Soil Survey Record No. 117

# Soils in Devon IX

Sheet SX68/78

[Moretonhampstead and Chagford]

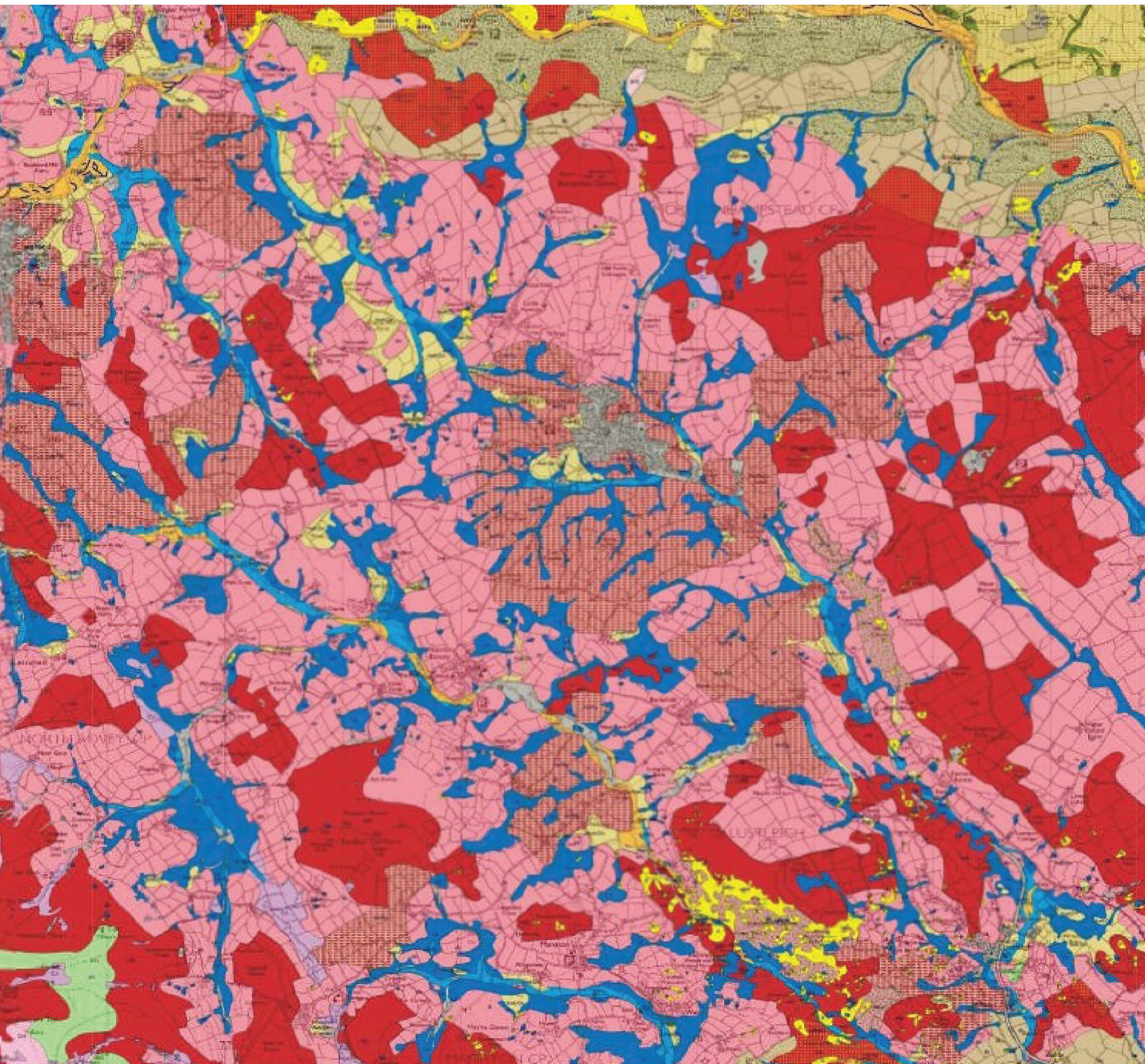


**Plate 1. The rolling in-bye, viewed southwestward from Hingston Rocks.**

On the far right's skyline is Hamel Down, the dark area in front of it marking the 20th century plantations on former farmland at Bowda, North Bovey. Haytor Rocks and Hound Tor, both just south of the survey area, stand out on the skyline across the left and centre.

**Plate 2. The high moorland, near East Dart Head, looking down valley.**

Most of this land is underlain by thick, [2-7 m], blanket peat. Some variety is added by the strip along the valley floor, plus, on the right, by the scarp of Black Hill. For eight or nine months the *Molinia*-dominated vegetation is bronze and beige, broken by a short-lived, green flush in summer.

**Soil Survey Record No. 117**

# Soils in Devon IX

Sheet SX68/78 [Moretonhampstead and Chagford]

**T.R. Harrod**

Crediton 2017

Starting in 1968 the Soil Survey of England and Wales began a systematic soil mapping programme, sampling representative Ordnance Survey 1:25,000 scale sheets in the country's main natural regions. Of the scheduled surveys in Devon and Cornwall, only that described in this Record remained to be done when this mapping programme was abandoned in 1987. The author made up this shortfall as a *pro bono publico* retirement project.



