A SOIL SURVEY OF THE SHIRE OF WHITTLESEA, VICTORIA

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Summary
A survey has been made of the soils of the Shire of Whittlesea, to provide a background for a study of farming and living conditions in the district by the School of Agriculture, University of Melbourne.

The climate, physiography, geology, vegetation and soils of the district are described, and the soil types are defined. Their distribution is shown in a general map and in two detailed maps of typical areas.

The phosphorus status of the district soils, the difficulty of establishing subterranean clover on some soil types, and the problem of soil depletion are discussed.

Contents

Introduction

The Shire of Whittlesea is a rural area of some 215 square miles to the north of Melbourne, extending from twelve to thirty miles from the centre of the city, from the limit of the outer suburbs to the top of the Great Dividing Range. (Fig. 1.)

The population of the Shire is about 3,000. Most of the working population is engaged in farming, though the Shire is increasingly taking on the character of an outer suburb and many workers go to Melbourne daily; minor occupations include timber-getting and water supply (two of the city's reservoirs are in the area). The largest township is Whittlesea, with 300 people, and the Shire offices are in the township of Epping. There are half a dozen lesser centres, and there is still a slight concentration of settlement in former closer settlement areas such as Eden Park.

The earliest description of the district occurs in 1836; by 1840 most of the best land had been alienated; and by 1854 two-thirds of the present occupied area was in private hands. A demand for flour, dairy produce, and meat arose from the rapid growth of Melbourne, and after 1865 the hilly country east of the Plenty River was cleared for orcharding. The district's nearness to Melbourne has always made it a food and fodder producing area for the city, but its market has been threatened or lost from time to time by the extension of transport facilities to areas of more favourable soils and climate. Wheatgrowing in the Shire declined when the railway reached northern Victoria and Gippsland as dairying land. By 1915 the order of importance of the main industries, was firstly, dairying for whole milk production, then sheep and cattle raising, then the growing of oaten hay for the city's horses, and lastly orcharding. Since motor transport superseded horse transport in the 1920's, hay-growing has become quite unimportant, and there has been a great increase in dairying, particularly in the depressions years 1929-36. Lately, the whole milk market has been threatened by competition from milk bought long distances by road.

In 1946 a survey of land use, farm management, and living conditions in the Shire of Whittlesea was made for the School of Agriculture, University of Melbourne (1). The soil survey now described was designed to serve as a background for this work, which gives a complete account of the matters mentioned in this introduction.

Climate

The physiography of the Shire is shown by the contour map (Fig. 2), which indicates the contrast between the mountains in the north and the plains in the south.

The northern boundary of the Shire is the crest of the Great Dividing Range, and near it lie some 50 square miles of most rugged country, of which the most notable features are Mount Disappointment, Mount Sugarloaf, Howe's Lookout and the Kinglike Plateau, and the valleys of the Plenty's tributaries (some of which supply the Torturing Reservoir) and the Running Creek gorge.

From the main range the foothills run south in two spur systems, with the broad valley of the Plenty dividing them. To the west are the hills round Eden Park, with a long narrow spur running south to the She Oak Hill; to the east are the hills beyond the Yam Yean Reservoir, extending far past Arthur's Creek, the Shire boundary.

To the west and south of the foothills are the plains, their eastern limit the Plenty Gorge, their only interruption in the Moran Hills, Summer Hill and some minor rises, and the courses of the Daring and Merry Creeks.

The main drainage lines of the agricultural area are thus Merry Creek; Dare bin Creek; the Plenty River and its tributaries, chiefly Bruce's, Crystal and Scrubby Creeks, and Barber's Creek; Arthur's Creek and its tributaries, chiefly Deep Creek and Running Creek.

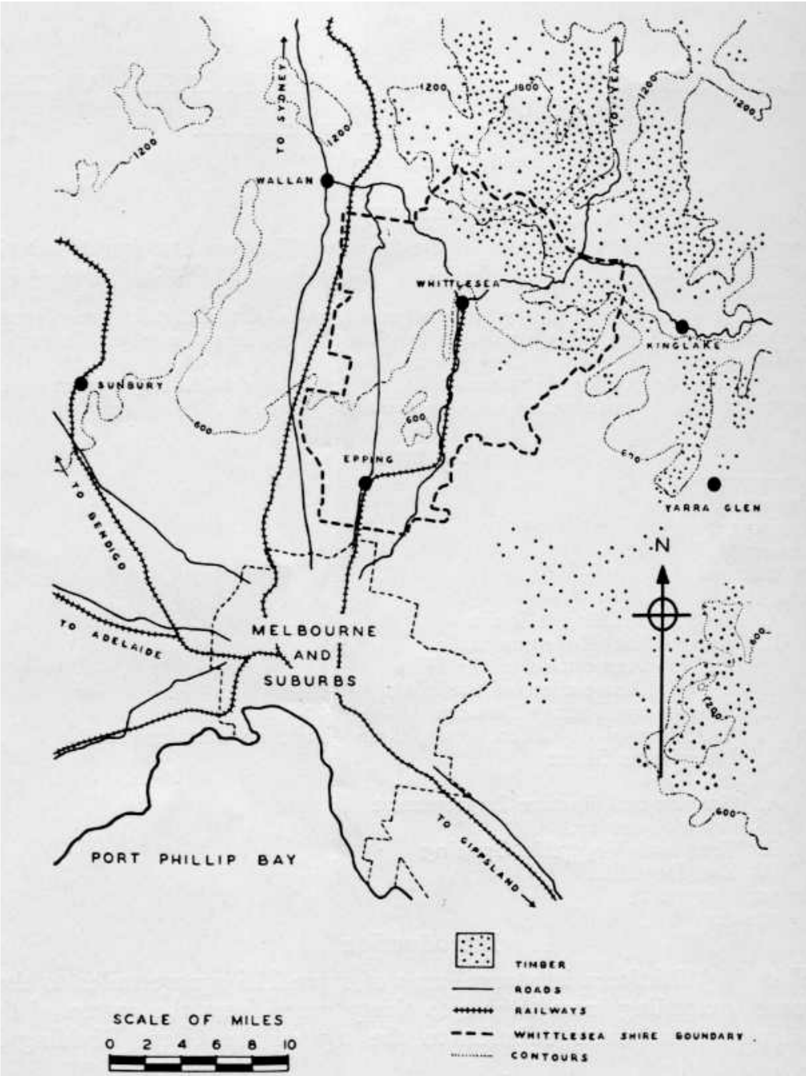

Fig 1. – Locality Plan for the Shire of Whittlesea, showing also the extent of forested country

Geology

The Shire of Whittlesea is covered by quarter sheets of the Geological Survey of Victoria (2), and the soil map of the present survey (Fig. 3) is closely related to this geological reconnaissance map. Briefly, the north-eastern half of the Shire is mostly Silurian sediments, and the south-western half mostly Newer Basalt.

