundary to:-
 41 - 52 $\frac{1}{2}$ " + 5Y 4/1 dark grey, light sandy loam; no mottles; weak coarse angular blocky; wet and sticky; organic matter as above; no roots.

Water table 26".

III. 16.

PIT NO. : D. 016
 LOCATION : Run 269 : photo 59
 TOPOGRAPHY : Flat and level
 PARENT MATERIAL : Riverine alluvium
 VEGETATION : Grassland; wild primrose : Wainodoi grass:
 Guava nearby
 DRAINAGE : Very poor
 SOIL CLASS : Tokotoko - F
 DESCRIPTION

0 - 5" 5Y 5/1 grey, clay to silty clay; many medium prominent red mottles; moderate fine sub-angular blocky; wet and plastic; medium organic matter; abundant roots; clear wavy boundary to:-

5 - 12" 2.5Y 5/0 grey, clay; few coarse prominent red mottles; weak medium angular blocky; wet and very plastic; low organic matter; few roots; smooth diffuse boundary to:-

12 - 18" 5Y 5/1 grey, clay; few fine faint brown mottles; moderate fine angular blocky; wet and very plastic; few roots; low organic matter; smooth clear boundary to:-

18 - 32" 2.5Y 5/0 grey, clay; no mottles; weak coarse prismatic otherwise missing; wet and very plastic; low organic matter; no roots; smooth diffuse boundary to:-

32 - 46" + 5Y 6/2 grey, silty clay; moderate medium angular blocky breaking to medium platy (vertical axes); many medium distinct brown mottles; wet and slightly plastic; low organic matter; no roots. Water table 12".

PIT NO. : D. 017
 LOCATION : Run 275 : photo 21
 TOPOGRAPHY : On slight ridge of ridge and swale topography
 PARENT MATERIAL : Coastal sands
 VEGETATION : Para grass : ferns : coconut plantation
 DRAINAGE : Poor
 SOIL CLASS : Deuba - C
 DESCRIPTION

0 - 8" 10YR 4/1 dark grey, light sandy loam; moderate medium sub-angular blocky; wet and sticky; few roots; medium organic matter; smooth clear boundary to:-

8 - 15" 10YR 4/4 dark yellowish brown and 6/2 light brownish grey, sand; very weak medium angular blocky; wet and non-sticky; few roots; very low organic matter; clear smooth boundary to:-

15 - 17" 2.5Y 6/2 light brownish grey, sand; many coarse red mottles; single grain; wet and non-sticky; few roots; clear smooth boundary to:-

17" + 7.5YR 5/0 grey, sand; single grain; wet and non-sticky; no roots; very low organic matter.
 Water table 17".

III. 18.

PIT NO. : D.018
 LOCATION : Run 274 : photo 04
 TOPOGRAPHY : Very gently sloping on inside of old meander
 PARENT MATERIAL : Riverine alluvium
 VEGETATION : Para grass : Navua sedge
 DRAINAGE : Moderately well
 SOIL CLASS : Rewa - $\frac{M}{C}$

DESCRIPTION

0 - 11" 10YR 4/3 dark brown, loam to fine sandy clay loam; few fine faint grey mottles; moderate medium sub-angular blocky breaking to moderate granular; moist and firm; medium organic matter; many roots; smooth clear boundary to:-
 11 - 17" 10YR 4/3 dark brown, loam; few fine faint grey mottles; weak coarse sub;angular blocky; moist and firm; few manganese mottles; clear smooth boundary to:-
 17 - 31" 10YR 4/4 dark yellowish brown, heavy sandy loam; weak medium angular blocky; moist and friable; a few roots; medium organic matter; few andesitic gravel; smooth diffuse boundary to:-
 31 - 44" 10YR 5/4 yellowish brown, light coarse sandy loam; weak medium angular blocky; moist and friable; few roots; many gravel, smooth clear boundary to:-
 44 - 60" 10YR 4/3 dark brown, sand; single grain; moist and loose; few coarse distinct reddish brown mottles; few roots; low organic matter.
 Water table 60".

PIT NO. : D.019
 LOCATION : Run 274 : photo 04
 TOPOGRAPHY : Riverine alluvium
 VEGETATION : Para grass
 DRAINAGE : Moderately well
 SOIL CLASS : Rewa - $\frac{M}{C}$

DESCRIPTION

- 0 - 10" 10YR 4/3 dark brown, silt loam; moderate medium sub-angular blocky breaking to moderate granular; moist and friable; many roots; medium organic matter; smooth diffuse boundary to:-
- 10 - 17" 10YR 4/4 dark yellowish brown, heavy sandy loam; few fine distinct grey mottles; weak medium angular blocky; few manganese mottles; few roots; medium organic matter; smooth diffuse boundary to:-
- 17 - 28" 10YR 5/2 greyish brown, light sandy loam; weak medium angular blocky; moist and very friable; few roots; medium organic matter; smooth clear boundary to:-
- 28 - 34" 10YR 5/2 greyish brown, heavy sandy loam; few medium distinct red and grey mottles; weak medium sub-angular blocky; moist and firm; few roots; medium organic matter; smooth clear boundary to:-
- 34 - 39" 10YR 5/4 to 4/4 yellowish brown to dark yellowish brown, loamy sand; very weak angular blocky; moist and very friable; few roots; low organic matter; smooth clear boundary to:-

III. 20.

39 - 45"

10YR 5/4 yellowish brown; light sandy loam; moderate medium angular blocky; moist and very friable; few roots; medium organic matter; smooth clear boundary to:-

45 - 54"

2.5YR 5/4 to 6/4 light olive brown to light yellowish brown, loamy sand; very weak medium angular blocky; moist and very friable; few roots; few grave; low organic matter; smooth diffuse boundary to:-

54 - 68"+

10YR 5/6 yellowish brown, loamy sand; weak medium angular blocky; moist and very friable; few roots; low organic matter.

Water table 68".

PIT NO.	:	D. 021
LOCATION	:	Run 276 : photo 32
TOPOGRAPHY	:	Very gently sloping near edge of Navua levee
PARENT MATERIAL	:	Riverine alluvium
VEGETATION	:	Navua sedge
DRAINAGE	:	Imperfect to poor
SOIL CLASS	:	Navua - F
DESCRIPTION		
0 - 6½"		10YR 4/2 to 4/3 dark greyish brown to dark brown, fine sandy clay loam to clay loam; many fine distinct rusty mottles; moderate fine sub-angular blocky; moist and friable, many roots; medium organic matter; earthworms; smooth diffuse boundary to:-
6½ - 18"		5Y 4/4 olive very fine sandy clay loam; few coarse distinct yellowish mottles; moderate medium angular breaking to strong granular; moist and firm; many manganese mottles; few roots; low organic matter; smooth clear boundary to:-
18 - 25"		2.5Y 5/2 greyish brown, silty clay; many coarse distinct yellowish mottles; moderate angular blocky; wet and sticky; few roots; many large root channels - low organic matter; smooth clear boundary to:-
25 - 35"		5Y 4/2 olive grey, clay; abundant medium distinct red mottles; moderate medium prismatic breaking to medium angular blocky; wet and plastic; few roots; many old root channels; medium organic matter; clear smooth boundary to:-
35 - 53"		2.5Y 6/2 light brownish grey, silty clay; abundant coarse prominent red mottles in old root channels - strong angular blocky to platy in vertical plane; moist and firm; no roots; low organic matter; water movement in old root channels; smooth clear boundary to:-
53" +		2.5Y 6/0 grey, very fine sandy clay loam; few coarse prominent red mottles; structure as above. Water table 35".

PIT NO.	LOCATION	TOPOGRAPHY	PARENT MATERIAL	VEGETATION	DRAINAGE	SOIL CLASS	DESCRIPTION
D. 021	Box 578, page 51	Very gentle slope along edge of Invas forest	Riverbank alluvium	Alnus sedge			0 - 18" <p>Dark brown to black, silty clay loam, very sticky, low plasticity. Many roots, medium organic matter, moist and friable. Substratum boundary low.</p> <p>2Y 4-6 clay very fine sandy clay loam, low coarse distinct yellowish mottles, moderate medium angular, breaking to very granular moist and firm, many manganese nodules, low roots, low organic matter, smooth clear boundary low.</p>
							18 - 25" <p>2Y 5-6 fine to medium brown, silty clay, many coarse distinct yellowish mottles, moderate angular blocky, wet and sticky, low roots, many large root channels, low organic matter, smooth clear boundary low.</p>
							25 - 35" <p>2Y 5-6 olive grey, clay, abundant medium distinct red mottles, moderate medium prismatic, breaking to medium angular blocky, wet and plastic, low roots, many old root channels, medium organic matter, clear smooth boundary low.</p>
							35 - 55" <p>2Y 5-6 light brownish grey, silty clay, abundant coarse prismatic blocky, in old root channels strong angular blocky to platy in wet clay planes, roots and fine roots, low roots, low organic matter, movement in old root channels, smooth, clear boundary low.</p>
							55" - 65" <p>2Y 5-6 grey, very fine sandy clay loam, low coarse prominent red mottles, moderate angular blocky, movement in old root channels, smooth, clear boundary low.</p>

APPENDIX IV

Soil Analyses

Methods

Sample preparation

The soil sample was air-dried and lightly ground by hand to pass a 2 mm sieve.

The sub-sample was ground in a mechanical mortar to pass a 0.5 mm sieve. This finely ground sample was used for the determination of organic carbon, total nitrogen, total phosphorus, total potassium and total carbonate.

All other determinations were done on the fraction passing the 2 mm sieve.

APPENDIX IV

Particle size analysis

40 g of soil were dispersed by shaking overnight with 50 ml. of five per cent sodium hexametaphosphate solution and 150 ml. of water. The suspension was then transferred to a one litre cylinder, made up to volume and stirred. A Bouyoucos hydrometer, calibrated in grams of soil per litre at 20°C was used to take readings of the density of the suspension at various settling times:

SOIL ANALYSES

METHODS

- (1) 45 seconds for coarse silt, silt plus clay.
- (2) 4 minutes 45 seconds for silt plus clay.
- (3) 5 hours for clay.

Coarse silt has a particle size between 0.55 and 0.62 mm.

The density readings were corrected for temperature variations and the dispersing agent content.

