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The AGRICULTURAL POTENTIAL of OWINGUP SWAMP

1. Soil Survey of Owingup Swamp
2. Comparison of Owingup and Grasmere Swamps

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THE AGRICULTURAL POTENTIAL OF OWINGUP SWAMP

by C. V. Malcolm, L. T. Jones and J. P. Fallon

SUMMARY

The two swamps, Owingup and Grasmere, shown on the location map are practically identical with regard to soil conditions. Grasmere swamp however has been cleared and used for agriculture for some 60 years while Owingup swamp is as yet unalienated. Soils on both swamps consist of mainly organic diatomaceous clay.

The survey reported here was aimed at assessing the agricultural potential of Owingup swamp in the light of experience gained since the clearing of Grasmere swamp.

Findings of the survey indicate that some 2000 acres at Owingup swamp would be suitable for vegetable growing following clearing and draining. Possible problems associated with soil acidity and salinity would be prevented by drainage, liming and other management practices.

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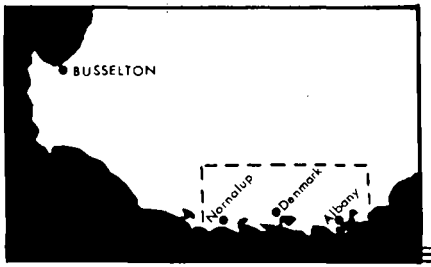
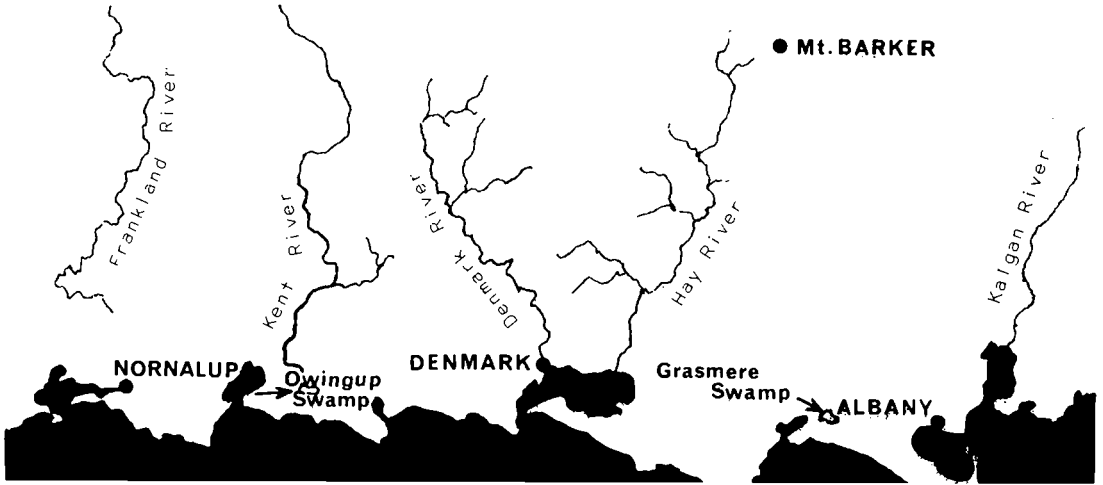


LOCATION MAP SHOWING THE POSITIONS OF OWINGUP AND GRASMERE SWAMPS ON THE SOUTH COAST OF WESTERN AUSTRALIA

A plan of the survey method used in Owingup swamp is shown on the aerial photograph in the back of this technical bulletin



1. SOIL SURVEY OF OWINGUP SWAMP

By C.V. Malcolm and L.T. Jones

INTRODUCTION

Owingup Swamp is a flat area of about 2000 acres of densely vegetated low lying terrain. Contour lines show that it is below the level of adjacent Owingup Lake although in fact it was probably once continuous with the lake, and may still be encroaching on the lake. The air photograph of the swamp shows what appear to be creeks and in fact flowing water is encountered at one of these points (Appendix V).