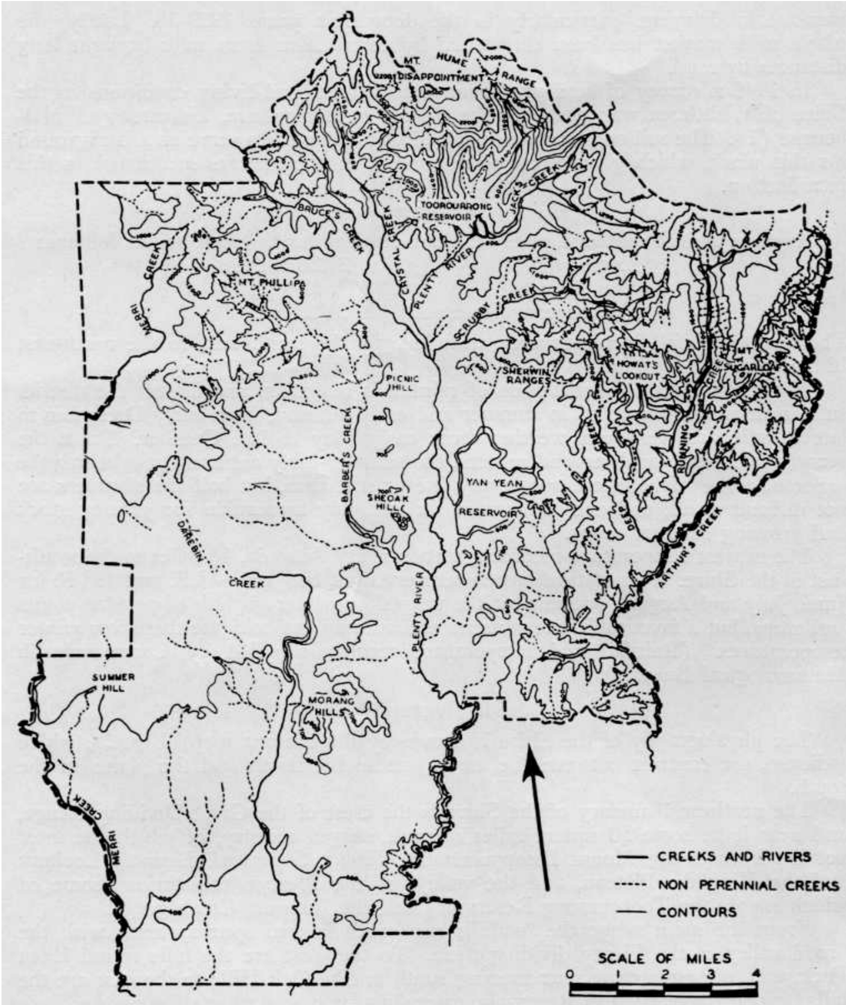

Fig. 2 – Map of the Shire of Whittlesea, showing physical features.

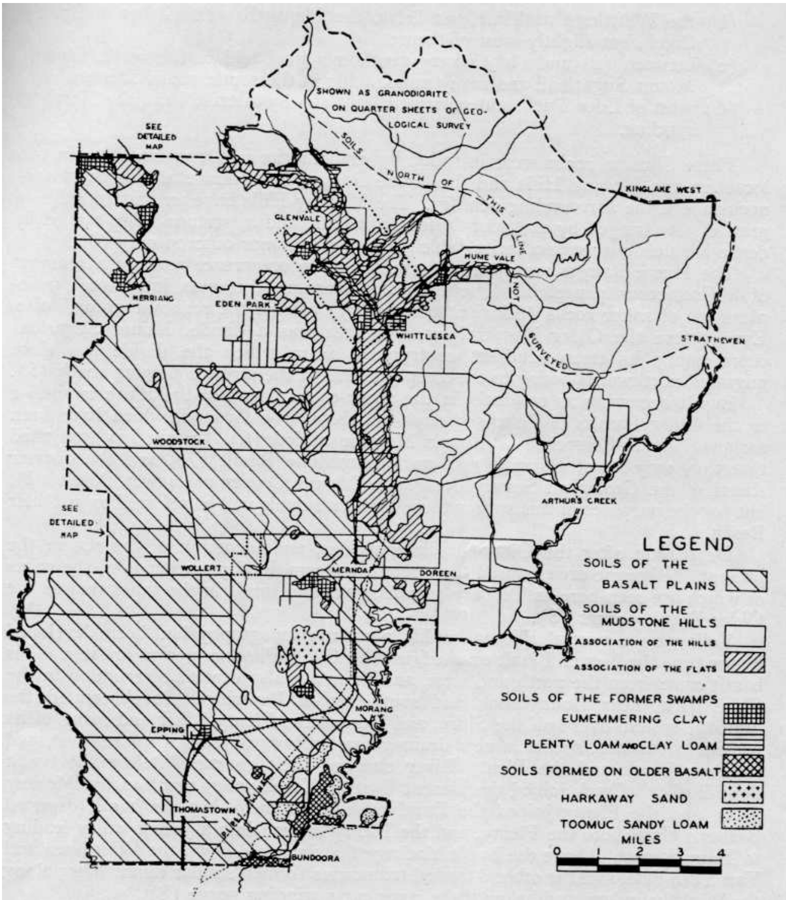

Fig. 3. – Soil Map of the Shire of Whittlesea, showing also place names

There are also occurrences of Devonian granodiorite, Older Basalt, and Tertiary sediments.

The oldest rocks in the area are the Silurian sandstones, mudstones and shales, folded as follows (R. B. Whither, privy. comm.; 3).

a. the Temples owe anticline, in the general direction of Arthur's Creek and east of it;

b. the Whittlesea anticline, parallel to the Plenty River and then to Bruce's Creek, but slightly west of them;

c. between (a) and (b), a very gentle synclinal fold in the north, towards Mount Sugarloaf, and many minor folds in the south, round Doreen;

d. west of Eden Park, and separated from (b) by a strike fault, the Metering syncline.

These Silurian rocks were intruded by granodiorite in Devonian times in two localities, the Moran Hills and the Hume Ranges, both now standing as monadnocks above the surrounding country. The Moran Hills have an eastern ridge of granodiorite fringed by metamorphosed sediments, and a western ridge capped by dense hornfels over granodiorite, which shows as a minor outcrop only (4).

The Hume Ranges are a much more extensive occurrence and are a remnant of a Cretaceous peneplain. The Kinglike Plateau represents a later peneplanation of softer rocks (Silurian sedimentary) around the resistant granodiorite. Even before the Older Basalt flows, this areas was a divide, Mount Sugarloaf representing its steep southern escarpment, from which the divide has since migrated northwards owing to the steep gradient of the streams flowing south (5).

Basalt occurring as residuals in the south-eastern part of the Shire is similar to the Older Basalts of Greensborough and Kangaroo Ground, which have been assigned to the Oligocene or Lower Miocene period (6). Jutson has suggested that they may be of Pliocene age, and Intermediate Basalt (7), and the quarter sheets of the Geological Survey even show Mount Cooper as Newer Basalt (2), but for the purpose of this survey these basalt residuals will be referred to as Older Basalt.

Depression after the Older Basalt eruptions, and incursion of the sea in the present Melbourne area, caused the streams to form flood plain deposits, the relics of which are seen here as Tertiary gravels, grits and sands in the same area as the Older Basalt occurs(5).
Following a general Pliocene uplift, a mature topography had been developed by the time the Newer Basalt erupted, in the Middle Pliocene period or later. This basalt came from the north and west, and there are also centres of eruption in the Shire itself, near Donnybrook and south-east of Beveridge. It obliterated the drainage system over half the Shire, and blocked the Plenty River and many of its present tributaries, so that a new drainage system was developed in the west, and Barber’s Creek and the Plenty River changed their courses. Before the basalt flow, Barber’s Creek joined the present Dare bin Creek valley north of the Moran Hills, and the Plenty joined the Dare bin south of them, but the basalt diverted Barber’s Creek into the Plenty, and the Plenty in turn into a young valley leading to Temples owe. Above the basalt blockage the river laid down the Whittlesea and Yam Yean flats, and the other dammed tributaries formed similar minor flats; along the basalt boundary and below it the river cut a winding gorge (8).