The soil suspension was then washed through an 80 mesh (0.2 mm) sieve and the coarse sand fraction weighed after drying.

Extractable Phosphorus

The soil was extracted with 2.5 per cent sodium acid using a soil extractant ratio of 1:20. After filtration and suitable dilution the extract

APPENDIX IV

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Particle size analysis

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- (1) 46 seconds for coarse silt, silt plus clay.
- (2) 4 minutes 48 seconds for silt plus clay.
- (3) 5 hours for clay.

Coarse silt has a particle size between 0.05 and 0.02 mm.

The density readings were corrected for temperature variations and the dispersing agent content.

The soil suspension was then washed through an 80 mesh (0.2 mm) sieve and the coarse sand fraction weighed after drying.

Extractable Cations

The soil was extracted with 2.5 per cent acetic acid using a soil extractant ratio of 1:20. After filtration and suitable dilution the extract

was analysed for calcium, magnesium, sodium and potassium using atomic absorption techniques. Strontium was used as the releasing agent to overcome the interference of aluminium and phosphorus and also to prevent ionisation of sodium and potassium in the air - acetylene flame.

Exchangeable Hydrogen

The soil was equilibrated with a buffer mixture of paranitrophenol and calcium acetate. The pH of the suspension was measured after standing for one hour (Woodruff, 1948).

Exchangeable Aluminium

Two methods were used:

- (1) Extraction with normal potassium chloride.

The soil was leached with normal potassium chloride using a 1.5 soil leachant ratio. Aluminium was determined directly in the leachate by atomic absorption using the nitrous oxide/acetylene flame.

- (2) Extraction with ammonium acetate.

The soil was extracted with normal ammonium acetate buffered at a pH of 4.8. Aluminium was determined in the filtered extract in the presence of 1000 ppm potassium. Atomic absorption techniques and the nitrous oxide/acetylene flame were employed.

pH

A glass electrode was used for the determination of the pH of a 1:2.5 soil water suspension. One eighth molar calcium chloride was then added to bring the effective concentration to M/100. The suspension was re-stirred, equilibrated for one hour and the pH read again (Schofield and Taylor, 1955).

Electrical Conductivity

A 1:1 soil water suspension was prepared for inorganic soil samples and a 1:5 soil water suspension for peat and muck soils. The electrical conductivity of the filtrate was measured using a conductivity bridge.

Acetate Soluble Sulphate

The soil was shaken with an ammonium acetate/acetic acid mixture (Bardsley and Lancaster, 1960). An aliquot of the filtrate was taken and the sulphate precipitated as barium sulphate. The turbidity of the resulting suspension was then analysed using a nephelometer (Butters and Chenery, 1959).

Loss on ignition

Organic matter was destroyed by ignition overnight in a muffle furnace at a temperature of 450°C.

Total Nitrogen

The Kjeldahl method was used. One gram of soil was digested with concentrated sulphuric acid using a catalyst mixture of potassium sulphate, copper sulphate and selenium. The digest was then made alkaline, the ammonia steam distilled into boric acid and titrated against standard acid.

Total Phosphorus and Potassium

Five g of soil were mixed with 1 g of powdered magnesium acetate and ignited overnight at 550°C. The soil was then digested with 50 ml. of concentrated hydrochloric acid by heating for two hours on a boiling water bath. The acid extract was filtered and made up to a known volume. Aliquots were taken and treated as follows:

Phosphorus

The yellow vanadomolybdo-phosphoric colour was developed in a hydrochloric acid system. The intensity of the yellow colour was measured on a spectrophotometer at a wavelength of 470 millimicrons (Jackson, 1958).

Potassium

Determined by atomic absorption spectroscopy.

Cation Exchange Capacity

The soil was saturated with barium using a barium chloride-triethanolamine buffer at a pH of 8.1 (Mehlich, 1948). The barium was then displaced by adding a standard magnesium solution to the barium saturated soil. The amount of magnesium absorbed was found by measuring the magnesium content of the supernatant liquid and comparing with the magnesium content of the added standard solution (Bascomb, 1964).

Magnesium determinations were carried out on the atomic absorption spectrophotometer using strontium as the releasing agent.

Total Soluble Salts

A 1:5 soil water suspension was prepared and shaken for one hour. After filtration a suitable aliquot was evaporated to dryness and the weight of residue determined.

Copper

Two methods were used. In both cases the final analysis was carried out by atomic absorption techniques.

- (1) Extraction with O. I. N. hydrochloric acid using a 1:2.5 soil extractant ratio (Cheng and Bray, 1953).
- (2) Extraction with ammonium citrate and ethylene diamene tetra-acetic acid (Cheng and Bray, 1953).

Available Phosphorus

The soil was extracted with 0.05 N sulphuric acid for one hour, filtered and an aliquot assayed for phosphorus using the molybdenum blue colour and reduction with 1.2 per cent ascorbic acid. The blue colour was developed by boiling in a water bath for five minutes and the light absorption was measured at 660 millimicrons.

pH Determinations

Soil samples were collected in the field using a special core sampling device. The cores were saturated with water then placed in the porous plate apparatus and subjected to a pressure of 7.6 cm mercury. When the sample and pressure were in equilibrium, water ceased to flow from the pressure chamber. The sample was then removed and weighed to determine the moisture content.

The determinations were repeated at pressures of 25.4 cm of mercury and at 76 cm mercury.

The samples were then transferred to the high pressure chamber (pressure membrane) and the soil moisture content determined when in equilibrium with a pressure of fifteen atmospheres.

Bulk Density

The weight of dry soil in the core was determined and the bulk density calculated.

Manganese

The soil was extracted with normal ammonium acetate buffered at a pH of 4.8. Manganese was determined in the filtered extract using atomic absorption techniques.

Zinc

Two methods were used. In both cases the final analysis was carried out by atomic absorption techniques.

- (1) Extraction with O.I.N. hydrochloric acid using a 1:2.5 soil extractant ratio (Tucker and Kurtz, 1955).
- (2) Extraction with normal ammonium acetate at a pH of 4.8.

Total Trace Elements in Soil

The soil sample was ignited at 450°C to destroy organic matter then ground to pass an eighty mesh (0.2 mm) screen. A sub-sample was mixed with carbon and subjected to a DC arc spectrographic technique.

The results of the analyses are set out in Tables IV. 1 - IV. 6.

TABLE IV. 1 Analytical Data from Profile Pits

TAMANUA SERIES

PROFILE NO. D001

Soil Separates
Cations extracted by 2.5% acetic acid me/100g.

SAMPLE NO.	Depth in.	% Coarse snad (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na	K	Exchangeable H me/100g. Soil	CEC me/100g. Soil	% Base Saturation	pH Soil : Water	pH Soil : Ca Cl ₂	EC 1:1 suspn. mmhos cm -1	Total N %	Available P ppm.	Total P ppm.	Total K ppm.
D001	0 - 9	5	23	51	31	41	3.82	4.18	0.55	0.08	9.8	15.9	38.4	4.8	4.3	0.15	0.23	4	252	760
D002	9 - 14	4	26	44	29	41	4.16	4.03	0.47	0.04	6.0	15.7	61.8	5.0	4.5	0.16		2	199	980
D003	14 - 19	13	20	39	26	41	4.23	4.12	0.54	0.04	2.0	9.1	78.0	5.9	5.4	0.18		2	233	980
D004	19 - 35	9	19	42	29	43	4.65	4.59	0.56	0.04	1.8	11.0	83.6	6.0	5.8	0.34		8	272	920

NAITONITONI SERIES

PROFILE NO. D002

SAMPLE NO.	Depth in.	Soil Separates					Cations extracted by 2.5% acetic acid me/100g.					CEC (me/100g. Soil)	% Base Saturation	pH Soil : Water	pH Soil : CaCl ₂	EC 1:1 suspn. mmhos cm -1	Total N %	Available P ppm	Total P ppm	Total K ppm
		% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na	K	Exchangeable H me/100g. Soil									
D005	0 - 5	4	21	39	34	41	3.40	3.22	1.03	0.04	12.0	17.9	33.0	4.7	4.3	0.32	0.22	2		
D006	5 - 9½	9	34	34	24	33	2.81	2.11	1.06	0.02	11.6	-	-	4.7	4.2	0.35		3		
D007	9½ - 14	32	42	14	7	19	1.43	0.84	0.84	0.02	8.0	8.8	9.0	4.5	4.2	0.63		5		
D008	14 - 23	32	45	16	8	15	2.19	1.16	1.01	0.02	20.4	23.1	12.0	3.3	3.3	1.68		2		
D009	23 - 30	ND	ND	ND	ND	ND	2.25	1.42	0.99	0.02	20.4	22.5	10.0	2.5	2.5	3.14		0		

PROFILE NO. D003

TOGURU SERIES

SAMPLE NO.	Depth in.	Soil Separates				Cations extracted by 2.5% acetic acid me/100g.				CEC me/100g. Soil	% Base Saturation	pH Soil : Water	pH Soil : CaCl ₂	EC 1:1 suspn. mmhos cm ⁻¹	Total N %	Available P ppm	Total P ppm	Total K ppm	
		% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na										K
D010	0 - 9	23	30	29	21	26	11.93	1.62	0.27	0.31	4.0	17.8	77.8	5.6	5.2	0.24	0.24	14	
D011	9 - 18	34	40	18	9	17	13.48	1.79	0.17	0.04	3.8	14.4	73.6	5.3	5.2	0.69		21	
D012	18 - 27	41	33	19	9	17	26.97	6.84	0.29	0.02	26.2	11.7	-	2.7	2.7	4.90		43	
D013	27 - 36	43	25	22	14	18	221.15	10.16	2.74	0.08	0.8	6.7	88.0	6.1	6.0	2.26		0	

PROFILE NO. D003

TOGURU SERIES

PROFILE NO. D004

NAVUA SERIES

Soil Separates Cations extracted by 2.5% acetic acid me/100 g.

