Department of Agriculture, Victoria

Division of Agricultural Chemistry

SOILS OF THE VINEYARDS

OF

THE ARARAT DISTRICT

By

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Soils Officer

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SOILS OF THE VINEYARDS OF THE ARARAT DISTRICT

By Nabil S. Badawy

Soils surveyed by N.S. Badawy and N.B. Lewis

SECTION 1 - SCOPE AND PURPOSE OF THE INVESTIGATION

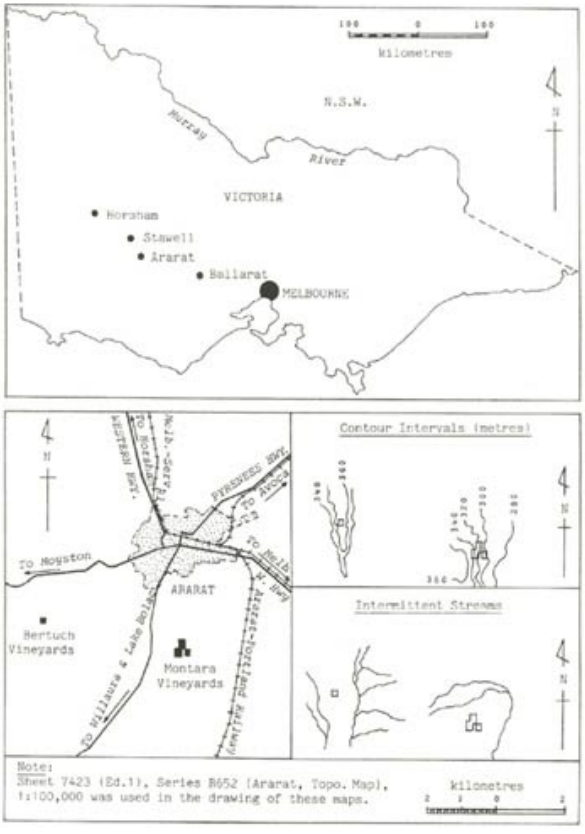
The Great Western and District Viticultural Association, representing the wine-grape growers in the Stawell, Ararat and Avoca districts indicated that in recent years the overall grape production in several vineyards has markedly declined owing to a fall in vine vigour. Variability in vine performance, differences in topography and relief, earlier reconnaissance survey work and local experience all suggest considerable variation in critical soil properties. Some of these properties may require special soil management practices if plantings are to remain viable. Since it is likely that such special management practices will be specific to different soils, it is appropriate to identify and locate (ie. classify and map) the various soils of the relevant areas.

The Victorian Department of Agriculture has conducted a soil survey aiming at describing and mapping the distribution of the various soil types used for growing grapevines in the shires of Stawell and Ararat. The field operation of the survey was carried out during autumn and spring, 1980.

The present report summarises the soil data and other relevant information obtained for the vineyards surveyed in two areas south and west of Ararat. In this survey, thirteen different soils have been recognised and shown on soil maps. In addition to having adverse properties, some of these soils occur on topographical positions unfavourable for the optimum performance of grapevines.

It is envisaged that the data included in this report will form the basis for initiating future soil-water-plant studies with the overall objectives of maximising wine-grape production in Western Victoria.

Figure 1 – Locality Plan



SECTION 2 - GENERAL INFORMATION ABOUT THE AREA

2.1 Area and Location

The total area included in the present survey is about 24 hectares situated near Ararat, approximately 200 kilometres west north-west of Melbourne (Figure 1). It consisted mainly of vineyards separated in two locations in the Shire of Ararat, County of Ripon; and presented in this report as follows:

(i) Montara Vineyards (about 20 hectares)
- Allotments 28 and 31 in Section 19, Parish of Ararat.
- Allotment 1B in Section 8, Parish of Burrumbeep.

(ii) Bertuch Vineyards (about 4 hectares)
- Allotment 4 and 5 in Section 12, Parish of Ararat.

2.2 Climate

In general, moderately dry hot summers and wet mild winters are the common climatic features of the area surveyed.

In addition to rainfall and air temperature other elements including relative humidity, frost, wind, and sunshine are considered to be economically important to the productivity of grapevines. For the purpose of this report, the relevant weather recording station is Ararat. Presented below is a summary of the climatic data obtained for this station from up-to-date computer records supplied by the Bureau of Meteorology, Melbourne.

(a) Rainfall

On average, the surveyed area receives about 610 mm rainfall annually. Usually 60-65% of these rains fall during the May-October period. January is often the driest month. Table 1 and Figure 2 below, illustrate the distribution pattern of the long-term average rainfall through the year, using the data recorded at Ararat.

Figure 2 - Distribution of the Annual Rainfall at Ararat

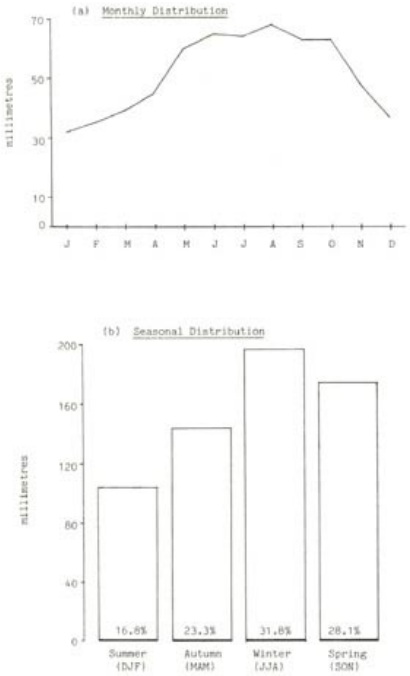


Table 1 - Rainfall Data for Ararat*

Month	J	F	M	A	M	J	J	A	S	O	N	D	Year
mm	32	35	39	45	60	65	64	68	63	63	48	37	619
Rain days (No.)	5	6	6	9	13	15	15	15	14	12	9	7	126

* Average 120 years

(b) Temperature

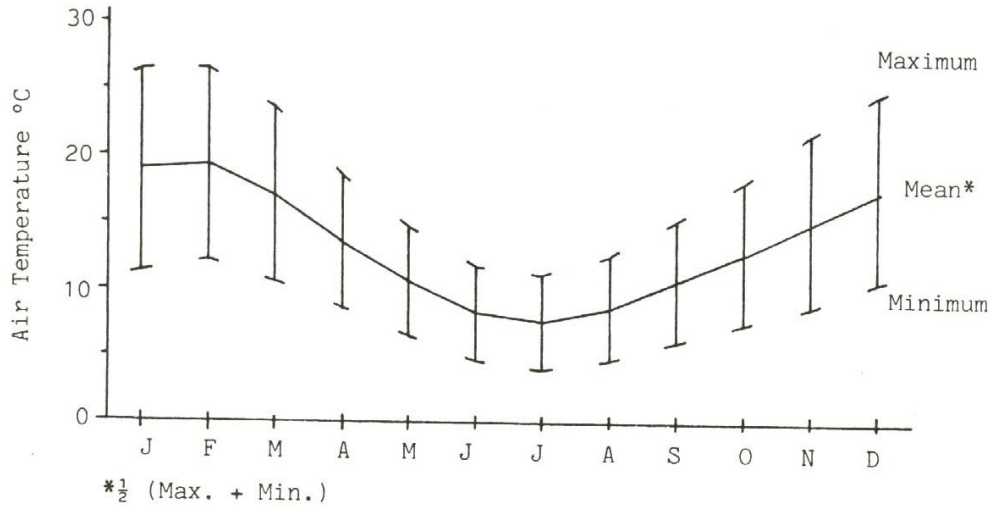
Generally, the area has cool winters and hot summers. January and February are, usually, the hottest months of the year and July is the coolest. Temperatures fall rapidly during the autumn months and then more gradually with the onset of winter. Distribution pattern of the minimum temperatures through the year usually follows that of the maximum temperatures (Figure 3). Table 2, below, lists the long-term average temperature data obtained for Ararat.

Table 2 - Average Monthly Temperatures at Ararat*

	J	F	M	A	M	J	J	A	S	O	N	D
Max ^{o}C	26.5	26.4	23.4	18.6	14.6	11.5	10.9	12.3	15.0	17.9	21.2	24.3
Min ^{o}C	11.5	12.1	10.6	8.3	6.6	4.7	4.0	4.6	5.9	7.2	8.6	10.2

* Average for 78 years

Figure 3 - Average Monthly Temperatures at Ararat.



(c) Relative Humidity

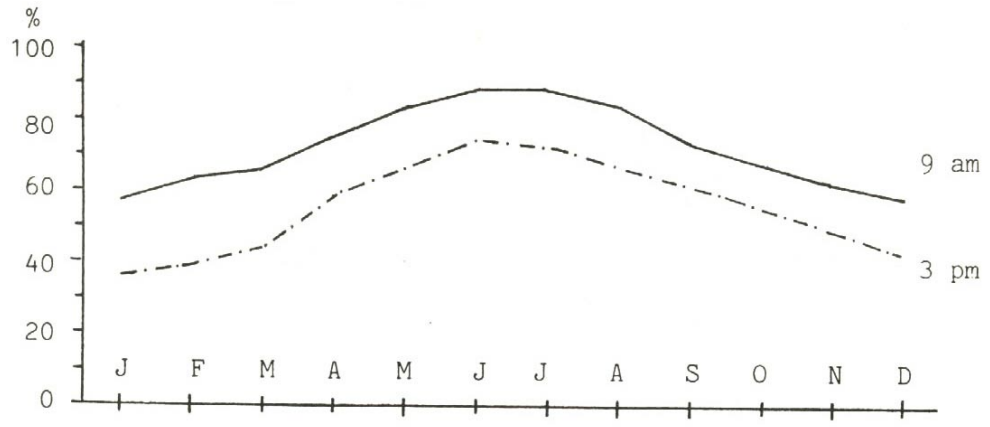
The aridity of the climate depends on total rainfall, temperature, and relatively humidity. As for temperature, the relative humidity at 9 am approximates the mean value for the day (24 hours). The relative humidity at 3 pm, occurring around the warmest part of the day on the average, is representative of the lowest daily values. Similarly, the daily maximum relative humidity is usually in the early morning when air temperature is at a minimum. Table 3 and Figure 4, below, illustrate the distribution pattern of the relative humidity averages through the year, using the data recorded at Ararat.

Table 3 - Average Relative Humidity at Ararat*

Month	9 am		3 pm	
	Average	Range	Average	Range
	%	%	%	%
January	57	46-74	36	24-68
February	63	43-80	39	23-69
March	66	46-81	44	26-72
April	75	64-85	58	40-86
May	83	68-92	66	51-85
June	88	76-94	74	63-91
July	88	78-96	73	62-87
August	83	69-91	67	50-88
September	74	62-88	62	39-87
October	68	37-87	55	25-85
November	62	49-80	49	31-78
December	58	41-77	42	29-69

* Using available data for all years of record since 1908.

Figure 4 - Average Relative Humidity at Ararat



(d) Frost

Light frosts usually occur when air temperatures drop below 2.2°C, while severe frosts are commonly associated with 0°C or lower. In the study area, severe frosts are common each year during the cooler period (may-October). Light frosts however, may occur as early as March and as late as December. Air temperature data recorded at Ararat indicate that the average frost-free period is 240 days (Table 4, below).

Table 4 - Frost Data for Ararat*

Average Number of Frost Days													Frost-free Period **
J	F	M	A	M	J	J	A	S	O	N	D	Year	
0	0	1	2	3	8	10	8	5	5	2	1	45	240

* Using temperature data (number of days of 2.2 °C or lower) available for all years of record since 1962.

** Period between last and first temperature of 2.2 °C or lower in two successive years. Data listed in this column are from the Resources Survey, Wimmera Region (1951).