The present irregular surface of the Newer Basalt country is part of the solidified surface of the original basalt sheet, the stony rises and stony plains having been the basalt surface, and the depressions having been alleviated (9). The depressions are probably due to collapse of the solid crust of a basaltic sheet from the withdrawal of molten basalt from beneath. Possible causes of stony rise formation are:

- (a) lateral pressure on the solid crust of the lava sheet;
- (b) a lava’s upthrust of its crust against irregularities of the buried surface;
- (c) holding up of a solid crust by a buried irregularity while the molten lava around flows out and lets its unsupported crust collapse;
- (d) small fissure eruptions, marked by the present stony rises.

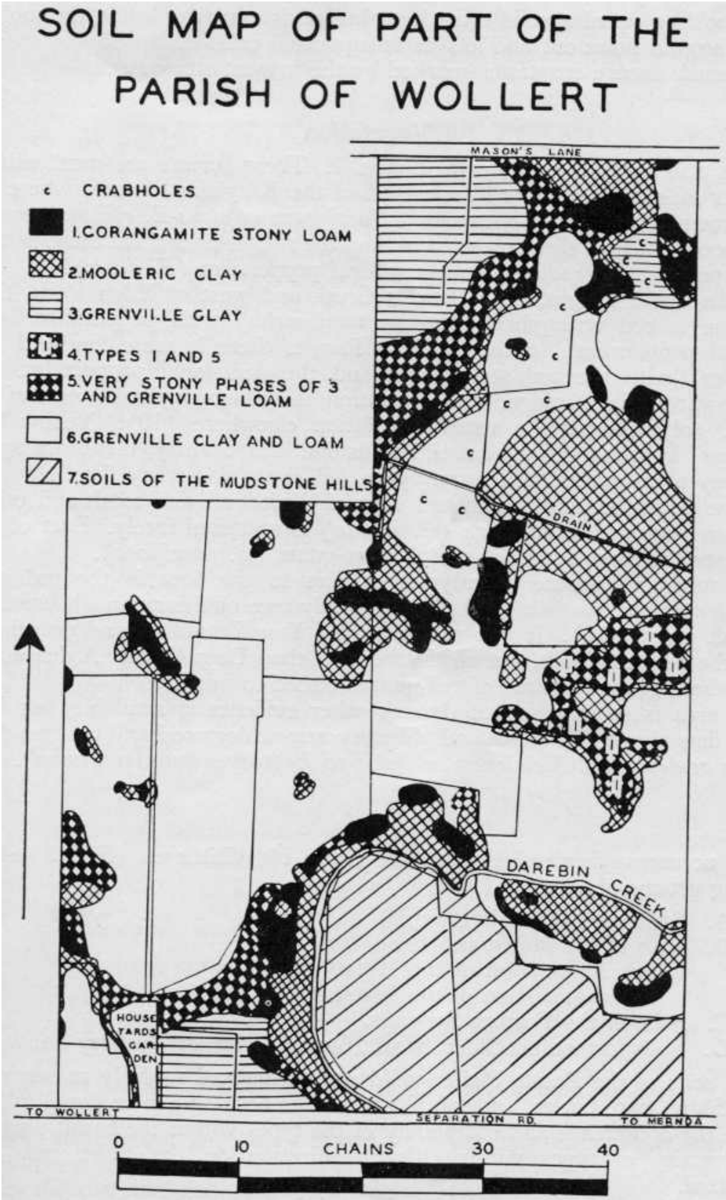

Fig. 4. – Detailed Soil Map of part of the Basalt Plains

Vegetation

Areas still forested are shown in Fig. 1. These forests are most valuable on the better soils of the Hume Ranges and of the Kinglike Plateau, where there is a well-grown mountain ash-messmate (*Eucalyptus regnans – E. obliqua*) association. On the poorer soils of these plateaux and on the ranges near them there is messmate with peppermint (*E. radiata*) and broad-leaf peppermint (*E. dives*).

On the lower ranges; near Bruce's Creek and west of Eden Park, the usual association is red stringybark (*E. macrorhyncha*) with peppermint and some broad-leaf peppermint. In the Sherwin Ranges there is more long-leaf box (*E. elaeophora*) with the red stringybark and the occasional peppermint. Further south, towards Hyrstbridge, the association is red stringybark – long-leaf box – red box (*E. polyanthemos*), a usual association elsewhere (10). Yellow box (*E. melliodora*) is found throughout the mudstone hills country, messmate appears in almost any of its gullies, and swamp gum (*E. ovata*) on many flats.

In the cleared country north and west of Whittlesea and south and east of the Yam Yean reservoir, Candlebark (*E. rubida*) is scattered freely. East of the Yam Yean reservoir there are also several snow-gums (*E. pauciflora*).

The most widespread Eucalpytus species in the area is the red gum (*E. camaldulensis* syn. *rostrata*), which is the tree on the basalt plains (11). It also grows on the Yam Yean flats and on other minor flats in the mudstone hills, but not further east than Deep Creek. A dense undergrowth occurs where ground cleared of red gum is closed to grazing.

The area is so long settled that no other evidence is available, but it is said that the flats above Whittlesea had a dense cover of dogwood and tea-tree (probably *Cassinia aculeata* and *Melaleuca ericifolia* or *Leptospermum lanigerum*)

Soils

The accompanying soil map of the Shire of Whittlesea (Fig. 3) shows the following groups of soils:

- A. Soils of the Basalt Plains
- B. Soils of the Mudstone Hills
    - i. Association of the Hills
    - ii. Association of the Flats
- C. Soils of the Former Swamps
- D. Soils formed on Older Basalt, Granodiorite or Tertiary Sands.

The soils of the Basalt Plains could not be mapped usefully as separate types on the Shire map, but an area of 330 acres has been shown in detail in Fig. 4 to indicate the occurrence and complexity of the types within the basalt plains catena. The diversity of types within this classification on the Shire map must be emphasized.

In a similar way the two associations of the soils of the Mudstone Hills have been mapped to cover a number of types and of their varieties, and details of the occurrence are shown for 5,000 acres, including the important Whittlesea flats, in Fig. 5.

