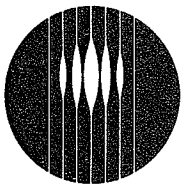

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Division of Water Resources

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ABSTRACT

Field data from a reconnaissance of vegetation, soils and landforms from tropical coastal sand dunes at Shoalwater Bay, Central Queensland are presented. The data were collected from 191 sites in December 1975 and May 1976. The data suggest an age sequence of dunes including the Holocene and Pleistocene periods. The soils are mostly podsols and humus podsols and showed progressive changes in depths of horizon development across the dunes sequence. The species composition of the vegetation also varied across the dunes. A total of 282 species of vascular plants were recorded, with species numbers ranging from 9-38 per 400 m^2. The details of the soils and vegetation differ significantly from that recorded at the Cooloola sandmass (500 km to the south). The Shoalwater dunes are strategically located on the tropic of Capricorn, and further study could make significant contributions to our knowledge of the Quaternary geomorphic history and climate of Australia.

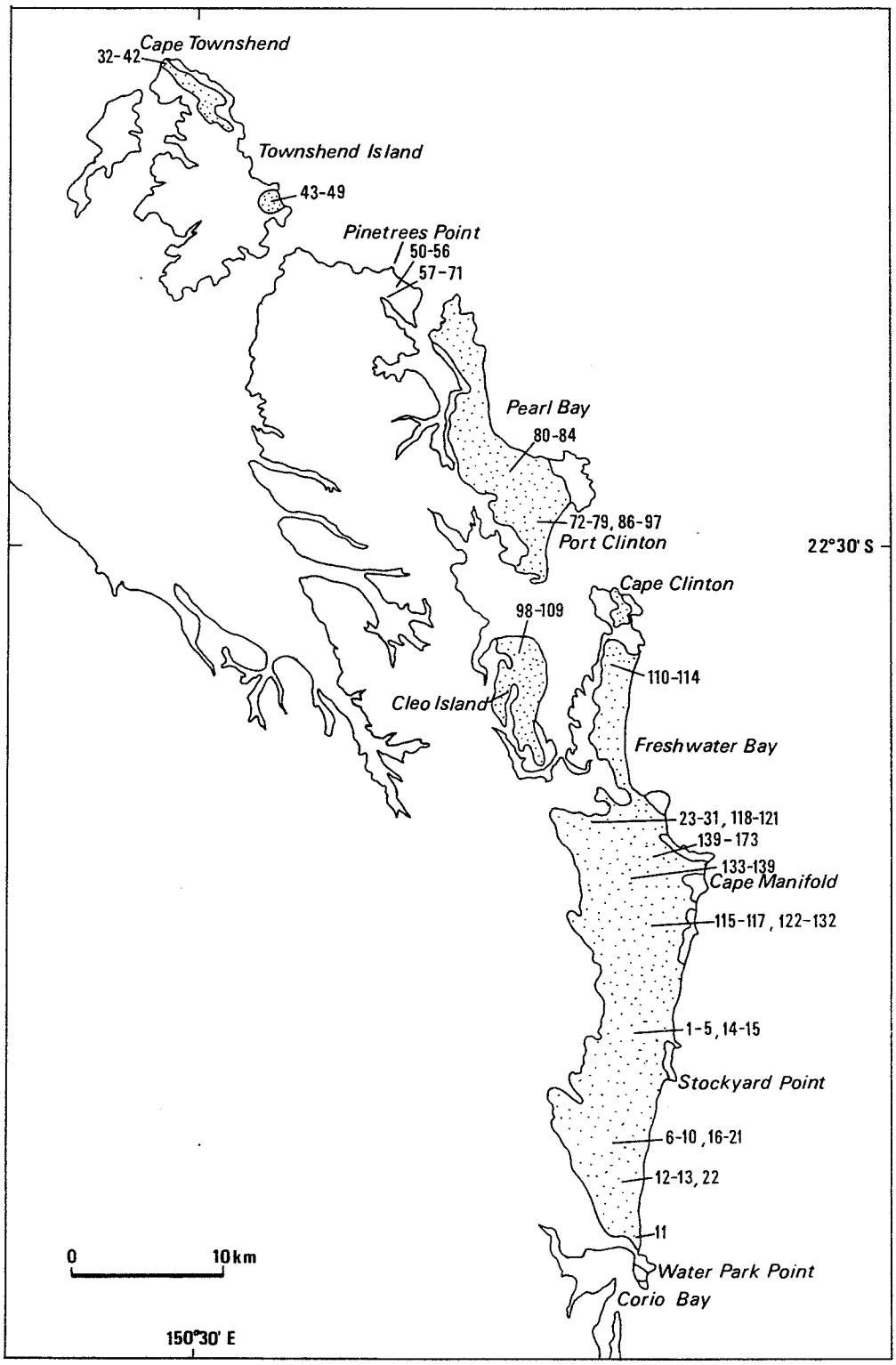

Figure 1

Approximate distribution of soil and vegetation sites in the coastal fringe of the Shoalwater Bay area

1. Introduction

A reconnaissance was made of the vegetation, soils and landforms of the coastal dunes in the Shoalwater Bay area during short visits in December 1975 and May 1976. The survey was undertaken to:

1. Ascertain if the dune systems, soil and vegetation relationships at Shoalwater Bay were analogous to those being studied at Cooloola by CSIRO Division of Soils (Thompson 1981; Thompson and Moore 1984)

2. Determine if the progressive and retrogressive model of plant succession evident at Cooloola (Walker et al. 1981) could also be applied to sand dune systems in the tropics

3. Provide additional data on vegetation, soils and landforms of the Shoalwater Bay coastal dunes which might lay the foundations for more detailed studies with a view to the eventual production of vegetation and or soil maps of this section.

The area had previously been covered by the Atlas of Australian Soils mapping (Isbell et al. 1967) and in a land unit survey of the Australian Army Training Area at Shoalwater Bay (Gunn et al. 1972). These surveys provided information on soils and vegetation at about 30 sites in the coastal dunes but were insufficient in detail and number to answer questions 1 or 2. A seven day examination of the southern part of the coastal fringe (December 1975) indicated that some of the dune systems were analogous to those at Cooloola. With air support from the Australian Army, further reconnaissance throughout the coastal dunes of the Training Area was carried out in May 1976. In total fifteen days were spent in collecting data.

The area examined during these two field periods extends northwards along the coast from Water Park Point to Cape Townshend (Fig. 1). The western boundary is the inland margin of the sand mass but was extended to include Cleo Island which is largely composed of beach ridges. Vegetation data were recorded at 191 sites and soil data at 185 sites.

The purpose of this report is to bring together and make available the various data resulting from the reconnaissance. These are presented in tables to allow the data to be viewed and interpreted as a set.

2. Methods

2.1. Site selection

Sites for inspection on the ground were selected using stereoscopic examination of black and white air photos. Selection was based on obtaining both geographic and geomorphic coverage of the dune systems and their vegetation. Many desirable sites had to be rejected because of poor access. Access to the southern or Bayfield section (sites 1-22) and the Freshwater Bay traverse (sites 23-31) was by vehicle and on foot (December 1975). Transport to the remaining sites (32-143) in the Army Training Area (May 1976) was by helicopter to points as near as possible to the selected sites. Sites were then located on foot. The location of each site is referenced to the Australian Topographic Survey (1:100 000) Shoalwater Bay Special, Edition 1, Series R 631; elevations given are estimates from the nearest map contour or spot height.

Geomorphology and soils

The major geomorphic components of the parabolic dunes (Thompson 1983) were identified on the air photos and the boundaries at each site confirmed in the field. The major components were further subdivided according to a scheme used at Cooloola (Thompson unpublished) recognising coastal, medial and inland sections of parabolic dunes and a range of components in other coastal landforms.

The soils were examined using a 75 mm sand auger (Dormer Engineering, Murwillumbah, NSW) which recovers very clean samples at about 20 cm intervals and is suitable for hand augering to depths in excess of 20 m. The soils were classified according to A Handbook of Australian Soils (Stace et al. 1968) and A Factual Key (Northcote 1971). Most of the soils are podzols or humus podzols and these have been further subdivided according to degree and depth of profile development following a scheme used at Cooloola recognising rudimentary, common, and giant forms (Thompson 1992). Detailed descriptions of the characteristic horizons of subtropical podzols and of progressive changes in horizon depths that occur over time are given elsewhere (Thompson and Hubble 1980; Thompson 1992).

Vegetation

Data for the structure and floristics of the vegetation were recorded in sample areas of 400 m^2 at each of the soil sites. The shape of the sampling areas was adjusted to the boundaries of the various geomorphic components as in the collection of vegetation data at Cooloola (Harrold et al. 1987). Plant species were also recorded on one or two lines crossing each geomorphic component to supplement the plot data. Plant specimens were checked by the staff at the Queensland Herbarium, Brisbane and the species names listed are those that

were extant at that time (1976). Batianoff and McDonald (1980) carried out a survey of plant species for the Capricorn Coast sand dunes and headland vegetation and this should be consulted for comparison.

Soil chemistry

At most sites, two samples were taken for analysis representing 0-10 cm and a 10 cm depth in the underlying C horizon or in the A_2 or B horizon where C horizon was unobtainable due to water tables etc. Two sites on the dunes and an additional site on the coastal plain were sampled as soil profiles to provide some chemistry on podzols and humus podzols in the tropics The samples were air dried, passed through a 2 mm sieve and subsamples ground to 0.5 mm for carbon and nitrogen analyses or in a Tema Mill for X-ray fluorescence determinations.

The methods used in the chemical analyses were:

pH in 1:5 aqueous suspension (McLeod et al. 1974) acid extractable phosphorus - 0.005 M H_2SO_4 extract (Kerr and von Stieglitz 1938), organic carbon by LECO induction furnace, nitrogen by Kjeldahl digestion and total phosphorus, calcium, potassium, magnesium, sulfur, copper and zinc by X-ray fluorescence using a pressed powder pellet with a boric acid backing (Norrish and Hutton 1969). Particle size was determined by pipette, using 100 gm samples because of the very low clay and silt contents. Clay suspensions from two samples were examined by X-ray diffraction techniques using a Phillips High-angle Diffractometer. Sodium pyrophosphate and oxalate extractions followed the methods of Soil Survey Staff (1972) and the sodium dithionate/sodium citrate extract that of Holmgren (1967).

Comments

The air photo patterns imply an age sequence of several dune systems in the Shoalwater Bay sandmass; this was confirmed by the reconnaissance. Field relationships, degrees of dune denudation and soil development indicate that the age sequence includes both Holocene and Pleistocene dunes. The Holocene dunes have many features equivalent to those seen in Dune Systems 1, 2, 3 at Cooloola (Thompson 1983, 1992) but the relationships of the Pleistocene systems are less certain. The older dunes at Shoalwater may not necessarily equate with the older dunes at Cooloola. Further field examinations and thermoluminescence dating should resolve this question.