(e) Wind

Wind is a highly variable element, especially when blowing over a strongly undulating ground surface similar to that of the area presented in this report. However as a guide only, Table 5 (below) lists the yearly average occurrence and distribution of days of strong wind (greater than 25 knots) recorded at Ararat.

Table 5 - Frequency of Strong Wind (>25 knots) at Ararat*

Average Number of Days												
J	F	M	A	M	J	J	A	S	O	N	D	Year
1	2	1	1	2	2	1	2	2	3	2	3	22

* Using available data for all years of record since 1962.

(f) Sunshine and Radiation

There is a strong negative correlation between cloudiness and duration of bright sunshine. Also, like sunshine, global (short wave) radiation is affected by cloudiness, but to a different degree. Records of sky cloudiness, but to a different degree. Records of sky cloudiness available for Ararat therefore, are summarised below (Table 6) in order to be used as a guide indicating the intensity and duration of sunshine and radiation in the study area.

Table 6 - Sky Cloudiness Data for Ararat*

Element	J	F	M	A	M	J	J	A	S	O	N	D
Number of clear days δ	8	8	8	6	2	3	2	2	2	4	3	5
Number of cloudy days $\delta\delta$	8	7	10	13	17	16	19	17	15	16	14	12
Mean cloud cover (oktas):												
- @ 9 am	3	4	4	4	5	5	5	5	5	5	4	4
- @ 3 pm	3	3	3	4	5	5	5	5	5	5	4	4

* Using available data for all years of record since 1908.

δ Less than $^2/_8$ cloud cover.

$\delta\delta$ Greater than $^6/_8$ cloud cover.

SECTION 3 - SOIL SURVEY METHODS

Soil Mapping

Aerial photographs at a scale of 1:8,800 were used in this survey. Interpretations of their photo-patterns and photo-tones were examined before attempting the field work. In the field, observations were made regarding the landscape, topography and soils. The soils were described from borings, using a spade and a 10 cm diameter Jarret soil auger. Changes in topography and soils, aided by photo-interpretations were the basic criteria in delineating map unit boundaries.

The soils were mapped in the field on the basis of soil series, type and phase. A soil series consists of one or more soil types which have essentially similar profiles, particularly as regards subsoil conditions, but differ in the texture of the surface soil. A soil type may include one or more soil phases wherein a particular feature such as depth of surface soil or stoniness is emphasised. The soil types and their corresponding series have been given similar names, for example, Ararat series has one type, Ararat sandy clay loam. Stony profile and deep surface phases occur within this soil type.

Some areas with rapid changes over small distances, however, were mapped as complexes. Similarly, due to the scale of mapping, no attempt was made to separately map the gully soils which were found

to be particularly variable. On the other hand, soils of limited occurrence in the area surveyed have been regarded as "minor soil types" and referred to by number, for example, Minor Type 1 (M.T.1).

Detailed descriptions were obtained for selected sites representing the mapping units. These descriptions included topography, condition of the surface soil and the morphological features of a 100 cm soil profile. At some sites, however, boring was abandoned at shallower depths due to the presence of rocks. Profile samples were collected for subsequent laboratory examination and the soils were classified using the Factual Key Classification System (Northcote, 1979).

On average, the density of the recorded sites was about 1 ha/site. It should be appreciated, however, that any unit shown on the soil map may have, intermixed with its main soils, small areas of other soil types or phases, but not to a greater extent than one tenth of the occurrence.

Sampling

3.1.1 Soil Sampling

At each site, samples were collected from the main morphological horizons of the soil profile. All samples were dried at 40^{o}C (forced draught) for 48 hours before being sub-sampled and prepared for the various physical and chemical analyses.

At selected sites, representing the different soil types, separate samples were taken from the surface layer (0-7.5 cm) for the determination of bulk density and degree of stoniness.

3.1.2 Water Sampling

In late spring-early summer, water samples were collected from all existing water sources currently used, or considered for future use, for irrigating the vineyards. These samples were analysed to assess their salinity levels.

Analyses

Listed below are the various determinations conducted on the soil and water samples with a reference to the methods used. Full details of the analytical methods, however, are described in the "Chemical Methods Handbook" published by the Division of Agricultural Chemistry, Department of Agriculture (Vic.), except where indicated otherwise.

3.3.1 Soil Analyses

(a) Surface soils (0-7.5 cm)

On these soils, bulk density was determined using soil cores and the method outlined by McIntyre and Loveday (1974). Mineral fractions coarser than 2 mm were sieved and weighed. Their volume was estimated (a density of 2.7 was assumed). On the fine earths (soil material < 2 mm), water retentions at -15 bar (approximately 'Wilting Point') and $-^{1}/_{3}$ bar (approximately 'Field Capacity') were determined as outlined by McIntyre (1974) using a ceramic plate pressure unit (Soil-Moisture Equipment Co., California).

(b) Soil profile samples

All profile samples were analysed for pH, electrical conductivity (EC) and chloride contents using a 1:5 soil (<2 mm aggregates) – water suspension shaken for one hour. A glass electrode was used for the pH determinations and a conductivity cell and meter for the EC. Chloride, as % sodium chloride was determined by the electrometric titration method (Best, 1931).

Water retentions at -15 bar and $-^{1}/_{3}$ bar were also determined on all soil samples.

Aggregate structural stability was determined on 3-5 mm soil aggregates using the Emerson (1967) and Loveday (1974) dispersion tests.

(c) Representative soil profiles

For each soil type, a representative soil profile was chosen for additional analyses; i.e.

- Particle – size Analysis – Estimating the distribution (%) of coarse sand, fine sand, silt and clay – sized fractions in the soil mass, using the Plummet balance method.

- Total Nitrogen (surface soil horizon only) – The Kjeldahl method was used.

- Organic Carbon (surface soil horizon only) – The wet combustion method of Walkley and Black was used. Results have been multiplied by an empirical recovery factor of 1.25.

- Exchangeable Cations – Basically the extraction method of Tucker (1974) was used for the removal of soluble salts and for leaching the cations, but at least three extractions were carried out for removal of soluble salts. The extractant used was 1 M. NH_4Cl in 60% alcohol at 8.5.

  In the leachate calcium, magnesium and potassium were determined by atomic absorption spectrophotometry, and sodium was determined by flame emission spectrophotometry. The individual cations have been expressed as milligram equivalents per 100 g of soil.

- Exchangeable Acidity – This is Mehlich's barium chloride – triethylamine method (reference point pH 8.0), using the modification of Peech et al. (1962). This method is applicable only to soils below pH 8.0.

- pH – This was determined by the glass electrode using a 1 to 5 soil water extract.

3.3.2 Water Analyses

The water samples were analysed for the following:-

- Electrical Conductivity (Total Soluble Salts)
- Chloride
- Soluble Cations (Calcium, Magnesium and Sodium)

SECTION 4 - SURVEY RESULTS

4.1 The Soils

Three different soil types and seven phases, grouped under three soil series, were recognised in the survey. Also, three minor soil types of limited occurrence in some parts of the vineyards have been described. Table 7, below, lists the soil units mapped in the survey.

Table 7 - Soil Units Mapped in the Survey

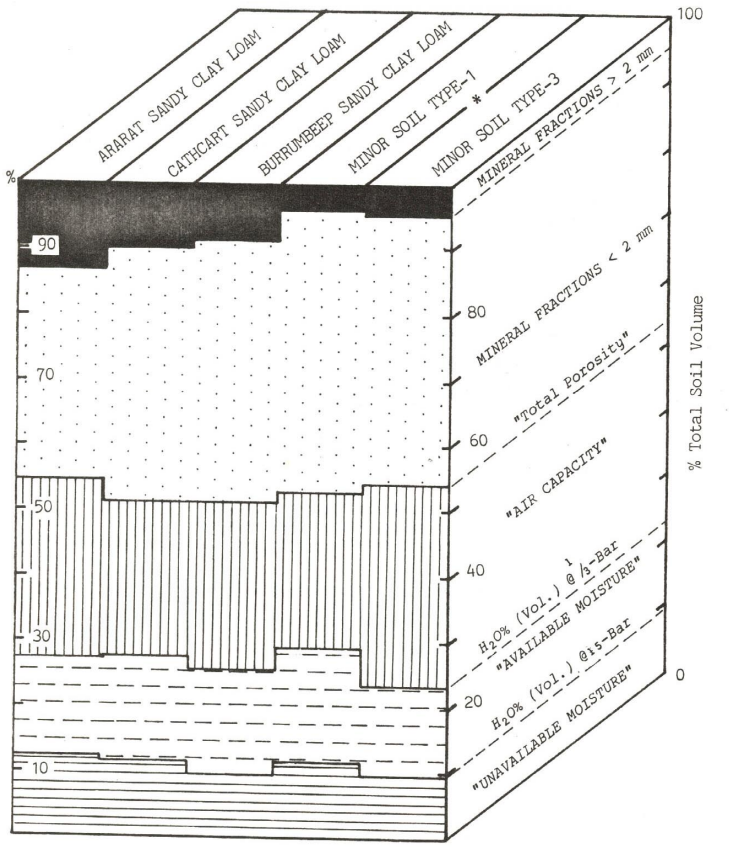
Series	Types	Phases
Ararat	Ararat sandy clay loam	- Deep surface - Stony profile - Deep surface & stony profile
Cathcart	Cathcart sandy clay loam	- Deep surface - Deep surface & stony profile
Burrumbeep	Burrumbeep sandy clay loam	- Deep surface - Stony profile
- - -	Minor Soil Type -1 Minor Soil Type -2 Minor Soil Type -3	- -. -

The main morphological features of these soils are outlined below, using modal profile descriptions in order to allow for the variability that will occur within each unit. The average values for physical and

chemical properties are also listed for each soil unit using the analytical data obtained for all profiles recorded in that unit. For comparison, the data listed are those for the surface (0-7.5 cm) soil layer and three standard depths down the soil profile, i.e.

- depth A : 0-10 cm
- " B : The uppermost 30 cm segment of the clayey subsoil
- " C : 60-90 cm, unless augering was abandoned at a depth shallower than 90 cm.

Figure 5: Physical Properties of the Surface Soils (0-7.5 cm)



* No data available for Minor Soil Type-2

The average values for the soil types with regard to physical properties of their surface soils (0-7.5 cm) are shown in Figure 5.

Detailed descriptions for soil profiles representing the mapping units however, are presented in Appendix I and the analytical data for these profiles are listed in Appendix II. A diagrammatic presentation of the particle size distribution for selected profiles is shown in Appendix III.

I Ararat Series

Soils included in this series have distinct texture contrasts between hard setting surface soil horizons and moderately to strongly pedal clayey subsoils. The uppermost subsoil layer, that is at least 15 cm thick, is whole-coloured and red. The soil reaction trend is usually neutral. In the present survey, this series includes one soil type and three phases.

Ararat Sandy Clay Loam (AR scl)

Distinguishing Features

Surface Soil:

- 10-15 cm thick
- Brown to dark reddish brown
- Sandy clay loam
- A_2 "subsurface soil horizon" is absent

Subsoil:

- Red or yellowish red, gradually becoming mottled with brownish and/or yellowish colours at about 40-60 cm. At depth the degree of mottling increases and some gleyed colours may occur.
- Medium to heavy clay. The deep clayey subsoils may become sandier and gritty.

Soil Inclusions:

- Trace to slight amounts of quartz fragments and ferruginous concretions are commonly found throughout the soil profile. Higher amounts (up to light amounts) however, may occur in some surfaces.
- Trace to slight amounts of weathered sandstone and other rock fragments are commonly found in the deep subsoils.