ISBN 978-1-9998453-0-8

# PREFACE

In 1664 the Royal Society set up its Georgicall Committee, which suggested that information on the country's soils be collected. Around 25 questions were asked of 'experienced husbandmen in all shires and counties', the first of which required information as to the kinds of soils. Samuel Colpresse, [Stanes 1964 and Stanes *et al.* 2008], reported back in 1667 concerning Devon and Cornwall, although, from his answers, his knowledge appears to have been confined to the country bordering the English Channel, between Fowey in Cornwall and Lyme Regis. Charles Vancouver reported to the Board of Agriculture in 1808 with his *General view of the agriculture of the county of Devon*, with broad descriptions of the county divided into eight districts, which include some accounts of the soils. In 1939 the Soil Survey of England and Wales was formally established with the purpose of characterising the permanent physical and chemical properties of soils.

1959 saw the first detailed soil surveying in Devon with 1:25,000-scale work carried out over 103 $km^2$, supporting the Nuffield Farm Project in the Middle Teign Valley. There followed 900 $km^2$ mapped around Exeter and Teignmouth, completed in 1967 at 1:63,360-scale. In 1968 the Soil Survey of England and Wales began a programme of detailed soil mapping on selected Ordnance Survey 1:25,000 map sheets across the country. These were picked to exemplify the major soil landscapes as dictated by geology, physiography and climate. Most often these maps were 10 km x 10 km, although, like this survey, some were 10 km x 20 km.

This Second Series 'double' sheet [SX68/78] is named Moretonhampstead by the Ordnance Survey, although Chagford is more centrally located. The map represents the granite country of Dartmoor from the wettest high moorland to the relatively dry terrain 15 km to the east in the Teign and Wray valleys. It is the ninth of those 1:25,000-scale sample surveys to be completed in Devon. The previous eight were carried out by the Soil Survey of England and Wales prior to its break-up in 1987. Apart from a few days of preliminary reconnaissance work in 1977, SX68/78 was left unsurveyed.

In 1979 the 1:25,000 programme, begun in 1968, was interrupted for five years by surveying at 1:¼ million-scale for the National Soil Map. Much of that was carried out by extrapolating lessons learned in the sample 1:25,000 surveys across wider tracts of country. For Dartmoor, although some understanding of the soils had been gained before 1979, the 1:250,000 scale mapping was done without the benefit of an existing, full, detailed sample survey.

After 1987, when Soil Survey staff were either made redundant or put on very different consultancy or research work, systematic soil mapping in this country effectively ceased, with SX68/78 only having received a few visits. Living only a few km north of the map area, the author resolved to eventually carry out the Dartmoor survey as a retirement project. This is now complete, with the 1:25,000 soil map, plus an accompanying terrain map, published in the summer of 2015, the United Nations' 'Year of the Soil'.

During the Middle Teign Valley and Exeter soil surveys the eastern 10 percent of SX68/78 was mapped. In the light of developments in soil classification since the 1960s some revision of that ground was carried out in the current survey.

Around 500 days have been given to the field work between 2003 and 2014, with a similar amount of time going on related deskwork and the preparation of this explanatory Record. Finalisation and publication of the maps and Record have only been possible thanks to the financial support from the organisations and individuals acknowledged in the following pages. Satisfyingly the maps were completed and this Record written, all in 2015, the International Year of Soils.

The layout of this account follows the pattern of previous Soil Survey Records in Southwest England. An introductory chapter on the district's physical setting, land use and land cover is followed by one outlining the methods involved in the survey, the construction of the maps and descriptions of the soil map units. The third chapter treats each map unit in detail, describing the make-up of the main and subsidiary soils in it, then considering their economic, ecological and environmental functions. This is followed by a chapter with a broad view of these roles across the district. Chapter 5 describes work on measuring the thickness of peat on the moorland, followed by an account of methods used for the soil analyses given in Chapter 3. A consideration of landscape in the many broad ways that the layman appreciates it is presented in Chapter 7, 'The Essence of Dartmoor's Landscape', at the suggestion of one of the sponsors. After the bibliographic references, there is an appendix giving details of the wealth of climatic information now available from the Met Office, followed by a glossary of terms used in the text.

In this Record the six figure National Grid References within the 100 km grid square SX are quoted for local places, other than Moretonhampstead and Chagford, when first mentioned in any section of text.

This investigation of soils across a representative part of the Dartmoor National Park will complete the 'box set' of 1:25,000-scale detailed soil surveys in Devon. More importantly it offers insights into soils on the granite and peat for their effective and sustainable use and for the protection and appreciation of all aspects of the natural environment, of which soils form components. The maps and the Record detailing the soils, their backgrounds, their various functions and uses are available from me in both paper and digital forms.

*T.R. Harrod, Old Smithy, Woodland Head, Yeoford, Crediton, Devon. EX17 5HF*
*2015*

**ACKNOWLEDGEMENTS**

This survey, carried out as a *pro bono publico*, 'citizen science' retirement project, has only been feasible through the permission of farmers and landowners to survey their land. I am grateful for their cooperation and support while carrying out the fieldwork. Many were encouraging and enthusiastic about my undertaking, some were bemused as to why a pensioner should spend free time in this way. My answer to the latter group is "what better way to do something worthwhile, at the same time once more enjoying 500 days in rural England at its best, in all its seasons and all its moods?"

Part of the motive for carrying out this survey was to complete the unfinished business of the former Soil Survey of England and Wales' 1:25,000 mapping programme, not to mention a gesture of defiance to the forces that had emasculated an efficient and effective organisation, of which I had been proud to be part. In the long term I must acknowledge the friendship and mentoring during my early days as a soil surveyor by the late Ben Clayden, which left me with a life-long enthusiasm for seeing the natural environment from this unique perspective. When I approached the end of my career and talked of this survey as a retirement project I received eager, almost fervent, encouragement from the late Prof Peter Bullock. The part played with me by D.V. Hogan in the brief and aborted reconnaissance of this sheet in1977 must not go unmentioned.