Soil profile development in the age sequence generally parallels that recorded at Cooloola but there are insufficient data to be certain that the depths of solum development are of the same order in what appear to be equivalent dune systems for both localities. The rates of profile development may be greater at

Shoalwater Bay because of higher soil temperatures but the rates of dune reduction by water erosion are also likely to be more rapid due to (presumed) higher rainfall intensities and generally thinner soil surface cover.

Both Holocene and Pleistocene beach ridges were observed in the area. The western and central parts of Cleo Island consist of degraded beach ridges that are obviously older than Holocene and may represent deposition during the high sea levels of the last interglacial period, some 120 000 years ago. The parabolic dune remnants on the northern coast of the island are also of Pleistocene age; the soil B horizon development in these remnants is similar to that recorded in Pleistocene dunes at Cooloola and on North Stradbroke Island. Beach ridges of apparent Holocene age occur along the eastern shore of Cleo Island and elsewhere along the coast, e.g. south of Pine Tree Point.

In detail, the floristics and structure of the vegetation on the sand mass at Shoalwater Bay differ from that at Cooloola. A total of 282 species of vascular plants were collected against 603 at Cooloola (Harrold et al. 1987). How close this is to the actual total is difficult to estimate. Fewer rainforest or former rainforest sites were encountered during the reconnaissance and this undoubtedly reduces species richness compared with Cooloola. On individual sites (400 m^2), species numbers ranged from 9 to 38 species - numbers fairly comparable to Cooloola. Overall trends in succession across the dune ages showed similar progressive and retrogressive phases as described for Cooloola (Walker et al. 1981; Thompson and Walker 1987). While the vegetation on the sand mass at Shoalwater Bay has been ravaged by fires and cyclones to a greater extent than at Cooloola, the data imply that the major determinant of succession is related to nutrient availability (as at Cooloola).

As at the sandmasses in southern Queensland, it is possible to infer that vegetation has been involved in stabilising and holding the sands since they first began to accumulate along this section of the coast. Without vegetation, the winds would have moved the bare sands elsewhere, there would be no preservation of parabolic dunes and no giant soil profiles. Therefore the area must have carried vegetation since before the formation of the oldest parabolic dunes and certainly through the last glaciation (c 18 000 - 15 000 years ago) when conditions in many parts of Australia are believed to have been much drier. It seems that these dunes and beach ridges (and their vegetation) could make significant contributions to our knowledge of the Quaternary geomorphic history and climate of the central Queensland coast.

Acknowledgments

The reconnaissance of the coastal dunes at Shoalwater Bay was jointly funded by the then CSIRO Divisions of Land Use Research and Division of Soils, Brisbane. The chemical analyses were done in the Brisbane Soils Laboratory. The Australian Army gave its approval for the survey and provided helicopter transport during one of its training exercises in May 1976. Many of the sites are inaccessible without helicopter transport and we are very grateful to the Army for this service. We also thank Major Ken Gardiner who provided liaison with the Army, Mr B.A. Zarcinas (Division of Soils, Adelaide) for analysis of the pyrophosphate, dithionite/citrate and oxalate extracts, Mr D.J. Williams (Division of Soils, Brisbane) for clay minerology and Mrs B.A. Milloy for compilation.

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Table 1

GEOMORPHIC COMPONENTS OF COASTAL LANDFORMS CODE LIST

1.	**Parabolic Dunes**
1.1	Apex
1.11	--
.111	no qualification
.112	V-shaped crest
.113	slip face
.114	gully head slope
.115	gully i.e. water-worn channel
.116	fan
1.2	dune floor
1.21	coastal section
.211	no qualification
.212	sandbar
.213	platform
.214	depression
.215	gully
.216	fan
.217	remnant of older dune
.218	low knoll
.219	younger sand veneer
1.22	medial section
.221	no qualification
.222	sandbar
.223	platform
.224	depression
.225	gully
.226	fan
.227	remnant of older dune
.228	low knoll
1.23	inland section
.231	no qualification
.232	sandbar
.233	platform
.234	depression
.235	gully
.236	fan
.237	remnant of older dune
.238	low knoll
.239	sloping floor

1.3	trailing arms
1.31	coastal section
.311	crest
.312	internal slope
.313	external slope
.314	gully head slope
.315	gully
.316	fan
.317	remnant of older dune
.318	blowout
.319	younger sand veneer
1.32	medial section
.321	crest
.322	internal slope
.323	external slope
.324	gully head slope
.325	gully
.326	fan
.327	remnant of older dune
.328	blow out
1.33	inland section
.331	crest
.332	internal slope
.333	external slope
.334	gully head slope
.335	gully
.336	fan
.337	remnant of older dune
.338	blow out

2.	**sandhills and elongated sandridges (primary aeolian form not evident)**
2.1	elongated sandridges
2.11	--
.111	crest
.112	upper slope
.113	middle slope
.114	basal slope
.115	fan
.116	corridor floor
.117	corridor depression
.118	corridor gully
.119	saddle

2.2	whaleback sandhills
2.21	--
.211	crest
.212	upper slope
.213	middle slope
.214	basal slope
.215	fan
.216	corridor floor
.217	corridor depression
.218	corridor gully

2.3	lunette
2.31	--
.311	crest
.312	upper slope
.313	middle slope
.314	basal slope
.315	fan

3.	**beach ridge plains, foredunes, berms and beaches**
3.1	beach ridge plains
3.11	--
.111	ridge crest
.112	ridge slope
.113	swale
.114	swampy depression
.115	sand sheet
.116	low sandy banks
.117	modified (e.g. mined area)

3.2	foredunes
3.21	--
.211	crest
.212	slope
.213	swale
.214	swampy depression
.215	truncated (wind eroded)
.216	older dune remnant
.217	modified (e.g. mined area)

3.3	berms and beaches
3.31	--
.311	berm crest
.312	berm slope
.313	beach
.314	intertidal mud

4.	**coastal plains**
4.1	sandplains
4.11	--
.111	bank
.112	flat (general level)
.113	depression
.114	fan

4.2	valley plains
4.21	--
.211	levee
.212	flood plain
.213	depressions
.214	fan
.215	terrace

4.3	delta plains
4.31	--
.311	levee
.312	flood plain
.313	depression

5.	**headlands, escarpments and hills of country rock**
5.1	headlands
5.11	--
5.111	crest
.112	upper slope
.113	middle slope
.114	basal slope
.115	talus
.116	sea cliff

5.2	escarpment
5.21	--
5.211	crest
.212	upper slope
.213	middle slope
.214	basal slope
.215	fan
.216	cliff

5.3	low convex hills
5.31	--
.311	crest
.312	upper slope
.313	middle slope
.314	basal slope
.315	fan
.316	gully

Table 2

SOIL GROUPING CODE LIST

SOILS

SiS	Siliceous sands
CaS	Calcareous sands
Pz	Podzols
HPz	Humus podzols
PPz	Peaty podzols
APe	Acid peats

QUALIFYING TERMS

r	Rudimentary
g	Giant
b	buried
t	truncated
>	greater than
<	less than

Table 3

SOIL CHEMISTRY CODE LIST

OC	organic carbon
N	nitrogen
AP	weak acid extractable phosphorus
P	phosphorus
Ca	calcium
K	potassium
Mg	magnesium
S	sulphur
Cu	copper
Zn	zinc
Fe	iron
Al	aluminium
Si	silica
Q	quartz
Kao	kaolin
Vi	chloritised vermiculite
I	illite
H2O	water (distilled)
%	weight on an over dry basis
ppm	parts per million
XRF	X-ray fluorescence
part. size	particle size

Table 4

GEOMORPHIC COMPONENTS, SOIL GROUPINGS AND THICKNESS OF HORIZONS

SITE NO	MAP REF	GEOMORPHIC COMPONENT	ELEV METRES	SOIL GROUPING	FACTUAL KEY	THICKNESS cm SOLA	A1	DEPTH TO B cm
1	399734	2.215	45	HPz	Uc2.20	160	85	140
2	411738	2.214	80	gHPz	Uc2.20	540	100	210
3a	413738	2.212	95	gPz	Uc2.22	>910	110	670
3b	417739	2.211	125	Pz	Uc2.22	>520	90	140
4a	419727	2.211	180	gPz	Uc2.22	>750	90	490
4b	419731	2.211	150	gPz	Uc2.22	>600	90	390
5	413715	1.112	150	Pz	Uc2.22	550	60	150
6	415697	2.211	100	gPz	Uc2.22	>1050	80	850
7	416695	1.321	110	Pz	Uc2.21	270	40	55
8	417694	1.112	110	Pz	Uc2.21	90	500	115
9a	447686	3.211	2	SiS	Uc1.21	5	5	--
9b	447686	3.211	3	SiS	Uc1.21	5	5	--
10a	446686	3.112	3	bHPz	bUc2.20	>120	20	80
10b	446687							
10c	446687	3.114	1	bgHPz	bUc2.20	>330	80	290
10d	446687	3.117	2	btPz	bUc5.23	>450	110	110
10e	446687	3.115	2	HPz	Uc2.33	>150	10	40
11a	440586	3.111	8	CaS	Uc1.11	50	50	--
11b	440586	3.113	6	SiS	Uc1.21	45	45	--
11c	441586	3.211	8	CaS	Uc1.11	50	50	--
12a	438608	1.321	10	SiS	Uc1.21	20	20	--
12b	428607	1.221	6	SiS	Uc1.21	20	20	--
12c	437608	1.112	10	SiS	Uc1.21	10	10	--
13a	437607	1.234	6	rHPz	Uc2.	>150	30	>150
13b	436608	1.321	15	SiS	Uc1.21	15	15	--
13c	436607	1.231	9	SiS	Uc1.21	20	20	--
13d	435609	1.112	15	SiS	Uc1.21	20	20	--
14a	407737	2.215	50	HPz	Uc2.20	220	70	130
14b	406738	2.215	50	HPz	Uc2.23	340	80	175
14c								
14d	407739	2.215	50	Pz	Uc2.21	130	40	60
15a	416723	2.213	120	gPz	Uc2.22	>1210	75	1130
15b	416723	2.213	120	gPz				
16	433703	2.213	80	gPz	Uc2.22	>1060	80	920
17	434699	1.321	115	Pz	Uc2.21	400	60	85
18	433698	1.321	115	Pz	Uc2.21	300	50	75
19	439694	1.211	40	Pz	Uc2.21	220	75	135
20a	446686	1.311	15	rPz	Uc3.21	30	10	10
20b	445686	1.211	12	bHPz	bUc2.20	>300	40	230
20c	445685	1.331	15	rPz	Uc4.22	50	15	20
20d	444687	1.331	15	rPz	Uc4.22	50	15	25