Analytical Data

(i) Analytical data for the surface soil (0-7.5 cm):

Stoniness (mineral fractions >2 mm)	%	13.2
Bulk Density		
- Total soil material	g cm^{-3}	1.25
- Stoneless soil material	g cm^{-3}	0.94
Total porosity	%	54.6
Void Ratio		1.21
Air Capacity	%	28.2
Moisture Retention		
- @ 15-Bar	%	9.8
- @ $^1/_3$-Bar	%	21.7

(ii) Analytical data for selected depths down the profile:

Depth	pH	Total Soluble Salts	Sodium Chloride *	Moisture Retention @ 15-Bar	Moisture Retention @ $^1/_3$-Bar
		%	%	%	%
A	6.4	0.017	-	10.8	23.6
B	6.0	0.015	-	14.9	27.5
C	6.7	0.020	-	14.1	27.9

* The dashes recorded in this column indicate negligible amounts of sodium chloride.

Occurrence

Ararat sandy clay loam is commonly found on the upper slopes and crests of the undulating plains and moderately hilly areas.

Phases

(a) Deep surface profile:
- The depth to the clayey subsoil is 25-30 cm
- A non-bleached massive A_2 horizon (15-20 cm thick) is usually present
- The total depth to the bedrocks is commonly 60-80 cm
- Usually occurs on the upper slopes

(b) Stony profile:
- Light to moderate amounts of stones occur throughout the soil profile
- On average, the stone contents of the surface layer (0-7.5 cm) is about 15%
- Usually, the soil profile is impenetrable to a hand auger at about 100 cm due to bedrock
- Commonly occurs on the crests and upper slopes

(c) Deep surface and stony profile:
- The depth to the clayey subsoil is 25-30 cm
- A non-bleached massive A_2 (15-20 cm thick) is usually present
- Light to moderate amounts of stones occur throughout the soil profile
- On average, the stone content of the surface layer (0-7.5 cm) is about 18%
- Some soil profiles are impenetrable to a hand auger due to bedrocks at depths as shallow as 60 cm
- Usually occurs on the crests and upper slopes

II Cathcart Series

Soils included in this series have distinct contrasts between hard setting surface soil horizons and moderately to strongly pedal clayey subsoils. The uppermost subsoil layer, that is at least 15 cm thick, is mottled and dominantly red. The soil reaction trend is usually neutral. In the present survey this series includes one soil type and two phases.

Cathcart Sandy Clay Loam (CA scl)

Distinguishing Features

Surface Soil:

A_1 horizon:
- 20-25 cm thick
- Brown to dark brown, occasionally dark reddish brown
- Sandy clay loam

A_2 horizon:
- 3-5 cm thick, massive
- brown to reddish brown (moist) with sporadically bleached near white (dry) soil material. This horizon however, often occurs only as nests of sporadic bleaching at the interface between the A and B horizons
- Sandy clay loam

Subsoil:
- Mottled red (or yellowish red) and brown. The red colour decreases gradually at about 60-80 cm
- Heavy clay, becomes slightly gritty in the deep subsoils
- Decomposed sandy parent materials usually occur at about 80 cm and the soil profile becomes impenetrable to a hand auger at about 100 cm due to bedrock

Soil Inclusions:
- Slight to light amounts of quartz fragments and ferruginous concretions are usually found in the surface soil horizons and only trace to slight amounts in the clayey subsoils
- Slight amount of weathered sandstone and other rock fragments are commonly found in the deep subsoils

Analytical Data

(i) Analytical data for the surface soil (0-7.5 cm):

Stoniness (mineral fractions > 2 mm)	%	10.1
Bulk Density		
- Total soil material	g cm^{-3}	1.32
- Stoneless soil material	g cm^{-3}	1.06
Total Porosity	%	51.2
Void Ratio		1.06
Air Capacity	%	23.6
Moisture Retention		
- @ 15-Bar	%	8.9
- @ $^1/_3$-Bar	%	20.9

(ii) Analytical data for selected depths down the profile:

Depth	pH	Total Soluble Salts	Sodium Chloride *	Moisture Retention	
				@ 15-Bar	@ $^1/_3$-Bar
		%	%	%	%
A	6.5	0.023	-	8.6	21.1
B	6.7	0.022	-	23.0	39.6
C	7.3	0.046	-	21.9	35.9

* The dashes recorded in this column indicate negligible amounts of sodium chloride

Occurrence

Cathcart sandy clay loam is commonly found on the upper and intermediate slopes in the strongly undulating plain and hilly areas.

Phases:

(a) Deep surface:

- The depth to the clayey subsoil is 30-40 cm
- A conspicuously bleached massive A_2 (20-25 cm thick) is usually present
- The stone contents may increase to light amounts in the A_2 horizon and in the deep subsoils
- Usually occurs on the crests and upper slopes

(b) Deep surface and stony profile:

- The depth to the clayey subsoil is 50-60 cm
- A conspicuously bleached massive A_2 (40-50 cm thick) is usually present
- Moderate amounts of stones usually occur throughout the soil profile. Some profiles however, have only slight or light amounts of stones in the A_1 horizons
- On average, the stone content of the surface layer (0-7.5 cm) is about 20%
- Bedrocks may occur at about 100 cm
- Usually occurs in slight depressions in hilly areas

III Burrumbeep Series

Soils included in this series have distinct texture contrasts between hard setting surface soil horizons and moderately to strongly pedal clayey subsoils. The uppermost subsoil layer, that is at least 15 cm thick, is mottled and dominantly yellow. The soil reaction trend is usually acid. In the present survey this series includes one soil type and two phases.

Burrumbeep Sandy Clay Loam (BU scl)

Distinguishing features

Surface Soil:

A_1 horizon:

- 10-15 cm thick
- Brown to dark brown
- Sandy clay loam to fine sandy clay loam

A_2 horizon:

- 15-20 cm thick, massive
- Light brown to yellowish red (moist), conspicuously bleached near white (dry)
- Loam to sandy clay loam

Subsoil:

- Mottled brownish yellow to strong brown (or reddish yellow) and red
- Medium to heavy clay
- Moderately compacted layer (hardpan) may occur in the deep subsoils (at about 80 cm)

Soil Inclusions:

- Trace to slight amounts of quartz fragments and ferruginous concretions are commonly found throughout the soil profile. Higher amounts, however, may occur in the surface horizons.

Analytical Data

(i) Analytical data for the surface soil (0-7.5 cm):

Stoniness (mineral fractions > 2 mm)	%	8.5
Bulk Density		
- Total soil material	g cm^{-3}	1.34
- Stoneless soil material	g cm^{-3}	1.03
Total Porosity	%	51.4
Void Ratio		1.07
Air Capacity	%	25.2
Moisture Retention		
- @ 15-Bar	%	7.4
- @ $^1/_3$-Bar	%	20.0

(ii) Analytical data for selected depths down the profile:

Depth	pH	Total Soluble Salts	Sodium Chloride *	Moisture Retention	
				@ 15-Bar	@ $^1/_3$-Bar
		%	%	%	%
A	5.8	0.013	-	8.2	23.1
B	5.8	0.011	-	15.6	28.6
C	6.3	0.020	-	18.1	33.1

* The dashes recorded in this column indicate negligible amounts of sodium chloride

Occurrence

Burrumbeep sandy clay loam is usually found in the crests and upper slopes in the moderately hilly areas. In some areas however, this soil type occurs, mixed with varied soils, on lower slopes, gully floors and slight depressions.

Phases:

(a) Deep surface:

- The depth to the clayey subsoil is 40-50 cm
- On average, the thickness of the conspicuously bleached A_2 horizon is about 30 cm.
- Commonly occurs on the lower slopes.

(b) Stony Profile:

- Light to moderate amounts of stones occur throughout the soil profile. The upper horizons of the clayey subsoils, however, may contain only slight amounts of stones.
- On average, the stone contents of the surface layer (0-7.5 cm) is about 20%
- Commonly occurs on the lower slopes.

IV Minor Soil Types

Discussed below are three minor soil types, none of which fitted the descriptions of any of the soil types mentioned above. Because of the limited occurrence of these minor types, the following descriptions and analyses have been generally based on only few observations. Soils included in the three minor types have distinct texture contrasts between hard setting surface soil horizons and moderately to strongly pedal clayey subsoils. These minor types occur, mixed with other varied soils, in gullies and shallow depressions.

Minor Soil Type 1 (M.T.1)

Distinguishing features

- The surface soil is about 10 cm thick, brown to dark brown fine sandy clay loam to sandy clay loam (heavy).
- The A_2 (subsurface soil horizon) is commonly absent. Nest of bleached (near white) soil materials, however, may occur at the interface between the A and B horizons.
- The uppermost subsoil layer, that is at least 15 cm thick is dark (to very dark) greyish brown (whole-coloured) medium to heavy clay. Mottled brown, yellowish brown and/or strong brown colours, however, occur at about 40-50 cm. Some red colours also commonly occur in the mottled deep subsoils.
- The soil reaction trend in usually neutral.
- Trace to slight amounts of quartz fragments and ferruginous concretions are commonly found throughout the soil profile.
- Bedrocks may occur at about 100 cm.

Analytical Data

(i) Analytical data for the surface soil (0-7.5 cm):

Stoniness (mineral fractions > 2 mm)	%	3.9
Bulk Density		
- Total soil material	g cm^{-3}	1.27
- Stoneless soil material	g cm^{-3}	1.17
Total Porosity	%	53.0
Void Ratio		1.13
Air Capacity	%	23.9
Moisture Retention		
- @ 15-Bar	%	9.2
- @ $^1/_3$-Bar	%	22.9

(ii) Analytical data for selected depths down the profile:

Depth	pH	Total Soluble Salts	Sodium Chloride *	Moisture Retention	
				@ 15-Bar	@ $^1/_3$-Bar
		%	%	%	%
A	6.1	0.026	-	10.3	26.7
B	5.8	0.026	-	12.7	27.1
C	7.1	0.068	0.030	16.7	28.6

* The dashes recorded in this column indicate negligible amounts of sodium chloride

Minor Soil Type 2 (M.T.2)

Distinguishing features

- The surface soil is 40-50cm thick, brown to dark brown sandy clay loam.
- The A_2 (subsurface soil horizon) may be present but not bleached.
- The uppermost subsoil layer, that is at least 15 cm thick is mottled brown (to reddish brown) and pale brown (to yellowish brown) heavy clay (sandy).
- The soil reaction trend in usually neutral.
- Trace to slight amounts of quartz fragments and ferruginous concretions commonly occur throughout the soil profile. Higher amounts (up to light amounts) however, may occur in the deep subsoils.
- Bedrocks may be found at about 90-100 cm.

Analytical Data

(i) Analytical data for the surface soil (0-7.5 cm):

No data available

(ii) Analytical data for selected depths down the profile:

Depth	pH	Total Soluble Salts	Sodium Chloride *	Moisture Retention	
				@ 15-Bar	@ $^1/_3$-Bar
		%	%	%	%
A	7.3	0.034	-	10.2	20.1
B	7.4	0.026	-	13.1	27.2
C	7.9	0.027	-	15.7	26.4

* The dashes recorded in this column indicate negligible amounts of sodium chloride

Minor Soil Type 3 (M.T.3)

Distinguishing features

- The A_1 (surface soil horizon) is about 30 cm thick, brown to dark brown sandy clay loam.
- The A_2 (subsurface horizon) is about 20 cm thick, pale brown to brownish yellow, conspicuously bleached near white (dry), light sandy clay loam.
- The B horizons (the clayey subsoils) are mottled yellowish brown (or pale brown), brown, yellow and red heavy clay (sandy).
- The soil reaction trend in usually alkaline. Profiles with neutral reaction trend, however, may occur.

- Trace to slight amounts of quartz fragments and ferruginous concretions are commonly found throughout the soil profile. Higher amounts (up to moderate amounts) however, may occur in the A_2 (subsurface) horizons.
- Bedrocks may be found at about 100 cm.