SAMPLE NO.	Depth in.	% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na	K	Exchangeable H me/100g. Soil	CEC me/100g. Soil	% Base Saturation	pH Soil : Water	pH Soil : CaCl ₂	EC 1:1 suspn. mmhos cm -1	Total N %	Available P ppm	Total P ppm	Total K ppm
D014	0 - 9	10	28	44	26	36	7.87	3.54	0.62	0.07	8.7	25.7	66.0	5.2	4.4	0.17	0.24	6	385	860
D015	9 - 17	2	16	46	36	46	5.55	3.73	0.47	0.04	9.0	19.1	52.9	5.2	4.4	0.17		13	425	560
D016	17 - 27	1	17	44	36	46	4.41	3.15	0.57	0.04	14.0	26.1	46.4	4.8	4.1	0.20		22	348	460
D017	27 - 34	2	16	29	24	58	4.06	3.56	0.56	0.04	14.2	20.9	32.0	4.7	4.2	0.23		22	536	560

PROFILE NO. D005

TOKOTOKO SERIES

Cations extracted by 2.5% acetic acid me/100g.

Soil Separates

SAMPLE NO.	Depth in.	% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na	K	Exchangeable H me/100g. Soil	CEC me/100g. Soil	% Base Saturation	pH Soil : Water	pH Soil : CaCl ₂	EC 1:1 suspn. mmhos cm ⁻¹	Total N %	Available P ppm	Total P ppm	Total K ppm	
D018	0 - 13	10	25	39	29	36	3.98	2.34	0.37	0.09	7.9	23.8	66.8	5.1	4.4	0.15	0.19	5			
D019	13 - 20	9	18	40	30	43	4.00	2.03	0.47	0.09	8.0	20.3	60.6	5.1	4.3	0.12		3			
D020	20 - 28	10	17	40	30	43	2.90	2.01	0.36	0.06	8.0	19.1	58.1	5.0	4.1	0.10		0			

PROFILE NO. D005

TOKOTOKO SERIES

SAMPLE NO.	Depth in.	Soil Separates					Cations extracted by 2.5% acetic acid me/100 g.							EC 1:1 suspn. mmhos cm ⁻¹	pH Soil : CaCl ₂	pH Soil : Water	Total N %	Available P ppm	Total P ppm	Total K ppm	
		% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na	K	Exchangeable H me/100g. Soil	CEC me/100g. Soil	% Base Saturation								
D020A	0 - 12	13	32	32	22	33	3.82	2.11	0.38	0.09	6.6	22.4	70.5	5.1	4.3	0.12	0.22	2	2		
D021	12 - 20	18	39	25	16	27	2.65	2.01	0.36	0.04	5.5	13.1	58.0	5.2	4.5	0.07	0	0	0	0	
D022	20 - 34	23	37	22	12	28	1.73	1.73	0.28	0.06	3.8	10.8	64.8	5.0	4.3	0.07	0	0	0	0	0

TAMANUA SERIES

PROFILE NO. D007

SAMPLE NO.	Depth in.	Soil Separates				Cations extracted by 2.5% acetic acid me/100g.							CEC me/100g. Soil	% Base Saturation	PH Soil : Water	PH Soil : CaCl ₂	EC 1:1 suspn. mmhos cm ⁻¹	Total N %	Available P ppm	Total P ppm	Total K ppm
		% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay	Ca	Mg	Na	K	H Exchangeable me/100g. Soil										
D023	0 - 10	10	22	42	32	36	4.89	2.86	0.50	0.11	11.8	28.9	59.2	4.9	4.4	0.18	0.30	12			
D024	10 - 18	7	23	42	29	41	5.88	3.61	0.37	0.04	4.9	27.6	82.4	5.7	5.0	0.12		0			
D025	18 - 30	9	18	40	30	43	4.06	3.39	0.28	0.04	4.8	19.4	75.3	5.3	4.7	0.07		0			

TAMANUA SERIES

PROFILE NO. D007

TAMANUA SERIES

PROFILE NO. D008

SAMPLE NO.	Depth in.	% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na	K	Exchangeable H me/100g. Soil	CEC me/100g. Soil	% Base Saturation	pH Soil : Water	pH Soil : CaCl ₂	EC 1:1 suspn. mmhos cm -1	Total N %	Available P ppm	Total P ppm	Total K ppm
D023	41 - 22	25	35	47	30	32	2.13	2.55	0.58	0.40	30.2	30.2	88.8	5.7	5.2	0.21	0.06	0.420	0.420	0.420
D035	31 - 41	25	35	49	29	31	2.21	3.04	0.30	0.53	4.6	30.2	88.8	5.7	5.2	0.21	0.10	0.430	0.430	0.430
D031	114 - 31	35	35	47	30	38	2.32	2.81	0.58	0.31	3.2	23.1	86.2	6.2	5.6	0.12	0.15	0.512	0.512	0.512
D030	2 - 114	35	35	47	32	35	2.48	3.41	0.58	1.00	2.0	16.6	87.9	6.3	5.9	0.12	0.08	0.420	0.420	0.420
D050	0 - 114	35	35	47	32	43	5.86	3.34	0.47	0.04	2.0	16.6	87.9	6.3	5.9	0.12	0.08	0.420	0.420	0.420
D026	0 - 15	5	35	49	29	31	7.68	3.08	0.50	0.09	4.6	30.2	84.8	5.7	5.2	0.21	0.24	3	3	3
D027	15 - 24	2	30	47	30	38	6.81	2.14	0.29	0.02	3.2	23.1	86.2	6.2	5.6	0.12	0	0	0	0
D028	24 - 38	3	22	47	32	43	5.86	3.34	0.47	0.04	2.0	16.6	87.9	6.3	5.9	0.12	0	0	0	0

Soil Separates
Cations extracted by 2.5% acetic acid me/100g.

TAMANUA SERIES PROFILE NO. D008

PROFILE NO. D009

REWA SERIES

Cations extracted by 2.5% acetic acid me/100g.

Soil Separates

SAMPLE NO.	Depth in.	Soil Separates					Ca	Mg	Na	K	Exchangeable H me/100g. Soil	CEC me/100g. Soil	% Base Saturation	pH Soil : Water	pH Soil : CaCl ₂	EC 1:1 suspn. mmhos cm -1	Total N %	Available P ppm	Total P ppm	Total K ppm
		% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)														
D029	0 - 3	5	40	52	32	23	5.48	4.91	0.28	1.07	6.0	27.3	78.0	5.1	4.7	0.08	0.32	6	600	1900
D030	3 - 11½	5	37	54	32	26	5.35	3.87	0.28	0.71	4.9	25.9	81.1	5.4	4.8	0.15	0	450	1900	
D031	11½ - 31	2	43	52	29	26	5.70	3.07	0.36	0.32	3.0	25.9	88.4	5.4	4.9	0.12	0	275	1600	
D032	31 - 41	0	30	51	39	31	6.35	3.13	0.37	0.22	3.2	28.9	88.9	5.7	4.9	0.10	0	430	1600	
D033	41 - 55	0	32	55	35	33	6.13	3.22	0.29	0.40	3.0	30.8	90.3	5.6	5.0	0.08	6	430	1700	
D034	55 - 63	0	52	52	25	23	5.37	2.94	0.30	0.23	2.1	18.9	88.9	5.7	5.1	0.06	6	250	900	

NAVUA SERIES

PROFILE NO. D010

Cations extracted by 2.5% acetate acid me/100g.

Soil Separates

% Coarse sand (I)

% Fine sand (II)

% Silt (USDA)

% Silt (III)

% Clay (IV)

Ca

Mg

Na

K

H me/100g. Soil

CEC me/100g. Soil

% Base Saturation

pH Soil : Water

pH Soil : CaCl₂

EC 1:1 suspn. mmhos cm⁻¹

Total N %

Available P ppm

Total P ppm

Total K ppm

SAMPLE NO.

Depth in.

D035	0 - 7½	7	30	37	32	31	4.97	5.08	1.31	0.44	9.0	25.9	65.3	5.2	4.6	0.12	0.59	21
D036	7½ - 14	6	29	40	32	33	4.05	4.88	0.77	0.08	14.2	31.8	55.4	5.0	4.3	0.12		11
D037	14 - 26	7	30	47	25	38	3.10	4.91	0.47	0.06	3.9	22.0	82.3	5.2	4.8	0.18		9
D038	26 - 39	12	28	39	24	36	1.91	3.16	0.37	0.07	7.6	18.3	58.5	4.8	4.4	0.12		13
D039	39 - 47	17	30	42	25	28	2.09	3.43	0.36	0.10	14.4	21.2	32.1	3.4	3.4	1.41		11

NAVUA SERIES

PROFILE NO. D010

SAMPLE NO.	Depth in.	Soil Separates				Cations extracted by 2.5% acetic acid me/100g.				Exchangeable H me/100g. Soil	CEC me/100g. Soil	% Base Saturation	pH Soil : Water	pH Soil : CaCl ₂	EC 1:1 suspn. mmhos cm ⁻¹	Total N %	Available P ppm	Total P ppm	Total K ppm
		% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Mg										
D040	0 - 7	3	57	52	22	18	5.34	3.60	0.35	0.67	4.0	25.6	84.4	5.2	4.9	0.24	0.26	34	34
D041	7 - 14	4	63	42	15	18	4.62	2.89	0.36	0.06	2.0	23.3	91.4	5.7	5.2	0.15	18	18	18
D042	14 - 22	46	46	3	3	5	3.67	1.94	0.18	0.06	0.7	16.6	95.8	5.9	5.3	0.07	30	30	30
D043	22 - 26	5	77	27	8	10	4.88	2.86	0.36	0.11	2.2	24.5	91.0	5.3	4.9	0.20	31	31	31
D044	26 - 52	4	48	42	25	23	3.90	1.79	0.19	0.13	10.0	26.8	62.7	4.6	4.1	0.18	37	37	37
D045	52 - 64	9	63	25	10	18	4.39	1.30	0.27	0.17	11.8	23.6	50.0	4.6	3.9	0.07	31	31	31

PROFILE NO. D011

WAIKALOU SERIES

PROFILE NO. D013

Cations extracted by 2.5% acetic acid me/100g.

Soil Separates

% Coarse sand (I)

% Fine sand (II)

% Silt (USDA)

% Silt (III)

% Clay (IV)

Ca

Mg

Na

K

H Exchangeable me/100g. Soil

CEC me/100g. Soil

% Base Saturation

pH Soil : Water

pH Soil : CaCl₂

EC 1:1 suspn, mmhos cm -1

Total N %

Available P ppm

Total P ppm

Total K ppm

SAMPLE NO.

Depth in.