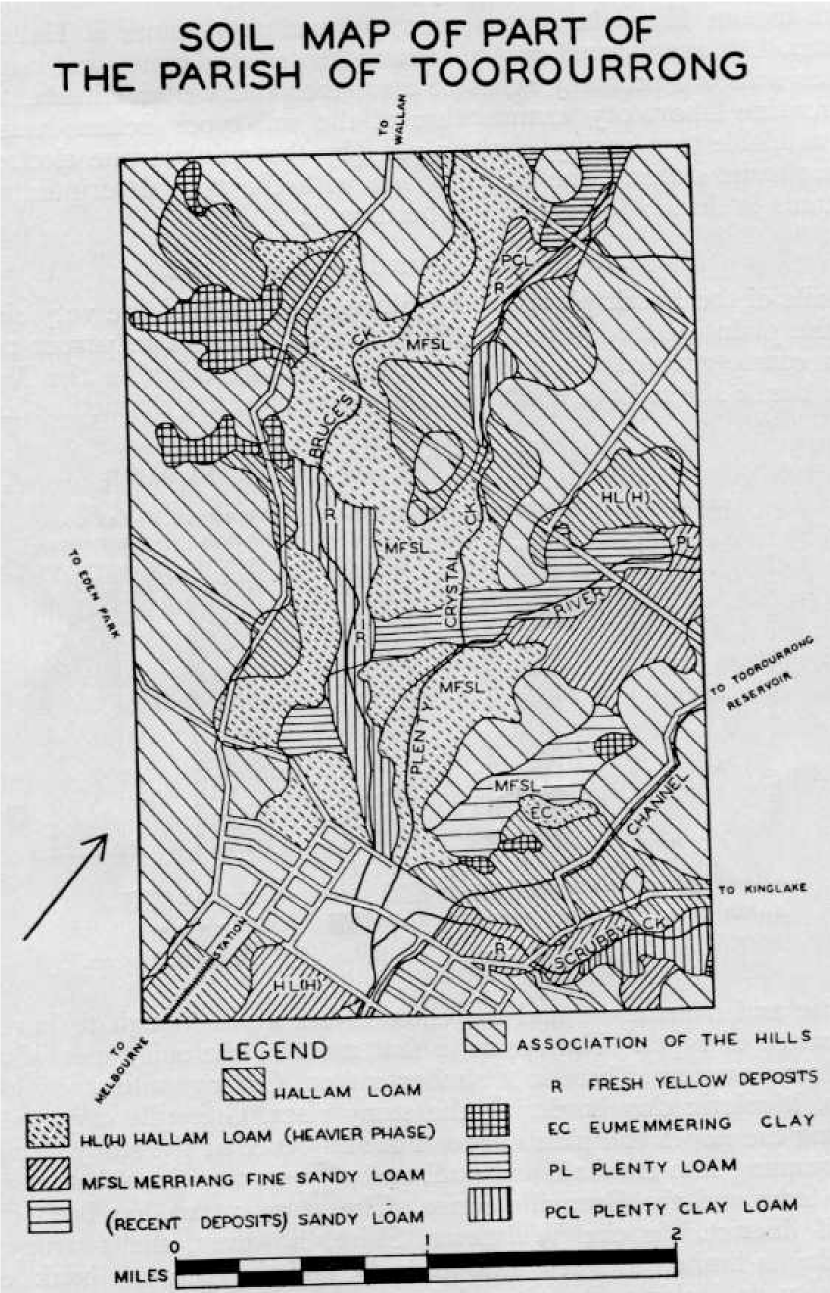

Fig.5. – Detailed Soil Map pf part of the Whittlesea Flats

The other two groups have been shown by types in Fig. 3, the last group of unrelated minor soils being linked here merely for convenience.

Soils of the plateaux have not been mapped. Within the Shire, the plateau known as the Hume Range and much of the slopes leading up to it have been reserved for forestry and water supply; for this area only the granite-sedimentary boundary of the Geological Survey quarter sheet (2) has been shown. The soils of the Kinglike Plateau include deep red-brown or grey friable clay-loams and clays (the famous Kinglike potato soils) as well as variants of Hallam and Yam Yean loams. All are formed on the same Silurian sandstones and mudstones, but the heavier soils are probably relics of a warmer and wetter climate.

The routine laboratory examination of the soil types defined was limited by the time available to a survey of their pH (by the quinhydrone electrode) and of their phosphorus status. The pH is given with the type description, and phosphorus status is dealt with under sub-heading E.

A. Soils of the Basalt Plains

The soils of the Basalt plains in the Shire of Whittlesea are very similar to the 'soils of the plain' in the Mount Gellibrand area (12). The parent rock in both areas is a coarse-grained olivine-rich basalt, often vesicular, of the Newer Basalt flows; the basalt sheets have had similar topographies, the characteristic alternation of stony rise and depression, and the climates are alike enough to have produced the same range of types. The result is that most of the soil types of the Mount Gellibrand area are found here in a similar catena, Corangamite stony loam on the stony rises, Mooleric clay bordering the stony rises, Grenville clay and Grenville loam forming the slopes and plains beyond the influence of the stony rises, Grenville mite stony loam and the Grenville series. The same catena has been observed in the Riddell district. In the Whittlesea Shire, however, the swampy phase of Grenville clay is limited to a few swamps only, and the 'pan and bank' complex of the depression is lacking, its place being taken by a very crabholey phase of Grenville clay or by a soil type like Mooleric clay. The only two basaltic hills in the Shire, one east of Donnybrook and one south-east of Beveridge, have soils that are classed with the plains types.

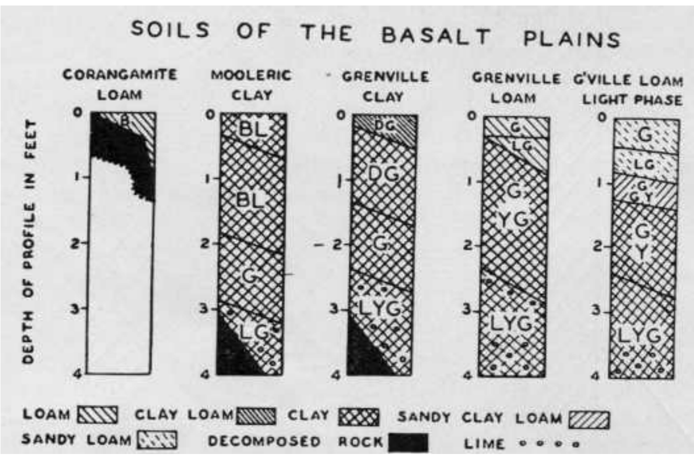

Fig. 6. – Diagrams of Profiles, Soils of the Basalt Plains

1. Corangamite stony loam

This is the soil of the typical stony rise, a brown loam up to four inches deep over the solid rocks or filling the crevices between them. It has a pH 5.9 and is an immature soil, with no horizons differentiated, friable when wet and draining rapidly to be very dusty when dry, high in organic matter and very fertile. Occurrences range from a few square yards to four acres, but it is far too stony for cultivation.

2. Mooleric clay

The type profile is:

0-6	inches	Friable black clay	pH 6.3
6-24	"	Black heavy clay	pH 6.3
24-36	"	Colour changing to light grey, heavy clay	
36-48	"	Light grey heavy clay with light or medium amounts Of soft or concretionary lime	pH 7.8

Lime may occasionally come right to the surface, and basalt may be met at any depth below three feet. The surface is almost as uneven as crabholey ground, but there is no marked difference between the soils of rise and hollow, so the unevenness is best described as hummocky.

Mooleric clay occurs typically as patches or strips about a chain wide at the lower edges of stony rises, where it is enriched by wash and leaching from the Corangamite loam. Where similar enrichment has taken place by accumulated drainage, as in many depressions, Mooleric clay is formed away from stony rise influence. Such black hummocky flats are common along the wandering creeks of the basalt country, and in closed depressions up to 100 acres in extent, where the soil may be very deep.

3. Grenville clay

The profile of this type is:

0-3	inches	Dark grey clay	pH 6.3
3-18	"	Dark grey heavy clay	pH 6.7
18-30	"	Grey heavy clay, traces of soft and nodular lime	pH 7.3
30-48	"	Light yellowish grey heavy clay, horizons with light to medium amounts of soft or nodular lime.	

The country basalt is found at any depth below three feet, and basalt 'floaters' up to a foot or two in diameter are common, their clearing from the surface giving the material for the stone fences characteristic of this countryside.