Analytical Data

(i) Analytical data for the surface soil (0-7.5 cm):

Stoniness (mineral fractions > 2 mm)	%	4.8
Bulk Density		
- Total soil material	g cm^{-3}	1.23
- Stoneless soil material	g cm^{-3}	1.11
Total Porosity	%	54.3
Void Ratio		1.23
Air Capacity	%	30.8
Moisture Retention		
- @ 15-Bar	%	8.0
- @ $^1/_3$-Bar	%	19.0

(ii) Analytical data for selected depths down the profile:

Depth	pH	Total Soluble Salts	Sodium Chloride *	Moisture Retention	
				@ 15-Bar	@ $^1/_3$-Bar
		%	%	%	%
A	7.3	0.109	0.007	7.6	20.2
B	7.5	0.049	0.005	14.3	24.9
C	8.0	0.052	0.006	15.6	26.5

The Soil Maps

4.2.1 Montara Vineyards

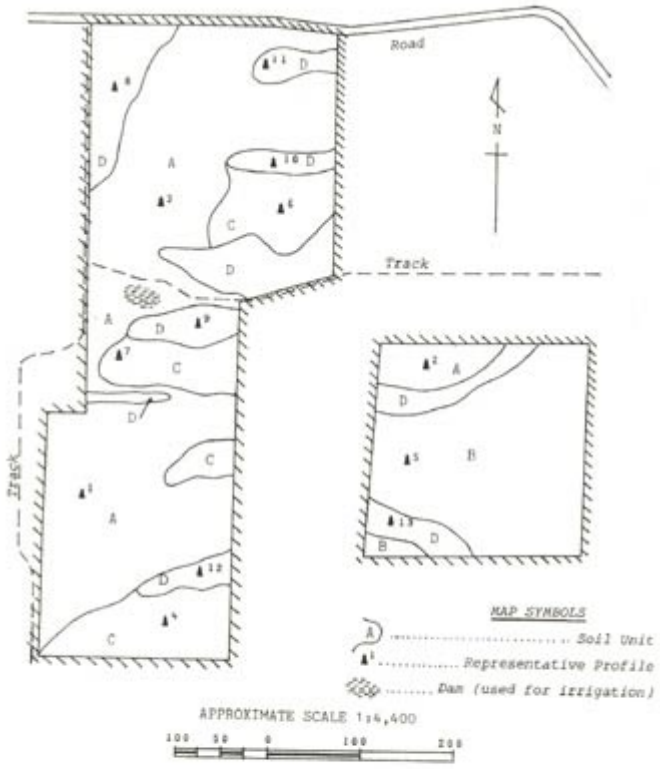
Although most of the soils recognised in the survey were mapped separately, two complex units were used where more than one soil type recurred over short distances. The two units and their dominant soils are as follows :-

- Complex I:
  - Cathcart sandy clay loam
  - " " " " (deep surface)
  - Burrumbeep sandy clay loam

- Complex II (varied soils in gullies, slight depressions and lower slopes):
  - Burrumbeep sandy clay loam
  - " " " " (deep surface)
  - Minor soil type -1
  - Minor soil type -2
  - Minor soil type -3

The approximate area of each mapping unit (% of the total area surveyed) is listed in Table 8 and the areal distribution is shown on the soil map (Figure 6).

Figure 6: Soil Map (Montara Vineyards) Ararat, County of Ripon, Victoria



DEPARTMENT OF AGRICULTURE, VICTORIA
DIVISION OF AGRICULTURAL CHEMISTRY
SOILS SECTION
Field Operations: 1980
Soil Surveyors: N.S. Badawy and N.B. Lewis
Map compiled and drawn by:
Nabil S. Badawy, Soils Officer

LEGEND

(i) Mapping Units

Unit	Soils
A	- Ararat sandy clay loam [AR scl] - " " " " (stony profile) [AR scl (s)]
B	Cathcart sandy clay loam [CA scl]
C	Soil Complex I: - Cathcart sandy clay loam [CA scl] - " " " " (deep surface) [CA scl (d)] - Burrumbeep sandy clay loam [BU scl]
D	Soil Complex II: - Burrumbeep sandy clay loam [BU scl] - " " " " (deep surface) [BU scl (d)] - Minor soil type -1 [M.T.1] - Minor soil type -2 [M.T.2] - Minor soil type -3 [M.T.3]

(ii) Representative Profiles

Map Reference	Report Reference	Soil Classification PPF (Northcote '79)	Soil Type
Δ1	Prof. # 1	Dr 2.12/SCL (10 cm)	AR scl
Δ2	Prof. # 2	Dr 2.12/SCL (15 cm)	"
Δ3	Prof. # 4	Dr 2.12/SCL (10 cm)	AR scl (s)
Δ4	Prof. # 6	Dr 3.32/SCL "gr" (10 cm)	CA scl
Δ5	Prof. # 7	Dr 3.32/SCL (25 cm)	"
Δ6	Prof. # 8	Dr 3.42/SCL (35 cm)	CA scl (d)
Δ7	Prof. # 11	Dy 3.42/FSCL "gr" (30 cm)	BU scl
Δ8	Prof. # 13	Dy 3.41/SCL (45 cm)	BU scl (d)
Δ9	Prof. # 15	Dy 2.32/FSCL (6 cm)	M.T.1
Δ10	Prof. # 16	Dd 1.12/FSCL (20 cm)	"
Δ11	Prof. # 17	Dy 3.12/SCL (45 cm)	M.T.2
Δ12	Prof. # 18	Dy 3.42/SCL (45 cm)	M.T.3
Δ13	Prof. # 19	Dy 3.43/SCL (50 cm)	M.T.3

Table 8 - Distribution of the Mapping Units (Montara Vineyards)

Mapping Units	Area % (approx.)
(A) Ararat sandy clay loam (incl. Stony prof. Phase)	47
(B) Cathcart sandy clay loam	20
(C) Soil Complex I	15
(D) Soil Complex II	18
	100

4.2.2 Bertuch Vineyards

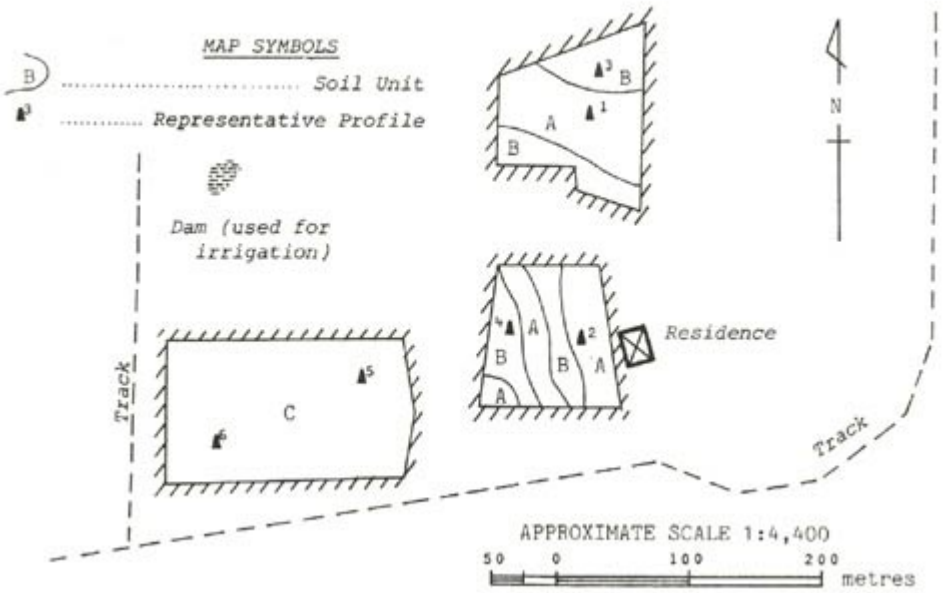
The main soils of the Bertuch vineyards belong to the three soil series included in this investigation. Table 9, below, lists the various mapping units recognised in these vineyards and the approximate area

of each unit (% of the total area surveyed). The areal distribution of these units is shown on the soil map (Figure 7).

Table 9 - Distribution of the Mapping Units (Bertuch Vineyards)

Mapping Units	Area % (approx.)
Unit A (Ararat Series); including: - Ararat sandy clay loam (deep surface) - " " " " (deep surface & stony profile)	27
Unit B (Cathcart Series); including: - Cathcart sandy clay loam (deep surface) - " " " " (deep surface & stony profile)	24
Unit C (Burrumbeep Series); including: - Burrumbeep sandy clay loam - " " " " (stony profile)	49
	100

Figure 7 - Soil Map (Bertuch Vineyards) Ararat, County of Ripon, Victoria



(i) ***Mapping Units***

Unit	Soils
A	- Ararat sandy clay loam (deep surface) [AR scl (d)] - " " " " (deep surface & stony profile) [AR scl (d & s)]
B	- Cathcart sandy clay loam (deep surface) [CA scl (d)] - " " " " (deep surface & stony profile) [CA scl (d & s)]
C	- Burrumbeep sandy clay loam [BU scl] - " " " " (stony profile) [BU scl (s)]

(ii) ***Representative Profiles***

Map Reference	Report Reference	Soil Classification PPF (Northcote '79)	Soil Type
$\Delta 1$	Prof. # 3	Dr 2.22/FSCL "gr" (10 cm)	AR scl (d)
$\Delta 2$	Prof. # 5	Dr 2.22/SCL "gr" (30 cm)	AR scl (d & s)
$\Delta 3$	Prof. # 9	Dr 3.42/SCL (35 cm)	AR scl (s)
$\Delta 4$	Prof. # 10	Dr 3.42/SCL (60 cm)	CA scl
$\Delta 5$	Prof. # 12	Dr 3.41/SCL (30 cm)	"
$\Delta 6$	Prof. # 14	Dr 3.41/SCL (30 cm)	CA scl (d)

4.3 The Irrigation Water

Quality aspects were determined on water samples from two dams located near the surveyed areas in the Montara and Bertuch Vineyards (Table 10). The two dams are currently utilised to drip and/or spray irrigate these vineyards. The location of both dams are shown on the soil maps.

Table 10 - Analytical Data for Dam Water Samples

Sample Reference	EC *	TSS ***	Cl^- ***	Soluble Cations				SAR $\delta\delta$
				Ca^{++}	Mg^{++}	Na^+		
	µS/cm	ppm	ppm	m.e/l	m.e/l	m.e/l	% δ	
Montara Vineyards								
930	619	206	1.21	1.21	6.63	77.7	6.80
Bertuch Vineyards								
182	148	24	0.41	0.41	1.20	68.2	2.27

* Electrical Conductivity at 20°C.
** Total Soluble Salts.
*** Chlorides as sodium chloride (common salt).
δ Sodium Percentage = 100 (Na^+)/ $Ca^{++} + Mg^{++} + Na^+$.
$\delta\delta$ Sodium – Adsorption – Ratio = $Na^+ / \sqrt{(Ca^{++} + Mg^{++})/2.}$

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The landholders, without exception, freely allowed the soil surveyors access to their properties and provided all the relevant information.

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The author extends his sincere thanks to all of these people.

APPENDIX I - DESCRIPTION OF REPRESENTATIVE PROFILES

ARARAT SANDY CLAY LOAM
(two representative profiles)

(i) Profile # 1

Profile reference: WM 13/38 (Montara vineyards)
Topography: Upper-moderate slope in a hilly area
Soil Classification: Dr 2.12/SCL (10 cm)

Soil Description:

Surface Soil

0-10 cm; dark reddish brown (5YR3/4m) sandy clay loam; weakly pedal, hard setting; slightly plastic and slightly sticky (wet); trace amounts of quartz fragments and ferruginous concretions; sharp boundary to:

Subsoil

10-40 cm; red (2.5YR4/6m) heavy clay (gritty); strong fine and medium angular blocky structure; smooth-ped fabric; moderately hard (dry), friable (moist), plastic and sticky (wet); trace amounts of quartz fragments and ferruginous concretions; clear boundary to:

40-80 cm; as above but; mottled yellowish brown (10YR5/8m) and red (2.5YR5/6m); gradual boundary to:

80-100 cm^{+}; as above but; mottled yellowish brown (10YR5/6m) and reddish yellow (5YR7/6m) medium clay (sandy); slight amounts of weathered sandstone fragments.