SITE NO	MAP REF	GEOMORPHIC COMPONENT	ELEV METRES	SOIL GROUPING	FACTUAL KEY	THICKNESS cm SOLA	A1	DEPTH TO B cm
20e	446687	1.111	14	rPz	Uc5.11	40	10	10
21a	445690	1.211	20	SiS	Uc1.21	0	0	--
21b	445689	1.217	20	bHPz	bUc2.20	>300	40	230
22a	435607	1.211	15	HPz	Uc2.	>120	10	>120
22b	435608	1.212	16	SiS	Uc1.21	5	5	--
22c	434607	1.217	16	SiS	Uc1.21	10	10	--
22d	434608	1.218	18	SiS	Uc1.21	5	5	--
23a	409884	1.239	135	Pz	Uc2.21	360	120	180
23b	411883	1.239	120	Pz	Uc2.21	180	40	70
24a	413883	4.215	45	Pz	Uc2.21	130	30	80
24b	414883	4.212	40	rHPz	Uc4.23	>120	50	60
24c	414882	4.215	42	Pz	Uc2.21	85	45	60
25	418880	4.215	40	HPz	Uc2.20	>160	55	100
26a	420883	1.336	45	Pz	Uc2.21	120	40	80
26b	421883	1.336	50	rPz	Uc3.21	50	5	15
26c	421884	1.231	60	Pz	Uc2.21	>450	70	100
27a	423884	1.231	65	Pz	Uc2.21	>450	65	100
27b	424884	1.234	60	Pz	Uc2.21	>300	70	120
27c	425885	1.231	65	Pz	Uc2.21	>300	70	100
27d	426886	1.331	70	Pz	Uc2.21	>300	70	115
27e	427886	1.333	60	rPz	Uc3.21	40	10	15
28a	427887	1.321	50	Pz	Uc2.21	>350	70	100
28b	427887	1.332	55	rPz	Uc3.21	40	5	20
28c	428887	1.331	60	Pz	Uc2.21	60	15	30
28d	428887	1.333	55	rPz	Uc3.21	40	10	20
29a	444892	3.111	5	rHPz	Uc2.23	>260	80	200
29b	444891	3.113	3	rHPz	Uc2.23	>200	40	140
29c	443890	1.316	5	SiS	Uc1.21	40	40	--
29d	443889	1.316	15	Pz	Uc2.21	170	20	65
30a	428888	4.113	2	APe	O	--	120	--
30b	428889	4.113	2	APe	O	--	--	--
31a	414897	1.231	60	Pz	Uc2.21	220	75	95
31b	414896	1.231	60	Pz	Uc2.21	220	85	95
31c	415896	1.239	55	Pz	Uc2.21	270	45	60
31d	416897	1.233	50	rPz	Uc3.21	30	10	15
32	122380	1.231	60	Pz	Uc2.21	270	90	140
33	121380	1.331	60	Pz	Uc2.21	120	30	45
34	121379	1.333	50	rPz	Uc4.21	50	10	10
35	122378	1.234	60	bPz	bUc2.21	190	70	90
36	123380	1.112	60	Pz	Uc2.21	280	90	105
37	123380	1.331	60	Pz	Uc2.21	280	85	115

SITE NO	MAP REF	GEOMORPHIC COMPONENT	ELEV METRES	SOIL GROUPING	FACTUAL KEY	THICKNESS cm SOLA	A1	DEPTH TO B cm
38	123381	1.333	55	rPz	Uc4.21	60	10	10
39	122381	1.336	50	Pz	Uc2.21	100	20	30
40	127378	1.331	60	Pz	Uc2.21	120	10	60
41	126377	1.234	50	SiS	Uc2.12	110	30	--
42	125376	1.232	52	rP2	Uc4.22	100	40	40
43	159359	1.213	45	rPz	Uc4.22	210	60	75
44	159360	1.312	50	gPz	Uc2.21	285	120	210
45	159361	1.311	50	Pz	Uc2.21	120	20	30
46	159362	1.112	50	gPz	Uc2.21	400	130	240
47	159363	1.112	50	Pz	Uc2.21	400	90	170
48	156357	1.214	30	bPz	bUc2.21	>400	80	120
49	161357	1.217	30	rPz	Uc4.2	100	10	20
50	279233	3.111	5	rPz	Uc4.2	70	10	20
51	280233	3.113	2	rHPz	Uc2.22	125	50	110
52	280234	3.113	2	rHPz	Uc2.22	100	25	60
53	281234	3.111	3	rHPz	Uc2.22	150	25	90
54	281235	3.113	1	SiS	Uc1.21	20	20	--
55	282235	3.111	2	SiS	Uc1.21	35	35	--
56	282236	3.115	1	SiS	Uc1.21	25	25	--
57	312193	4.111	5	HPz	Uc2.	>80	70	>80
58	313190	1.231	30	Pz	Uc2.21	120	20	40
59	312191	1.231	35	Pz	Uc2.21	50	15	20
60a	313185	1.331	15	Pz	Uc2.21	200	25	50
60b	313185	1.331	15	Pz	Uc2.21	300	110	145
61	314185	1.234	3	HPz	Uc2.	>100	45	>100
62	315185	1.333	25	Pz	Uc2.21	140	45	60
63	316186	1.331	25	Pz	Uc2.21	100	20	30
64	315187	1.234	5	HPz	Uc2.	>60	40	>60
65	314187	1.232	8	Pz	Uc2.21	100	30	40
66	324182	1.224	3	HPz	Uc2.	>120	40	>120
67	327180	1.322	12	rPz	Uc3.21	>100	30	60
68	330179	1.311	10	rPz	Uc4.21	120	40	50
69	331178	1.211	5	SiS	Uc1.21	100	40	--
70	332178	3.211	3	SiS	Uc1.21	20	20	--
71	331178	3.211	2	SiS	Uc1.21	10	10	--
72	358082	4.111	20	Pz	Uc2.21	280	50	90
73	354086	4.112	20	gHPz	Uc2.	>360	80	>360
74	354088	1.323	45	Pz	Uc2.21	210	25	80
75	354089	1.323	50	rPz	Uc4.21	90	20	25
76	354090	1.321	60	Pz	Uc2.21	200	35	60
77	353097	1.222	75	Pz	Uc2.21	200	50	70

SITE NO	MAP REF	GEOMORPHIC COMPONENT	ELEV METRES	SOIL GROUPING	FACTUAL KEY	THICKNESS CM SOLA	A1	DEPTH TO B cm
78	355099	1.221	75	Pz	Uc2.21	160	30	50
79	356099	1.221	75	Pz	Uc2.21	150	20	60
80	353110	1.331	105	Pz	Uc2.21	200	40	60
81	348113	1.331	105	Pz	Uc2.21	120	25	45
82	348112	1.233	100	Pz	Uc2.21	200	60	90
83	349110	1.233	100	Pz	Uc2.21	300	40	70
84	355106	1.224	70	Pz	Uc2.21	180	50	85
85	356108	1.224	65	Pz	Uc2.21	470	60	85
86	375078	1.221	30	rPz	Uc4.21	40	10	20
87	375079	1.311	35	rPz	Uc4.21	50	10	20
88	374080	1.311	35	Pz	Uc2.21	120	30	60
89	371081	1.331	40	Pz	Uc5.11	70	10	10
90	369085	1.231	40	Pz	Uc2.21	110	40	50
91	368084	1.233	40	Pz	Uc2.21	150	20	25
92	368083	1.234	35	Pz	Uc2.21	180	20	40
93	369081	1.331	30	rPz	Uc3.21	40	20	25
94	369080	1.237	25	rPz	Uc3.21	150	10	20
95	375076	1.211	15	SiS	Uc1.21	5	5	--
96	378076	1.214	10	rHPz	Uc2.	>50	10	>50
97	379078	1.311	15	SiS	Uc1.21	10	10	--
98	370978	3.115	3	HPz	Uc2.	>160	75	>160
99	368978	3.113	2	HPz	Uc2.	>100	40	>100
100	366978	3.111	3	HPz	Uc2.	>160	40	>160
101	365978	3.113	2	HPz	Uc2.	>100	40	>100
102	375978	3.111	12	gPz	Uc2.21	430	85	240
103	376978	3.111	15	Pz	Uc2.21	200	30	55
104	351981	3.114	2	HPz	Uc2.	>80	60	>80
105	349981	2.212	12	Pz	Uc2.22	>400	70	200
106	348981	2.211	15	Pz	Uc2.22	250	70	100
107	347981	3.114	1	APe	O	--	80	--
108	347999	2.211	10	gPz	Uc2.22	>750	90	600
109	355999	3.111	10					
110	415983	1.331	20	Pz	Uc2.21	70	10	15
111	416984	1.234	10	HPz	Uc2.33	>150	25	100
112	416982	1.112	20	Pz	Uc2.21	180	30	90
113	419981	1.224	5	HPz	Uc2.20	>150	50	140
114	419979	1.322	20	Pz	Uc2.21	360	45	120
115	410820	2.213	100	gPz	Uc2.22	>1300	70	1270
116	412818	2.211	120	gPz	Uc2.22	>1400	70	1340
117	412819	2.211	120	gPz				
118	388879	1.331	105	Pz	Uc2.21	400	50	90

SITE NO	MAP REF	GEOMORPHIC COMPONENT	ELEV METRES	SOIL GROUPING	FACTUAL KEY	THICKNESS CM SOLA	A1	DEPTH TO B cm
119a	388882	1.331	120	Pz	Uc2.22	450	65	75
119b	388884	1.333	105					
120a	387881	1.332	105	Pz	Uc2.21	45	10	20
120b	387880	1.332						
121	386880	1.231	95	Pz	Uc2.21	>450	70	110
122	406838	2.311	85	gHPz	Uc2.	>820	60	>820
123	411840	2.311	85					
124	411843	1.321	100	Pz	Uc2.21	>120	25	50
125	400817	4.113	60	HPz	Uc2.20	>80	25	40
126	399816	4.111	60	HPz	Uc2.20	>150	50	115
127	398816	1.336	70	Pz	Uc2.21	390	60	90
128	397816	1.331	100	Pz	Uc2.21	70	10	15
129	393818	1.112	90	Pz	Uc2.21	200	40	65
130	394818	1.231	90	Pz	Uc2.21	300	60	90
131	394817	1.239	85	Pz	Uc2.21	200	30	65
132	395816	1.231	80	Pz	Uc2.21	300	60	90
133	439842	1.222	82	Pz	Uc2.21	420	50	90
134	439840	1.234	78	gHPz	Uc2.33	>320	50	250
135	438842	1.224	80	Pz	Uc2.21	290	70	150
136	438843	1.323	85	Pz	Uc2.21	390	60	90
137	839843	1.321	100	Pz	Uc2.21	120	25	50
138	841894	1.221	80	Pz	Uc2.21	360	70	125
139	451868	1.217	100	Pz	Uc2.21	340	60	100
140	451867	1.217	90	?gPz	Uc2.	>600	80	>600
141	451866	1.331	110	Pz	Uc2.21	200	60	90
142	452865	1.112	110	Pz	Uc2.22	>360	60	150
143	453864	1.333	100	gPz	Uc2.22	>360	70	240