Grenville clay is one of the soils of the flat or gently sloping country between the stony rises. The presence of an occasional crabhole and puff, or sometimes a scattered group of them, is typical. Sometimes the occurrence of crabholes and puffs is so dense that no level soil can be found; this is mapped as –

3a. Grenville clay, crabholey complex

This complex has two members, crabhole puff and crabhole depression. The former is a heavy clay throughout the profile, grey at the surface and becoming lighter coloured and yellower with depth. The surface soil collapses to a nutty structure when dry, and soft or concretionary lime sometimes shows on the surface as well as at depth; pH for the first six inches, and for the next foot, is 6.5.

The depression has about six inches of dark grey silty or clay loam, pH 5.2, usually sticky when wet, and hard and cloddy when dry, overlying a rather dark grey heavy clay which becomes lighter in colour with depth. The horizons of puff depression, and Grenville clay are the same below three feet, with a pH of about 7.

Puff and depression alternate. Each puff is a mound a yard or two side, separated from other puffs by depressions of about the same width, the differences in level being six to twelve inches.

4. Grenville loam

With Grenville clay, Grenville loam from the flat or sloping country away from the stony rises. The typical profile is:

0-4	inches	Grey silty loam	pH 5.4
4-8	"	Lighter grey silty loam	pH 5.4
8-18	"	Mixed grey and yellow grey heavy clay	pH 5.8
18-30	"	Lighter coloured mixed grey and yellow-grey heavy clay	pH 6.3
30-60	"	Light yellowish grey heavy clay, up to light amounts of soft lime and some lime concretions	pH 7.9

This profile overlies mixed clay and decomposing basalt, a transition to the country rock. The lighter coloured sub-surface soil may be absent, and about 1% of 'buckshot' (ironstone nodules) is usual throughout the profile.

4a. Grenville loam, light phase

This phase differs from the type in having deeper and somewhat lighter textured A_1 and A_2 horizons, and a marked transition from them to the heavy clay below. Typically

0-5	inches	Grey fine sandy loam	pH 5.4
5-10	"	Light grey fine sandy loam	pH 5.7
10-15	"	Mixed grey and yellow-grey fine sandy clay	pH 6.1
15-24	"	Mixed dark grey, grey and yellow heavy clay	pH 6.1

And then as the type profile.

There are five hundred acres of this phase in the northern part of the Shire, forming plains behind the stony rises and slightly higher than them. Important centres of basalt eruption are so close that wind-blown additions to the parent material are suggested as a cause of the lightness of this basaltic soil (cf. distinction between Grenville clay and Grenville loam at Mount Gellibrand (12)).

5. Very stony phases of Grenville loam and Grenville clay

These phases, which correspond to 'Type 2' of the Mount Gellibrand survey, differ from the normal in having country basalt at or near the surface, as well as the typical boulders or floaters. Rock outcrop may form about a quarter of their surface. The soil between outcrops is two or three inches of grey loam or clay loam over dark grey clay, or a surface of friable self-mulching grey clay, solid rock coming at a depth of less than a foot. The crabholey phase of Grenville clay also occurs in the complex, usually with more puff than depression, and patches of Mooleric clay only a few yards in extent are also frequent.

These very stony phases appear to be the result of soil formation under the restricted drainage of flat outcroppings of the original basalt sheet; under free drainage Corangamite stony loam is found at the front of the rise, and the very stony phases of Grenville loam and Grenville clay occupy the shelf behind the stony plains. Some of these patches have been cleared of stone, but it is usually considered impracticable to do so, and is certainly not economic.

B. Soils of the Mudstone Hills

Hills of Silurian mudstone like those of the Whittlesea Shire were covered by the soil survey of the country around Berwick (13). The types Hallam loam, Hallam loam (Silurian phase) hereafter called shaley phase), and ‘rugged Silurian country’ described there form the greatest part of the Whittlesea country mapped as ‘Association of the Flats’.

Similar hills have also been studied near Warrandyte. (School of Agriculture, University of Melbourne, Students’ Survey, 1946. Unpublished.)

The two associations are distinguished by their different topography arising from their different origins, the association of the hills including all types formed on mudstone or colluvium* at the foot of the hills, and the association of the flats those formed on alluvium deposited by streams whose drainage was blocked by the Newer Basalt flows. In practice the distinction is sharper than would appear from the separation of colluvium and alluvium.

The association of the hills is made up of

(1) Hallam loam.
(2) Hallam loam (shaley phase).
(3) Yam Yean loam, the ‘rugged Silurian country’ of the Berwick survey.
(4) An unnamed type.

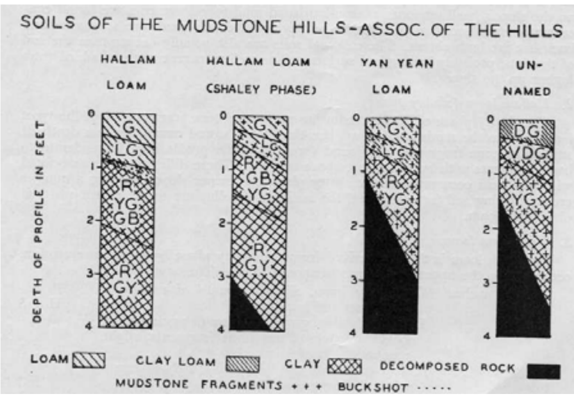

Fig. 7. – Diagrams of Profiles, Soils of the Mudstone Hills, Association of the Hills

*Alluvium has been defined as material deposited by streams; colluvium as material deposited by more general erosion.

The association of the flats is made up of

	Hallam loam
(5)	Hallam loam (heavy phase)
(6)	Merriang fine sandy loam
(7)	Unnamed sandy loam, recent deposits.

The variation of fertility within the types of the association of the hills could not be covered by sampling on this survey, but an attempt to do so has been made by discussing geology and vegetation for this association in some detail.

Descriptions of the types are as follows:

1. Hallam loam

This type is common to both associations, covering the lowest and gentles slopes in the mudstone hills country, and the higher level of the flats. The type description for the Whittlesea Shire is:

0-6	inches	Grey silty loam	pH 5.3
6-12	"	Light grey silty loam	pH 5.3
12-15	"	Mixed light grey and yellow-grey clay loam	pH 5.5
15-24	"	Mixed grey-brown and yellow-grey with red heavy clay	pH 5.9
24 on	"	Greyish yellow with red heavy clay	

The softened mudstone is met at about six feet and becomes harder with depth. The great change from the silty loam horizons to the heavy clay horizons is notable and is often emphasized by the absence of any clay loam transition layer. Typically concentrated with buckshot just above the clay; on the flats mudstone fragments an buckshot are both absent. The colluvial soils are also usually deeper than the soil of the flats, probably having had surface soil as well as parent material added from higher up the slopes.

2. Hallam loam (shaley phase)

The shaley phase of Hallam loam has more mudstone fragments than the type, less depth to the mudstone below (less than 5 feet), and commonly less depth of soil. Mudstone fragments are found throughout the profile, and in moderate to heavy amounts with buckshot just above the clay. These differences are associated with the usual occurrence of the shaley phase on steeper slopes, causing a quicker erosion during soil formation and the addition of colluvium to the parent material of Hallam loam.

3. Yam Yean loam

Yam Yean loam is the soil derived from the shaley phase by even more erosion, occurring on the uppermost or most exposed slopes. The profile runs:

0-4	inches	Grey silty loam, slight amounts of mudstone fragments and buckshot	pH 5.3
4-8	"	Light yellowish grey clay loam, moderate to heavy amounts of mudstone fragments, slight amounts of buckshot	pH 5.3
8-18	"	Yellow grey with red heavy clay, light amounts of mudstone fragments	pH 5.3

and then soft mudstone, the depth varying from little more than a foot to about three feet.