(ii) Profile # 2

Profile reference: WM 15/2 (Montara vineyards)
Topography: Top of small rise in a hilly area
Soil Classification: Dr 2.12/SCL (15 cm)

Soil Description:

Surface Soil

0-15 cm; reddish brown (5YR4/4m) sandy clay loam; weakly pedal, hard setting; hard (dry, slightly friable (moist), moderately plastic and moderately sticky (wet); slight amounts of quartz fragments and ferruginous concretions; sharp boundary to:

Subsoil

15-60 cm; red (2.5YR4/6m) medium to heavy clay; strong fine and medium angular blocky structure; smooth-ped fabric; hard (dry), friable (moist), plastic and sticky (wet); slight amounts of quartz fragments and ferruginous concretions; gradual boundary to:

60-100 cm; as above but; mottled yellowish brown (10YR5/8m) and yellowish red (5YR5/6m) heavy clay.

ARARAT SANDY CLAY LOAM (Deep Surface)
(one representative profile

Profile # 3

Profile reference: WM 15/5 (Bertuch vineyards)
Topography: Upper-moderate (to steep) slope in a hilly area
Soil Classification: Dr 2.22/FSCL "gr" (25 cm)

Soil Description:

Surface Soil
0-10 cm; dark brown (7.5YR3/4m) fine sandy clay loam (gritty); weakly pedal, hard setting; hard (dry), friable (moist), moderately plastic and moderately sticky (wet); light amounts of shale fragments and trace amounts of ferruginous concretions and quartz fragments; sharp boundary to:

10-25 cm; yellowish red (5YR5/6m) clay loam (gritty); weakly pedal, compacted; hard (dry), friable (moist), moderately plastic and sticky (wet); slight amounts of stone fragments; clear boundary to:

Subsoil
25-50 cm; yellowish red (5YR4/6m) heavy clay (gritty); strong fine and medium angular blocky structure; smooth-ped fabric; slight amounts of shale fragments; clear boundary to:

50-60 cm; as above but; yellowish red (5YR5/8m); moderately pedal; moderate to heavy amounts of weathered sandstone and shale fragments; bedrock at 60 cm.

ARARAT SANDY CLAY LOAM (Stony Profile)
(one representative profile)

Profile # 4

Profile reference: WM 13/45 (Montara vineyards)
Topography: Upper-moderate slope in a hilly area
Soil Classification: Dr 2.12/SCL (10 cm)

Soil Description:

Surface Soil
0-10 cm; dark reddish brown (5YR3/4m) sandy clay loam; weakly pedal, hard setting; hard (dry) friable (moist), slightly plastic and slightly sticky (wet); light amounts of quartz fragments and ferruginous concretions; clear boundary to:

Subsoil
10-40 cm; red (2.5YR4/6m) heavy clay (gritty); strong fine and medium angular blocky structure; smooth-ped fabric; hard (dry), friable (moist), plastic and sticky (wet); moderate amounts of quartz fragments and ferruginous concretions; gradual boundary to:

40-65 cm; as above but; mottled red (2.5YR4/8m) and strong brown (7.5YR5/8m); the amounts of stones decrease to light; clear boundary to:

65-100 cm; as above but; mottled strong brown (7.5YR5/8m), red (2.5YR4/8m) and pale brown (10YR6/3m); non-friable (moist); the amounts of stones increase to moderate; weathered sandstone fragments are present, bedrock at 100 cm.

ARARAT SANDY CLAY LOAM (Deep Surface & Stony Profile)
(one representative profile)

Profile # 5

Profile reference: WM 15/7 (Bertuch vineyards)
Topography: Upper-moderate slope in a hilly area
Soil Classification: Dr 2.22/SCL "gr" (30 cm)

Soil Description:

Surface Soil

0-10 cm; dark reddish brown (5YR3/4m) sandy clay loam (gritty); weakly pedal, hard setting; hard (dry), friable (moist), slightly plastic and slightly sticky (wet); moderate amounts of ferruginous concretions and quartz and shale fragments; clear boundary to:

10-30 cm; as above but; reddish brown (5YR4/4m) clay loam (gritty); clear boundary to:

Subsoil

30-60 cm; yellowish red (5YR4/6m) with some brownish yellow medium clay (gritty); moderately fine and medium angular blocky structure; smooth-ped fabric; hard (dry), friable (moist), plastic and sticky (wet); moderate amounts of stones, bedrock at 60 cm.

CATHCART SANDY CLAY LOAM
(two representative profiles)

(i) Profile # 6

Profile reference: WM 13/39 (Montara vineyards)
Topography: Upper-gentle slope in a hilly area
Soil Classification: Dr 3.32/SCL "gr" (25 cm)

Soil Description:

Surface Soil

0-20 cm; brown (7.5YR4/4m) sandy clay loam (gritty); weakly pedal, hard setting; hard (dry), friable (moist), slightly plastic and slightly sticky (wet); light amounts of quartz fragments and ferruginous concretions; sharp boundary to:

20-25 cm; as above but; strong brown (7.5YR5/6m) sporadically bleached pink (7.5YR7/4d); sharp boundary to:

Subsoil

25-55 cm; mottled dark red (2.5YR3/6m) and yellowish red (5YR5/6m) heavy clay; strong fine and medium angular blocky structure; smooth-ped fabric; hard (dry), friable (moist), plastic and sticky (wet); trace amounts of quartz fragments and ferruginous concretions; gradual boundary to:

55-100 cm^{+}; as above but; mottled dark red (2.5YR3/6m) and yellowish brown (10YR5/6m).

(ii) Profile # 7

Profile reference: WM 13/50 (Montara vineyards)
Topography: Mid-moderate slope in a hilly area
Soil Classification: Dr 3.32/SCL (25 cm)

Soil Description:

Surface Soil
0-25 cm; brown (10YR5/3m) sandy clay loam; weakly pedal, hard setting; hard (dry), slightly friable (moist), slightly plastic and slightly sticky (wet); slight amounts of quartz fragments and ferruginous concretions; nests of sporadically bleached pink (7.5YR7/4d) soil materials are present at the sharp boundary between this horizon and the clayey subsoil below:

Subsoil
25-80 cm; mottled red (2.5YR4/8m) and yellowish brown (10YR5/6m) heavy clay; strong fine and medium angular blocky structure; smooth-ped fabric; very hard (dry), moderately friable (moist), very plastic and sticky (wet); trace amounts of quartz fragments and ferruginous concretions; clear boundary to:

80-110 cm; as above but; mottled yellowish red (5YR5/6m) and yellowish brown (10YR5/8m); the amounts of stones increase to slight; bedrock at 110 cm.

CATHCART SANDY CLAY LOAM (Deep Surface)
(two representative profiles)

(i) Profile # 8

Profile reference: WM 13/44 (Montara vineyards)
Topography: Upper-moderate slope in a hilly area
Soil Classification: Dr 3.42/SCL (35 cm)

Soil Description:

Surface Soil
0-10 cm; dark brown (7.5YR3/2m) sandy clay loam; weakly pedal, hard setting; hard (dry), friable (moist), slightly plastic and slightly sticky (wet); slight amounts of quartz fragments and ferruginous concretions; sharp boundary to:

10-35 cm; as above but; yellowish red (5YR4/6m) conspicuously bleached pink (5YR7/3d); clear boundary to:

Subsoil
35-65 cm; mottled yellowish red (5YR4/6m) and strong brown (7.5YR5/8m) heavy clay (gritty); strong fine and medium angular blocky structure; smooth-ped fabric; hard (dry), friable (moist), plastic and sticky (wet); gradual boundary to:

65-90 cm; as above but; the yellowish red colour becomes subdominant to the strong brown in the mottle; the amounts of stones increase to light; bedrock (or hardpan ‘quartz’) at 95 cm.

(ii) Profile # 9

Profile reference: WM 15/6 (Bertuch vineyards)
Topography: Upper-moderate slope in a hilly area
Soil Classification: Dr 3.42/SCL (35 cm)

Soil Description:

Surface Soil

0-10 cm; dark brown (7.5YR3/4m) sandy clay loam; weakly pedal, hard setting; hard (dry), friable (moist), slightly plastic and slightly sticky (wet); slight amounts of shale fragments; sharp boundary to:

10-35 cm as above but; brown (7.5YR5/4m) conspicuously bleached pink (7.5YR7/4d); clear boundary to:

Subsoil

35-55 cm; mottled red (2.5YR4/6m) and strong brown (7.5YR5/6m) heavy clay (gritty); strong fine and medium angular blocky structure; smooth-ped fabric; hard (dry), friable (moist), plastic and sticky (wet); slight amounts of shale fragments; clear boundary to:

55-85 cm; as above but; mottled yellowish brown (10YR5/8m) and red (2.5YR4/6m); gradual boundary to:

85-110 cm^{+}; as above but; mottled light yellowish brown (2.5YR6/4m) and strong brown (7.5YR5/8m) heavy clay (smooth); moderately pedal.

CATHCART SANDY CLAY LOAM (Deep Surface & Stony Profile)
(one representative profile)

Profile # 10

Profile reference: WM 15/8 (Bertuch vineyards)
Topography: Slight gully on a moderate slope in a hilly area
Soil Classification: Dr 3.42/SCL (60 cm)

Soil Description:

Surface Soil

0-10 cm; dark reddish brown (5YR3/4m) sandy clay loam; weakly pedal, hard setting; hard (dry), friable (moist), slightly plastic and slightly sticky (wet); slight amounts of shale and quartz fragments; clear boundary to:

10-60 cm as above but; yellowish red (5YR5/6m) conspicuously bleached pink (5YR7/4d) sandy clay loam (gritty); moderate to heavy amounts of stones; sharp boundary to:

Subsoil

60-90 cm^{+}; mottled yellowish red (5YR4/6m) and yellowish brown (10YR5/4 & 5/6m) heavy clay (gritty); strong fine and medium angular blocky structure; smooth-ped fabric; hard (dry), friable (moist), plastic and sticky (wet); moderate amounts of stones.

BURRUMBEEP SANDY CLAY LOAM
(two representative profiles)

(i) Profile # 11

Profile reference: WM 13/36 (Bertuch vineyards)
Topography: Upper-moderate slope in a hilly area
Soil Classification: Dr 3.42/FSCL "gr" (30 cm)

Soil Description:

Surface Soil

0-10 cm; brown (7.5YR4/4m) fine sandy clay loam (gritty); weakly pedal, hard setting; hard (dry), friable (moist), moderately plastic and sticky (wet); slight amounts of quartz fragments and ferruginous concretions; sharp boundary to:

10-60 cm as above but; yellowish red (5YR5/6m) conspicuously bleached pink (7.5YR7/4d) loam; clear boundary to:

Subsoil

30-70 cm; mottled brownish yellow (10YR6/6m) and red (2.5YR4/6m) heavy clay (gritty); strong fine and medium angular blocky structure; smooth-ped fabric; hard (dry), friable (moist), plastic and sticky (wet); slight amounts of stones; gradual boundary to:

70-100 cm; as above but; mottled strong brown (7.5YR5/8m) and yellowish red (5YR4/6m), the amounts of stones decrease to trace; a hardpan at 100 cm.