The Ordnance Survey topographic base maps and Plate 8 are published under copyright licence 100024842 with the permission of the Dartmoor National Park Authority.

I must record my gratitude to D.V. Hogan and Prof P.J. Loveland, who edited the text of this account and to Dr R.J.A. Jones for bringing the presentation of the text to a standard appropriate for publication. Not only did they point out technical and grammatical shortcomings in the draft and text, but made many helpful suggestions for improvements in the document as a whole.

Technical advice has been given freely over many aspects of the survey and the preparation of this Soil record by:

(i) Former colleagues in the Soil Survey [later the National Soils Research Institute]: *R.G.O. Burton, Dr A.D. Carter, Dr L.K. Deeks, Dr S.H. Hallett, R. Hartnup, F.W. Heaven, J.M. Hollis, D.V. Hogan, Dr R.J.A. Jones, Caroline Keay, Prof P.J. Loveland, Prof A.J. Moffat, R.C. Palmer, M.J. Reeve, S.J. Staines, T.R.E. Thompson, I.G.Truckell and P.S. Wright.*

(ii) *And* specialists in other disciplines: *Dr T.A.P. Greeves, [The Dartmoor Society], A.C. Crabb, D. Partridge and M. Travis [Dartmoor National Park Authority], S.C. Satterly and Dr R.P. Smith [Environment Agency], B.O. Philipps and P. Verney [Forestry Commission], Dr. E.I. Vanguelova [Forest Research], Dr R. Bol [Forschungszentrum, Jülich, Germany], S.M. Butler [Halsgrove Publishing], W. Towers [James Hutton Institute], C.A. Hoult and J.T. Mills [Langaford Farm Trust], M.R. Beswick [Meteorological Office Archive], S. Peel and Dr M.J. Shepherd [Natural England], the latter contributing the comments in Chapter 4 on fungi, microbes and invertebrates, Dr M.S.A. Blackwell, Dr J.A.J. Dungait, Dr S.J. Granger, Dr J.M.B. Hawkins and R. Matthews [Rothamsted Research, North Wyke], W.S. Horner [Devon County Council], Dr B. Pears [University of Exeter], Dr R.M. Fyfe and Dr R.J. Parkinson [University of Plymouth], C.T. Munro [Upstream Thinking], Lt Col [Retd] A.H. Clark, A. Hopkins, Mrs P.A. Jacoby, P. Newman, J.C.White and Bud Young.*

The success of this undertaking has been ensured by the excellent cartographic support provided by Hanno Koch at Latitude Cartography, Manaton.

Completion of the survey, notably soil analyses, cartography and printing and publication of the maps and this Record, was made possible thanks to the financial generosity of the organisations and individuals named below:

**Individuals**

Mr and Mrs G.R. Beard

Dr J.A. Bennett

R.G.O. Burton

T.E.J. Cuming

Dr Cristina Dorador Ortiz

Dr and Mrs R. Evans

Miss C. de Fleur

Robert and Jenny Golding

Dr Tom Greeves

Prof Chris Harrod

J.B. Killingbeck

C.C. Kilvington

Prof J.D. Mather

Mr M.W. Moss and Mrs J.S. Moss

Mr R.W. Naish

J.D. Robson

Bud and Rosemary Young

## Organisations

Dartmoor Magazine

Dartmoor Mires Project, *including its partners:*

Dartmoor Commoners' Council

Duchy of Cornwall

Environment Agency

Natural England

Dartmoor National Park Authority

Dartmoor Preservation Association

Land Research Associates

Landscape Research Group

The Dartmoor Society

The Dartmoor Trust

The Stapledon Memorial Trust

South West Water

Upstream Thinking

Woodland Trust

National Trust

These acknowledgements would not be complete without reference to the cheerful patience, forbearance and unflinching support of my wife, Sue. Much as she would have liked, her eyesight prevented her from accompanying me in the field, where what to me would be a mildly rutted or poached gateway or gully, to her becomes a succession of ill-seen trip hazards.

# CONTENTS

**Tables** **Page**

## Figures

## Plates

**Plates** **Page**

## Plates

**Plate 3. Heather moorland between Birch Tor and Headland Warren farm.**
The streaks on the middle distance's hillside are tin workings.

**Plate 4. Soils matter! The River Teign in spate at Fingle Bridge.**
This river is prized as a game fishery and turbid sediment, as is entering here in a plume from the Fingle Brook, is less than welcome. While the Teign's catchment on the granite generates little or no harmful clayey sediment, that is not the case for the Fingle Brook and other left bank tributaries draining the Dunland.

# Chapter 1 Description of the District

## 1.1 INTRODUCTION

The 20 km x 10 km rectangle of Ordnance Survey National Grid squares SX68 and 78 extends across 20,000 hectares [nearly 50,000 acres] of the northeastern part of the Dartmoor National Park. The rectangle's location within the southwestern peninsula is shown on the inset map beneath the accompanying soil map. The western boundary runs north-south by Cut Hill [598827], that in the east through Heltor Rock [799870], while the northern limit is the OS northing from near East Mill Tor [599897], by Castle Drogo [723901] and just north of Clifford Bridge [781897], the border to the south passing from Horse Hole [601801], by Jay's Grave [732991] to Plumley [800801]. Although the name was long-confined to the true moorland, progressively, and particularly since the Park's establishment in 1951, Dartmoor has grown to mean the whole of the National Park.

