APPENDIX C SPECIFIC METHODOLOGY

C.1 Map Unit Determination

Map units were delineated according to geology and slope category (McDonald et al. 1984) using geological mapping, topographical mapping, aerial photography and field survey techniques.

C.2 Field Observations

Most field descriptions (refer Table A.11) are based on McDonald et al. (1984) or Northcote (1979). The definition for soil horizon boundaries is listed below.

S	Sharp	< 5 mm
A	Abrupt	5-20 mm
C	Clear	20-50 mm
G	Gradual	50-100 mm
D	Diffuse	> 100 mm
+	Continuing	

C.3 Field Tests

C.3.1 Saturated Hydraulic Conductivity

Site selection:

Considerable time and effort is required to obtain meaningful permeability (K_{sat}) values. It is imperative that sites are chosen carefully prior to the day of measurement. The sites should have nil, or at most, minimal disturbance.
Procedure:

i) Insert six infiltration rings so that each ring is approximately 100 mm into the main clay horizon - remove some topsoil if necessary. Use the mechanical vibrator and special plate to insert rings.

ii) Rings need to be at least 2 metres apart and located at random. Relocate ring if obstacles such as stones or roots prevent an even downward movement of the ring into the soil.

iii) Fill ring with water and set up reservoir tank so that water is added when the level drops below the outlet tube. Record the time and date on field sheets.

iv) Check that all containers are full and will last overnight to allow soil to saturate and conductivity rate to equilibrate.

v) Next day, remove water container and fill each ring. Mark that point as zero for future measurements and record zero time. At appropriate time intervals, depending on rate of infiltration - 5 min, 15 min, 30 min, 60 min, record the drop in water level in mm on sheets provided. If water levels are getting low, fill rings to zero again straight after taking readings.

vi) Record measurements for 3 hours or until the rate of infiltration is constant.

vii) Dig out each ring taking care not to disturb the soil contained within the ring. Up-end the ring and record the proportion of soil area that has been transmitting water for each ring and record if water movement has been evenly distributed or confined to root/worm holes or structural cracks. Note any other differences, i.e. rocks, sand, clay patches.

C.4 Laboratory Analysis

Samples collected for each soil horizon were air dried, ground with a mortar and pestle and separated with 4.75 and 2 mm sieves into three fractions: gravel > 4.75 mm, gravel 4.75 - 2.0 mm and soil < 2.0mm. The two gravel fractions were combined and reported as a percentage of the air dried field sample, then discarded. All subsequent tests were carried out on the soil samples and, except for EC, pH and Cl, were reported in terms of oven dried (105 ^{o}C) samples .

C.4.1 Physical Properties

1. Particle size analysis

The method used for particle size analysis is based upon that of Hutton (1955), which divides the soil sample into the following four principal size groups:

Coarse sand	2.0 - 0.2 mm
Fine sand	0.20 - 0.02 mm
Silt	0.02 - 0.002 mm
Clay	< 0.002 mm

In this method the soil sample is mechanically dispersed using 5 ml 1.0M sodium hydroxide and 10 ml of 10% pentasodium triphosphate (sodium tripolyphosphate), shaken in a sedimentation cylinder, and silt and clay percentages determined on a 2% soil water mixture using a plummet balance. After hand decanting the silt and clay suspension, the sand fractions are determined by sieving and weighing the oven dried (105 ^{o}C) sand fractions. The fines fraction (< 0.074 mm) is determined by calculation.

Due to the presence of both organic material and solutes in the soil and also due to the limitations of the technique used, the sum of the four fractions does not always equal

100%. Limits of 4% variation for surface horizons and 2% variation for lower horizons are regarded as acceptable. The determination is repeated for samples outside these limits. If repeat samples still remain outside these limits, then the closest result is accepted.

2. Emerson class

Soil dispersion is tested using the method of Emerson, (1977), and based upon the Australian Standard AS1289, C8.1, (1980). However subdivision of classes 2 and 3 were made according to Loveday and Pyle (1973).

The following subdivision classifications were used:

E3.1, E3.2	low dispersion
E3.3, E3.4	moderate dispersion
E2.1, 2.2, 2.3	high dispersion

3. Atterberg limits

Atterberg investigated the behaviour of fine grained soil with varying water content. He used the following definitions, quoted in Hicks (1991):

(a) The liquid limit is the water content at which a trapezoidal groove of specified shape, cut in moist soil held in a special cup, is closed after 25 taps on a hard rubber plate.