SAMPLE NO.	Depth in.	% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na	K	H Exchangeable me/100g. Soil	CEC me/100g. Soil	% Base Saturation	pH Soil : Water	pH Soil : CaCl ₂	EC 1:1 suspn, mmhos cm -1	Total N %	Available P ppm	Total P ppm	Total K ppm	
D051	0 - 12	49	38	12	5	8	0.63	0.27	1.74	0.08	7.4	25.1	70.5	5.2	4.4	0.06	0.31	4			
D052	12 - 17	64	29	4	2	5	1.53	0.02	1.33	0.02	1.5	12.7	88.2	5.1	4.8	0.02		12			
D053	17 - 28½	68	25	0	0	7	0.51	0.04	0.16	0.02	0.8	10.9	92.7	5.0	4.9	0.04		9			
D054	28½ - 31	61	33	1	1	5	1.16	0.24	1.32	0.06	0.8	10.1	92.1	5.4	5.2	0.02		5			
D055	31 - 37	87	7	1	1	5	0.30	0.04	0.18	0.04	0.2	8.2	97.6	5.5	5.2	0.02		16			
D056	37 - 41	70	25	0	0	5	0.61	0.22	0.18	0.06	0.9	10.0	91.0	5.7	5.2	0.02		11			
D057	41 - 50	79	16	0	0	5	1.51	0.18	0.26	0.04	0.2	8.1	97.6	5.7	5.3	0.02		7			

DEUBA SERIES

PROFILE NO. D014

Cations extracted by 2.5% acetic acid me/100g.

Soil Separates

SAMPLE NO.	Depth in.	% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na	K	H me/100g. Soil	CEC me/100g. Soil	% Base Saturation	pH Soil : Water	pH Soil : CaCl ₂	EC 1:1 suspn. mmhos cm -1	Total N %	Available P ppm	Total P ppm	Total K ppm
D058	0 - 7	40	41	11	6	13	4.15	0.62	0.27	0.10	6.2	24.7	74.9	5.5	4.6	0.11	0.22	5		
D059	7 - 18	63	28	2	2	7	0.43	0.19	0.37	0.04	2.0	14.0	85.8	5.2	5.1	0.02		2		
D060	18 - 27	52	42	1	1	5	0.51	0.16	0.30	0.06	1.0	10.0	90.0	5.4	5.2	0.02		4		
D061	27 - 35	37	57	3	1	5	0.61	0.43	0.34	0.06	1.8	11.0	83.6	5.1	5.0	0.07		6		
D062	35 - 39	61	34	0	0	5	0.81	0.26	0.26	0.06	1.0	9.3	89.2	5.3	5.1	0.03		7		
D063	39 - 45	51	42	4	0	7	2.27	1.34	0.35	0.08	2.1	13.6	84.6	5.5	4.8	0.02		0		

LOGAN SERIES

LOGAN SERIES

PROFILE NO. D015

TOGURU SERIES

Cations extracted by 2.5% acetic acid me/100g.

Soil Separates

% Coarse sand (I)

% Fine sand (II)

% Silt (USDA)

% Silt (III)

% Clay (IV)

Ca

Mg

Na

K

Exchangeable H me/100g. Soil

CEC me/100g. Soil

% Base Saturation

pH Soil : Water

pH Soil : CaCl₂

EC 1:1 suspn. mmhos cm⁻¹

Total N %

Available P ppm

Total P ppm

Total K ppm

SAMPLE NO.

Depth in.

SAMPLE NO.	Depth in.	% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na	K	Exchangeable H me/100g. Soil	CEC me/100g. Soil	% Base Saturation	pH Soil : Water	pH Soil : CaCl ₂	EC 1:1 suspn. mmhos cm ⁻¹	Total N %	Available P ppm	Total P ppm	Total K ppm	
D064	0 - 7	27	38	29	16	19	1.31	0.85	1.37	0.08	7.0	24.0	70.9	5.2	4.4	0.06	0.24	1			
D065	7 - 11	34	33	21	14	19	0.52	0.36	0.46	0.04	4.7	20.6	77.2	5.2	4.6	0.04		2			
D066	11 - 19	44	28	19	9	19	0.88	0.73	0.35	0.04	3.5	20.4	82.8	5.1	4.6	0.07		0			
D067	19 - 28	44	21	29	16	19	0.95	0.91	0.26	0.08	3.8	15.0	74.7	5.1	4.4	0.07		0			
D068	28 - 41	40	35	21	11	14	3.71	4.25	0.76	0.04	20.4	22.0	7.3	2.8	2.8	3.29		0			
D069	41 - 52	40	35	17	9	16	2.88	5.38	1.33	0.04	18.4	20.6	10.7	2.9	2.9	2.52		1			

PROFILE NO. D015

DEPTH SERIES

Soil Separates
Cations extracted by 2.5% acetic acid me/100g.

SAMPLE NO.	Depth in.	Soil Separates					Ca	Mg	Na	K	Exchangeable H me/100g. Soil	CEC me/100g. Soil	% Base Saturation	PH Soil : Water	PH Soil : CaCl ₂	EC 1:1 suspn. mmhos cm -1	Total N %	Available P ppm	Total P ppm	Total K ppm
		% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)														
D070	0 - 5	0	32	39	32	36	2.98	3.56	0.57	0.11	18.2	26.5	31.3	4.6	3.9	0.07	0.53	3	330	730
D071	5 - 12	0	15	47	44	41	4.19	4.43	0.99	0.06	13.6	26.9	49.5	4.8	4.2	0.11		4	260	920
D072	12 - 18	0	22	49	44	34	3.66	5.18	0.70	0.05	7.1	30.7	76.9	5.2	4.4	0.02		9	335	920
D073	18 - 32	0	22	50	37	41	6.12	5.92	0.80	0.06	7.0	28.4	75.4	5.1	4.5	0.11		13	370	920
D074	32 - 46	0	37	42	24	39	3.72	4.27	1.08	0.06	4.1	25.5	83.9	5.3	4.6	0.07		5	170	480

PROFILE NO. D017

DEUBA SERIES

SAMPLE NO.	Depth in.	Soil Separates					Cations extracted by 2.5% acetic acid me/100g.										EC 1:1 suspn. mmhos cm ⁻¹	Total N %	Available P ppm	Total P ppm	Total K ppm
		% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na	K	H me/100g. Soil	CEC me/100g. Soil	% Base Saturation	pH Soil # Water	pH Soil # CaCl ₂						
D014	35 - 40	0	31	45	54	30	3.15	4.51	1.08	0.09	4.1	52.2	83.0	2.3	4.9	0.03	2	110	480		
D013	18 - 35	0	55	20	33	41	0.15	2.05	0.80	0.09	3.0	4	12.4	2.1	4.2	0.11	13	310	350		
D015	15 - 18	0	50	40	44	34	3.00	2.19	0.10	0.02	30.1	0	0	5	2	0.05	4	322	350		
D01	2 - 15	0	1	4	44	41	4.10	4.43	0.00	0.09	0	0	0	8	5	0.11	4	60	350		
D010	0 - 2	0	3	3	33	33	5.08	3.20	0.21	0.11	0	2	1.3	9	0	0.03	0	23	30	130	
D075	0 - 8	57	20	14	9	14	1.81	2.06	0.63	0.10	3.8	16.9	77.5	5.3	4.7	0.14	3	0.12	3		
D076	8 - 15	74	22	1	0	4	1.51	2.00	0.44	0.08	1.8	11.1	83.8	5.5	4.8	0.04	3		3		
D077	15 - 17	52	41	4	1	6	2.80	2.43	0.84	0.06	1.2	15.4	92.2	5.6	4.9	0.03	2		2		
D078	17 - 20	75	21	1	0	4	1.87	1.08	0.53	0.04	2.4	12.3	80.5	5.0	4.2	0.02	12		12		

Scale 1:1000
Cations extracted by 2.5%

SKOLITE NO D018

LOKOLOKO SERIES

PROFILE NO. D018

REWA SERIES

SAMPLE NO.	Depth in.	Soil Separates					Cations extracted by 2.5% acetic acid me/100g.					CEC me/100g. Soil	% Base Saturation	PH Soil : Water	PH Soil : CaCl ₂	EC 1:1 suspn. mmhos cm - 1	Total N %	Available P ppm	Total P ppm	Total K ppm
		% coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na	K	Exchangeable H me/100g. Soil									
D079	0 - 11	8	39	42	27	26	5.57	3.52	0.53	0.55	4.9	18.3	73.2	5.1	4.9	0.20	0.19	43		
D080	11 - 17	17	36	37	25	22	5.62	3.29	0.55	0.23	3.2	18.8	83.0	5.5	5.1	0.12		5		
D081	17 - 31	30	41	20	12	17	5.68	2.53	0.55	0.09	2.0	17.8	88.8	5.8	5.3	0.05		6		
D082	31 - 44	54	24	13	8	14	4.30	1.76	0.84	0.14	1.8	11.2	83.9	5.7	5.3	0.05		13		
D083	44 - 60	82	12	2	0	6	3.19	1.08	0.26	0.06	1.0	5.8	82.8	5.8	5.3	0.03		3		

SOIL SEPARATES
 CATIONS EXTRACTED BY 2.5% ACETIC ACID ME/100G

REWA SERIES
 PROFILE NO. D018

Cations extracted by 2.5% acetic acid me/100g.

Soil Separates

SAMPLE NO.	Depth in.	Soil Separates					Cations extracted by 2.5% acetic acid me/100g.							CEC me/100g. Soil	% Base Saturation	pH Soil : Water	pH Soil : CaCl ₂	EC 1:1 suspn. mmhos cm ⁻¹	Total N %	Available P ppm	Total P ppm	Total K ppm
		% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na	K	H Exchangeable me/100g. Soil											
D084	0 - 10	10	41	42	22	27	4.91	4.17	0.36	0.23	5.2	19.0	72.6	5.1	4.7	0.20	0.18	5				
D085	10 - 17	28	35	27	15	22	4.68	3.08	0.35	0.06	3.1	18.6	83.3	5.3	4.9	0.11		1				
D086	17 - 28	54	27	10	5	14	4.18	2.05	0.62	0.06	2.2	13.5	83.7	5.5	5.0	0.07		3				
D087	28 - 34	53	20	20	10	17	4.58	2.09	0.36	0.04	2.3	16.0	85.6	5.5	5.0	0.05		2				
D088	34 - 39	70	20	4	2	8	3.20	1.26	0.18	0.04	1.7	7.3	76.7	5.6	5.1	0.06		22				
D089	39 - 45	37	40	21	9	14	4.80	2.03	0.36	0.04	1.8	16.2	88.9	5.6	5.1	0.04		7				
D090	45 - 54	75	12	8	4	9	3.82	1.51	0.61	0.04	1.1	7.8	85.9	5.7	5.3	0.06		16				
D091	54 - 68	51	37	9	4	8	4.61	2.10	0.47	0.04	1.5	13.0	88.5	5.7	5.3	0.03		15				

NAVUA SERIES

PROFILE NO. D020

Cations extracted by 2.5% acetic acid me/100g.