Most of the survey area is underlain by the Dartmoor Granite, although Carboniferous sediments are found over a few hundred hectares in both the northeast and southeast. Blanket peat has formed above about 500 m O.D. in the west, where the ground at the Hangingstone [617861] and Whitehorse [615812] Hills reaches over 600 m O.D. The height of the land declines to the east, the lowest point being about 50 m O.D. on the Bovey floodplain south of Lustleigh [785813]. The granite landscape is a sequence of rounded hills separated by basins, the latter often connected by abrupt, steep-sided gorges. Some crests and valley sides carry tors and fields of boulders, known locally as clitter. Much of the ground has a marked grain trending broadly north-northwest to south-southeast. Several of the principal rivers of Devon rise in the west of the district, in some semblance of a radial pattern, with the River Teign, and its tributary the Bovey, draining the larger part of this survey district.

Land above about 300 m O.D. is largely open moorland, principally in the western half of the district, although several isolated out-lying patches exist further east, often as hill tops. Below the moorland the enclosed *in-bye* or *in-country* is dominated by grassland, while there are numerous deciduous woodlands and coniferous plantations, particularly on steeper slopes. At Fernworthy [650830] and Soussons [680800] several hundred hectares of moorland were planted with conifers in the early part of the last century.

## 1.2 GEOLOGY

### 1.2.1 GRANITE

The Dartmoor Granite was emplaced at depth as molten magma about 280 million years ago. It is coarsely grained with quartz, feldspar and biotite mica crystals of 2-3 mm diameter dominating, and with an overall grey appearance. Typically in the ground mass are large orthoclase phenocrysts, commonly appearing as paler coloured strips up to 15 cm long. These large crystals can make up to 30% of the rock in the eastern three quarters of the district, although west of around easting [2]66 their numbers gradually reduce. As well as this so called giant granite there are rarer occurrences of finer grained granite with crystals about 0.5 mm or smaller. Veins of such finer rock occasionally cut the giant granite. British Geological Survey Sheet 338 [Dartmoor Forest] [1995a], shows two small outcrops of fine granite. One is on the slope west of the upper West Dart, northeast of Rough Tor [606798], the other between Quintin's Man [621839] and Great Varracombe [628842]. Remnants of country rock and patterns of sub-horizontal floor joints suggest that the present generalised upper surface of the granite is close to the original roof of the pluton [Durrance and Laming, 1982].

The granite is diversified by processes that operated after its emplacement. In places the rock contains mineral veins and inclusions. Also there are incorporations of small [a few cm diameter] xenoliths, inclusions of the surrounding country rocks, often ovoid in shape. Narrow veins, usually only a few mm across, of the black mineral tourmaline are found widely in the granite. They are commonly associated with quartz veins that have near vertical alignments, often showing on joint faces in the rock. More restricted are thicker veins of quartz-tourmaline, locally termed blue or black granite or ironstone. The development of *saprolite*, granite softened and decayed by kaolinisation and / or deep weathering of the feldspars, is quite widespread.

Mineralisation of the granite, after it solidified, as evidenced by veins of quartz containing cassiterite [tin-stone in local parlance] and the iron mineral haematite, has occurred in a number of places. Both the common alignment of these veins on east-northeast to west-southwest or east-west lines and their former economic importance can be gauged from the pattern of disturbed ground shown on the soil map, particularly south and southwest of Birch Tor [687814]. This mineralisation is thought to have occurred during the cooling of the previously molten granite.

Kaolinisation of the granite's feldspars is likely to have taken place as it cooled, with both hydrothermal action [water at high temperature and pressure is very corrosive] and pneumatolysis [caused by hot, corrosive gases] involved. This alteration of the feldspars to clay minerals, notably kaolinite, is found widely, often affecting crystals within a few cm of unaffected blocks of granite. The saprolite usually retains the superficial appearance of unaltered granite, but often the kaolin pseudomorphs can be cut with the fingernail and the rock crumbles when touched. While the survey area has no kaolinised granite of economic importance, many exposures reveal the process at a smaller scale, sometimes affecting pieces of rock only a few metres in extent. Elsewhere the alteration appears more extensive, involving tens of hectares. The occurrence of hydromorphic soils in unexpected physiographic locations, plus localised clayey subsoils, are indicative of the presence of altered granite.

**Plate 5. Decomposed, *in situ* granite or saprolite.**

The feldspars have been converted to kaolinite, softening the rock so that the knife could be stuck into it. About 3 cm above the blade, the slot in the white psuedomorph of a megacryst was cut with a fingernail.

Subaerial deep weathering under tropical or sub-tropical climates can also bring about kaolinisation of the granite. That such conditions must have prevailed over this region after the retreat of the Cretaceous sea until the climatic decline heralding the Pleistocene, is supported by Oligocene kaolinitic deposits at Petrockstow, 25 km northwest of Chagford, where the kaolinite is from a non-granitic source.

Jointing is a striking feature of many tors and exposures of the granite, both in near vertical and sub-horizontal planes. Blyth [1962] and Durrance and Laming [1982] describe such joint patterns, along with those of faults and veins. The near vertical joints strike in all directions, but with a preponderance along north-south, east-west, northwest-southeast and northeast-southwest alignments. Tear faulting is considered to have produced the northwest-southeast and northeast-southwest groups. Near horizontal floor joints, or pseudo-bedding, are roughly horizontal on interfluves, but usually broadly mimic physiographic form into valleys, steepening to as much as $25^{O}$ on some hillsides. The grooved faces of some joint blocks show evidence of movement as slickensiding. Spacing of joints is highly varied, from a few centimetres to tens of metres, although in many exposures and quarries their numbers can be seen to increase as the ground surface is approached. Very few joints affect the granite in quarries such as Blackingstone [784858] or on tors like Kestor Rock [666863], whereas very close pseudo-bedding is evident at Watern [629868] and Wild [623877] Tors. Jointing is likely to have come about in response to cooling of the rock, tectonic forces during orogenies and as a consequence of ‘unloading’, that is the removal of overlying rocks by erosion.