Table 5

SOIL CHEMISTRY

Site No	Sample depth cm	pH H_2O	OC%	N%	AP ppm	XRF Analyses ppm P	Ca	K	Mg	S	Cu	Zn
2	0-10	5.1	1.00	.026	4	<10	290	40	150	70	7	3
	230-240	5.6				10	30	60	150	<10	5	7
3	0-10	5.8	1.77	.063	6	15	560	50	200	120	5	1
4	0-10	4.9	1.52	.039	3	<10	250	30	100	100	7	2
5	0-10	5.5	1.35	.044	3	15	220	30	200	100	4	1
	590-600	6.0				<10	15	30	50	10	5	2
6	0-10	5.0	1.17	.030	2	<10	200	25	100	90	8	1
	1040-1050	5.4				30	15	110	50	10	4	1
7	0-10	5.6	0.78	.023	3	15	280	60	150	40	5	1
	440-450	5.6				10	20	80	50	15	4	4
10d	160-170	5.3				220	30	220	100	110	6	5
11a	20-30	7.1				170	1400	3300	800	120	3	11
	150-160	7.2				40	460	2200	350	40	3	4
14a	0-10	6.5	0.21	.009	3	10	130	30	50	20	2	2
	390-400	5.7				10	15	130	50	10	4	1
14d	0-10	5-8	1.00	.043	4	50	400	1400	250	80	7	6
15a	0-10	4.9	2.85	.094	5	<10	780	50	350	170	6	3
	1190-1200	5.3				60	20	70	50	15	5	3
15b	0-10	5.1	1.34	.035	5	10	290	20	100	90	5	1
16a	0-10	5.0	1.86	.050	4	<10	400	40	250	110	7	1
	1040-1050	5.0				140	20	80	50	20	3	1
17a	0-10	4.9	1.67	.060	4	10	260	50	200	100	7	2
	440-450	5.5				10	20	50	50	20	2	3
18	0-10	5.0	1.07	.038	3	20	150	60	150	70	5	3
	440-450	5.6				10	30	90	50	20	1	2
19	0-10	6.2	0.83	.039	6	15	490	90	200	70	7	1
	230-240	5.4				50	20	80	100	30	3	2
20a	0-10	5.7	0.74	.044	11	70	130	500	250	70	2	7
	90-100	5.4				70	80	420	250	40	1	8
22a	0-10	6.0	0.10	.009	3	<10	10	30	<50	15	5	1
22b	0-10	5.7	0.01	.009	5	10	30	110	<50	30	3	1
22c	0-10	5.8	0.29	.016	7	40	40	260	100	50	7	1
22d	0-10	5.6	0.45	.024	9	40	70	320	100	50	5	1
23a	0-10	6.5	1.14	.033	6	15	670	50	150	60	8	1
	370-380	5.6				20	30	60	50	20	4	4
24a	0-10	5.6	1.14	.035	6	<10	310	80	100	40	5	2
	120-130	6.2				10	90	1350	300	15	2	2
24b	0-10	6.1	0.82	.033	4	10	360	560	250	50	6	5
25	0-10	5.5	0.89	.034	5	10	460	80	150	60	4	4
	100-110	5.2				60	40	410	300	70	2	7
26a	0-10	5.2	0.70	.033	4	10	300	50	100	50	4	2

Site No	Sample depth cm	pH H_2O	OC%	N%	AP ppm	XRF Analyses ppm P	Ca	K	Mg	S	Cu	Zn
26a	140-150	5.9				10	20	60	<50	20	2	4
26c	0-10	4.8	4.00	.146	8	15	980	70	500	200	8	1
	440-450	5.4				<10	15	50	<50	15	7	1
27a	0-10	4.9	2.78	.095	5	10	580	50	250	150	7	1
	440-450	5.4				15	15	60	50	20	4	1
27c	0-10	5.1	2.19	.063	7	10	750	60	200	100	4	1
	290-300	5.6				10	15	60	<50	20	4	1
27e	0-10	5.5	0.65	.023	3	20	190	80	100	100	9	1
28a	0-10	5.3	2.05	.066	5	15	850	50	250	80	9	1
28b	0-10	5.7	0.61	.023	4	40	160	90	150	40	1	6
28c	0-10	5.7	0.74	.028	3	15	240	80	150	50	7	6
	290-300	6.0				10	10	70	100	20	3	1
28d	0-10	5.7	0.73	.026	5	20	220	80	150	50	5	2
29a	0-10	6.3	0.90	.041	12	110	830	1700	400	90	1	7
	90-100	6.9				40	250	1800	250	30	2	6
29c	0-10	6.3	1.37	.080	7	110	980	650	450	130	6	2
29d	0-10	6.3	0.80	.036	5	30	510	500	200	50	8	3
30	0-10	4.6	--	1.29	60	720	3200	350	1700	7200	1	6
31a	0-10	5.1	2.15	.085	7	10	760	70	250	120	10	1
	590-600					15	20	70	100	10	5	2
31b	0-10	5.0	2.94	.107	6	20	770	70	300	140	10	1
31c	0-10	5.6	0.82	.026	4	20	270	90	200	50	2	4
32	0-10	5.5	0.91	.030	3	<10	410	60	150	60	14	3
	440-450	5.8				20	30	80	50	30	5	5
33	0-10	5.2	1.03	.050	5	20	360	80	200	60	6	7
	440-450	5.7				15	20	80	100	90	7	5
34	0-10	5.7	0.59	.028	6	20	130	110	200	70	4	5
	290-300	5.9				20	20	90	100	15	1	6
35	0-10	6.2	0.51	.023	5	10	350	80	100	40	6	6
	290-300	6.2				15	20	80	50	20	3	2
36	0-10	6.5	1.64	.077	--	<10	260	50	100	80	7	2
	440-450	4.5				15	15	70	<50	20	3	2
37	0-10	4.8	1.46	.071	4	10	250	80	150	90	7	3
	440-450	5.3				20	15	70	50	30	3	2
38	0-10	5.8	0.97	.042	5	15	140	110	200	60	8	3
	290-300	5.6				20	20	90	100	40	2	5
39	0-10	6.0	0.58	.030	5	40	220	110	200	60	6	4
	290-300	5.4				10	20	120	100	10	4	4
40	0-10	5.4	0.47	.025	5	20	200	110	150	40	8	5
	290-300	6.1				30	30	100	100	20	3	4
41	0-10	6.0	0.67	.030	3	20	360	300	250	50	8	4

Site No	Sample depth cm	pH H_2O	OC%	N%	AP ppm	XRF Analyses ppm P	Ca	K	Mg	S	Cu	Zn
41	130-140	6.2				190	140	5300	1000	80	45	20
42	0-10	6.3	0.54	.030	3	40	390	170	200	50	8	4
	290-300	6.5				20	40	120	150	30	6	10
43	0-10	5.7	0.94	.051	4	40	620	140	200	50	4	5
	440-450	6.4				50	30	130	150	20	3	7
44	0-10	4.7	1.09	.044	4	10	170	80	100	80	7	2
	300-310	4.8				140	30	80	50	20	4	1
45	0-10	4.7	1.02	.057	4	30	180	90	100	90	4	2
	290-300	5.2				30	15	100	50	30	4	2
46	0-10	5.9	2.23	.110	25	40	850	110	100	150	11	3
	440-450	5.1				170	20	210	300	40	7	3
47	0-10	5.2	1.03	.062	6	15	490	70	100	90	6	2
	390-400	5.1				30	20	110	50	20	7	3
48	0-10	6.4	0.42	.024	5	60	320	650	400	30	7	7
	390-400	6.0				90	380	2900	1400	60	11	14
49	0-10	6.3	0.80	.048	7	90	690	900	400	70	8	5
	290-300	6.2				80	90	1300	400	20	9	8
50	0-10	5.9	0.91	.055	7	90	830	3200	350	100	2	14
	90-100	6.7				60	360	2300	350	30	1	8
51	0-10	5.1	1.00	.044	6	60	410	3000	250	90	2	7
	110-120	5.8				30	210	2700	250	30	25	4
52	0-10	5.5	1.06	.044	6	40	680	2700	250	90	25	6
	90-100	6.0				40	160	2600	250	30	25	2
53	0-10	5.9	0.81	.041	7	40	640	2100	300	80	30	5
	90-100	6.2				40	190	2500	250	30	25	5
54	0-10	5.6	1.53	.068	13	80	1150	2150	400	110	25	9
	60-70	6.1				15	270	2450	250	30	5	7
55	0-10	6.0	0.88	.051	10	130	900	2350	500	100	1	11
	60-70	7.0				60	410	3700	450	30	2	7
56	0-10	7.3	0.82	.042	10	340	630	1450	1400	100	1	30
	60-70	7.4				40	320	2600	450	30	1	5
57	0-10	4.8	1.23	.037	3	10	150	70	150	90	3	2
	70-80	5.5				<10	20	40	100	50	1	3
58	0-10	5.0	0.67	.021	3	<10	140	100	100	40	3	3
	290-300	5.9				<10	20	90	50	20	4	4
59	0-10	5.1	0.69	.062	3	<10	150	130	150	70	3	3
60a	0-10	4.9	0.97	.065	4	20	280	120	250	70	1	7
	290-300	5.7				20	40	130	200	15	1	9
60b	0-10	5.1	0.59	.055	4	<10	190	70	100	50	4	4
	290-300	5.7				20	30	120	100	30	1	2
61	0-10	5.3	0.40	.009	4	10	110	60	100	50	5	2

Site No	Sample depth cm	pH H_2O	OC%	N%	AP ppm	XRF Analyses ppm P	Ca	K	Mg	S	Cu	Zn
61	60-70	5.8				<10	15	30	50	20	1	3
62	0-10	5.4	0.34	0.11	4	15	120	100	100	40	2	3
	290-300	5.6				10	20	90	50	15	3	2
63	0-10	5.3	0.35	.014	2	<10	110	130	150	30	4	6
	190-200	5.6				10	40	140	150	30	1	6
64	0-10	4.8	2.35	.063	4	20	300	120	150	120	8	2
65	0-10	4.9	1.00	.036	5	<10	180	80	100	70	6	1
	190-200	6.0				10	30	60	100	30	3	4
66	0-10	5.5	0.35	.019	3	10	120	110	100	40	2	3
67	0-10	6.2	0.20	.012	4	30	140	410	200	30	1	4
	290-300	6.0				15	60	530	150	20	1	3
68	0-10	5.7	1.13	.039	5	50	290	400	300	80	1	10
	290-300	6.1				20	30	160	100	20	2	8
69	20-30	6.5	0.82	.036	4	30	420	570	300	90	6	5
	290-300	6.1				<10	60	390	150	30	1	5
70	0-10	6.2	0.10	.010	4	20	70	600	200	40	1	7
	140-150	6.0				15	50	500	100	20	1	4
71	0-10	6.3	0.12	.009	5	20	160	530	200	30	2	2
	140-150	6.6				<10	90	480	150	30	2	3
72	0-10	4.6	0.64	.029	4	10	70	70	50	60	5	1
	210-220	5.6				20	30	250	100	30	1	6
73	10-20	5.0	0.54	.024	3	<10	100	50	50	40	6	4
	350-360	5.8				<10	15	10	50	10	2	1
74	0-10	5.8	0.27	.017	4	10	120	70	50	40	5	1
	430-440	5.8				30	15	110	50	10	2	1
75	0-10	5.4	0.80	.030	4	50	100	130	300	50	1	9
	100-110	5.7				10	15	60	50	20	2	1
76	0-10	5.2	0.83	.031	5	<10	260	60	100	60	6	4
	440-450	5.9				20	20	120	100	20	1	4
77	0-10	5.4	0.48	.024	5	<10	140	110	100	50	5	2
	290-399	5.8				20	30	280	50	20	1	2
78	0-10	5.3	0.50	.031	5	15	100	290	50	60	4	1
	290-300	5.9				10	20	380	100	20	2	2
79	0-10	5.9	0.36	.018	4	20	190	260	100	40	5	1
	290-300	6.1				15	20	330	100	20	2	2
80	0-10	5.4	0.38	.018	4	<10	110	100	50	30	5	1
	290-300	5.9				20	30	340	100	20	1	2
81	0-10	6.1	0.32	.004	4	15	210	300	100	50	4	2
	290-300	6.4				15	40	300	100	30	1	3
82	0-10	5.1	0.47	.023	4	<10	150	110	50	40	4	3
	290-300	5.8				<10	20	260	50	30	1	2