Soil Separation

SAMPLE NO.	Depth in.	Soil Separation						Cations extracted by 2.5% acetic acid me/100g.										EC 1:1 suspn. mmhos cm ⁻¹	pH Soil : CaCl ₂	pH Soil : Water	Total N %	Available P ppm	Total P ppm	Total K ppm
		% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na	K	H Exchangeable me/100g. Soil	CEC me/100g. Soil	% Base Saturation											
D092	0 - 6	5	22	48	36	37	1.94	1.73	0.63	0.23	15.2	20.8	27.0	4.4	4.1	0.12	0.36	16						
D093	6 - 10	5	27	38	31	37	1.29	1.68	0.84	0.09	13.8	22.6	39.1	4.7	4.0	0.07	9	3						
D094	10 - 18	2	18	46	33	47	1.61	3.08	0.99	0.04	9.6	20.1	52.2	4.7	4.2	0.07	3	3						
D095	18 - 28	1	34	60	35	30	1.59	3.13	0.47	0.06	7.0	18.1	61.3	4.8	4.4	0.09	7	7						
D096	28 - 36	4	25	45	40	31	1.59	3.32	0.55	0.09	10.0	20.1	50.0	4.7	4.0	0.07	5	5						
D097	36 - 50	7	25	39	26	42	1.34	2.57	0.65	0.09	11.8	19.7	40.2	4.6	4.0	0.09								

Soil Separates Cations extracted by 2.5% acetic acid me/100g.

SAMPLE NO.	Depth in.	Soil Separates					Cations extracted by 2.5% acetic acid me/100g.							CEC me/100g. Soil	% Base Saturation	pH Soil : Water	pH Soil : CaCl ₂	EC 1:1 suspn. mmhos cm ⁻¹	Total N %	Available P ppm	Total P ppm	Total K ppm
		% Coarse sand (I)	% Fine sand (II)	% Silt (USDA)	% Silt (III)	% Clay (IV)	Ca	Mg	Na	K	Exchangeable H me/100g. Soil											
D098	0 - 6½	23	26	42	25	26	6.17	3.65	0.46	0.11	3.8	21.2	82.1	5.2	5.0	0.21	0.21	32				
D099	6½ - 18	4	30	48	33	33	7.31	4.44	0.47	0.06	3.0	23.2	87.1	5.7	5.4	0.14		5				
D100	18 - 25	4	20	52	37	39	6.15	4.80	0.58	0.04	2.8	19.5	85.6	5.7	5.5	0.15		4				
D101	25 - 35	5	17	39	31	47	6.45	5.87	0.36	0.06	3.9	21.6	82.0	5.6	5.4	0.17		6				
D102	35 - 53	2	19	41	32	47	4.15	5.06	0.55	0.09	2.0	20.3	90.2	5.9	5.6	0.11		6				

NAVUA SERIES PROFILE NO. D021

TABLE IV. 2 Minor and Trace Elements (Total in parts per million)

Site No.	Depth (inches)	Element	Ga	V	Cu	Zn	Ti	Ni	Co	Mn	Cr	Mo
D002	0 - 5	Sensitivity	2	2	2	50	50	5	5	5	2	2
	5 - 9½	Soil Series	20	300	85	200	6000	40	20	600	60	2*
	9½ - 14	Naitonitoni	20	200	60	200	4000	40	20	400	50	2
	14 - 23		13	85	20	50	3000	20	10	500	60	3
	23 - 30		20	300	50	50	4000	20	30	500	50	3
D003	0 - 9		16	200	40	100	5000	16	20	600	50	2*
	9 - 18	Soil Series	16	160	30	50	3000	16	20	400	50	2*
	18 - 27	Toguru	16	200	20	100	5000	20	30	500	50	2*
	27 - 36		13	100	20	50	3000	20	20	600	40	2
D008	0 - 15		20	300	60	300	6000	30	30	2000	60	2*
	15 - 24	Soil Series	20	200	85	200	6000	30	30	1600	50	2*
	24 - 38	Tamanua	30	300	85	500	6000	50	40	2000	85	2*

* Signifies less than

Site No.	Depth (inches)	Element	Ga	V	Cu	Zn	Ti	Ni	Co	Mn	Cr	Mo
		Sensitivity	2	2	2	50	50	5	5	5	2	2
D009	0 - 3		16	200	50	200	4000	20	20	1300	60	2*
	3 - 11½		16	300	60	500	6000	20	30	2000	60	2*
	11½ - 31	Soil Series	16	300	50	400	5000	20	30	1300	50	2*
	31 - 41	Rewa	16	300	50	500	6000	40	40	1600	60	2*
	41 - 55		20	300	60	500	6000	30	30	1600	60	2*
	55 - 63		16	300	50	500	6000	30	30	1300	60	2*
D010	0 - 7½		20	300	50	400	6000	30	30	1600	50	2*
	7½ - 11	Soil Series	16	200	50	600	5000	30	20	1000	50	2*
	14 - 26	Navua	20	300	40	400	5000	20	16	1000	50	2*
	26 - 39		16	300	40	300	8500	20	16	500	60	2*
	39 - 47		20	300	40	400	5000	20	10	1000	60	2*

* Signifies less than

Site No.	Depth (inches)	Element										
		Ga	V	Cu	Zn	Ti	Ni	Co	Mn	Cr	Mo	
		2	2	2	50	5	5	5	5	5	2	2
		Sensitivity										
D013	0 - 12	20	300	20	500	5000	16	20	1300	40	2*	
	12 - 17	16	200	20	300	4000	20	20	1000	40	2*	
	17 - 28½	13	160	16	200	1600	10	10	600	30	2*	
	28½ - 31	20	200	20	200	3000	10	13	1000	30	2*	
	31 - 37	16	200	20	200	3000	16	16	1300	30	2*	
	37 - 41	20	100	20	160	2000	20	16	600	40	2*	
	41 - 50	16	200	20	600	3000	20	30	1300	60	2*	
D016	0 - 5	16	200	50	600	6000	20	30	1000	50	2*	
	5 - 12	20	300	50	500	6000	30	30	2000	60	2*	
	12 - 18	20	300	50	400	6000	30	30	1600	60	2*	
	18 - 32	20	300	60	500	6000	40	30	2000	60	2*	
	32 - 46	20	200	40	500	5000	20	20	1000	50	2*	
D017	0 - 8	16	130	16	200	2000	16	20	850	30	2*	
	8 - 15	20	130	20	300	2000	20	30	6000	20	2*	
	15 - 17	16	100	20	200	2000	20	30	400	20 c	2*	
	17 - 20	16	100	20	200	2000	10	30	400	20	2*	

* Signifies less than

TABLE IV. 3 Levels of Extractable Aluminium Manganese and Zinc:

SITE NO.	SAMPLE NO.	Aluminium me/100g.		Manganese ppm.	me/100g.	Zinc ppm in Soil Acetate
		KCI	Acetate	Acetate		
D001	D001	1.95*	3.14	41.9	0.15	3.80
	002	0.86	1.84	19.0	0.07	2.00
	003	0.06	1.02	16.5	0.06	1.20
	004	-	0.89	20.4	0.07	<u>0.80</u>
D002	005	3.60*	6.72	28.8	0.11	2.20
	006	2.66*	7.39	22.7	0.08	<u>0.60</u>
	007	1.88*	6.24	7.7	0.03	-
	008	6.83*	8.10	11.3	0.04	1.60
	009	23.85*	16.88	28.7	0.11	6.30
D003	10	0.06	1.01	<u>4.3</u>	<u>0.02</u>	1.00
	11	0.06	0.87	<u>3.9</u>	<u>0.01</u>	0.80
	12	13.73*	11.55	98.8	0.36	21.50
	13	0.06	0.86	144.3	0.53	7.10
D004	14	3.85*	5.15	50.2	0.18	6.55
	15	2.75*	3.80	91.7	0.33	4.00
	16	4.25*	6.07	109.2	0.40	3.35
	17	4.22*	8.54	97.7	0.36	1.60
D005	18	2.01*	6.07	13.4	0.05	1.60
	19	3.44*	5.49	26.7	0.97	3.80
	20	3.40	4.11	137.4	0.50	2.90
D006	20A	2.62*	4.32	8.9	0.03	1.00
	21	1.95*	2.75	13.8	0.05	16.20
	22	1.95*	1.82	14.3	0.05	1.80
D007	23	2.07*	4.85	32.1	0.12	2.60
	24	0.13	2.45	14.9	0.05	1.00
	25	0.27	2.05	8.7	0.03	1.40
D008	26	0.07	0.94	<u>6.2</u>	<u>0.02</u>	1.60
	27	-	0.94	<u>3.9</u>	<u>0.01</u>	17.60
	28	-	1.49	<u>5.9</u>	<u>0.02</u>	1.20
D009	29	0.13	1.48	46.4	0.17	5.00
	30	0.27	1.66	16.9	0.06	2.40
	31	0.49	1.48	10.1	0.04	3.10
	32	0.42	1.21	<u>6.0</u>	<u>0.02</u>	2.40
	33	0.36	1.40	<u>4.3</u>	<u>0.02</u>	2.00
	34	0.45	1.12	3.7	0.01	2.20