**Plate 6. Granite saprolite excavated with a JCB.**
The dark column right of centre is topsoil infilling either an animal burrow or a posthole.

That joints clearly affect the patterns of kaolinisation and decomposition of granite and the parallel isolation of sub-rounded, residual corestones is well demonstrated in exposures, such as at Two Bridges [609760] as described by Linton in 1955, and Wormhill quarry at 721846. At the surface these patterns and processes influence the shapes, sizes and distribution of tors and of detached boulders in clitters and other less dense arrays of surface rocks. Generally boulders are subangular or subrounded [Hodgson, 1997, Figure 8] and show fairly high sphericity or are tabular. Exceptions to this occur where jointing is closer, for example near Watern Tor, and where fine grained granite has formed. Closer jointing results in smaller, tabular or platy boulders, while the finer granite breaks down to a smaller, more angular regolith. At larger scales joint densities and alignments, along with associated faulting and enhanced saprolite formation, are thought by many, such as Waters [1957], to play a controlling part in the development of patterns of hills and ridges, basins and valleys across Dartmoor.

### 1.2.2 CARBONIFEROUS

The Dartmoor Granite was emplaced in older country rocks, in the case of this mapped district marine shales of earlier, Carboniferous age. These outcrop in the northeast and southeast of the district, much of them being thermally altered in the metamorphic aureole fringing the granite. The British Geological Survey 1:50,000 map of the Okehampton district [Sheet 324] [1969] shows Crackington Formation beds following the granite's northern margin along the Teign Gorge eastward from near Castle Drogo [723901] towards Clifford Bridge [781898]. East from there British Geological Survey Sheet 325 around Exeter [1995b] maps out narrow outcrops of the older Teign Cherts and Ashton Shales abutting the granite south of Cod Wood [788887]. Only in the extreme northeastern corner of sheet SX78, east of Clifford Bridge, do the Crackington shales become closely interbedded with turbidite sandstones, more typical of the wider Crackington Formation. In all, this northeastern Carboniferous outcrop extends to about 1,100 ha. A further outcrop of about 200 ha [British Geological Survey,1976] occurs south and southwest of Lustleigh [785813], a mixture of Teign Cherts and Lower Carboniferous – Upper Devonian shales, in which there are a few small dolerite intrusions. Unpublished field maps by W.A.E. Ussher from 1896 in the BGS archive record the country rocks in Hound Tor Wood [770805] as hornfels, quartzite, spotted and banded grits and andalusite-spotted black shales and as spotted shales, quartz veined grit and quartzite on the slopes of the lower Becka valley.

The most intense thermal alteration in the metamorphic aureole closest to the granite contact, converted the sediments into hard, almost flinty, hornfels. Further from the granite the aureole rocks are spotted slates. In places, notably on and north of Mardon Down [772879], tourmalinisation of the hornfels has produced distinctive massive boulders of 'black granite' or 'ironstone'. Locally, as near Cranbrook [740891], isolated cupolas of granite are surrounded by aureole rocks. Surface boulders remote from the main granite outcrop suggest there may be a further cupola between Leign [784875] and Smallridge [781885], east of Mardon Down. The angular or subangular, tabular shape of stones weathered from the aureole rocks gave rise around Dartmoor to the term 'woodstone', distinguishing them from 'shillot', which is applied locally to more platy and often smaller stones of shale and slate. About 100 ha of Crackington shales and turbidites, east of Clifford Bridge and north of Boyland [793894] are unaffected by the thermal metamorphism.

### 1.2.3 TERTIARY

Small Tertiary outliers, Eocene - Oligocene in age, are shown by the British Geological Survey [1969 and 1976], southeast of Lustleigh [785813], in the higher part of Knowle Wood [792808] and north of Chagford near Parford [713899]. At Knowle Wood several metres of Wolley Grit, grey, hard, siliceous coarse and conglomeratic sandstones containing fragments of coniferous wood, outcrop over a few hectares, culminating in a tor-like feature at the south end of Loxter Copse [792810]. The Parford deposits, pale clays with quartz tourmaline conglomerate and siliceous sand cemented with chalcedony, are probably of Wolley grit age. Much of the Parford outlier has been worked out as a source of tin ore. During this soil survey the Parford deposit was found to extend further east-southeast than shown on the Geological Survey map. A small exposure of unconsolidated siliceous sand was observed in building work around 732886 [Uppacott]. The anomalous patch of Princetown soils shown on the soil map at Wrayland, close to Lustleigh [786812] may include a pale deposit similar to that at Parford or an outlier of the Oligocene Bovey Formation, along with patches of altered granite.

### 1.2.4 HEAD

Much of the district, both on the granite and on the Carboniferous outcrops, is mantled by a surface layer of *head,* which varies in thickness upwards from a few centimetres. Over the granite it is commonly known by the Cornish term *growan.* The head is made up of broken up rock or *regolith*, unconsolidated mixtures of stones and boulders in an earthy matrix, which occur variably as confused, rubbly melanges, in places almost stoneless, elsewhere crudely bedded with layers from a few centimetres to several metres thick. Particle size in the fine fraction of the granite-derived head is dominated by gritty and coarse sandy grains. Occasionally, probably indicating derivation from kaolinised granite, are pockets and bands with elevated clay content. Highly silty, loessial inclusions, as encountered on southern Dartmoor [Harrod *et al.*1973], seem to be absent from this area of northeastern Dartmoor.