Site No	Sample depth cm	pH H_2O	OC%	N%	AP ppm	XRF Analyses ppm P	Ca	K	Mg	S	Cu	Zn
83	0-10	5.3	0.45	.022	4	<10	130	100	50	40	3	2
	290-300	5.6				20	40	440	100	30	2	3
84	0-10	4.6	2.16	.068	9	10	460	40	150	100	8	3
	290-300	5.7				<10	15	30	50	20	2	2
85	0-10	4.4	1.16	.047	5	<10	20	30	100	80	7	4
	490-500	5.3				30	30	250	50	40	1	1
86	0-10	5.5	0.56	.036	5	60	240	550	150	70	5	3
	290-300	5.5				<10	15	130	100	30	4	1
87	0-10	6.1	0.65	.030	9	40	310	570	200	60	5	5
	140-150	6.3				20	40	440	100	30	3	1
88	0-10	5.2	0.62	.041	5	15	150	380	200	80	1	4
	290-300	5.0				<10	30	200	50	30	4	2
89	0-10	6.6	0.95	.050	5	10	220	270	150	60	3	2
	290-300	5.5				<10	15	190	50	30	2	1
90	0-10	5.5	0.39	.027	4	<10	220	170	150	50	4	2
	290-300	5.8				<10	30	190	150	40	2	5
91	0-10	5.7	0.85	.037	5	15	360	110	150	50	9	4
	290-300	5.7				15	30	190	150	20	3	4
92	0-10	5.3	0.75	.037	5	15	310	140	150	20	6	3
	290-300	5.6				10	20	210	150	50	4	6
93	0-10	5.6	0.46	.025	7	20	200	350	200	60	4	2
	140-150	5.6				10	30	310	100	30	2	2
94	0-10	5.0	0.57	.026	3	10	110	120	50	40	6	1
	290-300	5.6				10	10	50	50	30	4	1
95	0-10	5.6	0.10	.011	5	20	70	560	100	30	3	2
	140-150	5.7				20	50	500	50	20	1	2
96	0-10	5.3	0.12	.011	6	70	130	420	400	40	1	15
	50-60	5.5				660	550	110	2900	15	1	150
97	0-10	5.7	0.22	.009	7	40	170	1200	250	30	4	4
	290-300	5.3				10	80	760	100	40	2	2
98	0-10	4.9	1.54	.064	4	<10	500	60	100	110	5	2
	150-160	5.3				<10	20	30	50	20	3	3
99	0-10	4.7	3.56	.137	12	50	790	100	200	270	5	1
100	0-10	5.2	0.59	.031	5	<10	290	30	50	70	3	1
101	0-10	4.8	1.24	.045	5	<10	50	60	100	110	4	1
102	0-10	4.4	1.54	.074	6	<10	210	70	150	120	6	1
	440-450	5.2				50	50	900	100	70	5	2
103	0-10	5.0	1.18	.072	5	15	590	700	200	130	6	5
	290-300	5.6				20	80	1550	200	30	3	3
104	0-10	4.5	4.18	.117	5	15	160	100	250	290	11	1
105	0-10	4.6	1.82	.078	4	<10	140	70	300	140	3	4

Site No	Sample depth cm	pH H_2O	OC%	N%	AP ppm	XRF Analyses ppm P	Ca	K	Mg	S	Cu	Zn
105	290-300	4.8				10	60	650	150	70	4	4
106	0-10	4.1	3.77	.171	5	<10	90	150	300	210	5	2
	290-300	4.8				20	60	1050	150	50	4	3
107	0-10	4.2	15.29	.547	15	160	570	3000	900	1600	6	9
	100-110	4.6				30	30	780	200	1100	8	2
108	0-10	4.9	2.33	.110	4	10	650	110	200	140	6	4
	610-620	--				10	580	120	250	150	4	1
110	0-10	4.8	0.59	.027	5	20	20	260	50	30	5	1
	20-30	4.9				20	200	950	150	50	5	1
	140-150	5.2				10	80	1100	100	50	4	5
111	0-10	5.6	0.44	.022	4	10	210	490	50	60	3	1
	110-120	5.5				40	40	900	100	180	8	2
112	0-10	5.5	0.54	.031	5	10	190	870	100	60	2	2
	290-300	5.8				10	50	910	100	30	5	1
113	0-10	4.7	0.97	.059	4	<10	180	530	100	120	2	1
	140-150	5.1				15	60	1200	150	50	3	1
114	0-10	5.2	0.33	.021	4	<10	110	520	100	50	1	1
	140-150	5.6				10	40	820	100	30	2	1
115	0-10	4.9	0.60	.023	3	<10	70	15	50	50	3	2
	1290-1300	4.5				90	20	100	50	20	4	2
116	0-10	4.8	1.69	.068	5	<10	280	20	200	110	3	1
	1350-1360	5.0				80	15	130	50	20	5	3
118	0-10	5.6	0.87	.033	4	<10	70	30	250	60	2	1
	440-450	4.5				10	10	50	50	30	2	2
119	0-10	3.9	1.33	.054	5	15	150	40	200	80	4	4
	740-750	4.9				20	20	60	150	30	1	6
120	0-10	4.9	0.61	.026	4	15	70	50	150	40	1	6
	50-60	5.4				15	20	50	200	10	1	6
121	0-10	4.4	2.28	.079	5	15	480	30	250	110	3	1
	440-450	5.2				15	10	40	50	15	4	2
122	0-10	4.0	1.30	.052	4	<10	40	20	150	90	4	1
	810-820	5.4				<10	5	5	50	15	3	1
123	0-10	4.4	1.27	.063	5	<10	200	40	150	70	2	3
	290-300	4.4				15	20	60	100	15	1	4
125	0-10	4.6	0.69	.039	3	<10	30	40	50	90	2	1
	50-60	4.9				20	20	90	50	90	6	3
126	0-10	4.7	1.28	.044	3	<10	230	40	150	90	2	1
	125-135	4.6				10	20	90	100	20	5	4
127	0-10	4.4	1.49	.046	6	10	170	40	200	80	5	1
	390-400	5.4				<10	20	60	100	20	4	2
128	0-10	5.4	0.44	.021	4	10	100	80	100	30	1	2

Site No	Sample depth cm	pH H_2O	OC%	N%	AP ppm	XRF Analyses ppm P	Ca	K	Mg	S	Cu	Zn
128	390-400	5.7				20	15	70	50	30	2	6
129	0-10	5.2	0.53	.027	4	15	180	40	100	50	6	3
	290-300	5.6				10	20	80	100	30	3	4
130	0-10	4.4	1.17	.047	4	<10	220	40	150	50	1	1
	290-300	5.5				15	15	60	50	20	4	2
131	0-10	4.5	1.20	.031	3	20	130	40	100	60	2	3
	290-300	5.7				20	15	80	50	20	3	2
132	0-10	4.4	0.72	.046	5	10	180	40	100	80	5	1
	290-300	5.1				20	15	80	50	15	3	1
133	0-10	4.7	1.47	.035	5	<10	70	30	150	100	5	2
	410-420	5.0				<10	10	50	50	30	3	1
134	0-10	5.2	0.35	.022	4	<10	90	20	50	30	4	1
	250-260	5.1				40	10	80	50	120	5	1
135	0-10	4-8	0.64	.040	5	<10	110	30	100	50	3	3
	270-280	4.3				<10	10	50	50	20	4	2
136	0-10	4.7	0.71	.042	5	<10	100	30	100	50	2	2
	440-450	5.7				10	15	80	50	20	2	4
137	0-10	5.2	0.40	.025	4	<10	160	70	100	40	1	2
	190-200	5.9				10	15	90	50	20	3	1
138	0-10	4.8	1.92	.076	4	20	510	30	250	100	4	1
	290-300	5.1				10	15	40	150	20	1	4
139	0-10	4.6	0.74	.038	3	<10	50	30	100	60	1	1
	440-450	4.5				80	15	120	100	90	2	1
140	0-10	4.4	1.55	.034	4	10	210	30	150	110	2	1
	590-600	5.2				<10	10	10	50	10	2	1
141	0-10	4.8	0.97	.044	5	10	180	50	150	50	2	4
	290-300	5.3				<10	20	50	50	10	3	1
142	0-10	4.7	1.89	.085	6	<10	270	50	250	130	2	2
	290-300	5.0				15	20	70	150	15	1	6
143	0-10	4.8	0.86	.045	4	20	210	30	150	90	2	4
	290-300	5.7				20	10	30	50	15	3	2

Profile	B872 Townshend Island Podzol
Location	Townshend Island, Site No 32, Australia 1:50000 Topographic Survey, Cape Townshend 120378
Landform	Floor of parabolic dune near apex
Parent material	Aeolian quartzose sands
Great Soil Group	Podzol
Factual Key	Uc2.21

Horizon	Depth cm	Morphology
A_{11}	0-1	Light brownish grey (10YR 6/1,5/1) sand; loose dry; discrete organic matter fragments and charcoal. Sharp to;
A_{12}	1-50	Very dark brownish grey (10 YR 3/1) sand; loose dry; diffuse and discrete organic matter, occasional charcoal. Diffuse to:
A_{13}	50-120	Dark brownish grey (10 YR 4/1,5/1) sand; barely coherent moist; very diffuse organic matter and staining. Diffuse to:
A_2	120-135	Pale brown (10 YR 6/3,d7/2) sand; loose. Clear to:
B_{2s1}	135-180	Reddish brown (5 YR 3/4), with brown (7.5 YR 3/3) streaks, sand; weakly coherent moist. Diffuse to:
B_{2s2}	180-210	Brown (7.5 YR 3/3), with yellowish brown (7.5 YR 5/6, 6/6) patches, sand; barely coherent moist. Diffuse to:
B_3	210-270	Yellowish brown (7.5 YR 5/6,6/6) with brown (7.5 YR 4/4) patches, sand; barely coherent moist. Diffuse to:
C_1	270-360	Yellowish brown (7.5 YR 6/6) sand; loose. Diffuse to:
C_2	360-450	Light yellowish brown (7.5 YR 7/6) sand; continuing below 450 cm