4. Unnamed type

Small and unrelated occurrences of a darker and heavier type are found in the mudstone hills. The largest patch found was about 10 acres in extent, the parent material seemed to be the same Silurian mudstone as the Hallam and Yam Yean loams, and no hypothesis of the type's origin could be formed. Descriptions vary, but all are very different from the nearby Hallam or Yam Yean loam. A characteristic profile is:

0-4	inches	Dark grey clay loam	pH 5.7
4-12	"	Very dark grey clay	pH 5.7
12-14	"	Yellowish grey heavy clay, light amounts of mudstone fragments	pH 6.1
24-42	"	Mixed yellow grey heavy clay, traces of mudstone and then soft mudstone	pH 6.6

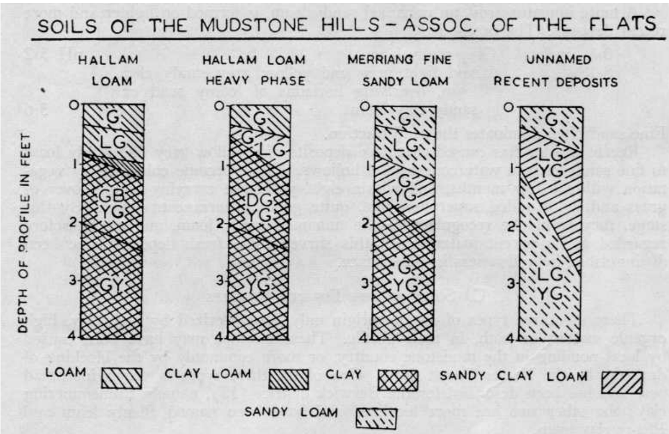

Fig. 8. – Diagrams of Profiles, Soils of the Mudstone Hills, Association of the Flats.

5. Hallam loam (heavy phase)

This heavy phase of Hallam loam usually occurs on slightly lower parts of the flats, mostly along drainage lines, but it may have a very even topography. The phase profile is:

0-6	inches	Grey loam	pH 5.1
6-15	"	Grey, mixed with light grey and yellowish grey, sandy clay loam	pH 5.3
15-24	"	Dark grey, mixed with yellowish grey, heavy clay continuing as a rather yellower heavy clay	pH 5.3

In some places on the flats north of Whittlesea the above profile may be gravelly throughout.

6. Merriang fine sandy loam

This type and the next are formed on material deposited at the foot of hiss, often where a valley meets the Newer Basalt country. The typical Merriang fine sandy loam profile is:

0-6	inches	Grey fine sandy loam	pH 5.3
6-15	"	Light grey fine sandy loam	pH 5.4
15-24	"	Mixed grey and yellow grey fine sandy clay	pH 5.5
24-36	"	Mixed grey and yellow heavy clay continuing for several more feet	pH 6.4

This is an immature soil, with a lighter surface then Hallam loam and a more gradual transition to the heavy clay horizons.

7. Unnamed sandy loam recent deposits

A more immature soil, an unnamed sandy loam, is formed on lighter and more recent deposits. The profile is:

0-8	inches	Grey sandy loam	pH 5.2
8-18	"	Mixed light grey and yellow grey sandy clay loam, overlying horizons of loamy sand or sandy clay loam	ph 5.6

Fine sand often dominated the sand fraction.

Recent erosion has caused extensive deposits of a yellow-grey fine sandy loam to fine sandy clay in watercourses and hollows. These become colonized by vegetation within a few months, and within eight years are carrying a fair cover of grass and, with added superphosphate, quite good subterranean clover. By this stage, they would be recognized as the unnamed sandy loam, and are therefore regarded as its parent material. In this survey these fresh deposits have been distinguished by yellowness in the surface.

C. Soils of the Former Swamps

There are three types of swamp origin only, characterized by high clay, high organic matter, or both, in their profile. These swamps may have been caused by local ponding in the mudstone country, or more commonly by the blocking of drainage by the Newer Basalt flows. One of the tree types is very widespread here and has been described for the Berwick district (13), namely Eumemmering clay; the other two are more localized and have been named Plenty loam and Plenty clay loam.

1. Eumemmering clay

Eumemmering clay in the Whittlesea Shire occurs extensively in basins in the mudstone country, like its Berwick prototype, but it is also characteristic of depressions lying between the mudstone hills and the Newer Basalt. Mooleric clay, which may lie near it in the latter circumstances, differs from Eumemmering clay in forming hummocks, in having a darker colour, and in having a higher pH and lime within four feet. The profile for this Shire is:

0-3	inches	Very dark grey friable clay	pH 5.9
3-12	"	Very dark grey heavy clay	pH 6.1
12-24	"	Dark grey heavy clay	pH 6.3
24-36	"	Grey, with a little yellow-grey, heavy clay	pH 7.0

Thereafter becoming lighter and yellower in colour but remaining heavy.

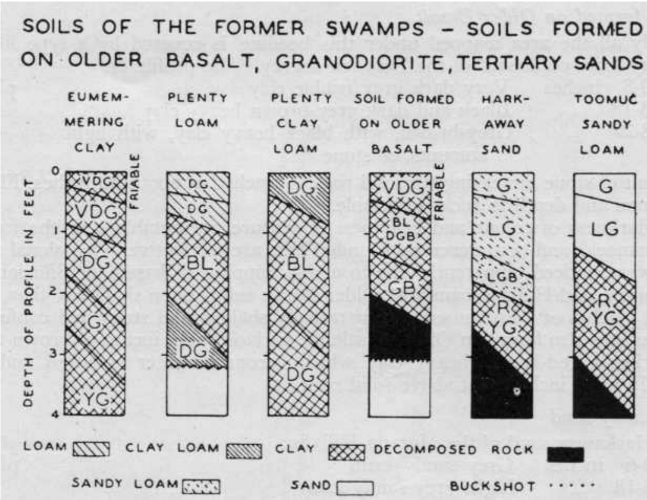

Fig. 9. – Diagrams of Profiles, Soils of the Former Swamps formed on Older Basalt, Granodiorite and Tertiary Sands

2. Plenty series

The two types of the Plenty series, Plenty loam and Plenty clay loam, are both high in organic matter, and are confined to the flats of the Plenty River and its tributaries above Whittlesea. Typical profiles are:

(a) Plenty loam

0-9	inches	Dark grey peaty loam	pH 4.9
9-12	"	Transition	
12-30	"	Black friable heavy clay	Ph 4.9

then a dark grey clay loam which was always water-logged when found on the survey.

(b) Plenty clay loam

0-9	inches	Dark grey friable clay loam	pH 5.2
9-30	"	Black heavy clay	pH 5.3

continuing as a dark heavy clay for several feet deeper.

D. Soils formed on Older Basalt, Granodiorite or Tertiary Sands

Two types of soil have been identified in this survey on Older Basalt parent material, but their naming has been deferred until more extensive occurrences of similar soils to the east of the Shire have been investigated. The soils formed on granodiorite in the Moran Hills area have been assigned to the type Harkaway sand, and on Tertiary sands to the type Toomuc sandy loam, of the Berwick survey (13).