Some exposures display an upward passage from undisturbed, decomposed granite saprolite into variably stony, sometimes bedded growan. In places *in situ,* granite saprolite is cheek by jowl with sound, unweathered granite corestones. In some exposures head formation appears to have inverted the rock’s weathering products, with a later, Upper Head, as described by Waters [1964, 1965, 1971], comprising large granite stones and boulders, resting on and breaking the surface. Waters’ explanation has been questioned by Green and Eden [1973] who saw little other than a single event, suggesting that subdivisions of the head more probably reflect different aspects of the same geomorphological process, rather than temporal differences. The distribution of the surface boulders ranges from a scatter of isolated individuals to the dense agglomerations of clitter. The terrain map accompanying the soil map, gives an indication of the occurrence of surface boulders and rocks across the district, described in Chapter 3, Sections 3.25 and 3.27. Many of these boulders may accord with Waters’ Upper Head, although some are outcrops of *in situ* granite.

Head has clearly accumulated upon the physical weathering of rocks and subsequent downslope movement. Where bedded growan is in association with distinctive bands in undisturbed granite, for example reddish, iron-rich veins, the upward transition can demonstrate the downslope movement of the head, as in Plate 7.

**Plate 7. 'Outcrop curvature' picked out by an iron-rich mineralised band in the granite.**
This demonstrates the gradual downslope movement of weathered material or head, so prevalent under periglacial conditions in the past.

Such movement is generally accepted as evidence of the contributions of Pleistocene periglacial *cryoturbation* and *solifluction* [described in Section 1.4.2] in the formation of head. In lowland England a frequent feature in head is the presence of swirl-like contortions, or involutions. Although one such structure was described by Waters [1961] near Princetown, no well-formed examples were observed during this survey. *Fragipans,* dense, indurated subsoils with fine platy structures, are evident in some exposures.

Durrance and Laming [1982] note that head thicknesses on Dartmoor can reach 5-6 m. An excavation on a gentle, concave footslope at Pinmoor [760884], Moretonhampstead in 2012 exposed at least 5 m of bedded growan. Aerial photography taken under drought conditions [Plate 8] illustrates how rapidly thickness in the soil and growan changes laterally, in places with variations in slope shape. In the present survey area altitude appears to make little difference to the form and distribution of growan and surface boulders, whether on the high moorland or at the lowest levels, as in Lustleigh Cleave [770810] and the Bovey Valley Woodlands.

On the Carboniferous outcrop frost action broke down the upper layers of the rock into rubbly head containing little fine earth smaller than 2 mm diameter. In most places the depositional sequences noted above that have affected the granite are not evident over these rocks. However, where more resistant bands formed, notably on and near Mardon Down [772879] the later, Upper Head occurs as large surface boulders of tourmalinised hornfels and quartz, along with further travelled granite boulders, in places having spread downslope a kilometre or more as far as the River Teign.

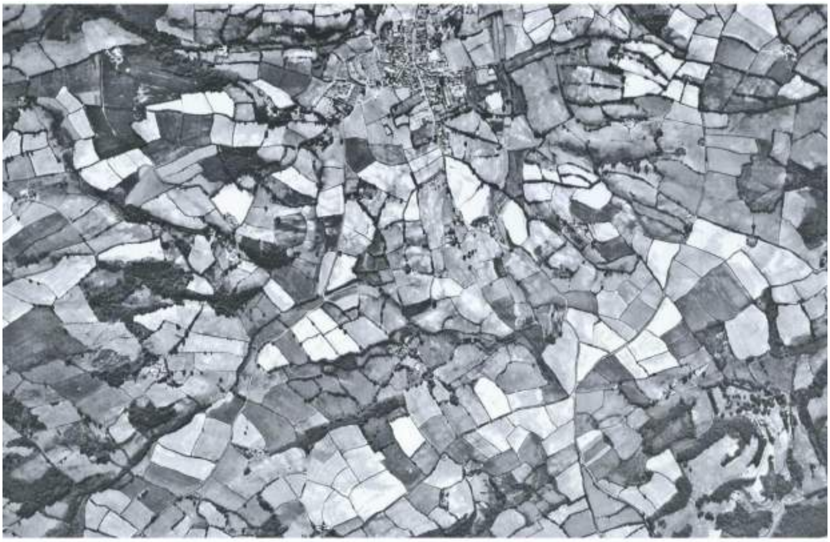


**Plate 8. Aerial photograph of the land immediately west of Moretonhampstead [top centre]. North is to the left.**

This black and white vertical image was taken in July 1975, following the second driest spring and early summer of the period 1927-2013. The widespread mottling reflects varying drought stress in the grass crops, pale tones indicating sound granite subsoils, darker colours being over softer bedrock. On photographs from this sortie showing areas away from the decayed granite, the crop tones are largely uniform. Air photo 75 298 049, © Ordnance Survey, licence 100024842.

Well-developed on the steep north side of the Teign Gorge between Castle Drogo [723901] and Bad Rock [760898] at the eastern end of Broadmoor Common [757899], are screes of angular rock fragments, spalled from the tors and crags higher on the valley side and containing little or no interstitial fine earth. Many of these screes are sparsely vegetated or bare. Smaller occurrences of scree have formed in places on the south side of the Teign Gorge and on the steep slopes near the confluence at 779801 of the Becka Brook and the River Bovey.

In this district both the head and the very limited river terraces are derived from the granite and Carboniferous rocks, often containing stones of similar shape and size. Periglacial disturbance of terrace deposits adds to the similarities. Furthermore large boulders can occur on and in both deposits, while river terraces in the district, can have relatively steep surface gradients. Together, these properties mean distinguishing between the small local river terraces and head deposits proved impractical in the soil mapping.