Table 6

B872 TOWNSHEND ISLAND PODZOL

					XRF Analyses ppm							Part size	
Sample depth cm	pH H_2O	OC %	N%	AP ppm	P	Ca	K	Mg	S	Cu	Zn	silt	clay
0-10	4.9	1.23	.051	2	26	570	70	150	50	4	3		
20-30	4.6	0.59	.016	2	10	110	50	100	30	9	2	0.0	0.0
50-60	4.6	0.20	.009	1	<10	50	40	50	40	4	2		
90-120	4.9	0.09	.004	1	<10	20	40	100	20	7	3		
120-135	4.9	0.05	.001	1	<10	20	50	50	10	2	2		
135-150	4.7	0.19	.006	2	10	20	80	100	20	5	5	0.0	2.0
150-180	4.9	0.18	.006	1	--	--	--	--	--	--	--	0.2	0.4
180-210	5.0	0.15	.005	2	10	20	80	100	20	1	2	0.1	0.3
210-240	4.9	0.13	.005	2	10	20	80	50	20	1	3	0.1	0.2
300-330	4.9	0.07	.003	4	10	20	90	50	20	1	7		

Table 7

B872 TOWNSHEND ISLAND PODZOL

Sample depth cm	Pyrophosphate		Dithionite/ citrate		Oxalate				Clay Mineral
	Fe	Al	Fe	Al	Fe	Al	Si	P	
135-150	1014	241	1441	181	602	142	<20	<20	Kao+Vi
150-180	--	--	2698	532	661	199	<20	<20	
180-210	593	320	1096	255	437	218	<20	<20	
210-240	394	393	921	300	279	308	<20	<20	
240-270	250	404	813	353	155	331	41	<20	

Profile	B874 Cleo Island Giant Podzol
Location	Northern margin of Cleo Island above low sea cliff, Site No 108 Australia 1:50000 Topographic Survey Mount Hummock 346999
Landform	Floor of parabolic dune remnant
Parent material	Aeolian quartzose sands
Great Soil Group	Giant podzol
Factual Key	Uc2.22

Horizon	Depth cm	Morphology
A_{11}	0-1	Light brownish grey (10YR 6/1,5/1) sand; loose dry; discrete organic matter fragments and charcoal. Sharp to;
A_{12}	1-50	Very dark brownish grey (10 YR 3/1,4/1) sand; loose dry; diffuse organic matter, occasional charcoal. Diffuse to:
A_{13}	50-90	Dark brownish grey (10 YR 4/1,5/1) sand; barely coherent moist; very diffuse organic matter and staining. Diffuse to:
A_2	90-450	Pale brown (10 YR 6/2, 6/3,d7/2) grading to off-white (10 YR 8/1, 9/1), sand; loose. Clear irregular to:
B_1	450-600	Off-white (10 YR 8/2, 9/2), with light brown (10 YR 6/4) and yellowish brown (7.5 YR 5/6) patches, sand; loose, Diffuse to:
B_{2s1}	600-630	Yellowish brown (7.5 YR 5/6), with dark brown (7.5 YR 3/2, 3/3) and off-white (10 YR 8/2, 9/2) areas, sand; weakly coherent moist, a pipey B_2
B_{2s2+h}	630-690	Yellowish brown (7.5 YR 5/6,5/4) with dark brown (7.5 YR 3/2, 3/3) and black (10 YR 2/1) patches, sand; weakly coherent moist. Diffuse to:
A_2+B_{2h}	690-720	Off-white (10 YR 9/2) and black (10 YR 2/1) sand and organic sand; A_2 pipe and pipe walls in pipey B_2 horizon; continuing below 800 cm

Table 8

B874 CLEO ISLAND GIANT PODZOL

Sample depth cm	pH H_2O	OC %	N%	AP ppm	XRF Analyses ppm P	Ca	K	Mg	S	Cu	Zn	Part size silt	clay
0-10	4.9	2.23	.109	4	10	650	110	200	140	6	4		
20-30	4.2	1.38	.046	2	<10	170	30	100	90	4	4	0.2	0.5
30-50	4.3	0.63	.023	2	<10	70	30	50	40	9	2		
60-90	4.7	0.17	.004	2	<10	20	20	<50	20	3	1		
120-150	4.9	0.04	.003	1	<10	10	20	<50	10	3	2		
390-450	5.1	0.01	.001	1	<10	5	20	<50	10	3	1		
510-540	5.2	0.02	.001	1	<10	10	40	<50	20	3	4		
600-630	4.6	0.11	.004	3	30	20	260	50	20	3	4	0.4	0.6
660-690	4.7	0.15	.005	4	--	--	--	--	--	--	--	0.3	1.5
Bhs 800	4.9	0.05	.001	3	20	20	430	<50	20	5	3	0.0	0.5
Bh 800	4.8	0.68	.021	2	20	50	280	100	30	5	2	0.0	0.5
A_2 800	5.2	0.01	.001	1	<10	10	70	<50	20	3	3	0.0	0.0

Table 9

B874 CLEO ISLAND GIANT PODZOL

Sample depth cm	Pyrophosphate Fe	Al	Dithionite/ citrate Fe	Al	Oxalate Fe	Al	Si	P	Clay Mineral
600-630	1163	47	2199	132	780	80	<20	<20	
630-660	1270	105	2177	212	999	84	<20	<20	
660-690	1194	166	2179	114	968	174	<20	<20	
690-720	721	240	--	--	362	218	<20	<20	
Bhs 800									Q+Kao+I

Profile	B873 Samuel Hill Humus Podzol
Location	Army airfield near Samuel Hill, Australia 1:50 000 Topographic Survey, Mount Hummock 296790
Landform	Gently sloping coastal plain
Parent material	Fine sandy alluvium of local origin
Great Soil Group	Humus podzol
Factual Key	Uc2.36

Horizon	Depth cm	Morphology
A_{11}	0-2	Light brownish grey (10 YR 6/1,5/1) loamy fine sand; massive hardsetting dry; firm moist, rain washed material. Sharp to;
A_{12}	2-15	Very dark brownish grey (10 YR 3/1) loamy fine sand; massive hardsetting dry; firm moist. Diffuse to:
A_{13}	15-20	Brownish grey (10 YR 4/1,5/1) loamy fine sand; massive, firm moist. Gradual to:
A_2	20-38	Pale brown (10 YR 6/2, 6/3) with paler patches, and off-white (10 YR 7/2, 8/2) dry, fine sand; firm to friable moist; few rusty rootlines. Clear to:
B_{2h}	38-43	Black (10 YR 2/1) fine sand with organic compounds; massive, firm to friable moist. Sharp to:
D_1	43-60	Brown (10 YR 4/4, 5/4) with very dark brown (10 YR 2/2) streaks of organic compounds, clayey fine sand; massive hard pan; very hard dry. Gradual to:
B_2	60-90	Yellow-brown (10 YR 5/6, 6/6) with very light grey (2.5 Y 7/1 vertical streaks, light fine sandy clay loam; massive hard pan; very hard dry; occasional water worn gravel (Paleozoic metamorphic rock), continuiing below 90 cm

Table 10

B873 SAMUEL HILL HUMUS PODZOL

					XRF Analyses ppm							Part size	
Sample depth cm	pH H_2O	OC %	N%	AP ppm	P	Ca	K	Mg	S	Cu	Zn	silt	clay
0-2	5.5	1.40	.046	7									
2-10	5.4	1.58	.044	6	<10	120	120	50	120	13	1	16	2.5
10-15	5.0	0.88	.025	4									
15-20	4.7	0.78	.019	3									
20-30	5.0	0.46	.014	2	<10	50	90	100	40	4	3	21	0.6
30-38	5.0	0.26	.010	2									
38-43	5.0	1.20	.036	3	10	150	160	250	160	13	2	20	3.0
43-60	5.2	0.77	.016	2	<10	110	190	300	140	5	6	23	0.7
60-90	5.0	0.11	.008	1								23	9.0

Table 11

SPECIES LIST

1	Acacia amblygonia	mimosa
2	Achyranthes aspera	amaran
3	Acacia aulacocarpa	mimosa
4	Acacia cunninghamii	mimosa
5	Acacia flavescens	mimosa
6	Acacia julifera	mimosa
7	Acacia sophoroe	mimosa
8	Acacia sparsifolia	mimosa
9	Aegiceras corniculata	myrsin
10	Ageratum conyzoides	astera
11	Ajuga australis	lamiac
12	Alphitonia constricta	rhamna
13	Alternanthera denticulata	amaran
14	Alphitonia excelsa	rhamna
15	Alloteropsis semtunlata	poacea
16	Alyxia spicata	apocyn
17	Alysicarpus vaginalis	fabace
18	Amaranthus viridus	amaran
19	Apophyllum anomalum	cappar
20	Aphananthe philippinensis	ulmace
21	Aristida armata	poacea
22	Aristida calycina	poacea
23	Araucaria cunninghamii	conife
24	Aristida jerichoensis	poacea
25	Aristida leptopoda	poacea
26	Aristida ramosa	poacea
27	Atylosia marmorata	fabace
28	Axonopus affinis	poacea
29	Banksia integrifolia	portea
30	Bacopa procumbens	scroph

31	Banksia robur	protea
32	Baeckea stenophylla	myrtac
33	Bidens pilosa	astera
34	Blumea saxilis	astera
35	Blechnum serrulatum	filice
36	Boronia bipinnata	rutace
37	Bothriochloa bladhii	poacea
38	Borreria brachystema	rubiac
39	Bothriochloa deciepens	poacea
40	Borreria multicaulis	rubiac
41	Brunonia australis	brunon
42	Brachyloma daphoides	poacea
43	Breynia oblongifolia	euphor
44	Bulbistylis barbarta	cypera
45	Bulbinopsis bulbine	liliac
46	Calandrina balonensis	portul
47	Cassia brewsteri	caesal
48	Caladenia caerula	orchid
49	Canthium coprosmoides	rubiac
50	Casuarina equisetifolia	casuar
51	Cassytha filiformis	cassyt
52	Calophyllum inophyllum	clusia
53	Casuarina littoralis	casuar
54	Cassia mimosoides	caesal
55	Casuarina torulosa	casuar
56	Ceriops tagal	rhizop
57	Chrysopogon fallax	poacea
58	Chenopodium trignon	chenop
59	Commersonia bratramia	stercu
60	Commelina lanceolata	commel
61	Coelospermum reticulatum	rubiac
62	Crotalaria calycina	fabace
63	Cryptostegia grandiflora	asclep
64	Crotalaria mitchelli	fabace
65	Crotalaria trifoliastrum	fabace
66	Cupaniopsis anacardioides	sapind
67	Cyperus aristatus	cypera
68	Cyperus cinnamometorum	cypera
69	Cyperus conicus	cypera
70	Cyperus fulvus	cypera