TABLE IV. 4 Soil Mixtures - Suction Relationships

SITE NO.	SAMPLE NO.	Aluminium me/100g.		Manganese ppm	Manganese me/100g.	Zinc ppm in Soil Acetate
		KCl	Acetate	Acetate		
D010	D035	0.69	3.39	26.7	0.10	2.00
	36	2.26*	3.34	19.7	0.07	2.40
	37	0.27	1.19	12.6	0.05	1.20
	38	3.00*	2.25	47.7	0.17	1.60
	39	3.37*	3.27	43.9	0.16	4.00
D011	40	0.06	1.30	33.6	0.12	2.20
	41	0.06	0.89	5.3	0.02	1.40
	42	0.12	0.62	3.9	0.01	1.40
	43	0.19	1.02	11.9	0.04	2.20
	44	2.60*	4.05	36.3	0.13	5.00
	45	4.07*	4.94	172.5	0.63	2.90
D012	46	5.86*	12.84	17.0	0.06	1.00
	47	3.71*	17.08	18.2	0.07	0
	48	2.66*	8.38	12.0	0.04	0.40
	49	19.30*	13.78	60.6	0.22	14.50
	50	14.41*	11.58	102.3	0.37	17.60
D013	51	0.78	13.99	3.4	0.01	1.80
	52	0.12	5.11	0.9	0.01**	1.20
	53	0.06	2.26	0.5	0.01**	0.80
	54	0.12	1.58	6.0	0.02	0.80
	55	0.06	0.84	0.5	0.01**	0.80
	56	0.18	1.12	1.3	0.01**	1.20
	57	0.12	0.61	2.0	0.01	0.80
D014	58	0.54	9.99	4.2	0.02	0.80
	59	0.19	3.99	0.5	0.01**	1.20
	60	0.12	1.74	0.9	0.01**	0.20
	61	0.32	1.91	1.6	0.01**	0.40
	62	0.18	1.12	1.3	0.01**	0.40
	63	0.68	1.41	4.6	0.02	1.00
D015	64	3.00*	6.06	3.7	0.01	0.40
	65	2.01*	6.79	3.7	0.01	0
	66	1.20*	4.35	2.9	0.01	0
	67	1.06	2.25	4.6	0.02	0.20
	68	4.75*	4.44	9.3	0.03	5.60
	69	5.02*	3.78	10.9	0.04	6.90

SITE NO.	SAMPLE NO.	Aluminium me/100g.		Manganese ppm me/100g.		Zinc ppm in Soil
		KCl	Acetate	Acetate	Acetate	
D016	D070	4.23*	5.58	252.7	0.92	4.25
	71	5.67*	4.63	346.5	1.26	3.10
	72	2.15*	4.32	192.4	0.70	3.10
	73	1.45*	3.39	258.4	0.94	3.60
	74	0.88	2.23	97.4	0.35	2.40
D017	75	0.41	2.14	<u>4.0</u>	<u>0.02</u>	<u>0.60</u>
	76	0.16	1.12	<u>8.1</u>	<u>0.03</u>	<u>0.60</u>
	77	0.16	0.85	<u>4.6</u>	<u>0.02</u>	<u>0.80</u>
	78	1.51*	1.41	49.1	0.18	1.00
D018	79	0.16	1.13	<u>5.1</u>	<u>0.02</u>	2.60
	80	0.17	1.17	17.9	0.07	1.20
	81	0.17	0.65	<u>3.4</u>	<u>0.01</u>	1.20
	82	0.16	0.63	<u>3.9</u>	<u>0.01</u>	1.00
	83	0.08	0.45	<u>5.6</u>	<u>0.02</u>	<u>0.80</u>
	84	0.25	1.65	39.2	0.14	1.80
	85	0.17	1.16	13.5	0.05	1.20
	86	0.32	1.01	<u>5.7</u>	<u>0.02</u>	1.20
	87	0.25	0.88	<u>3.4</u>	<u>0.01</u>	1.60
	88	0.08	0.62	<u>4.6</u>	<u>0.02</u>	1.00
	89	0.17	0.65	<u>3.0</u>	<u>0.01</u>	1.40
	90	0.08	0.45	<u>5.1</u>	<u>0.02</u>	1.00
	91	0.08	0.47	<u>2.1</u>	<u>0.01**</u>	1.80
	D020	92	4.11*	6.35	52.8	0.19
93		6.31*	7.35	54.8	0.20	2.40
94		5.96*	5.95	275.8	1.00	3.10
95		4.71*	3.67	367.4	1.34	4.25
96		2.84*	3.69	433.1	1.58	6.90
97		3.78*	5.10	361.7	1.32	6.90
D021	98	0.08	0.88	27.2	0.10	2.90
	99	0	0.90	14.0	0.05	2.00
	100	0	1.09	<u>3.6</u>	<u>0.01</u>	<u>0.80</u>
	101	0	1.33	<u>8.0</u>	<u>0.03</u>	<u>0.80</u>
	102	0	1.03	<u>5.3</u>	<u>0.02</u>	1.60

NOTES

- 1) Deficiencies - copper and zinc underlined
- 2) Excesses - i. e. toxic or potentially toxic amounts shown by asterisk
- 3) ** signifies less than

TABLE IV. 4 Soil Mixture - Suction Relationships

Lab No.	Bulk Density	% M @ "O" Tension	% M @ 1/10 Atmos	% M @ 1/3 Atmos	% M @ 1 Atmos	% M @ 15 Atmos	AWC %
D. 030A	1.13	68.0	53.9	50.6	48.3	18.7	31.9
D. 030B	1.14	69.1	54.3	51.2	48.9	19.0	32.2
D. 035A	0.87	119.9	86.3	82.8	80.1	28.7	54.1
D. 035B	0.89	119.1	81.9	77.8	75.1	28.8	49.0
D. 051A	0.94	73.1	52.4	48.2	45.8	10.4	37.8
D. 051B	0.95	71.9	51.7	46.4	43.9	11.8	34.6
D. 064A	1.05	74.6	58.8	54.4	51.4	11.3	43.1
D. 064B	1.03	78.5	60.7	56.4	53.3	11.6	44.8
D. 071A	1.08	154.9	137.5	127.2	119.8	27.2	100.0
D. 071B	1.04	138.0	123.3	112.1	106.4	27.7	84.4
D. 072A	1.39	75.9	71.9	67.4	63.3	19.4	48.0
D. 072B	1.32	72.5	67.7	64.5	60.7	24.1	40.4
D. 075A	1.18	71.8	62.1	59.1	56.7	24.3	34.8
D. 075B	1.19	67.3	57.8	54.9	52.2	23.3	31.6
D. 079A	1.25	48.6	37.6	31.6	28.7	7.0	24.6
D. 079B	1.20	49.4	39.4	33.6	31.3	7.9	25.7
D. 086A	1.41	38.0	27.5	23.5	21.7	10.1	13.4
D. 086B	1.37	38.0	26.6	22.6	20.8	9.7	12.9
D. 102A	1.15	73.9	65.4	62.4	59.3	28.5	33.9
D. 102B	1.22	80.4	71.4	67.0	63.3	28.5	38.5

Lab. No.	Bulk Density	% M @ O Tension	% M @ 1/10 Atmos	% M @ 1/3 Atmos	% M @ 1 Atmos	% M @ 15 Atmos	AWC %
D. 014A	1.20	67.4	57.9	54.7	50.8	26.1	28.6
D. 014B	1.21	64.9	57.5	54.7	50.5	25.8	28.9
D. 015A	1.33	58.4	53.7	52.5	51.2	28.8	23.7
D. 015B	1.40	56.9	52.3	51.2	49.7	26.1	25.1
D. 018A	1.31	51.6	47.0	40.7	41.1	19.3	21.4
D. 018B	1.30	53.7	47.4	45.0	41.5	19.9	25.1
D. 020AA	1.27	62.4	51.9	47.6	43.6	17.1	30.5
D. 020AB	1.21	70.6	59.7	54.6	50.2	17.2	37.4
D. 023A	1.19	80.6	70.5	64.9	60.1	25.1	39.8
D. 023B	1.19	80.7	69.9	64.3	58.1	25.7	38.6
D. 026A	1.14	89.9	76.5	72.2	64.9	20.6	51.6
D. 026B	1.10	82.7	69.5	65.3	58.2	22.3	43.0
D. 031A	1.24	48.0	42.2	40.4	38.0	21.9	18.5
D. 031B	1.22	45.7	40.8	39.1	36.8	19.5	19.6
D. 036A	1.10	79.3	67.5	65.0	60.8	36.0	29.0
D. 036B	1.15	72.5	65.6	64.1	60.3	31.4	32.7
D. 048A	1.03	65.4	59.3	51.1	44.1	8.8	42.3
D. 048B	0.97	77.9	71.8	63.8	55.2	10.5	52.3

Notes

(1) Results are expressed as percentage moisture on a dry weight basis.

AWC = % moisture at $\frac{1}{3}$ A minus % moisture at 15 A

AWC = available water capacity

(2) Bulk density is expressed in g/c. c. Most values lie within normal range which varies from 1.00 (clays) to 1.85 (sands).

(3) Results are generally reproducible to $\pm 2\%$ which is the same as USDA and Dutch findings.

Most variation between duplicates is at the $\frac{1}{10}$ and $\frac{1}{3}$ atmospheres and is most probably due to presence of racks/root channels, etc. This variation is not shown at 15A tension since here we are dealing with monomolecular water layers and the coarse channels have no effect on results.