### 1.2.5 ALLUVIUM

Being derived from the granite much of the floodplain deposits comprise sandy or loamy fine material overlying gravel. There is some variation in texture, including grade of sand, with silty and clayey bands and pockets derived either from kaolinised areas in the catchment or attributable to sorting during transport and deposition. Peat development adds further diversity, both as discrete areas and as beds and bands within the alluvium. Stone content, depth to gravel layers and the coarseness of gravel are also variable. In some locations substantial boulders are present on the floodplain. A number of reaches of the floodplains have been dug over in the search for alluvial tin. Such areas are shown as disturbed ground on the soil map and extend beyond the granite pluton's limits. A further consequence of tin streaming is the re-deposition of spoil downstream. Where the alluvial tracts broaden out a pattern develops with slightly raised levees close to the river, with lower backlands nearer to the valley side. Examples of this are along the Rivers Teign at 707895 near Chagford and Bovey below Drakeford Bridge [790801]. In places linear scour channels cross the floodplain.

In mapping soils developed in alluvium every attempt was made to confine the units to the well-defined floodplains. Usually the concavity to the valley side is abrupt. However at some sites the boundary to gently rising 'upland' ground is less easily determined. In places this protocol results in different delineations of alluvium to those shown on the four British Geological Survey maps covering SX68/78, where mapped alluvium often merges onto sloping ground, particularly where hydromorphic soils have formed. Elsewhere, for example along the Teign near Holy Street [689878], Chagford, distinct terrace features display discordant gradients from the floodplain and the two gradually merge or diverge.

### 1.2.6 PEAT

Peat, often several metres thick, has accumulated as a blanket across the highest parts of Dartmoor above about 500 m O.D., mantling all but the steepest slopes. Its composition varies, with *fibrous* peat retaining recognisable plant structures, which are absent in *humified*, amorphous peat. Blanket peat forms as a consequence of the wet and cool climate maintaining perennial waterlogging, although peat also develops at lower altitude in basins, where groundwater issues from the granite along springlines or as more isolated 'eyes'. The peat has been degraded in places by gully erosion and by cutting for fuel, both breaking up the blanket, altering the peat's hydrology and encouraging humification and shrinkage. Processes involved in the development of the peat are discussed below in Chapter 2 at Section 2.1.2. Erosion of the peat is considered at length below in Section 1.4.3 and in Chapter 5, its cutting for fuel in Section 1.6.2.

Fibrous peat, delineated by the soil map's Winter Hill map unit, constitutes the blanket deposit on the highest ground, where the peat is at its thickest. Amorphous peat, mapped as the Hepste map unit, occupies the lower margins of the blanket, giving way, along a marked bluff, to peaty topped mineral soils, which have peat less than 40 cm thick. Basin peat falls in the Crowdy map unit. Overall mean thickness of the peat measured in this survey [see Chapter 5] is 1.68 m, with a maximum of 7.4 m recorded on the summit plateau between Black Hill [604846] and Cranmere Pool [603858]. Mean thickness on the pristine areas of the Winter Hill unit is 3.47 m, on the Hepste unit, which has suffered much cutting and erosion, it is 70 cm, and in the basins 1.02 m.

Although peat is shown on both Sheets 324 and 338 of the Geological Survey, no defining depth or thickness limits are published. That mapping broadly accords with this survey, although that lack of a depth criterion produces discrepancies in details. Such areas with differences of delineation were double checked during this survey to confirm the validity of the current mapping, which uses a 40 cm cut-off between peat and mineral soils.

### 1.2.7 STRUCTURE

Direct evidence of faulting affecting the granite is confined to its contact with the surrounding country rocks. The trend directions affecting vertical joint patterns in the granite, already noted, are reflected in faulting, namely north to south, east northeast to west southwest, northwest to southeast and northeast to southwest.

The Sticklepath Fault, a major regional dextral wrench fault throwing up to 2 km around Sticklepath village [642941], runs southeastward from there to beyond Lustleigh [785813], where the displacement is about 1,500 m. Durrance and Laming [1982] point out that it comprises a zone of complex *en echelon* faulting rather than a single fault. On the Geological Survey's Newton Abbot map [sheet 339], in the Lustleigh area a fault sub-parallel to the Sticklepath Fault, is shown about 2 km to its northeast, extending from Bovey Tracey [815780] into the Wray valley to the edge of Sheet 339. At Bovey Tracey itself this forms the northeasterly boundary of the Tertiary Bovey Basin, [the Sticklepath Fault providing the Basin's opposite edge], but is not mapped northeastwards onto Sheets 338 [Dartmoor Forest] and 324 [Okehampton]. The impressive southwest facing cleaves along the east side of the Wray valley, paralleled by the A382, and running on towards Whiddon Deer Park [723894], limiting what Mercer [2009] recognises as a rift-like valley, invite speculative extension of that fault further to the northwest. This might then be construed as structurally contiguous with the

Bovey Basin, acknowledging a measure of vertical movement as well as wrench faulting.

The contact of the granite with the country rocks on northeast Dartmoor is generally steep. Consistent with this is the absence of deviation of the junction where crossed by the Teign near Castle Drogo [723901] or in the Doccombe [776868] valley. However the boundary is sinuous, suggesting a gentler gradient on the junction, with outliers of granite [cupolas or stocks] between Uppacott Down [735892] and Cranbrook [745888], plus a further, unmapped, cupola near Higher Leign [784880], east of Mardon Down [772879]. Similar isolated granite outliers occur in the south between Hound Tor Wood [770805] and Becka Falls [761801]. The metamorphic aureole affecting the country rocks is mapped [Geological Survey Sheets 324, 325 and 339] at around 1-1.5 km wide. However weathering patterns at one point south of Lustleigh [786806] in down faulted Carboniferous rock are more akin to those remote from the aureole than those from within a few tens of metres from the granite. Only about 100 ha in the extreme northeast of SX78 are shown on sheet 325 as outside the aureole.