Some sections of the swamp in the south west appear to have been buried beneath advancing sand dunes. However, except in one case, these dunes are now stable and have been so for many years.

In 1927 the Public Works Department prepared a plan for subdivision and drainage of Owingup Swamp as part of a proposed Returned Soldiers' Settlement Scheme.

A "Classification and Subdivision of Owingup Swamps and Adjacent Lands" was prepared in 1946 by the Department of Lands and Surveys. The subdivision used was the same as in 1927 but the vegetation and soil areas were described and mapped. The main large swamp was described as having rich black soil with a good clay subsoil.

When interest in the use of the swamp developed again in 1962 the soil survey reported here was undertaken to obtain precise information on which to assess the swamp's agricultural potential.

The survey was conducted in early June 1962, under extremely wet conditions.

SURVEY METHODS

Initially a base line (line A on the photograph) on a bearing of 30° E of N was established near the south eastern boundary of the proposed initial development area. Subsequent lines (B to G) were surveyed at right angles to this line and at the two other situations shown on the accompanying air photograph.

All cleared lines were sampled at 5 ch intervals to depths of 3-5 ft. Profile descriptions were made at all sites and samples were taken from most horizons for analysis in the laboratory. Notes were also made concerning the vegetation and depth of or to free water.

SURVEY FINDINGS

Vegetation

The swamp is heavily vegetated with watties (*Agonis juniperina*) and paperbark (*Melaleuca pubescens*). These species form stands which vary in density apparently because of the effects of fires. At times one or other assumes domin-

ance. Both species, but moreso the *Agonis* often exhibit a mallee form of growth, but occasionally, as single trees, both reach large proportions around 18-24 in. diameter 2 ft. above ground level. Frequently the watties grow so thickly and are crossed with fallen timber to such an extent that walking anywhere but on cut lines is a major operation.

Where the watties are less dense other species may be found, for example blister bush (*Phebalium argenteum Sm.*), rushes (*Cladium* sp.), tea-tree (*Astartea fascicularis* D.C.), *Agonis linearifolia* (D.C.) Schau., sword grass (*Lepidospermum gladiatum*), *Loxocarya flexuosa* (R.Br.) Benth, and *Oxylobium lanceolatum* (Vent) Druce. In some areas the vegetation opens considerably and patches of lillies (*Villarsia* sp.) occur. On the lake side of the swamp appreciable areas are covered by lillies and reeds (*Villarsia* sp. and *Cladium* sp.).

The swamp's edges are densely vegetated with sword grass and wattle (*Acacia pentadenia Lindl.*). Swamp Banksia (*Banksia littoralis*) and yate (*Eucalyptus* sp.) are also found on the fringes of the swamp.

Profile descriptions and soil type.

Profile examinations revealed the area to be very uniform and all profiles except two near the south-east edge of the swamp consisted of 'clay' on sand. The table below lists the numbers of profiles with sand and 'clay' encountered at various depths. In most cases the 'clay' was overlain by a layer of fibrous peaty material.

Depth Interval at which encountered-in.	Clay (no. of profiles)	Depth Interval at which encountered-in.	Sand (no. of profiles)
0- 6	33	0-10	2
7-12	26	11-20	1
13-18	10	21-36	38
19-24	1	37-48	24
25-30	0	49+	7
30+	2		

The term 'clay' is not fully descriptive as field handling suggested and laboratory examination confirmed that the clay material contained appreciable amounts of diatomaceous remains and sponge spicules. The resulting 'clay' was not as sticky as true clay and when dry was very light both in colour and weight.

A general profile description was made as follows to cover almost the entire swamp. -

Peat Horizon, absent or up to about 15 in. thick. Composed of fibrous peaty material, sometimes woody and/or loamy.

'Clay' Horizon, at the surface or underlying the peat, usually abruptly. Mottling of different greys and of ferric oxide in some profiles without any obvious textural or other changes. Sand or often sand and 'clay' layers replace the 'clay' at 20 - 50 in. The clay, generally a dark brownish grey, frequently tends to be greenish just above the sand layer.