(ii) Profile # 12

Profile reference: WM 15/9 (Bertuch vineyards)
Topography: Upper-moderate slope in a hilly area
Soil Classification: Dr 3.41/SCL (30 cm)

Soil Description:

Surface Soil

0-10 cm; dark brown (7.5YR3/2m) sandy clay loam; weakly pedal, hard setting; hard (dry), friable (moist), slightly plastic and slightly sticky (wet); light amounts of quartz fragments and ferruginous concretions; clear boundary to:

10-30 cm; as above but; brown (7.5YR5/4m) conspicuously bleached pink (7.5YR7/4d) loam; clear boundary to:

Subsoil

30-60 cm; mottled reddish yellow (7.5YR6/6m) and red (2.5YR4/6m) medium clay; moderate fine and medium angular blocky structure; smooth-ped fabric; hard (dry), friable (moist), plastic and sticky (wet); slight amounts of quartz fragments and ferruginous concretions; clear boundary to:

60-90 cm; as above but; mottled red (2.5YR4/6m) and strong brown (7.5YR5/8m) heavy clay; strongly pedal; very hard (dry); clear boundary to:

90-110 cm^{+}; as above but; mottled white (2.5YR8/0m), red (2.5YR4/8m) and brownish yellow (10YR6/6m).

BURRUMBEEP SANDY CLAY LOAM (Deep Surface)
(one representative profile)

Profile # 13

Profile reference: WM 13/48 (Montara vineyards)
Topography: Lower-gentle slope in a hilly area
Soil Classification: Dy 3.41/SCL (45 cm)

Soil Description:

Surface Soil

0-15 cm; dark brown (7.5YR3/4m) sandy clay loam; weakly pedal, hard setting; hard (dry), friable (moist), slightly plastic and slightly sticky (wet); slight amounts of quartz fragments and ferruginous concretions; sharp boundary to:

15-45 cm; as above but; light grey (10YR7/2m) conspicuously bleached white (10YR8/2d); moderate amounts of stones; clear boundary to:

Subsoil

45-75 cm; mottled brownish yellow (10YR6/6m) and red (2.5YR4/8m) heavy clay; strong fine and medium angular blocky structure; smooth-ped fabric; hard (dry), slightly friable (moist), very plastic and sticky (wet); trace amounts of quartz fragments and ferruginous concretions; gradual boundary to:

75-100 cm^{+}; as above but; mottled yellowish brown (10YR5/6m) and red (2.5YR4/8m).

BURRUMBEEP SANDY CLAY LOAM (Stony Profile)
(one representative profile)

Profile # 14

Profile reference: WM 15/10 (Bertuch vineyards)
Topography: Lower-moderate slope in a hilly area
Soil Classification: Dy 3.41/SCL (30 cm)

Soil Description:

Surface Soil

0-10 cm; brown (7.5YR4/2m) sandy clay loam; weakly pedal, hard setting; hard (dry), friable (moist), slightly plastic and slightly sticky (wet); light amounts of quartz fragments and ferruginous concretions; clear boundary to:

10-30 cm; as above but; reddish yellow (7.5YR6/6m) conspicuously bleached pink (7.5YR8/4d) sandy clay loam (gritty); the amounts of stones increase to moderate; clear boundary to:

Subsoil

30-60 cm; mottled strong brown (7.5YR5/8m) and red (2.5YR4/8m) heavy clay; strong fine and medium angular blocky structure; smooth-ped fabric; hard (dry), friable (moist), plastic and sticky (wet); slight amounts of quartz fragments and ferruginous concretions; clear boundary to:

60-90 cm^{+}; as above but; mottled red (2.5YR4/8m) and yellowish brown (10YR5/6m); light amounts of stones.

MINOR SOIL TYPE -1
(two representative profiles)

(i) Profile # 15

Profile reference: WM 13/37 (Montara vineyards)
Topography: Slight gully in a hilly area
Soil Classification: Dy 2.32/FSCL (6 cm)

Soil Description:

Surface Soil

0-6 cm; brown (10YR4/3m) fine sandy clay loam; weakly pedal, hard setting; hard (dry), slightly friable (moist), moderately plastic and moderately sticky (wet); trace amounts of quartz fragments and ferruginous concretions; nests of sporadically bleached white (10YR8/2d) soil materials are present at the sharp boundary between this horizon and the clayey subsoil below:

Subsoil

6-36 cm; dark greyish brown (10YR4/2m) medium clay; strong fine and medium angular blocky structure; smooth-ped fabric; hard (dry), slightly friable (moist), plastic and sticky (wet); clear boundary to:

36-60 cm; as above but; mottled brown (10YR5/3m) and strong brown (7.5YR5/8m) heavy clay (gritty); slight amounts of quartz fragments and ferruginous concretions; gradual boundary to:

60-80 cm; as above but; mottled greyish brown (10YR5/2m) and red (2.5YR5/8m); clear boundary to:

80-100 cm; as above but; mottled pale brown (10YR6/3m) and strong brown (7.5YR5/6m) medium clay (gritty); moderately pedal; bedrock at 100 cm.

(ii) Profile # 16

Profile reference: WM 13/47 (Montara vineyards)
Topography: Gully floor in a hilly area
Soil Classification: Dd 1.12/FSCL (20 cm)

Soil Description:

Surface Soil

0-20 cm; dark brown (7.5YR4/2m) fine sandy clay loam; weakly pedal, hard setting; hard (dry), friable (moist), moderately plastic and sticky (wet); trace amounts of quartz fragments and ferruginous concretions; sharp boundary to:

Subsoil

20-35 cm; very dark greyish brown (10YR3/2m) heavy clay (sandy); strong fine and medium angular blocky structure; smooth-ped fabric; hard (dry), moderately friable (moist), plastic and sticky (wet); trace amounts of quartz fragments and ferruginous concretions; clear boundary to:

35-70 cm; as above but; mottled brown (10YR5/3m) and yellowish brown (10YR5/8m); the amounts of stones increase to slight; gradual boundary to:

70-100 cm^{+}; as above but; mottled yellowish brown (10YR5/4m) and red (2.5YR5/6m).

MINOR SOIL TYPE -2
(one representative profile)

Profile # 17

Profile reference: WM 15/22 (Montara vineyards)
Topography: Gully floor in a hilly area
Soil Classification: Dy 3.12/SCL (45 cm)

Soil Description:

Surface Soil

0-30 cm; dark brown (7.5YR3/2m) sandy clay loam; weakly pedal, hard setting; hard (dry), friable (moist), slightly plastic and slightly sticky (wet); trace amounts of quartz fragments and ferruginous concretions; gradual boundary to:

30-45 cm; as above but; fine sandy clay loam; moderately pedal; clear boundary to:

Subsoil

45-60 cm; mottled strong brown (7.5YR3/2m) and pale brown (10YR6/3m) heavy clay (fine sandy); strong fine and medium angular blocky structure; smooth-ped fabric; very hard (dry), non-friable (moist), plastic and sticky (wet); slight amounts of quartz fragments and ferruginous concretions; clear boundary to:

60-90 cm^{+}; as above but; mottled yellowish brown (10YR5/8m) and brown (10YR5/3m) heavy clay (gritty); the amounts of stones increase to light.

MINOR SOIL TYPE -3
(two representative profiles)

(i) Profile # 18

Profile reference: WM 13/40 (Montara vineyards)
Topography: Gully floor in a hilly area
Soil Classification: Dy 3.42/SCL (45 cm)

Soil Description:

Surface Soil

0-30 cm; dark brown (7.5YR3/4m) sandy clay loam; weakly pedal, hard setting; hard (dry), friable (moist), moderately plastic and moderately sticky (wet); slight amounts of quartz fragments and ferruginous concretions; sharp boundary to:

30-45 cm; as above but; mottled pale brown (10YR6/3m) and brownish yellow (10YR6/6m) conspicuously bleached light grey (10YR7/2d); trace amounts of stones; clear boundary to:

Subsoil

45-60 cm; mottled yellowish brown (10YR5/4m) pale brown (10YR6/3m) and strong brown (7.5YR5/6m) heavy clay (gritty); strong fine and medium angular blocky structure; smooth-ped fabric; hard (dry), slightly friable (moist), plastic and sticky (wet); trace amounts of quartz fragments and ferruginous concretions; clear boundary to:

60-80 cm; as above but; mottled light grey (10YR7/1m) and strong brown (7.5YR5/8m); sandy clay (gritty); gradual boundary to:

80-100 cm^{+}; as above but; mottled yellowish brown (10YR5/6m), red (2.5YR4/6m) and pale brown (10YR6/3m) heavy clay gritty.

(ii) Profile # 19

Profile reference: WM 15/3 (Montara vineyards)
Topography: Slight gully in an undulating area
Soil Classification: Dy 3.43/SCL (50 cm)

Soil Description:

Surface Soil

0-25 cm; brown (10YR4/3m) sandy clay loam; weakly pedal, hard setting; hard (dry), friable (moist), slightly plastic and slightly sticky (wet); slight amounts of quartz fragments and ferruginous concretions; sharp boundary to:

25-50 cm; as above but; mottled very pale brown (10YR7/4m) and brownish yellow (10YR6/6m) conspicuously bleached white (10YR8/2d) light sandy clay loam; sharp boundary to:

Subsoil

50-80 cm; mottled yellowish brown (10YR5/6m), red (2.5YR4/6m) and brown (10YR5/3m) heavy clay; strong fine and medium angular blocky structure; smooth-ped fabric; very hard (dry), moderately friable (moist), plastic and sticky (wet); trace amounts of quartz fragments and ferruginous concretions; gradual boundary to:

80-110 cm^{+}; as above but; mottled yellowish brown (10YR5/8m), brown (10YR5/3m) and some yellowish red; the amounts of stones increase to slight.

APPENDIX II - ANALYTICAL DATA FOR REPRESENTATIVE PROFILES

Depth (cm)	Field Texture	pH	T.S.S. (%)	Chloride "as NaCl" (%)	Total N (% ad)	Org. C (% ad)	Exchangeable Cations "milliequivalents per 100 g soils" Ca	Mg	K	Na	H	Aggregate Stability Class (4)	Index (5)	Moisture (%) @ -15 Bar (6)	@ $-^{1}/_{3}$ Bar (7)
	(1)		(2)	(3)											
Profile # 1; ARARAT SANDY CLAY LOAM; Dr 2.12/SCL (10 cm)															
0- 10	SCL	6.5	0.026	-	0.210	2.2	3.9	0.9	1.3	0.1	6.7	2	10	6.3	18.9
10- 40	HC (gr)	6.1	0.015	-			1.7	0.6	0.4	0.1	3.8	5	0	10.2	26.6
40- 80	HC (gr)	6.8	0.008	-			0.8	0.6	0.1	0.1	2.0	3	2	12.3	26.5
80-100	MC (s)	6.9	0.017	-			0.7	2.2	0.2	0.1	4.1	5	0	9.8	26.4
Profile # 2; ARARAT SANDY CLAY LOAM; Dr 2.12/SCL (15 cm)															
0- 15	SCL	7.2	0.017	-	0.148	1.6	3.3	1.2	0.8	0.2	5.8	3	2	10.1	20.2
15- 60	M-HC	6.8	0.020	-			1.2	1.8	0.4	0.3	7.6	5	0	15.3	27.8
60-100	HC	7.2	0.022	-			0.5	4.4	0.4	0.9	5.9	5	0	18.0	28.6
Profile # 3; ARARAT SANDY CLAY LOAM (Deep Surface); Dr 2.22/FSCL "gr" (25cm)															
0- 10	FSCL (gr)	5.9	0.015	-								3	3	9.2	18.4
10- 25	CL (gr)	6.1	0.009	-								3	2	9.2	19.8
25- 50	HC (gr)	6.4	0.011	-								5	0	15.0	27.6
50- 60	HC (gr)	6.6	0.013	-								5	0	13.6	25.2
Profile # 4; ARARAT SANDY CLAY LOAM (Stony Profile); Dr 2.12/SCL (10 cm)															
0- 10	SCL	5.8	0.014	-	0.166	2.3	1.5	0.7	0.5	0.1	7.9	2	10	8.1	19.7
10- 40	HC (gr)	5.9	0.013	-			1.0	1.4	0.3	0.2	5.6	2	12	12.6	26.8
40- 65	HC (gr)	6.2	0.023	-			0.8	2.5	0.3	0.3	6.1	2	10	11.4	30.2
65-100	HC (gr)	6.5	0.021	-			0.2	2.5	0.1	0.4	3.1	2	10	10.2	25.1
Profile # 5; ARARAT SANDY CLAY LOAM (Deep Surface & Stony Profile); Dr 2.22/SCL "gr" (30 cm)															
0- 10	SCL (gr)	6.2	0.016	-	0.167	1.7	1.2	0.4	1.4	0.1	9.0	3	5	7.0	20.3
10- 30	CL (gr)	6.2	0.009	-			1.4	0.5	0.5	0.1	5.6	5	0	6.4	20.0
30- 60	MC (gr)	6.7	0.011	-			0.9	2.1	0.4	0.1	3.1	2	10	9.5	25.8