71	Cyperus gracillis	cypera
72	Cyperus haspan	cypera
73	Cyperus javanicus	cypera
74	Cyperus leicaulon	cypera
75	Cyperus perangustus	cypera
76	Cymbopogon refractus	cypera
77	Cyperus subulatus	cypera
78	Cyperus tetragonia	cypera
79	Dampiera ferruginea	gooden
80	Dactyloctenium radulans	poacea
81	Denhamia obscura	celast
82	Denhamia pittosporoides	celast
83	Desmodium variata	fabace
84	Digitaria ammophila	poacea
85	Dianella caerulea	liliac
86	Digitaria ciliaris	poacea
87	Digitaria diminuta	poacea
88	Digitaria leucostachya	poacea
89	Digitaria propinqua	poacea
90	Dianella revoluta	liliac
91	Dodonaea triquata	sapind
92	Dodonaea viscosa	sapind
93	Drypetes australasica	euphor
94	Drosera rotundifolia	droser
95	Ectrosia leporina	poacea
96	Emelia sonchifolia	astera
97	Entolasia stricta	poacea
98	Eremochloa bimaculata	poacea
99	Eragrostis brownii	poacea
100	Eragrostis elongatum	poacea
101	Eragrostis interrupta	poacea
102	Eragrostis lacunaria	poacea
103	Eriachne rara	poacea
104	Eucalyptus acmenioides	myrtac
105	Eucalpytus drephanophylla	myrtac
106	Euphorbia eremophila	euphor
107	Eucalyptus exserta	myrtac
108	Eucalpytus intermedia	myrtac
109	Eustrephus latifolius orange	philes
110	Euphorbia mcgullveryii	euphor

111	Eucalyptus polycarpa	myrtac
112	Eucalyptus robusta	myrtac
113	Eucalyptus tereticornis	myrtac
114	Eucalyptus tessellaris	myrtac
115	Eucalyptus trachyphloia	myrtac
116	Eucalyptus umbra	myrtac
117	Eucalyptus umbra var carnea	myrtac
118	Exocarpus cupressiformis	santal
119	Exocarpus latifolius	santal
120	Fenzlia obtosa	myrtac
121	Fimbristylis cannomometorum	cypera
122	Fimbristylis dichotoma	cypera
123	Fimbristylis monostachya	cypera
124	Ficus opposita	morace
125	Ficus platypoda	morace
126	Fimbristylis tetragona	cypera
127	Fimbristylis vaginata	cypera
128	Gahnia sieberana	cypera
129	Geitenoplesum cymosum black	philes
130	Gleichenia dicarpa	gleich
131	Glochidion disparipes	euphor
132	Glochidion ferinandi	euphor
133	Glochidion lobocarpum	euphor
134	Glochidion supra-axillare	euphor
135	Glycine tabacina	fabace
136	Glossogyne tenuifolia	astera
137	Glycine tomentella	fabace
138	Glycine tomentosa	fabace
139	Gnaphalium luteo-album	astera
140	Gonocarpus chinensis spp verrucosus	asclep
141	Gompholobium virgatum	fabace
142	Grevillea banksii	protea
143	Grewia latifolia	liliac
144	Grewia oblongifolia	liliac
145	Gynura pseudochina	astera
146	Hardenbergia violacea	fabace
147	Helichrysum albicans	astera
148	Heteropogon contortus	poacea
149	Hedyotis lapeyrousii	rubiac
150	Helipterum polyphyllum	astera

151	Helichrysum repcula	astera
152	Heteropogon triticeus	poacea
153	Hibbertia linearis	dillen
154	Hibbertia scandens	dillen
155	Hibbertia velutina	dillen
156	Hovea longifolia	fabace
157	Homoranthus virgatus	myrtac
158	Hybanthus enneaspermus	violac
159	Hyparrhenia hirta	poacea
160	Hypolaena laterifolia	restio
161	Imperata cylindrica	poacea
162	Ipomoea cairica	convol
163	Ipomoea calpica spelling	convol
164	Ipomoea eriocarpa	convol
165	Ipomoea pes-caprae	confol
166	Ischaemum fragile	poacea
167	Ischaemum villosum	poacea
168	Jacksonia scoparia	fabace
169	Jagera pseudorhus	sapind
170	Jasminum didymum	oleace
171	Juncus sp	juncac
172	Justicia procumbens	acanth
173	Lantana camara	verben
174	Leptospermum flavescens	myrtac
175	Lepidosperma laterale	cypera
176	Leucopogon leptospermoides	epacri
177	Leptospermum petersonii	myrtac
178	Leptospermum sericatum	myrtac
179	Livistona sp	arecac
180	Lomandra filiformis	xantho
181	Lomandra multiflora	xantho
182	Loranthus sp	lorant
183	Mallotus claoxyloides	euphor
184	Macaranga sp	euphor
185	Macrozamia miquelii	cycada
186	Malaisia scandens	morace
187	Melaleuca leucadendron	myrtac
188	Melinis minutiflora	poacea
189	Melaleuca nervosa	myrtac
190	Melaleuca quinquenervia	myrtac

191	Melichrus urceolatus	poacea
192	Melaleuca viridiflora	myrtac
193	Mirbelia rubiifolia	fabace
194	Mogmania parviflora	scroph
195	Mukia scabrella	cucurb
196	Oplismenus aemulus	poacea
197	Opuntia sp	cactac
198	Panicum buncei	poacea
199	Paspalidium constrictum	poacea
200	Panicum decomposiatum	poacea
201	Paspalum dilatatum	poacea
202	Panicum effusum	poacea
203	Parsonsia eucalyptifolia	apocyn
204	Passiflora foetida	passif
205	Paspalum intermedia	poacea
206	Paspalidium interupta	poacea
207	Parsonsia lanceolata	apocyn
208	Pandanus sp	pandan
209	Passiflora phycoides	passif
210	Paspalidium radiatum	poacea
211	Parsonsia stramineae	apocyn
212	Passiflora suberosa	passif
213	Pellaea falcata ver nana	filice
214	Persoonia linearis	protea
215	Petalostigma pubescens	euphor
216	Petalostigma quadriloculare	euphor
217	Perotis rara	poacea
218	Phyllanthus daphnoides	euphor
219	Phyllanthus fuernrohrii	euphor
220	Phyllota phylicoides	fabace
221	Phragmites sp	poacea
222	Phyllanthus simplex	euphor
223	Phebalium woombye	rutace
224	Pimelea linifolia	thymel
225	Pityrodia salvifolia	verben
226	Planchonia careya	burrin
227	Platsace linearfolia	hydroc
228	Podeliepes longipedata	astera
229	Poranthera microphylla	euphor
230	Pouteria sericea	sapota

231	Pomax umbellata	rubiac
232	Pseudanthus pimeleoides	euphor
233	Pseuderanthemum variable	acanth
234	Pteridium esculentum	dennst
235	Restio dichomata	restio
236	Restio tetrophyllus	restio
237	Ricinocarpus pinifolius	euphor
238	Sarcostemma australe	asclep
239	Sacciolepis indica	poacea
240	Schoenus apogon	cypera
241	Schizeae bifida	schiza
242	Schoenus calostachys	cypera
243	Schizea dichotorna	schiza
244	Scleria levis	cypera
245	Setaria glauca	poacea
246	Sesuvium portulacastrum	aizoac
247	Setaria surgens	poacea
248	Sida cordifolia	malvac
249	Smilax glychylla	smilac
250	Solanum esuriale	solana
251	Solanum nigram	solana
252	Solanum seaforthianum	solana
253	Sporobolus elongata	poacea
254	Spinifex hirsuta	poacea
255	Sprengelia sprengelioides	epacri
256	Sporobolus virginicus	poacea
257	Stylidium eglandulosum	stylid
258	Stephania japonica	menisp
259	Styphelia triflora	epacri
260	Tephorsia filipes	fabace
261	Themeda australis	poacea
262	Timonius timon	rubiac
263	Trema aspera	ulmace
264	Tristania conferta	myrtac
265	Tricoryne elatior	liliac
266	Triumfetta repens	liliac
267	Tristania suaveolens	myrtac
268	Urena lobata	malvac
269	Urochloa panicoides	poacea
270	Vernonia cinerea	astera

271	Vigna marina	fabace
272	Vitex negundo	verben
273	Wedelia spilanthoides	astera
274	Wikstroemia indica	thymel
275	Xanthorrhaea (broad)	xantho
276	Xanthorrhaea (narrow)	xantho
277	Zieria laxiflora	rutace
278	Zornia dyctiocarpa	fabace
279	Zornia multicaulis	fabace
280	Zoysia pungens	poacea

Table 12

SPECIES RECORDED AND NUMBER OF SPECIES AT EACH SITE

Site No.	1	2	3	4	5	6	7	8	9	10a
1	4	5	3	5	5	29	5	5	50	51
2	5	14	5	29	29	42	6	6	65	65
3	14	15	36	45	42	51	29	41	96	66
4	15	29	42	53	51	53	42	42	106	69
5	22	42	51	65	53	65	45	108	136	77
6	29	55	53	104	118	116	53	120	139	96
7	41	90	71	108	120	118	79	135	154	110
8	42	104	90	120	153	120	90	146	161	120
9	51	108	104	133	157	132	104	214	165	138
10	53	120	108	153	174	157	108	226	206	145
11	55	131	120	156	177	170	118	234	222	154
12	90	135	153	157	220	174	120	261	228	158
13	98	146	177	177	223	177	135	275	254	161
14	108	156	211	220	224	217	138		256	165
15	114	199	216	223	227	220	146			173
16	142	207	220	227	232	223	161			197
17	146	214	223	235	235	229	177			206
18	147	223	224	237	275	234	206			209
19	153	226	227	275	277	235	216			212
20	161	228	228	277		237	224			215
21	177	234	235			275	226			222
22	181	240	237				228			224
23	185	243	276				234			237
24	188	261					261			247
25	189	264					265			248
26	199	276					275			256
27	216						276			268
28	226									278
29	234									
30	241									
31	259									
32	264									
33	265									
34	267									
35	276									
36										
37										
No. of species	35	26	23	20	19	21	27	13	14	28

Site No.	10d	11c	11a	12a	12b	13a	13b	13c	13d	14a
1	6	51	16	14	14	6	6	29	29	5
2	14	59	19	66	29	29	22	66	53	14
3	43	64	29	96	76	43	29	90	66	15
4	50	65	66	101	136	66	43	91	67	29
5	51	66	67	110	139	142	89	120	90	32
6	65	101	81	136	161	161	120	142	119	42
7	66	133	90	161	190	165	142	161	142	43
8	70	136	93	165	215	169	161	169	161	51
9	71	161	114	182	228	190	169	170	169	53
10	77	165	119	190	258	204	199	173	173	53
11	90	170	124	204	273	212	204	204	190	90
12	119	173	125	212		215	212	225	226	104
13	120	195	132	228		226	215	226	273	108
14	133	212	169	256		267	220	267		110
15	138	247	170	258			224			120
16	142	248	173	274			226			137
17	169	254	179				239			138
18	170	256	186				258			161
19	173	258	204							168
20	197		212							177
21	204		230							181
22	205		252							190
23	212		258							214
24	215		272							226
25	224		276							227
26	225									234
27	226									240
28	258									261
29	268									264
30										270
31										275
32										277
33										
34										
35										
36										
37										
No. of species	29	19	25	16	11	14	18	14	13	32