(b) The plastic limit is the water content at which the soil begins to break apart and crumble when rolled by hand into threads 3 mm in diameter.

(c) The shrinkage limit is the water content at which the soil reaches its theoretical minimum volume, as it dries out from a saturated condition.

The plasticity index is the difference between the liquid and plastic limits, and represents the range of water contents that the soil remains in the plastic state.

Atterberg limits are determined on a sieved soil fraction with particles < 0.425 mm in size. The methods are based upon the Australian Standard 1289 (1977), as follows:

Liquid limit AS1289, C1.1
Plastic limit AS1289, C2.1
Plasticity index AS1289, C3.1
Linear shrinkage AS1289, C4.1

C.4.2 Chemical Properties

1. The pH represented in the soil profile description is determined by using a soil pH testing kit. Soil chemical analyses were carried out by the State Chemistry Laboratory, 5 MacArthur Street, East Melbourne, Victoria 3002.

Standard laboratory procedures for soil and water analyses are also described by Rayment and Higginson (1992).

EC, pH, and Cl determinations

These determinations are carried out on a 1:5 soil water suspension shaken for one hour, and allowed to equilibrate at 20 ^{0}C.

(a) Electrical conductivity

This test is used to estimate the concentration of soluble salts in the soil. Measurements are made on the soil water suspension using a dip cell and direct reading meter. Values are reported at 25 ^{0}C.
State Chemistry Laboratory, Method 004, July 1986.

(b) pH in H_2O

The pH of the above suspension is determined using a calomel electrode and digital pH meter.
State Chemistry Laboratory, Method 009 (1986).

(c) pH in $CaCl_2$

This is carried out on the soil water suspension after the pH in H_2O determination. One ml of 1M calcium chloride solution is added to the soil water suspension, and the mixture stirred. The pH is then measured again.
State Chemistry Laboratory, Method 009 (1986).

(d) Chloride

A fresh 1:5 soil water suspension is titrated with a silver nitrate solution, using an electrical circuit to determine the end point of the titration. Note that this determination may be omitted if the EC determination is < 0.1 dS/m.

State Chemistry Laboratory, Method 003 (1982).

2. Oxidizable organic carbon

In this determination the soil sample is oxidised by chromic acid in the presence of excess sulphuric acid, without the application of external heat (Walkley and Black, 1934). The colour produced is measured with a spectrophotometer.

State Chemistry Laboratory, Method 014 (1987).

3. Total nitrogen

Total nitrogen is determined by a Kjeldahl method, where the sample is digested with a sulphuric acid/selenious acid mixture. The resulting solution is analysed for nitrogen colorimetrically.

State Chemistry Laboratory, Method 021 (1985).

4. Available potassium

The Skene method is used where soil potassium is extracted with 0.05M hydrochloric acid, and the potassium determined with an atomic absorption spectrophotometer (Skene 1956).

State Chemistry Laboratory, Method 011 (1987).

5. Available phosphorus

Phosphorus is determined by the Olsen method in which the soil phosphorus is extracted with a 0.5M sodium bicarbonate solution at pH 8.5, (Olsen et al. 1954). The phosphorus is then measured colourimetrically after reduction with ascorbic acid.

State Chemistry Laboratory, Method 010 (1982).

6. Exchangeable aluminium and manganese

The soil sample is extracted with a 1M potassium chloride solution, and both determinations are made on the one extract. Aluminium is determined colourimetrically using pyrocatechol violet. Manganese is determined by atomic absorption spectrophotometry.

State Chemistry Laboratory, Method 001 (1985).

7. Exchangeable bases: calcium, magnesium, potassium and sodium

The bases are extracted from the soil with a 1M ammonium acetate solution at pH 7, and the bases are then analysed by atomic absorption spectroscopy.

State Chemistry Laboratory (1993) - draft procedure.

8. Total exchangeable bases

This is a calculated value consisting of the sum of the exchangeable bases calcium, magnesium, potassium and sodium, as determined in method 7 (above).

9. Exchangeable hydrogen

The exchangeable hydrogen is extracted from the soil using 0.053N triethanolamine and back titrated with 0.2M hydrochloric acid. This is a method modified by Peech et al. (1962).

State Chemistry Laboratory, Method 005 (1984).

10. Cation exchange capacity

This is a calculated value consisting of the sum of the exchangeable bases calcium, magnesium, potassium and sodium plus exchangeable hydrogen, as determined in methods 7 and 9 (above).