Depth (cm)	Field Texture	pH	T.S.S. (%)	Chloride "as NaCl" (%)	Total N (% ad)	Org. C (% ad)	Exchangeable Cations "milliequivalents per 100 g soils" Ca	Mg	K	Na	H	Aggregate Stability Class (4)	Index (5)	Moisture (%) @ -15 Bar (6)	@ $-^{1}/_{3}$ Bar (7)
	(1)		(2)	(3)											
Profile # 6; CATHCART SANDY CLAY LOAM; Dr 3.32/SCL "gr" (25 cm)															
0- 20	SCL (gr)	6.2	0.015	-	0.097	1.1						3	4	4.7	17.4
20- 25	SCL (gr)	5.5	0.009	-								3	6	4.0	14.6
25- 55	HC	6.5	0.030	-								3	2	27.0	45.0
55-100	HC	6.9	0.048	-								2	10	29.3	48.9
Profile # 7; CATHCART SANDY CLAY LOAM; Dr 3.32/SCL (25 cm)															
0- 25	SCL	6.7	0.017	-	0.195	2.0						3	2	8.0	18.4
25- 80	HC	7.0	0.036	-								2	12	23.9	39.5
80-110	HC	7.5	0.064	0.019								1	16	18.5	34.6
Profile # 8; CATHCART SANDY CLAY LOAM (Deep Surface); Dr 3.42/SCL (35 cm)															
0- 10	SCL	5.6	0.018	-								2	10	12.1	20.0
10- 35	SCL	5.7	0.013	-								2	12	13.5	19.6
35- 65	HC (gr)	6.4	0.017	-								1	14	20.4	25.2
65- 95	HC (gr)	6.7	0.018	-								1	14	16.8	26.0
Profile # 9; CATHCART SANDY CLAY LOAM (Deep Surface); Dr 3.42/SCL (35 cm)															
0- 10	SCL	6.1	0.016	-	0.242	3.2	2.1	0.8	0.8	0.1	9.6	2	10	8.9	19.7
10- 35	SCL	6.3	0.007	-			1.0	1.0	1.0	0.1	4.0	2	10	6.2	23.5
35- 55	HC (gr)	6.4	0.014	-			0.7	2.6	2.6	0.3	7.7	3	4	16.4	33.6
55- 85	HC (gr)	6.8	0.016	-			0.1	6.2	6.2	1.4	4.2	5	0	15.2	36.0
85-110	HC (gr)	7.1	0.018	-								1	16	11.2	32.9
Profile # 10; CATHCART SANDY CLAY LOAM (Deep Surface & Stony Profile); Dr 3.42/SCL (60 cm)															
0- 10	SCL	5.9	0.013	-								3	6	6.4	18.5
10- 60	SCL (gr)	6.4	0.010	-								2	10	5.8	16.4
60- 90	HC (gr)	7.3	0.017	-								2	10	12.9	22.8

Depth (cm)	Field Texture	pH	T.S.S. (%)	Chloride "as NaCl" (%)	Total N (% ad)	Org. C (% ad)	Exchangeable Cations "milliequivalents per 100 g soils" Ca	Mg	K	Na	H	Aggregate Stability Class (4)	Index (5)	Moisture (%) @ -15 Bar (6)	@ $-^{1}/_{3}$ Bar (7)
	(1)		(2)	(3)											
Profile # 11; BURRUMBEEP SANDY CLAY LOAM; Dy 3.42/FSCL "GR" (30 cm)															
0- 10	FSCL (gr)	5.9	0.015	-	0.162	1.9	1.9	0.5	0.4	0.1	6.8	2	10	11.8	21.3
10- 30	L	6.0	0.006	-			1.0	0.5	0.2	0.1	4.6	2	10	8.2	22.5
30- 70	HC (gr)	6.4	0.013	-			0.7	1.5	0.1	0.3	5.0	2	10	16.5	28.3
70-100	HC (gr)	6.8	0.013	-			0.2	2.6	0.1	0.4	3.3	2	10	11.2	28.0
Profile # 12; BURRUMBEEP SANDY CLAY LOAM; Dy 3.41/SCL (30 cm)															
0- 10	SCL	5.6	0.008	-								3	5	4.4	18.3
10- 30	L	5.5	0.006	-								2	10	5.1	19.2
30- 60	MC	5.5	0.007	-								2	10	10.4	27.6
60- 90	HC	5.9	0.011	-								3	4	17.4	36.6
90-110	HC	5.9	0.023	-								1	14	14.4	36.0
Profile # 13; BURRUMBEEP SANDY CLAY LOAM (Deep Surface); Dy 3.41/SCL (45 cm)															
0- 15	SCL	5.8	0.010	-	0.084	1.2	0.5	0.3	0.4	0.1	4.7	2	10	5.5	16.9
15- 45	SCL	6.0	0.005	-			0.4	0.3	0.1	0.1	0.8	2	12	4.0	9.9
45- 75	HC	5.5	0.037	-			1.2	3.6	0.3	1.3	8.9	1	16	22.5	31.9
75-100	HC	5.1	0.077	0.047			0.2	4.0	0.3	2.4	13.9	1	16	30.8	42.4
Profile # 14; BURRUMBEEP SANDY CLAY LOAM (Stony Profile); Dy 3.41/SCL (30 cm)															
0- 10	SCL	5.5	0.014	-	0.240	3.4	0.9	0.3	0.4	0.1	12.2	2	10	8.3	22.3
10- 30	SCL (gr)	5.4	0.005	-			0.3	0.1	0.1	0.1	5.9	2	10	5.1	16.5
30- 60	HC	5.6	0.006	-			0.4	0.6	0.1	0.2	11.0	2	10	15.2	27.1
60- 90	HC	5.9	0.011	-			0.1	1.5	0.1	0.5	12.3	2	10	20.5	30.2
Profile # 15; MINOR SOIL TYPE -1; Dy 2.32/FSCL (6 cm)															
0- 6	FSCL	6.0	0.044	-	0.169	1.9	2.8	0.5	0.5	0.1	5.8	3	3	8.7	21.6
6- 36	MC	5.3	0.028	-			1.7	0.5	0.2	0.2	9.2	2	10	12.8	25.8
36- 60	HC (gr)	5.8	0.023	-			1.1	1.7	0.2	0.4	5.3	2	12	13.7	24.0
60- 80	HC (gr)	6.4	0.047	-			0.8	3.6	0.2	1.5	4.8	1	16	17.4	28.1
80-100	MC (gr)	7.3	0.062	0.045			0.5	3.1	0.1	2.0	2.5	1	16	14.1	27.5

Depth (cm)	Field Texture	pH	T.S.S. (%)	Chloride "as NaCl" (%)	Total N (% ad)	Org. C (% ad)	Exchangeable Cations "milliequivalents per 100 g soils" Ca	Mg	K	Na	H	Aggregate Stability Class (4)	Index (5)	Moisture (%) @ -15 Bar (6)	@ $-^1/_3$ Bar (7)
	(1)		(2)	(3)											
Profile # 16; MINOR SOIL TYPE -1; Dd 1.12/FSCL (20 cm)															
0- 20	FSCL	6.0	0.028	-	0.251	3.4	2.5	1.5	0.5	0.2	10.1	2	10	9.6	22.0
20- 35	HC (s)	5.9	0.031	-			2.5	1.9	0.4	0.3	10.5	2	10	13.5	28.4
35- 70	HC (s)	6.7	0.033	-			1.1	2.7	0.2	0.8	3.6	2	12	11.8	25.9
70-100	HC (s)	7.8	0.140	0.099			0.9	3.9	0.2	3.2	2.0	1	16	19.1	29.1
Profile # 17; MINOR SOIL TYPE -2; Dy 3.12/SCL (45 cm)															
0- 30	SCL	7.0	0.040	-	0.400	7.1	9.6	3.4	0.5	0.5	10.6	2	10	10.4	18.1
30- 45	FSCL	7.2	0.027	-			5.1	2.9	0.4	0.4	7.7	2	10	11.3	20.9
45- 60	HC (FS)	7.2	0.023	-			1.4	2.4	0.3	0.5	5.8	1	14	12.1	28.0
60- 90	HC (gr)	7.9	0.027	-			1.4	3.1	0.3	0.7	2.3	1	16	15.7	26.4
Profile # 18; MINOR SOIL TYPE -3; Dy 3.42/SCL (45 cm)															
0- 30	SCL	6.1	0.018	-	0.113	1.4	1.6	0.5	0.3	0.2	6.3	3	4	12.9	22.7
30- 45	SCL	6.5	0.021	-			1.0	0.7	1.0	0.3	2.6	2	12	8.6	17.6
45- 60	HC (gr)	7.5	0.048	-			1.1	3.0	0.2	1.5	2.5	1	15	15.5	23.3
60- 80	SC (gr)	8.0	0.042	-			0.5	2.3	0.1	1.6	2.3	1	16	13.8	21.3
80-100	HC (gr)	7.9	0.069	0.035			0.3	3.3	0.3	3.7	3.6	1	16	20.6	29.6
Profile # 19; MINOR SOIL TYPE -3; Dy 3.43/SCL (50 cm)															
0- 25	SCL	7.0	0.342	0.006	0.088	1.1	5.1	0.2	0.3	0.1	1.6	3	2	4.7	14.5
25- 50	SCL (lt)	6.3	0.031	-			1.0	0.1	0.1	0.1	0.8	3	3	3.1	9.5
50- 80	HC	7.3	0.074	0.014			3.1	4.0	0.3	1.2	4.8	1	16	20.5	30.5
80-110	HC	8.2	0.066	0.028			2.1	6.5	0.4	2.9	3.1	1	16	22.9	34.8

(1) Field Texture; see Appendix IV definitions and symbols used.

(2) Total Soluble Salts (%) = Electrical Conductivity $(\mu S/cm) \times 3.3 \times 10^{-4}$.

(3) The dashes recorded in this column indicate negligible amounts of sodium chloride.

(4) Aggregate Stability Class (Emerson 1967).

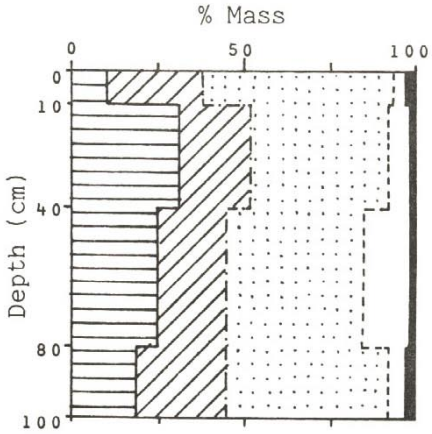
(5) Aggregate Dispersion index (Loveday 1974).

(6) Moisture (%) at -15 Bar; approximately "Wilting Point", see Appendix IV.