Sand Horizon, Sand usually layered with clay and frequently the upper sand layers very fine with coarser sand at depth. Sand generally white or grey but at times iron stained or black and organic. At three sites sand was not encountered before 60 inches.

Appendix I contains the results of detailed analyses carried out by the Government Chemical Laboratories on samples from the 0, 5, 10, and 15 ch marks on the base line.

Although the profiles fitted the above description there were minor variations in the soil which appeared to stem from several causal factors. Abrupt changes, thought to be due to fire damage occurred within short distances in the depth of peat over 'clay'. The peat material was not very compact and local experience confirmed that peats in the district were frequently damaged by fires. Records showed that a disastrous fire in 1937 destroyed valuable stands of very large watties, as evidenced by many logs lying in the swamp.

Flecking and mottling varied for no apparent reason. At some sites iron cementation was detected as slightly harder lumps in the generally smooth soft matrix. In other cases ferric oxide was in evidence only as faint flecks - in many profiles it was not apparent at all. Light and dark grey mottling and whitish flecking were also encountered.

Of the 72 profiles described, 23 exhibited ferric oxide flecking or mottling, and seven light grey mottling or flecking. Fifteen of the 23 iron stained profiles had water at or above the surface and the remainder had free-water well below the surface. The figures do not indicate a relationship between free-water depth and mottling and no relationship was been found between mottling and depth to sand or clay or vegetation type.

A few profiles in the lea of a large active sand drift contained a small fine sand fraction in the 'clay' horizon. As the clay horizon was free of sand, this sand may have come over the general area from the drift.

The sand and 'clay' layering was readily detected with the peat sounding rod, and confirmatory evidence obtained by sampling. Usually the upper sand layers were very fine in contrast to the sand to coarse sand base. As sampling did not extend beyond 60 in. due to failure to remain in the auger, the possibility of further on present knowledges layers exists. Layering was encountered over most of the swamp and, on present knowledge, could not be related to any particular cause.

Results of analysis

Profile samples returned to the Soils Divisions's laboratory were tested for salt and pH only, but some samples were analysed in detail at the Government Chemical Laboratories. The results of chloride and pH analyses are listed in Appendix II.

The salt contents of the samples ranged from 0.01 to 0.67 per cent. he following table shows the numbers of samples in various salinity and pH ranges.

% NaCl	No. of samples	pH	No. of samples
less than 0.1	45	less than 4.0	3
0.1 - 0.2	68	4.0 - 4.5	38
more than 0.2	23	4.6 - 5.0	55
		more than 5.0	40

DISCUSSION

The predominant pH range of 4.6 to 5.0 is satisfactory for subsoil for the growth of most crops, and considering the moisture holding capacity of the soil the salinity level is not dangerous. However, two possibilities must be borne i mind; firstly that the pH may alter after clearing and drainage, and secondly what measures will be necessary to ensure that soluble salts do not concentrate in the root zone or at the soil surface.

Experience at Ewart's swamp near Albany indicates that some south coastal swamps are capable of a period of good production after which they may become extremely acid and sterile. The accompanying report on an inspection of Grasmere swamp discusses liming practice at Grasmere and, in view of the similarity of this swamp to Owingup, the considerations are extrapolated.

There is some evidence at Owingup Swamp of a rise in pH along the Base line (A) moving from the lake towards the coast hills. The higher pH towards the coast could arise from seepage waters, presumably rich in lime, which enter the swamp along its coast hill boundary and there are limestone deposits in the adjacent hills. Development of the swamp should include regular checking and close control of pH. Although not sufficiently high to cause serious trouble while they remain in the subsoil, the salt levels are such that care must be exercised. Harmful concentrations of the salts in the surface soil could occur during summer if watertables are maintained too shallow. Ideally, trouble should be avoided by downwards irrigation and provision of adequate drainage.