Site No.	14b	14c	14d	15a	15b	16a	16c	17a	17b	18
1	29	5	14	42	42	5	5	5	5	5
2	32	15	29	45	44	29	6	29	29	22
3	51	29	32	53	45	42	29	42	36	29
4	53	32	51	108	53	45	45	45	51	42
5	90	42	55	116	108	53	51	53	53	51
6	104	53	87	118	116	116	53	79	79	53
7	120	90	90	120	118	120	120	108	108	108
8	138	104	104	133	120	153	153	116	120	120
9	161	146	105	153	133	224	177	120	153	157
10	177	177	108	177	153	227	216	153	155	174
11	180	199	109	223	174	235	220	157	174	177
12	187	234	153	227	177	237	223	174	220	214
13	200	240	158	235	223	275	237	214	234	220
14	226	261	161	237	227	277	237	220	235	223
15	234	264	169	275	235		275	223	240	227
16	261	270	175	277	237		277	227	275	235
17		277	216		275			234	276	237
18			226		277			237	277	240
19			234					275		275
20			240							
21			241							
22			258							
23			265							
24			267							
25			275							
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
No. of species	16	17	25	16	18	14	16	19	18	18

Site No.	19	20a	20b	21	22a	22b	22c	22d	23a	23b
1	6	5	6	6	39	22	22	14	5	5
2	15	6	14	29	45	29	29	43	29	29
3	29	14	16	51	53	43	53	53	55	39
4	42	16	18	53	142	53	120	87	90	42
5	45	53	45	66	153	118	153	90	104	55
6	64	66	64	90	192	120	161	120	107	90
7	79	71	66	118	206	153	174	131	108	104
8	90	90	70	120	220	161	220	153	131	108
9	108	119	71	142		177	225	169	138	110
10	120	120	80	146		220		206	161	131
11	146	142	90	169		225		258	226	146
12	153	173	118	173					233	156
13	161	197	120	192					234	161
14	168	204	139	202					240	224
15	190	205	142	204					261	226
16	206	212	161	206					264	231
17	214	215	169	212					275	233
18	216	225	192	215					277	234
19	220	233	197	225						240
20	226	258	204	254						243
21	234	275	206	261						259
22	235		212							261
23	261		215							265
24	267		215							275
25	275		219							
26	276		233							
27			247							
28			248							
29			251							
30			256							
31			268							
32			270							
33										
34										
35										
36										
37										
No. of species	26	21	32	21	8	11	9	11	18	24

Site No.	24a	24b	24c	25	26a	26b	26c	27a	27b	27c
1	5	4	5	5	5	5	5	5	5	5
2	29	29	29	29	29	6	6	6	6	42
3	55	31	55	42	90	29	42	42	42	45
4	87	35	87	55	104	53	90	53	104	90
5	90	55	104	90	108	56	104	71	108	104
6	104	72	115	97	120	104	108	104	120	105
7	108	86	120	108	161	108	120	105	157	108
8	110	90	131	112	168	120	131	108	177	120
9	131	114	161	120	177	142	161	120	227	133
10	156	124	208	131	179	156	177	177	235	146
11	161	131	214	146	194	161	199	214	237	153
12	194	140	226	156	214	177	206	216	276	161
13	208	149	234	161	224	199	214	220		214
14	226	187	240	164	226	214	224	227		216
15	234	201	261	181	228	220	228	233		224
16	240	208	264	185	233	225	234	237		227
17	261	213	265	213	234	235	235	259		228
18	264	233	275	228	259		237	275		261
19	275	240		234	261		275	277		275
20		244		240	264		277			277
21		249		243	266					
22		264		261	276					
23		281		275						
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
No. of species	19	23	18	23	22	17	20	19	12	20

Site No.	27d	27e	28a	28b	28c	28d	29a	29b	29c	29d
1	5	5	4	5	5	4	5	4	5	4
2	6	12	5	6	6	5	14	14	14	5
3	42	29	6	29	22	15	29	22	22	14
4	71	83	22	42	29	22	33	28	28	24
5	90	104	42	83	42	29	39	29	29	28
6	104	108	44	104	65	42	43	43	64	29
7	108	120	104	108	83	51	64	45	70	64
8	120	133	108	120	90	53	66	54	114	65
9	153	142	120	142	104	61	70	64	120	70
10	177	168	133	168	107	104	84	70	131	71
11	199	174	153	177	108	107	90	87	161	90
12	206	206	199	214	120	108	113	109	179	100
13	216	214	206	222	138	120	114	113	181	114
14	220	220	214	228	142	135	124	125	194	120
15	224	228	220	261	168	138	133	131	206	124
16	227	260	224	275	194	142	143	142	226	138
17	229	261	228	276	206	168	161	143	234	142
18	261	275	261		214	174	167	148	240	161
19	275		276		228	215	173	158	267	172
20	277		277		261	226	179	161		177
21					275	240	181	167		190
22					276	261	194	173		194
23						276	204	179		199
24							206	181		215
25							208	187		222
26							212	194		225
27							215	204		226
28							216	206		237
29							222	212		261
30							226	219		269
31							234	222		270
32							240	226		275
33							247	234		
34							258	261		
35							267	267		
36							268	269		
37							269	270		
38							270			
No. of species	20	18	20	17	22	23	38	37	19	32

	30a	31a	31b	31c	31d	110	110a	111	112	113
1	31	4	4	4	4	5	5	4	6	8
2	35	5	5	5	5	6	6	15	14	42
3	43	6	6	42	29	14	14	29	29	53
4	46	14	14	45	55	29	29	53	42	85
5	128	15	15	46	65	43	42	65	43	122
6	160	29	29	104	90	53	53	66	53	175
7	167	66	51	108	104	85	71	71	84	189
8	181	90	70	120	107	108	84	114	108	206
9	187	99	90	133	108	111	108	133	114	224
10	189	104	99	153	120	120	115	138	161	225
11	192	107	104	157	138	142	120	139	174	226
12	208	108	108	161	161	153	122	161	198	233
13	221	120	114	177	199	161	153	166	204	253
14	235	153	120	199	222	180	161	169	211	281
15	239	199	153	205	226	199	200	179	222	
16		206	161	216	228	200	204	190	225	
17		215	168	220	240	204	215	204	233	
18		225	177	224	259	207	276	226		
19		226	199	227	261	215				
20		261	206	228	275	225				
21		275	208	237		226				
22			214	243		233				
23			226	259		276				
24			261	261						
25			275	275						
26				277						
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										

Site No.	114	115	116	117	118	119	119b	120	120b	121
1	5	29	5	29	1	5	5	5	5	5
2	6	42	29	42	5	6	6	6	6	6
3	14	53	42	51	29	29	29	29	29	29
4	29	108	51	53	42	42	42	79	53	73
5	42	123	53	120	51	71	53	83	85	79
6	53	153	108	174	85	104	104	89	87	85
7	85	174	116	220	104	108	108	104	104	97
8	90	200	120	223	108	116	120	108	108	104
9	108	214	174	227	120	120	153	116	116	120
10	120	220	220	235	122	122	174	120	120	122
11	122	223	223	277	153	153	224	142	122	151
12	153	235	227		157	206	227	153	142	153
13	161	259	235		174	214	228	156	153	159
14	198	276	237		200	216	264	200	156	174
15	200	277	275		214	223	275	206	160	216
16	215		277		216	224		214	174	220
17	220				224	227		216	206	224
18	225				227	234		220	214	234
19	275				234	235		276	216	235
20					235	276			224	276
21					259	277			227	277
22					264				228	
23					276				261	
24					277				276	
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
No. of species	19	15	16	11	24	21	15	19	24	21

Site No.	122a	122b	123a	123b	124	125	126	127	128	129
1	5	5	5	5	5	31	5	5	5	5
2	6	6	6	29	6	32	29	6	6	6
3	32	29	29	42	32	51	32	29	29	29
4	36	53	42	53	42	94	42	32	42	51
5	42	120	53	85	53	116	51	42	53	108
6	53	157	85	174	85	160	53	51	116	120
7	120	220	120	200	108	171	115	79	120	122
8	122	223	122	220	116	174	116	108	138	153
9	223	227	174	223	120	175	118	116	142	161
10	227	235	220	227	122	190	120	120	151	168
11	235	237	223	235	133	191	174	146	153	206
12	237	276	235	259	156	220	180	153	156	214
13	259		237	275	161	224	200	156	168	224
14	275		275		174	235	214	213	174	228
15					199	255	220	214	224	241
16					206	276	227	220	227	261
17					214	277	235	224	234	264
18					216		264	227	261	276
19					224		275	234	264	277
20					234			235	274	282
21					276			241	276	
22								264		
23								275		
24								277		
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
No. of species	14	12	14	13	21	17	19	24	21	20

Site No.	130	131	132	133	134	135	136	137	138	139
1	5	5	29	29	42	42	5	5	5	3
2	6	6	42	42	53	51	29	6	6	29
3	32	29	104	53	71	52	42	29	15	42
4	42	32	108	85	99	53	53	42	42	53
5	51	42	146	108	120	99	104	104	85	104
6	104	51	174	116	153	118	108	120	104	108
7	108	104	220	118	174	120	120	142	120	118
8	120	108	227	120	175	122	146	156	122	120
9	122	120	235	122	201	153	153	161	153	122
10	174	142	275	174	216	174	156	174	156	153
11	214	168	282	200	220	199	174	181	161	174
12	216	174		214	228	200	200	198	200	214
13	224	203		216	267	214	214	199	214	220
14	234	213		220		216	224	214	216	223
15	235	234		224		220	227	216	220	227
16	241	235		227		227	241	224	235	235
17	261	264		235		235	259	227	241	237
18	264	276		237		277	261	259	261	259
19	275	282		275			275	261	276	
20	277			277			282	275		
21	282							282		
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
No. of species	21	19	11	20	13	18	20	21	19	18

Site No.	140	141	142	143
1	42	5	5	1
2	51	6	6	5
3	53	29	53	6
4	120	42	71	29
5	122	53	85	42
6	153	85	108	53
7	158	104	116	85
8	174	108	120	104
9	174	116	122	108
10	214	120	206	120
11	220	122	214	122
12	223	123	216	151
13	227	153	223	153
14	235	161	235	161
15		216	237	174
16		224	259	214
17		227	264	216
18		228	275	223
19		234		224
20		235		228
21		275		235
22				237
23				275
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
No. of species	14	21	18	23