TABLE IV. 5 Levels of Extractable Copper and Zinc in Peat and Organic Mineral Soils

Sample No.	Site No.	Copper ppm in Soil		Zinc ppm in Soil
		HCl	Citrate	HCl
R036	R039	<u>0</u>	2.0	4.50
37		<u>0</u>	2.8	3.40
38		<u>0</u>	4.4	2.30
39		<u>0.5</u>	5.9	4.50
R040	R042	<u>1.0</u>	7.6	9.00
41		<u>2.0</u>	21.0	10.80
42		<u>1.0</u>	19.0	11.20
R043	R047	<u>0.5</u>	9.2	3.80
44		<u>0.5</u>	3.6	<u>1.20</u>
R048	R050	<u>1.0</u>	2.0	2.30
R058	R054	<u>0.5</u>	4.4	6.95
59		<u>1.0</u>	2.8	25.00
R060	R055	<u>1.5</u>	7.0	13.20
61		<u>0.5</u>	3.6	11.60
R062	R056	<u>1.5</u>	4.4	2.90
63		<u>2.5</u>	3.6	3.80
R080	R065	3.0	10.8	16.40
81		3.0	5.9	22.60
82		2.0	2.8	14.60
R151	R115	5.5	23.0	3.80
152		9.0	10.8	29.50
R160	R122	4.0	7.2	19.40
R164	R125	<u>1.0</u>	10.0	7.20
165		<u>1.0</u>	11.7	2.30
166		<u>0.5</u>	5.9	<u>0.70</u>
167		<u>0.5</u>	4.4	<u>2.90</u>
168		<u>1.0</u>	2.0	<u>1.90</u>
169	R128	<u>0.5</u>	3.6	<u>1.41</u>
170		<u>1.0</u>	2.6	22.40
171		<u>1.0</u>	2.6	11.80
172		<u>1.0</u>	2.6	18.00

Sample No.	Site No.	Copper ppm in Soil		Zinc ppm in Soil
		HCl	Citrate	HCl
R173	R131	<u>0.5</u>	17.0	13.20
174		<u>0.5</u>	5.2	<u>1.70</u>
R178		<u>0.5</u>	2.8	8.60
179		<u>0.5</u>	<u>1.3</u>	3.80
R183	R139	<u>0.5</u>	2.8	8.25
184		6.5	23.0	16.40
R188	R141	2.0	11.7	10.00
189		<u>0.5</u>	<u>1.3</u>	4.00
190		<u>1.0</u>	<u>1.3</u>	6.20
191		<u>0.5</u>	3.6	5.30

NOTE: Deficient or potentially deficient values underlined.

TABLE IV.6 Acetate Soluble Sulphate in Soils

Site No.	Sample No.	Acetate ext. SO ₄		Total dissolved salts ppm	CaCO ₃ %
		ppm	me%		
R011	R004	118	0.25		
	005	306	0.64		
R012	R006	70	0.15		
	007	50	0.10		
	008	788	1.64		
	009	9500	19.79		
R013	R010	200	0.42		
	011	90	0.19		
	012	4500	9.38		
	013	9500	19.79		
R037	R029	2031	4.23	22300	0.06
	030	5125	10.68	28200	0.04
	031	14125	29.43	37800	0.04
R038	R032	60	0.13		
	033	35	0.07		
	034	9190	19.14		
	035	8750	18.23		
R039	R036	775	1.61		
	037	264	0.55		
	038	675	1.41		
	039	2750	5.73		
R042	R040	613	1.28		
	041	2125	4.43		
	042	244	0.51		
R047	R043	Nil	Nil		
	044	40	0.08		
	045	225	0.47		
	046	4283	0.89		
	047	15125	31.51		
R050	R048	60	0.13	860	
	049	2500	5.21	2520	0.08
	050	18000	37.50	18140	0.10

Site No.	Sample No.	Acetate ext. SO ₄ ppm	me% me%	Total dissolved salts ppm	CaCO ₃ %
R050	R051	24250	50.52	28000	0.06
R052	R054	180	0.38		
	055	638	1.33		
	056	8565	17.84		
	057	23625	49.22		
R054	R058	3750	7.81		
	059	18250	38.02		
R055	R060	8375	17.45	54640	
	061	14750	30.73	57100	
R056	R062	45	0.09		
	063	4063	8.46		
	064	8750	18.23		
R059	R065	375	0.78		
	066	85	0.18		
	067	2141	4.46		
	068	4188	8.73		
	069	10565	22.01		
R063	R075	245	0.51		
	076	1013	2.11		
	077	1119	2.33		
	078	12625	26.30		
	079	9500	19.79		
R065	R080	544	1.13	1560	
	081	16500	34.38	19140	
	082	11875	24.74	14640	
R068	R083	400	0.83		
	084	513	1.07		
	085	3250	6.77		
	086	11188	23.30		
	087	11188	23.30		
R069	R088	6750	14.06	19080	0.08
	089	7690	16.02	18360	0.12
	090	14500	30.21	30960	0.12
	091	13750	28.65	25840	Nil
	092	12250	25.52	23200	Nil

Site No.	Sample No.	Acetate ext. SO ₄		Total dissolved salts ppm	CaCO ₃ %
		ppm	me %		
R071	R093	163	0.34		
	094	25	0.05		
	095	30	0.06		
	096	118	0.25		
	097	1675	3.49		
R075	R098	45	0.09		
	099	105	0.22		
	100	1513	3.15		
	101	5875	12.24		
	102	4500	9.38		
R084	R112	90	0.19		
R097	R117	513	1.07	2440	0.12
	118	1575	3.28	7020	0.08
	119	613	1.28	6320	0.04
	120	869	1.81	3780	0.08
	121	1925	4.01	6160	0.04
R103	R128	30	0.06		
R107	R135	375	0.78		
R109	R136	158	0.33		
	137	330	0.69		
	138	3845	8.01		
	139	10000	20.83		
	140	10000	20.83		
R112	R141	290	0.60	400	0.21
	142	2313	4.82	2760	0.08
	143	9406	19.60	12160	0.12
	144	10438	21.75	12100	0.08
	145	6125	12.76	8180	Nil
R114	R146	6125	12.76	30900	0.04
	147	13000	27.08	39620	0.06
	148	11500	23.96	40080	Nil
	149	12250	25.52	35900	Nil
	150	11500	23.96	29900	0.04
R115	R151	218	0.45		
	152	180	0.38		
	153	18250	38.02		
	154	16125	33.59		
	155	4500	9.38		

Site No.	Sample No.	Acetate ext. SO ₄		Total dissolved salts ppm	CaCO ₃ %
		ppm	me %		
R122	R160	Nil	Nil		
	161	Nil	Nil		
	162	Nil	Nil		
	163	85	0.18		
R125	R167	7250	15.10		
	168	1938	4.04		
R128	R169	8	0.02		
	170	25	0.05		
	171	363	0.76		
	172	225	0.47		
R131	R173	385	0.80		
	174	513	1.07		
	175	341	0.71		
	176	195	0.41		
	177	335	0.70		
R136	R178	Nil	Nil		
	179	Nil	Nil		
R139	R183	388	0.81		
R141	R188	245	0.51		
	189	294	0.61		
	190	425	0.89		
	191	718	1.50		
R147	R192	78	0.16		
	193	50	0.10		
	194	1763	3.67		
	195	850	1.77		
	196	6750	14.06		
R152	R201	7875	16.41		
D002	D007	500	1.04		
	008	5250	10.94	5300	
	009	22815	47.53	27300	
D003	D012	26250	54.69	26180	
	013	12625	26.30	13020	

Site No.	Sample No.	Acetate ext. SO ₄		Total dissolved salts ppm	CaCO ₃ %
		ppm	me %		
D010	D039	3013	6.28	2940	
D012	D046	135	0.28		
	047	52	0.11		
	048	2503	5.22	3840	
	049	25558	53.22	35260	
	050	26250	54.69	42040	
D015	D068	7500	15.63	10100	
	069	7690	16.02	9020	
D020	D092	70	0.15		

Note: Calcium Carbonate determinations

- (1) Peat soils not analysed
- (2) Other soils (as well as peats) have acid reaction, give no visible effervescence with dilute HCl and yield a slight odour of H₂S. Thus it is most probable that the small amounts of gass evolved is H₂S not CO₂ and the actual carbonate content throughout is zero.

COMMENTS

IV. 7

Extractable cations.

- Calcium** Levels of extractable calcium are generally moderate, the normal range being 4 - 5.5 me/100g. Much lower values are recorded for soils of the coastal sands, and values tend to be low in the subsoils of Toguru soils. Very high values recorded in one Toguru soil (see pit D003) are due to a high shell content.
- Magnesium** The normal level of this cation in most soils is moderate to low, with very low values recorded in soils of the coastal sands. The magnesium tends to be rather high in relation to calcium and a low calcium magnesium ratio results. Values are rather more variable than for calcium, but generally in the range of 2.5 - 4.0 me/100g.
- Sodium** Values normally range from 0.3 - 0.6 me/100g. but very high values of more than 2.0 me/100g. are found in subsoils of some Toguru soils. Low values are found in the soils of coastal sands.
- Potassium** Very low values of this cation are found in soils of the Navua area, with values nearly always less than 0.2 me/100g. and less than 0.1 me/100g. in most cases
- Base saturation percentage** Values are generally high in most imperfectly to well drained soils mainly greater than 70 per cent. In gley soils, the values are somewhat lower particularly in soils of the Toguru series and in the top soils of the coastal sands.

Phosphorus

1. **Available phosphorus** Values are nearly all very low with zero values being often recorded. One Tamanua soil shows much higher values throughout the profile. The reason for this is not known. There is no history of recent heavy application of phosphate fertilizer, nor does the site receive additions of flood material.
2. **Total phosphorus** Since values for available phosphorus were exceedingly low, a few samples were analysed for total phosphorus contents. These results indicated that most soils were moderately well supplied with total reserves of phosphorus.

Extractable aluminium Soil acidity is the most important factor controlling soluble and exchangeable aluminium in soils. Soluble aluminium is not likely to be found in soils with a pH greater than 4.7 and exchangeable aluminium if the pH is greater than 5.0.

The aluminium extracted by normal potassium chloride solution is generally regarded as the exchangeable fraction. Normal ammonium acetate at a pH of 4.8 extracts exchangeable aluminium plus the soluble fractions. Consequently values for acetate extractable aluminium are higher than potassium chloride extractable values.

Soluble aluminium is extremely toxic to growing plants.

For interpretation purposes we have regarded more than one milliequivalent per 100g. soil of exchangeable (potassium chloride extractable) aluminium as potentially toxic.

There is a considerable difference between values in gley and non-gley soils. In the gley soils values are nearly always in excess of 1 me/100g. and less than this in better drained soils for KCl extractable aluminium. It would appear that the values may be harmful at low pH in most

gley soils, particularly in soils of the Toguru series, where some very high levels of aluminium have been recorded in some subsoils where pH is extremely low. Utilisation of phosphorus may be considerably affected by the aluminium contents of many soils in this area at existing pH levels. Liming is likely to be required in most soils to prevent problems in the uptake of phosphorus.

Manganese Levels of this element are mainly moderate to high in gley soils, but often low in better drained soils. In the latter case, most of the manganese is probably in an unavailable form as concretionary oxides. Some slight manganese deficiency may exist in the better drained soils.