The figures for loss on ignition and mechanical analysis show that the soils are rich in organic matter and clay. These clay and organic matter contents bear an obvious relationship to the exchange capacity figures which are quite high and indicate good fertility. Like the pH trends noted earlier the exchangeable calcium figures fall off with distance from the lime rich coast hills. The high soil water retention data (Appendix III) also reflect the high clay and organic matter content of the soils.

Comparison of the total soluble salt and sodium chloride figures shows that appreciable amounts of salts other than sodium chloride occur in the soils. The Deputy Government Agricultural Chemist reports as follows: "Examination of the water soluble salts of the soils showed that the difference between the total soluble salts and the sodium chloride consisted of calcium, magnesium and sodium sulphate."

CONCLUSIONS

Owingup Swamp is an essentially uniform area of soil with a typical soil profile of a thin layer of fibrous organic material overlying 2 to 4 ft of organic clay resting on sand. The clay contains a significant amount of diatomaceous remains and sponge spicules.

The soil is acid but not extremely so and should respond readily to liming. There is a moderate amount of salt in the soil and careful control of water levels would be needed to ensure winter leaching and avoid summer accumulation of salts. Downwards irrigation may be necessary to ensure salt removal.

A high nutrient holding capacity stems from high clay and organic matter contents and indicates that the soil should be a good growth medium. The nitrogen levels in the soil are high but potassium and phosphorus are low by world standards. However, because the soil has a high nutrient holding capacity, the use of these fertilisers would not be a serious expense.

In general the swamp is an attractive development prospect, largely free of the worries of burning, subsidence and overdrainage associated with peat swamps.

ACKNOWLEDGEMENTS

The ready co-operation of the Public Works and Water Supply Departments was greatly appreciated.

Attention is drawn to the excellent co-operation of all Department of Agriculture personnel concerned. Under the pressure of the breaking season and bad working conditions, free time was almost entirely used on the job and without hesitation. The willing spirit of all concerned contributed markedly to the success of the survey. Personnel on the job were, D.J. Carder, A.J.V. Janes, J. Broun, M. Harper, F. Williams.

Thanks are due to the Herbarium for identification of species and the Government Chemical Laboratories for some of the analyses.

2. A COMPARISON OF OWINGUP AND GRASMERE SWAMPS

By L.T. Jones, J.P. Fallon and C.V. Malcolm

The formation of Owingup and Grasmere swamps has followed similar lines and, as a result, the topographical features of the two swamps are very similar. Both are lowlying areas connected on the west side by an ill defined drainage system to an outlet which is open to the sea in winter and bounded to the north east by a lake receiving water from streams. Both swamps are bounded on the south by steep lime rich coast hills, and their levels are 5 and 7½ ft, respectively, above low water at Albany.

Soil conditions

Both swamps consist primarily of diatomaceous organic clay from 2 to 4 ft thick overlying a sand base. Some sections of the Grasmere swamp are more clayey than any encountered at Owingup but, although less productive, are still very valuable. On such clayey areas internal drainage needs greater attention. With the exception of the surface fibrous peat, the diatomaceous clay material will not burn.

Vegetation

The original vegetation on Grasmere swamp was apparently similar to that on Owingup swamp. Old residents who helped clear Grasmere swamp report that a dense stand of large watties and paperbarks grew on the more friable soils. The more clayey portions carried a more sparse coverage consisting of predominantly paperbark and rushes.

Drainage

Apart from the need for further internal drainage in the heavy clay areas the present drainage system at Grasmere swamp appears generally satisfactory. Some growers suggest that over-draining now occurs rendering some areas of the swamp susceptible to drought in dry years. For this reason it would be of considerable advantage to be able to raise the water table in summer should drought conditions be encountered.

Clearing

Experience at Grasmere swamp indicates that the following method would be practicable when clearing Owingup swamp.