1. Soils formed on Older Basalt

Nearly all the area mapped under this heading is covered by a type like the 'black clay loam on basalt' of the Berwick survey. The profile is:

0-8	inches	Very dark grey friable clay	pH 5.8
8-18	"	Black and dark grey-brown heavy clay	pH 5.9
18-27	"	Grey-brown, with black heavy clay, with light amounts of stone	pH 6.4

the amount of stone increasing till solid rock is reached at about 30 inches. Floaters are common and depth to rock is variable.

The darkness of colour and heaviness of texture are notable, and the freedom from hummocks and occurrence on rounded hills are distinctive. Occasional mixed profiles were noticed, apparently due to a thin capping of basalt on Silurian mud stone country, and Hallam loam near Older Basalt soil is often shallower than usual.

Small patches of a brown soil, comparatively shallow and stony and confined to clay overlies a red-brown heavy clay which becomes lighter coloured and very stony at 15 to 18 inches, just above solid rock.

2. Harkaway sand

The Harkaway sand of the Moran Hills is:

0-6	inches	Grey sandy loam	pH 5.6
6-18	"	Light grey sandy loam	pH 5.7
18-24	"	Light grey-brown sandy loam, light amounts of ironstone concretions	pH 5.9
24-30	"	Yellow-grey and red heavy clay	pH 6.1

which gives way at three feet or so to decomposing granite rock. The profile has much coarse sand in it throughout. The soil is deep, but granite boulders limit its useful extent, except on lower slopes where some wide areas free of boulders are found on the hill-wash.

3. Toomuc sandy loam

For the Whittlesea Shire, Toomuc sandy loam is described as:

0-5	inches	Grey loamy sand	pH 5.2
5-9	"	Lighter grey loamy sand	pH 5.2
9-18	"	Light grey loamy sand	pH 5.6
18-27	"	Yellow grey with red heavy clay, with appreciable sand,	

becoming at three or four feet the brightly coloured sandy clay of the Tertiary sands. A high proportion of coarse sand is found throughout the profile.

Toomuc sandy loam is confined to the south-east part of the Shire, often adjoining Older Basalt soils because of their common association with residual hills.

E. Phosphorus Status of the Soils

Phosphorus status of the type samples in shown in Table 1. Total phosphorus was extracted by the tri-acid method of Groves (14), and readily available phosphorus by a method adopted in the Queensland Department of Agriculture and Stock*, namely, shaking 1 gm Of soil with 200 mls Of 01 N euphoric acid for six hours. Phosphorus in the extracts was determined colourimetrically, total phosphorus by the molybdenum blue method of Zinzadze (15), and readily available by the stannous chloride method of the Troug and Meyer (16).

Table 1 – Total Phosphorus and Readily Available Phosphorus of Type Samples

	Horizon (inches)	Soil Texture	Total P %	P Soluble in N/100 H_2SO_4 ppm
Corangamite stony loam (v)	0-3	Loam	0.089	44
Mooleric clay	0-6	Friable clay	0.050	70
	6-25	Heavy clay	0.034	15
Grenville clay	0-3	Clay	0.031	24
Grenville clay, crabholey phase, crabhole puff (v)	0-6	Heavy clay	0.026	8
	6-16	Heavy clay	0.024	4
Grenville clay, crabholey phase, crabhole depression (v)	0-6	Silty loam	0.032	12
	6-16	Heavy clay	0.031	7
Grenville loam	0-3	Silty loam	0.027	23
	3-6	Silty loam	0.026	14
	6-7	Silty loam	0.019	
	7-18	Heavy clay	0.027	
	18-27	Heavy clay	0.026	
	30-42	Heavy clay	0.026	
	42-48	Heavy clay	0.024	
Grenville loam (another sample)	0-4	Loam	0.036	14
Grenville loam (light phase)	0-5	Fine sandy loam	0.010	10
	5-10	Fine sandy loam	0.009	4
Grenville clay, very stony phase	0-5	Friable clay	0.053	156
	5-12	Heavy clay	0.035	111
Hallam loam (on colluvium)	0-6	Silty loam	0.035	91
	8-12	Silty loam	0.009	11
Hallam loam (on alluvium)	0-6	Silty loam	0.043	78
	6-10	Silty loam	0.021	9
Hallam loam (shaley phase)	0-5	Silty loam	0.038	23
	5-13	Silty loam	0.029	10
Yam Yean loam	0-3	Silty loam	0.058	35
	3-8	Clay loam	0.017	7
Unnamed type	0-4	Clay loam	0.057	30
	4-11	Clay	0.011	14
Hallam loam (heavy phase)	0-6	Loam	0.036	5
	6-15	Sandy clay loam	0.020	3
Merriang fine sandy loam	0-7	Fine sandy loam	0.026	12
	7-15	Fine sandy loam	0.007	4
Unnamed sandy loam, recent deposits	0-8	Fine sandy loam	0.041	6
	8-18	Fine sandy clay loam	0.043	4
Eumemmering clay	0-3	Friable clay	0.054	48
	3-12	Heavy clay	0.022	6
Plenty loam	0-5	Peaty loam	0.099	98
	5-9	Peaty loam	0.106	89
Plenty clay loam	0-9	Clay loam	0.105	52
	9-30	Heavy clay	0.056	30
Soil on Older Basalt	0-8	Friable clay	0.064	35
	8-18	Heavy clay	0.042	30
Harkaway sand	0-6	Sandy loam	0.020	8
	6-18	Sandy loam	0.019	6
Toomuc sandy loam (v)	0-5	Sandy loam	0.004	15
	5-9	Loamy sand	0.004	7

(v) indicates soil never treated with fertiliser

* C. R. von Steiglitz, pers. Comm.

The most interesting of the total phosphorus figures are those for the Newer Basalt soils, since the phosphorus content ranges from 0.05% to 0.01% (except for the immature Corangamite stony loam at 0.09) while the basalt rock itself has 0.10%. For the profile of Grenville loam examined in detail the contrast between soil and parent rock is very striking; the average for the soil is 0.026% P, and the rock has 0.106%; material like soft discoloured basalt just above the parent rock has 0.024%. There is no concentration of phosphorus in the ironstone nodules found throughout the profile, since these have too little phosphorus in the ironstone nodules found throughout the profile, since these have too little phosphorus to determine.

An even greater loss of phosphorus during soil formation was found for the Mount Gellibrand basalts (12).

With the figures for readily available phosphorus, Table 2 shows quite a good relationship between an observed grading soil quantity and amount of phosphorus soluble in N/100 sulphuric acid, and three discrepancies are explainable. Von Stieglitz (privy. comm.) mentioned 83% of 'positive' correlations in 130 samples of sugar-cane soils, with 40 ppm as limiting.

Table 2 – Relation between Observed Grading of Soil Quality and Phosphorus Soluble in N/100 Sulphuric Acid

Soil Quality	Very good	Good	Fair	Poor
	156	48	24	35[3]
P soluble in	98	44	23	15
N/100 H_2SO_4	91	35	23	12
Pp,	78	30	14	8
	70	10[1]	12	8
	52	6[2]		5

1 and 2 are light soils growing good subterranean clover; 3 is a soil which will not grow healthy subterranean clover and is probably calcium deficient.