Sulphate In nearly all estuarine soils, levels of acetate extractable sulphate are very high. In the Toguru and Naitonitoni series the high levels occur mainly in the subsoils below 24 inches. This would indicate that most estuarine soils are potentially acid sulphate soils or "cat-sands", and the value of much of the present Dogo and Soso saline gleys for reclamation must be doubtful.

Extractable copper Copper was determined using two methods:

- (1) extraction with 0.1N hydrochloric acid (Cheng and Bray, 1953)
- (2) extraction with ammonium citrate and ethylene diamine tetra acetic acid (Cheng and Bray, 1953)

The results obtained are rather conflicting. The acid extraction method indicates that many soils are low in available copper whereas the citrate method gives higher results. It is probable that the citrate/EDTA method is removing copper bound by humic acids in soil organic matter and overestimating the available copper content. The soils should be regarded as potentially deficient in copper (Table IV. 5).

**Extractable
zinc**

A few instances of potential deficiencies of zinc were found (Table IV. 5).

Physical Analyses**Available
water
capacity**

Most of the soils in the Navua plains other than those derived from the very coarse coastal sands have reasonably high water holding capacities.

Permeability

All soils in the area have moderate to high permeability except for Tokotoko clays. The rather high levels in the fine textured Navua and Tamanua soils appears to be a function of well defined major structural planes along which lateral water movement is achieved.

Infiltration

Generally, infiltration rates are low except in the coarser textured soils. The effect of puddling is strikingly shown by soils of the Toguru series. In the low infiltration values, evaporation is likely to be of considerable significance and may account for up to 40 per cent of the values given. Maximum evaporation for this area appears to be about 0.2 inches per day. Evaporation during all tests is likely to be in excess of 0.15 inches per day, since measurements were carried out during dry, sunny periods.

TUCKER, F. G. and
KURTZ, L. T. (1955)

The measurement of soil pH,
Soil Sci. Soc. Amer. Proc. 19, 164.
A comparison of several chemical
methods with the bioassay procedure
for extracting zinc from soils.
Soil Sci. Soc. Amer. Proc. 19, 477-481

WOODRUFF, C. M. (1942)

Testing soil for lime requirement by
means of a buffered solution and the
glass electrode.
Soil Sci. Soc. 64, 51.

Extensive... A few instances of potential differences of sign were observed (Table IV.3).

Physical Analysis

Available water capacity... Most of the soil in the Negro plain other than those noted from the very coarse gravel sands have reasonably high water holding capacities.

Permeability

All soils in the area have moderate to high permeability except the... high levels in the texture of heavy and medium soils appears to be a function of well defined major structural planes along which lateral water movement is achieved.

Infiltration

Generally, infiltration rates are low except in the coarse textured soils. The effect of bedding is strikingly shown by soils of the Tugum series. In the low infiltration value, evaporation is likely to be of considerable significance and may account for up to 40 per cent of the value given. Maximum evaporation for this area appears to be about 0.2 inches per day. Evaporation during all tests is likely to be in excess of 0.15 inches per day, since measurements were carried out during dry, sunny periods.

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The Analyst 84: 339.
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- WOODRUFF, O. M. (1948)

I. EASTERN AREA

Description	Unit	Quantity	Rate	Amount
			\$	\$
A. PREPARE SITE				
Land clearing	acre	101	35.00	3,530
Land leveling	cu. yd.	93,760	0.30	28,110
Land excavation	acre	92	150.00	13,800
Total ..				45,440
B. IRRIGATION				
a) Pump stations				
Main pump station		1	sum	34,600
Misc. pump station		1	sum	9,900
Power supply systems			sum	8,250
Total ..				42,810

DETAILED ESTIMATED COSTS

<u>OF IRRIGATION AND DRAINAGE</u>				
b) Earthwork				
Main & secondary Canals cut	cu. yd.	3,185	0.44	1,400
Form cut into embankment	cu. yd.	1,185	0.36	420
Borrow	cu. yd.	58,390	0.60	35,030
Laterals				
Borrow	cu. yd.	96,000	0.40	37,600
Form cut from drainage into embankment	cu. yd.	40,000	0.16	6,400
Total ..				117,800
c) Structures				
Main Canal Cross Reg.		1	sum	5,450
Distrib. Head Reg.		2	sum	1,500
Distrib. Cross Reg.		1	sum	5,200
Lateral Head Reg.	No.	20	675.00	13,500
Lateral checks	No.	95	160.00	15,200
Turnouts	No.	174	170.00	29,380
Lateral Tail escapes	No.	35	200.00	7,000
Field gates	No.	313	10.00	3,130
Canal Culverts, Class I		23	sum	17,450
Underpasses		21	sum	77,640
Total ..				174,550

APPENDIX V

DETAILED ESTIMATED COSTS
OF IRRIGATION AND DRAINAGE

1. EASTERN AREA

Description	Unit	Quantity	Rate	Amount
			\$	\$
A. <u>Preliminary</u>				
Land clearing	acre	101	35.00	3,540
Land levelling	cu. yd.	93,700	0.30	28,110
Land expropriation	acre	92	150.00	13,800
Total ..				45,450
B. <u>Irrigation</u>				
a) Pump stations				
Main pump station		1	sum	24,680
Minor pump station		1	sum	9,900
Power supply system			sum	8,250
Total ...				42,830
b) Earthworks				
Main & Distributory Canals Cut	cu. yd.	1,185	0.44	520
Form cut into embankment	cu. yd.	1,185	0.16	190
Borrow	cu. yd.	88,390	0.60	53,090
Laterals				
Borrow	cu. yd.	96,000	0.60	57,600
Form cut from drains into embankment	cu. yd.	40,000	0.16	6,400
Total ..				117,800
c) Structures				
Main Canal Cross Reg.		3	sum	6,450
Distrib. Head Reg.		2	sum	1,600
Distrib. Cross Reg.		5	sum	5,200
Lateral Head Reg.	No.	20	675.00	13,500
Lateral checks	No.	95	160.00	15,200
Turnouts	No.	174	170.00	29,580
Lateral Tail escapes	No.	35	200.00	7,000
Field gates	No.	313	10.00	3,130
Canal Culverts Class 1		25	sum	17,450
Underpasses		23	sum	77,840
Total ..				176,950

II. CENTRAL AREA

Description	Unit	Quantity	Rate	Amount
			\$	\$
A. Preliminary				
Land clearing	acre	234	35.00	8,190
Land levelling	cu. yd.	41,130	0.30	12,340
Land expropriation	acre	3	150.00	450
Total ..				20,980
B. Irrigation				
a) Pump Stations				
Main pump station		1	sum	18,000
Minor pump station		2	sum	18,260
Power supply system			sum	5,250
Total ..				41,510
b) Earthworks				
Main & Distributory Canals Cut	cu. yd.	2,148	0.44	945
Form cut into embankment	cu. yd.	2,148	0.16	345
Borrow	cu. yd.	24,700	0.60	14,820
Laterals Borrow	cu. yd.	39,330	0.60	23,600
Form cut from drains into embankment	cu. yd.	11,500	0.16	1,840
Total ..				41,550
c) Structures				
Main Canal Cross Reg.		3	sum	4,000
Lateral Head Reg.	No.	9	675.00	6,075
Lateral Check	No.	32	160.00	5,120
Turn out	No.	78	170.00	13,260
Lateral Tail escape	No.	12	200.00	2,400
Field gates	No.	140	10.00	1,400
Canal Culverts Class 1		6	sum	4,965
Underpasses		6	sum	8,600
Total ..				41,820

III. WESTERN AREA

Description	Unit	Quantity	Rate	Amount
			\$	\$
A. <u>Preliminary</u>				
Land clearing	acre	119	35.00	4,170
Land levelling	cu.yd.	76,410	0.30	22,930
Land expropriation	acre	74	150.00	11,100
				38,200
Total ..				
B. <u>Irrigation</u>				
a) Pump stations				
Main pump station		1	sum	26,980
Minor pump station		1	sum	8,890
Power supply system		1	sum	12,800
				48,670
Total ..				
b) Earthworks				
Main & Distributory Canals				
Cut	cu. yd.	10,480	0.44	4,620
Form cut into embankment	cu. yd.	10,480	0.16	1,680
Borrow	cu. yd.	81,690	0.60	49,020
Laterals				
Borrow	cu. yd.	74,280	0.60	44,580
Form cut from drains into embankment	cu. yd.	20,000	0.16	3,200
				103,100
Total ..				
c) Structures				
Main Canal Cross Reg.		7	sum	13,700
Distrib. Head Reg.		2	sum	1,600
Distrib. Cross Reg.		1	sum	800
Lateral Head Reg.	No.	16	675.00	10,800
Lateral Check	No.	64	160.00	10,240
Turn out	No.	131	170.00	22,270
Lateral tail escape	No.	24	200.00	4,800
Field gates	No.	233	10.00	2,330
Canal Culverts Class 1		5	sum	4,100
Underpasses	x	11	sum	38,380
				109,020
Total ..				

IV. NORTHERN AREA

	Description	Unit	Quantity	Rate	Amount
				\$	\$
A. Preliminary					
	Land clearing	acre	12	35.00	420
	Land levelling	cu. yd.	39,570	0.30	11,880
	Land expropriation	acre	21	150.00	3,150
	Total ..				15,450
B. Irrigation					
a) Pump stations					
	Main pump station		1	sum	16,420
	Power supply system			sum	3,050
	Total ...				19,470
b) Earthworks					
Main Canal					
	Cut	cu. yd.	555	0.44	245
	Form cut into embankment	cu. yd.	555	0.16	90
	Borrow	cu. yd.	7,941	0.60	4,765
Laterals					
	Borrow	cu. yd.	31,170	0.60	18,700
	Form cut from drains into embankment	cu. yd.	7,000	0.16	1,120
	Total ...				24,920
c) Structures					
	Lateral Head Reg.	No.	6	675.00	4,050
	Lateral Checks	No.	24	160.00	3,840
	Turnouts	No.	35	170.00	5,950
	Lateral tail escapes	No.	10	200.00	2,000
	Field gates	No.	61	10.00	610
	Canal Culverts Class 1		1	sum	76
	Underpasses		4	sum	25,500
	Lining for main canal			sum	9,000
	Total ..				51,710