Some drainage would be necessary, in the form of a main drain or a drain along the outside perimeter, to enable the operation of bulldozers during the summer. It is suggested that bulldozing be carried out in late summer followed by windrowing. Burning can then be undertaken when conditions are suitable, preferably during spring and winter to preserve the bulk of the surface peat. Farmers at Grasmere swamp report that the soil does not burn more than one inch deep but original settlers report that they took care not to burn the peaty surface when clearing.

Soil problems

Before the completion of the present drainage system at Grasmere swamp, the area sometimes suffered from excessive acidity and salinity. This experience should be kept in mind when planning the drainage system at Owingup and due regard paid to the possibility of salinity and acidity becoming problems.

With the use of lime and better drainage, normal management practices have prevented acidity and salinity from becoming major problems at Grasmere. Limestone formations are similar and extensive near both swamps but a survey would be needed to locate sites at Owingup which could supply the highest grade lime sand.

Suitability for vegetable growing

Grasmere swamp is well known as a potato growing area and high yields of good quality potatoes have been consistently produced on the area since clearing 60 years ago. The swamp was also noted for its vegetable production in the early years of its development and produced large quantities of tomatoes, peas and leafy vegetables. Only small areas of vegetables other than potatoes have been produced on the swamp within recent years.

As soil conditions at Owingup swamp (Appendix IV) appear practically identical with those at Grasmere it is reasonable to assume that vegetable production would be satisfactory at Owingup.

Acknowledgements

The 60 years past experience of Messrs. C. Mowforth and R. Shirley was particularly valuable and the ready co-operation of present growers, namely Messrs. F. Reddin, H. Walker, E. Ackley, W. Lloyd and J. O'Loughlin was greatly appreciated. Many thanks are also due to Mr. G. Najman (Vegetable Instructor) whose local experience in the Albany district was of great assistance in collecting information.

APPENDIX I

Detailed Soil Analyses - Owingup Swamp

Field Book Sample No.	Depth (in.)	pH	TSS	* NaCl%	A	N (%)	Hydrochloric Acid Soluble P (%)	Hydrochloric Acid Soluble K (%)	Mechanical Analysis (per cent) cS	fS	Si	C	Exchangeable Cations (me/100g) Ca	Mg	Na	K	H (pH 7)	Cation Exchange Capacity (me/100g)
C411 ≠	0-9	6.1	0.37	0.12	49.0	0.60	0.048	0.06	-	-	-	-	45.6	10.0	3.8	1.1	1.2	61.7
C412	9-42	6.5	0.30	0.12	17.6	0.42	0.019	0.04	3.3	10.0	12.7	63.4	25.7	5.8	3.2	0.55	-	35.2
C413	42-54	6.6	0.14	0.02	7.7	0.10	0.004	0.05	-	-	-	-	12.2	2.5	0.90	0.30	-	15.9
C414	54-66	5.9	0.16	0.05	2.1	0.02	0.002	0.02	-	-	-	-	3.4	0.2	0.10	0.05	0.4	4.2
C407 ≠	0-16	5.1	0.24	0.07	43.4	1.01	0.034	0.06	-	-	-	-	16.7	8.4	1.6	0.85	5.4	33.0
C408	16-27	5.1	0.40	0.13	17.3	0.37	0.014	0.04	3.7	16.0	7.7	59.4	9.7	6.5	2.3	0.45	4.2	23.1
C409	27-30	5.3	0.44	0.15	14.3	0.27	0.010	0.04	-	-	-	-	8.6	5.1	1.1	0.40	2.0	17.2
C410	30-42	5.3	0.52	0.20	16.4	0.32	0.010	0.06	-	-	-	-	10.9	6.9	2.5	0.45	-	20.7
C401 ≠	0-12	4.7	0.39	0.23	40.7	1.12	0.040	0.09	-	-	-	-	8.3	9.0	2.0	0.90	4.2	24.4
C402	12-39	4.7	0.51	0.25	15.8	0.28	0.008	0.06	-	-	-	-	4.9	4.9	1.4	0.40	2.3	13.9
C403	39-60	5.4	0.13	0.08	2.0	0.03	0.003	0.02	7.4	16.6	10.0	54.5	1.7	1.2	0.10	0.10	0.3	3.4
C404	0-12	4.8	0.33	0.16	37.3	0.88	0.032	0.08	-	-	-	-	6.1	7.7	1.8	0.70	4.7	21.0
C405	12-33	4.8	0.34	0.18	20.0	0.43	0.016	0.06	2.6	8.8	13.1	58.5	4.4	4.5	1.6	0.40	5.9	16.8
C406	33-60	5.2	0.09	0.05	2.9	0.04	0.004	0.03	-	-	-	-	1.1	1.5	1.15	4.2	0.10	1.4