(7) Moisture (%) at $-^1/_3$ Bar; approximately "Field Capacity", see Appendix IV.

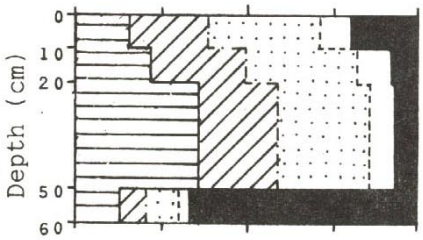
APPENDIX III - PARTICLE SIZE DISTRIBUTION FOR SELECTED PROFILES

Stones (>2 mm)	Sand % Coarse	Sand % Fine	Silt	Clay
3	4	55	28	10
2	6	40	21	31
2	13	40	20	25
3	6	47	26	19



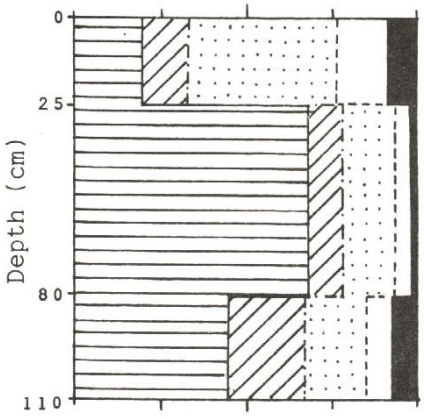
Profile #1; Ararat sandy clay loam

17	10	32	23	16
8	10	32	28	22
6	8	26	23	36
66	3	9	8	13



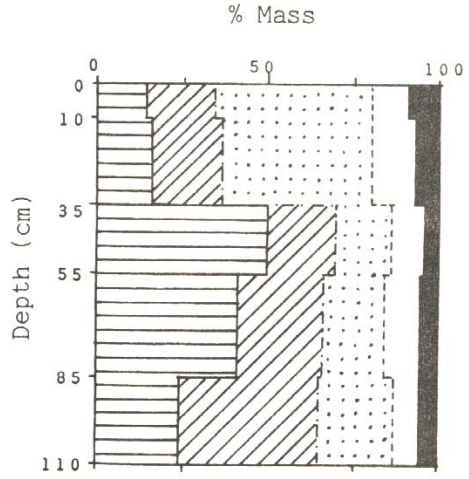
Profile #3; Ararat sandy clay loam (Deep surface)

8	13	43	14	19
3	5	15	10	68
9	7	18	22	45



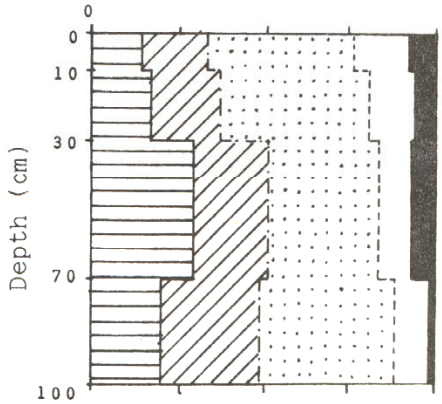
Profile #7; Cathcart sandy clay loam

Stones (>2 mm)	Sand % Coarse	Fine	Silt	Clay
8	8	46	21	13
6	12	44	21	15
5	11	16	20	50
6	12	17	25	41
6	8	22	41	24



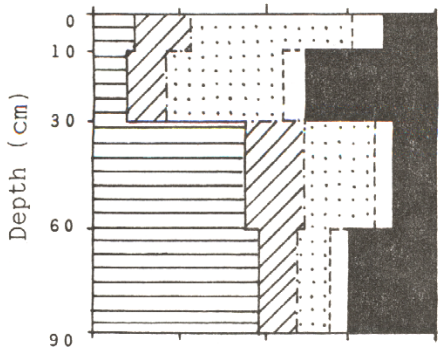
Profile #9; Cathcart sandy clay loam (Deep surface)

8	15	44	17	14
6	13	43	20	17
7	10	33	22	29
2	10	42	28	20



Profile #11; Burrumbeep sandy clay loam

16	10	47	16	12
37	8	33	12	9
14	5	21	17	44
27	5	10	11	48



Profile #14; Burrumbeep sandy clay loam (stony profile)

APPENDIX IV - DEFINITION OF SOIL TERMS

AGGREGATE STABILITY
The stability of the soil aggregate to water falling as rain or applied to irrigation. Many types of aggregate stability tests are available; two of which are those described by Emerson (1967) and Loveday (1974).

AMOUNTS
As used here, with reference to soil inclusions, the different terms and their percentages are as follows:- occasional (<1) – trace (1-5) – slight (6-15) – light (16-35) – moderate (36-70) – heavy (>70).

APEDAL
Means that in the moderately moist to the moist state, none of the soil material occurs in the form of peds; it is either massive or single grain and when disturbed separates into fragments or primary particles (see pedality).

BLEACHED
Describes a soil horizon which has become pale in colour owing to leaching. Two degrees of bleaching are recognised as follows:-

The conspicuous bleach: in which 80% or more of the soil horizon is bleached.

The sporadic bleach: in which less than 80% of the horizon is bleached.

COLOUR AND MOTTLING
Munsell Soil Colour Charts, 1973 Edition, are used in identifying soil colour names and their Munsell notations.

Munsell colour notations refer to moist soils; the suffix "d" indicates the colour of the dry soil (e.g., 10YR7/1d).

Some soil samples show more than one colour. The matrix (dominant) colour is always recorded first, followed by the sub-dominant colours.

When a sub-dominant colour is recorded only by name (i.e, without its Munsell colour notation) it indicates the failure of this particular colour to qualify for mottling, either by area or by colour differences, for the purpose of the Factual Key classification.

CONDITION OF SURFACE SOIL
Refers to the natural condition of the surface soil and its reaction to the usual wetting and drying cycle. Cultivation will often alter the condition of surface soil, but most conditions will reform when the soil is left undisturbed.

DUPLEX SOIL PROFILR
Refers to the soil profile showing a marked difference in texture between the surface and subsoil horizons. Texture contrast must be at least one and a half texture groups between A and B horizons (Northcote, 1979).

FERRUGINOUS CONCRETIONS
More or less rounded nodules of variable size and composed mainly of iron oxide.

FIELD CAPACITY
The percentage of water remaining in a soil two or three days after having been saturated and after free drainage has practically ceased. The $^{1}/_{3}$ bar percentages (using <2 mm sieved soil samples) is used only as a rough estimate to the field capacity.

FACTUAL KEY CLASSIFICATION
Refers to the soil classification system as described in "A Factual Key for the Recognition of Australian Soils", 4th Edition, by Keith H. Northcote, 1979.

For the duplex (D) soil profile, the Principal Profile Form (P.P.F) is extended to indicate other important soil properties. For example, Dr 2.23/SCL (14 cm) means a Dr 2.23 soil having a sandy clay loam surface with a 14 cm depth to the clayey subsoil. For the gradational (G) soils, additional suffix is only given to indicate the texture of the surface horizons.

FRIABLE
Refers to Soil Consistence.

HARDPAN
A hardened and/or cemented horizon in or below the soil profile.

HARD-SETTING
A surface soil is considered to be hard-setting when it becomes hard and apparently apedal on periodic drying out.

MASSIVE
Structureless (i.e. "apedal"). The soil material is coherent.

PAN (= SOIL PAN)
See Hardpan.

PED
An individual natural soil aggregate.

PEDAL
See Soil Pedality.

PLASTIC
Refers to Soil Consistence.

SMOOTH FABRIC (= SMOOTH-PED FABRIC)
Peds are evident, and characteristically more than 50 per cent of them are smooth-faced, that is, have a general lac condition on their surfaces

SOIL BOUNDARIES
The boundary between soil horizons defines the nature of the change from one horizon to that below. In this report it is specified by the measure of the thickness (or width) of the transition zone between horizons thus :

- Sharp (or Abrupt) = boundary <2 cm wide.
- Clear = boundary is 2-5 cm wide.
- Gradual = boundary is 5-10 cm wide.
- Diffuse = boundary >10 cm wide.

SOIL CONSISTENCE
Comprises the attributes of soil material that are expressed by the degree and kind of cohesion and adhesion or by the resistance to deformation or rupture. It is markedly affected by the moisture state of the soil. Terms used for consistence include: loose, soft, hard, friable, non-friable, plastic and sticky.

SOIL HORIZON
A layer of soil, more or less parallel to the land surface, similar throughout and recognisably different from the material above and below. The horizon may be distinguished by differences in one or more of the following characteristics: colour, texture, structure, consistence, mottling, organic matter content and the presence of visible products of weathering and leaching such as calcium carbonate, gypsum, iron oxide and ferruginous concretions. The following horizons in the soil profile may be recognised.

Surface or A Horizon: The surface layer of the soil in which organic matter has accumulated and which may be partly leached of clay and soluble material. It may be divided into two or more sub-horizons as follows:

A_1 horizon: The surface soil more or less darkened by organic matter – a zone of maximum biological activity.

A_2 horizon: A sub-surface layer lower in organic matter that the A_1 and, in consequence, usually lighter in colour. It is the zone of maximum leaching.

Subsoil or B Horizon: Situated below the surface or A horizon and is usually heavier in texture than that horizon. The B horizon represents the zone of accumulation of clay and other materials, including calcium carbonate and iron oxides.

SOIL MORPHOLOGY
The physical constitution of the various horizons and their arrangement in the soil profile.

SOIL PEDALITY
Refers to the relative proportion of peds in the soil, as follows :

Highly pedal (= pedal): in the moderately moist to the moist state, one-third or more of the soil material consists of peds.

Weakly pedal: in the moderately moist to the moist state, less than one-third of the soil material consists of peds.

Non-pedal (= apedal): essentially no recognisable peds.

SOIL PROFILE
This is the vertical section of a soil exposing the sequence of horizons from the surface to an arbitrary depth. For the purpose of this report, soil profiles were only discussed with regard to their A and B horizons.

SOIL REACTION TREND
Indicates the general direction of pH changes down the profile, eg.

Acid trend: The pH values are, for the surface soil, lower that 7.0, and for the deep subsoil, less that 6.5.

Neutral trend: The pH values are, for the surface soil, between 5.0 and 8.0, and for the deep subsoil, between 6.5 and 8.0.

Alkaline trend: The pH values are, for the surface soil, higher than 5.0, and for the deep subsoil, higher than 8.0

SOIL STRUCTURE
Describes the way in which the primary soil particles are arranged into soil aggregates (peds).

SOIL TEXTURE
Soil texture is a measure of the behaviour of a small handful of soil when moistened to sticky point (approximately to field moisture capacity), kneaded into a ball and then pressed out between thumb and forefinger. It is strongly influenced by clay contents and is affected by other properties, including clay mineral type, organic matter, oxides, carbonates and exchangeable cations. Texture is described in terms of texture grades some of which are listed below:-

LS = loamy sand	CL = clay loam
Cys = clayey sand	FSCL = fine sandy clay loam
SL = sandy loam	SC = sandy clay
FSL = fine sandy loam	LC = light clay
Lt SCL = light sandy clay loam	MC = medium clay
L = loam	M-HC = medium to heavy clay
SCL = sandy clay loam	HC = heavy clay

Other Qualifying Symbols

(s) = sandy	(h) = heavy
(gr) = gritty	(lt) = light
(fs) = fine sandy	(sm) = smooth

STICKY
Refers to Soil Consistence.

TOTAL SOLUBLE SALTS
Total Soluble Salts % = Electrical Conductivity $(\mu S/cm) \times 3.3 \times 10^{-4}$

WILTING POINT (PERMANENT WILTING PERCENTAGES)
The water content of a soil when indicator plants growing in that soil wilt and fail to recover when placed in a humid chamber. Often the 15-bar percentage is used as an approximation to the wilting point.