Land Use

A. Grazing and Pasture Improvement

Utilization of pasture is the most important activity in the Whittlesea Shire, and pasture improvement is widespread. At present the improvement aimed at seldom goes beyond the perennial rye grass-subterranean clover (*Lolium perenne – Trifolium subterraneum*) combination. Of other sown grasses, cocksfoot (*Dactylis glomerata*) has had only moderate success, and phalaris (*Phalaris tuberosa*), although very successful in some instances, may not generally be preferred to rye grass. Of other sown legumes, white clover (*Trifolium perenne*) is not widespread now and usually disappears soon after seeding, although one would have expected types such as Mooleric clay, the Older Basalt soils, and the Plenty series to be able to hold it. Some clovers have been tried and discredited without an understanding of their function, e.g., red clover (*Trifolium pratense*) was expected to perennate. No particular strain of subterranean clover is favoured, and so-called natives such as spotted medic (*Medicago maculata*) and trefoil (*Medicago tribuloides*) are welcomed. In few cases, lucerne (*Medicago sativa*) has grown well on Hallam loam in favoured situations.

Establishment of perennial rye grass – subterranean clover pastures appears practicable on all types except two, Yam Yean loam and Hallam loam (shaley phase). On these there have been many failures in establishment, the subterranean clover showing only as scattered and stunted plants, and the rye grass being weak for lack of clover support. Some of these failures have been corrected and some potential failures have been prevented by lime dressings, of the order of ¼ ton of agricultural lime to the acre, and on small areas the spreading of dung has been effective.

Some plots of the Department of Agriculture, six miles north of the Shire and on a soil which appears to be Yam Yean loam, have given a remarkable response to lime. Establishment of subterranean clover is normal on plots receiving superphosphate and lime, or superphosphate, potassium and lime, the lime being applied at the rate of 10 cwt to the acre. But the clover has failed under all other treatments – plots manured with superphosphate and other kinds of phosphate with and without potassium chloride, at several different rates of application, and cross-strips treated with zinc, copper, boron, magnesium, manganese and molybdenum.

During the soil survey a number of samples of the first three inches of soil were taken, and their pH determined (by the quinhydrone electrode) and tabulated against condition of clover. The results, in Table 3, show no correlation between growth of subterranean clover and pH for these soils.

Table 3 – Soil pH and condition of Subterranean Clover

Treatment Condition of sub. Clover	Good	Fair Patch	Failure	Fair Patch	Failure	None present
pH of top three inches ff soil	5.5[1] 5.6[2] 5.5[2]	5.6 - 5.8[3] - 5.5 - 5.7 5.4	5.5 5.3[3] 5.3	5.4 - 5.5 - 5.4	5.4 5.5	5.2 5.2[4] 5.2[5]

Adjoining samples are indicated by a link –

1. Treated with 5 cwt of lime eight years ago
2. Limed twenty years ago
3. Treated with horse manure
4. Mild sheet erosion
5. Severe sheet erosion

Further, a soil carrying good subterranean clover and one on which clover had failed were anlayzed for water-soluble aluminium (by the aurintricarboxylic acid method of Roller 17)) and manganese (by the permanganate method of Willard and Greathouse (18)), since both these elements might become toxic at such pH values. No significant difference between good and bad was found, and the amounts extracted were well below toxic limits, namely 1.2 ppm Al, while Mn was not determinable for good and bad clover soils. The problem therefore remains unsolved, but may be one of the calcium deficiency, a view which is supported by further work by the Victorian Department of Agriculture since the soil survey was completed (W. D. Andrew, privy. comm.).

The survey was not intensive enough to find more than a broad relation between problem and soil type. While the trouble can sometimes be related to sheet erosion on the two 'difficult' types, much of the land classed as Yam Yean loam and Hallam loam (shaley phase) has always been under timber or natural grass and yet has given a poor response to top-dressing. The native clovers have given little added growth, and subterranean clover has made as patchy progress as on long-cropped land where it has been sown down.

Of the area shown as 'Association of the Hills', about half is forest country, and most of the remainder is country on which subterranean clover establishment has been, or may be, difficult. However, it seams reasonably certain that lime in addition to the usual superphosphate dressings will give establishment.

On other soil types there is a good response to top-dressing with superphosphate alone; the native legumes are encouraged and subterranean clover is easily introduced. Toomuc sandy loam may be an exception, but the extent of attempted improvement on this type was too small to prove or disprove this. The only real difficulty is on the soils of the basalt plains, and is the physical difficulty of moving areas the top-dressing machinery over very stony ground. At least one grower of large areas of basalt plains finds that it pays to accept possible breakages of machinery and to top-dress natural pasture with introduced subterranean clover on the soils of the basalt plains.

B. Cereal Growing

Oats for hay, and to a lesser extent for grain, have been grown on all types, but those favoured are Yam Yean loam, Hallam loam (shaley phase), Hallam loam, Grenville clay, and Grenville loam, because of the quantity of the hay produced. The average yield on these soils is about 30 cwt of hay, and the Grenville series is rather remarkable in being able to produce such a yield year after year by means of a late harvest and late sowing, a six months' fallow, and manuring with 1 cwt of superphosphate per acre every year. Richer types, such as Mooleric clay or the unnamed type of the association of the hills, usually produce rather too leafy a crop, and on the Older Basalt soil, for example, weed control is a problem.

A little wheat is grown, mostly on Hallam loam and the Grenville series; a little barley is grown on Hallam loam and Hallam loam (shaley phase); linseed has been grown on Hallam loam; and summer fodders such as maize and millet are grown in many small areas on all types.

C. Fruit and Vegetable Growing

Apples are grown on Hallam loam (shaley phase) and Yam Yean loam in the north-east part of the Shire, because of the higher rainfall, in the important apple-growing districts of the Strathewen and Arthur's Creek and in orchards in the deep Creek area and on the ranges towards Kinglike West.

Potatoes and Peas grow well on the Plenty series, particularly Plenty loam. Tomatoes have done very well on the unnamed sandy loam on recent deposits along Arthur's Creek, with some irrigation.

D. Soil Depletion

It is hard to find good evidence of soil exhaustion by cropping in the Shire, despite a current impression to the contrary. Parish records for the last seventy years do show a slight decrease in average yield per acre of cereals in spite of increased areas of fallow and increased usage of superphosphate, but it was impossible to find particular instances of exhausted land. In one case examined, for example, where exhaustion was suspected, the true cause appeared to be poor cropping practice only.

On the other hand, the area sown down to mixed pasture has increased in that period, and although much former crop land has not been improved beyond letting it lie idle under wild grasses, there is another current impression that fertility of the Shire is increasing.

In this connection the survey of the phosphorus status in Table 1 is interesting, but it must be remembered that these figures are for the type samples, and do not represent a random selection to investigate depletion.

Evidence of soil exhaustion by erosion is abundant, and probably most easily seen in the areas of the unnamed sandy loam on recent deposits which is largely an erosion product, and of fresh yellow deposits which are solely due to erosion. Erosion is confined to the association of the hills except for gullying across the association of the flats and in one case across Grenville loam. In the association of the hills, all kinds of erosion may be seen, sheet, gullying, and the tunneling recently described in the Dookie district (19). Much orchard country has suffered severely, and crop land may suffer badly in an exceptional rain, but the most consistent damage is seen on the poor wallaby grass (Danthonia spp.) pastures on Yam Yean loam and Hallam loam (shaley phase). These are the very types with in the Soil Conservation Board erosion control demonstration at Merriang, where contour furrowing on grassland and contour cultivation on cropland are shown.

Salt accumulation is also conveniently dealt with here. Many occurrences have been observed, and the findings of the Berwick survey (13) apply equally well to patches are so small comparatively to the properties where they are found that attempts to reclaim them have been regarded as uneconomic,

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