TSS Total soluble salts %

* %NaCl = % chloride expressed as % NaCl

≠ Contained 41, 24 & 1.5 % respectively of material greater than 2 mm. This was all fibrous organic matter and was ground and incorporated with the sample in each case.

A Loss on ignition %.

APPENDIX II

Chloride and pH Analyses - Owingup Swamp

Line	Site (Distance from start) ch	Depth (in.)	* NaCl %	pH
A	0	0- 9	0.11	6.9
	0	9-42	0.12	6.5
	0	42-54	0.02	6.6
	0	54 +	0.04	5.9
	5	0-16	0.07	5.1
	5	16-27	0.12	5.1
	5	27.30	0.15	5.3
	5	30-42	0.19	5.3
	10	0-12	0.23	4.7
	10	12-39	0.25	4.7
	10	39-60	0.08	5.4
	15	0-12	0.16	4.8
	15	12-33	0.18	4.8
	15	33-60	0.05	5.3
	20	24	0.09	4.5
	20	36	0.04	4.7
	25	24	0.08	5.0
	30	24	0.13	4.4
	30	36	0.09	4.4
	35	30	0.13	4.2
	35	42	0.13	4.1
	40	16	0.11	5.1
	40	30	0.11	5.0
	40	42	0.24	4.2
	45	18	0.10	4.4
	45	30	0.09	4.6
	45	42	0.28	4.6
	50	21	0.15	4.8
	50	36	0.26	5.8
	55	30	0.12	4.6
	55	42	0.16	4.7
	60	6	0.10	5.1
	60	18	0.14	4.6
	60	30	0.09	4.8
	65	12	0.09	4.9
	65	18	0.09	4.3
	70	12	0.11	4.9
	70	30	0.11	4.6
	75	12	0.19	4.8
	75	30	0.60	4.3
	80	4	0.19	4.8
	80		0.07	3.7
	85	12	0.18	4.1
	85	22	0.20	4.2
	0	18	0.13	6.4
	0	30	0.15	6.6
	10	18	0.10	5.3
	10	30	0.22	4.5
	20	18	0.30	4.8
	20	30	0.12	4.8

APPENDIX II (Contd)

Line	Site (Distance from start)	Depth	* NaCl	pH
	ch	(in.)	%	
B	20	12-24	0.18	5.5
	20	24 +	0.15	5.0
	25	24	0.18	5.3
	25	30	0.26	4.9
G	10	9-15	0.06	5.6
	10	15-18	0.02	6.1
	15	12	0.67	5.3
	15	27	0.11	4.0
	30	15-16	0.43	4.6
	35	48	0.23	3.5
C	5	18	0.15	4.9
	5	30	0.26	4.6
	10	18	0.08	5.1
	10	36	0.14	4.3
	15	12	0.11	4.9
	15	30	0.24	4.5
	20	18	0.10	4.5
	20	30	0.10	4.7
	25	12	0.08	4.9
	25	30	0.13	4.3
	30	4	0.08	5.4
	30	18	0.07	5.2
	30	28	0.09	3.8
	35	18	0.09	5.0
	35	30	0.14	4.5
	40	18	0.13	4.9
	40	30	0.13	4.7
	42	18	0.11	4.6
	42	33	0.17	4.2
	45	18	0.08	5.2
	45	30	0.15	4.4
	50	12	0.06	4.8
	50	24	0.15	5.4
	55	6	0.07	4.0
	55	12	0.05	4.2
	55	21	0.11	4.2
	60	12	0.18	4.9
	60	20	0.14	5.0
	60	30	0.24	4.8
	65	12	0.16	5.2
	65	21	0.20	5.1
	65	30	0.24	5.5
	65	33	0.18	6.5
	65	42	0.13	6.5
	70	6	0.07	6.7
	70	18	0.37	7.6
D	5	12	0.09	4.5
	5	24	0.11	4.4
	5	36	0.09	4.6
	10	12	0.09	4.7
	10	24	0.10	4.6
	10	36	0.08	4.3

APPENDIX II (Contd)

Chloride and pH Analyses - Owingup Swamp

Line	Site (Distance from start) ch	Depth (in.)	* NaCl %	pH
	30	18	0.06	4.5
	30	30	0.23	4.7
	35	30	0.08	5.0
B	5	9-20	0.18	5.2
	5	30	0.42	5.8
	5	33	0.14	5.9
	10	12-20	0.25	5.0
	10	39	0.36	4.9
	15	12-20	0.12	5.1
	15	20	0.21	4.9
	15	30	0.30	4.7
	20	12	0.12	4.9
	20	24	0.12	4.8
	20	36	0.18	4.1
E	5	0- 2	0.08	4.8
	5	2-33	0.12	4.7
	5	33 +	0.06	4.8
	10	12	0.06	4.7
	10	30	0.10	4.3
	10	42	0.16	4.3
	15	12	0.07	4.9
	15	24	0.07	4.5
	15	36	0.12	4.3
	20	12	0.11	5.0
	20	27	0.10	5.0
	30	12	0.08	4.9
	30	24	0.10	4.4
	35	18	0.06	4.5
	35	36	0.05	4.0
	40		0.05	5.2
	40		0.06	5.0
	45	18	0.07	4.4
	45	48	0.01	4.2
	45	54	0.01	4.5

* % NaCl is chloride determined by titration and expressed as per cent sodium chloride.

APPENDIX III

Soil Water Retention Data - Owingup Swamp

Sample No.	Depth	% Water Retained At	
	in.	1/3 atmos	15 atmos
S 301	0 - 9	52.30	34.55
S 302	9 -24	44.50	24.85
S 303	24 -33	44.70	18.35

APPENDIX IV

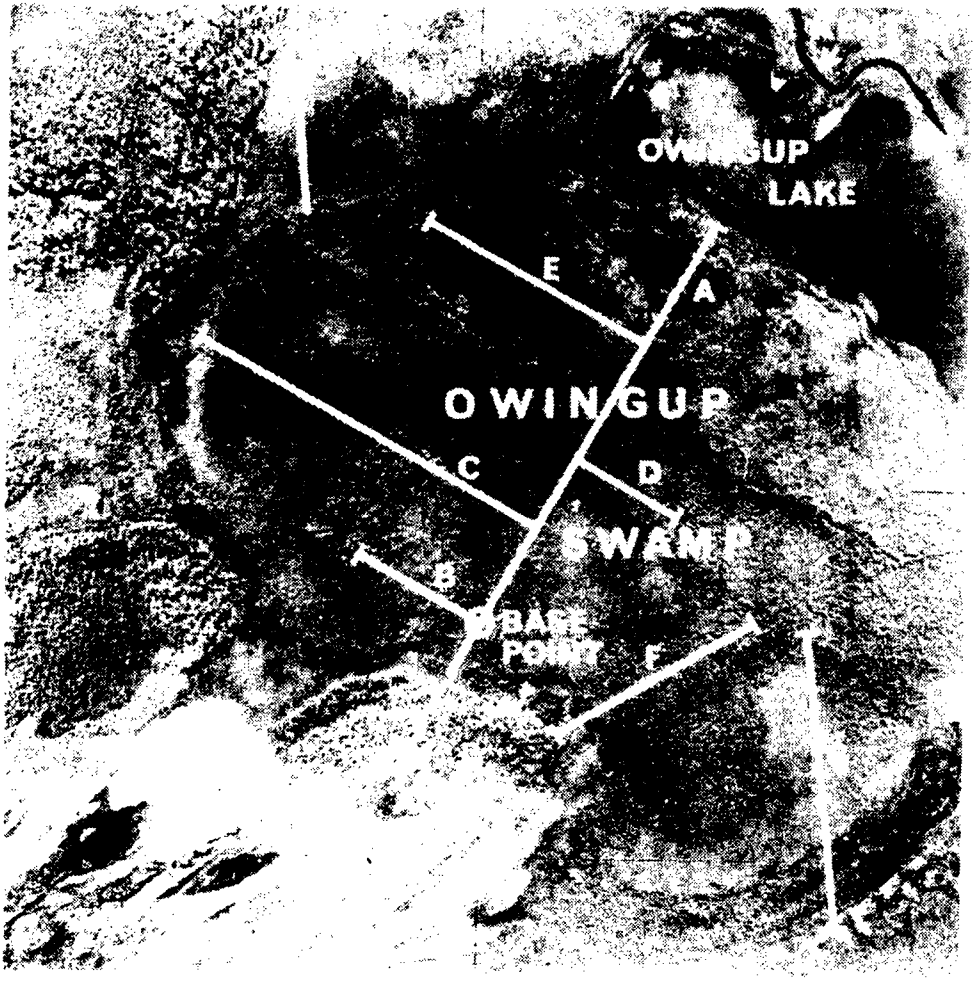
Sample Analyses from Grasmere Swamp

Site	Depth in.	Soil description	Salt Chloride expressed as % Sodium Chloride	pH	Comments
L. ELDRIDGE					
1.	0-15	Very dark grey fibrous peaty clay	0.14	6.4	Paperbark, rushes, salt tea-tree
	17-40	Grey clay brown tinges	0.65	4.6	
2.	0-15	Very dark grey organic clay	0.11	5.6	Good potato land. Has healthy
	15-27	Dark grey clay + mottles	0.22	5.4	oats stand.
	27-50	Grey clay + mottles	0.30	5.0	
F. REDDIN					
3.	0-12	Very dark brown grey organic clay	0.03	5.3	Good potato land very healthy
	12-36	Dark brown grey organic clay+mottles	0.06	3.9	oats.
	36-48	Dark brown grey clay	0.06	3.6	
4.	0- 9	Very dark brown grey organic clay	0.02	6.3	Once good potato land now over-
	9-18	do.	0.05	6.2	limed and scabby. Rate used 10 tons per acre approx.
H. WALKER					
8.	0- 9	Dark brown grey clay	0.02	5.5	Evidence of hardpan and bad drain-
	9-20	Dark brown grey clay + mottles	0.11	6.4	age.
E. ACKLEY					
9.	0- 9	Grey clay	0.02	5.9	Similar to Site 8.
	9-14	do	0.02	6.8	
	16-24	Light grey clay iron cementation	0.03	7.6	
	50-54	Black peaty clay	0.10	7.6	
	0- 9	Dark grey brown organic clay	0.01	6.0	Similar to Site 8.
	9-18	Grey clay + mottles	0.02	6.7	
	18-22	White diatomite	0.05	7.3	
W. LLOYD					
11.	0-12	Very dark brown grey clay	0.04	6.3	Grows good crops
	12-18	Grey clay	0.04	6.8	
	18-42	Grey clay	0.03	7.0	

Sample analyses indicate that salinity and acidity levels are not far removed from those at Owingup. Some farmers reported that areas previously too "mineral" (presumably salty and acid) had improved following the provision of better drainage. Acidity is unlikely to create a serious problem.

APPENDIX V

Survey Lines used at Owingup Swamp



Aerial photograph 5212 WA331 Parry Inlet run 1 2.5.57