Structure in the Carboniferous in the northeast is dominated by east to west or east-northeast to west-southwest strike with very steep dips, up to $80^{O}$, in which the way up is uncertain. The down throwing between the Sticklepath and Bovey Tracey Faults at the north end of the Bovey Basin accounts for the preservation of the patch of Devonian / Lower Carboniferous shales and Teign Cherts south of Lustleigh. Dips are commonly $30\text{-}50^{O}$. Ussher's field map of 1896 notes "on end" in part of Hound Tor Wood.

Beyond the boundaries of SX68/78 dextral wrench faulting parallel to the Sticklepath fault affects the granite at Prewley [548911] and is evident across much of the Carboniferous outcrop north of Dartmoor. There the faults are often little more than one km apart. Selwood *et al.* in Durrance and Laming [1982] note that although these have Variscan origins, Tertiary reactivation took place. These seem likely to be repeated in the granite, bearing in mind the similar orientation of many joints and the physiographic grain commented on by Waters [1957] and others and discussed in Section 1.3 below.

### 1.2.8 HYDROGEOLOGY

Although the granite in hand specimen has negligible porosity, water moves in and around joints and faults, resulting in the rock as a whole being potentially aquiferous. The occurrence of kaolinised saprolite bodies can further complicate the movement of water. Often groundwater emerges in basins and valley floors, as the distribution of hydromorphic soils on the soil map demonstrates east of the blanket peat soils. In places consistency of the height of spring lines, for example on the upslope margins of wet ground in basin sites around Whitemoor Marsh [651892] on Gidleigh Common or between Barramoor [717835] and Lettaford

Cross [709841], North Bovey, suggests continuous and uniform watertables in the granite there. However water movement is not always undeviating, issuing in localised flushes or seepage zones high on valley sides. In some examples, as about 735883, southeast of Uppacott, similarly on the slope east of Watern Tor around 636866, this takes place without the development of a valley-side re-entrant.

Elsewhere, as west of the Forder Valley towards Drewston Cross [721876] or north of Chagford between Monks Withecombe [696893] and Waye [689899], hydromorphic soils follow minor re-entrants into the interfluves. The formation of hydromorphic soils high in the landscape is suggestive of kaolinisation of the granite. Such development can be of some extent, as between Mardon Down [772879] and Butterdon Hill [753885] and east of North Bovey [740839], or form a scatter of small patches, as around Moretonhampstead.

Above about 500 m O.D. peat mantles all but the steeper slopes, in response to the increasing wetness and severity of the climate. Its forms and development are discussed above. The pristine thick peat of the high blanket bog is perennially waterlogged and is mostly fibrous with reported bulk density [Fyfe *et al.* 2010 and 2012] around 0.2 t $m^{-3}$, indicating that it comprises about 80% water. Where affected by erosion some measure of drainage and humification takes place, depending on the depth, form and age of channelling. Areas affected by erosion are shown on the supplementary terrain phase map and the scale and form involved discussed in Chapter 5**.** Around the margins of the blanket bog the fibrous peat is largely replaced by humified peat. This is often thinner and widely affected by peat cutting and erosion so that its hydrology is complex. Relatively undisturbed areas and the floors of certain channels, some containing near-permanent pools, approach the perennially wet state of the fibrous peat, some mildly modified sites are seasonally waterlogged while the side slopes of gullies are rarely saturated. Bulk density in humified peat is greater, more typically around 0.3 t $m^{-3}$.

The pattern noted above of spring lines on the upslope side of basins appears to fade on the high blanket bog. There is little evidence of enhanced spring discharge in basins such as between Black Hill [604846] and the broad valley followed by the upper East Dart in its first kilometre. This might suggest that the blanket peat modifies movement of water into the granite beneath.

Open water occurs as occasional pools in some basins, most notably at Raybarrow Pool [638900] on South Tawton Common, where it is around 100 m wide in places. Smaller water bodies, with floating vegetation are present here and there, as at the north end of Broad Marsh [616821] and along the North Walla Brook east of Wild Tor Well [627876]. Parts of some of these pools have abrupt and straight margins and may have been produced or modified by peat cutting or tin streaming.

The dominant hydrological characteristic of the Carboniferous rocks, both those in the metamorphic aureole and the Crackington Formation, is their impermeability, with water movement largely confined to the near-surface layers in the permeable head and on sporadic fault lines. The weathering characteristics of the Crackington rocks outside the metamorphic aureole produce clayey soils in gently sloping sites, with freely draining, rubbly regolith on strong slopes. Soils analogous to the latter cover most sites within the aureole, although in Houndsmoor Wood [762895] and at Seaman's Borough [766899], gley soils reveal contrasting hydrological or weathering patterns.

## 1.3 PHYSIOGRAPHY

As in much of the wider southwest region the district displays broad accordance of summit levels within various height bands, below which the landscape is one of rounded hills separated by basins, abrupt valleys and undulating slopes. At the highest the mapped area stands over 600 m O.D. on the moorland in the west, its lowest point being just above 50 m O.D. on the Bovey floodplain south of Lustleigh [785813]. Much of it has a marked grain, which across the moorland is close to north-south, whereas a strong northwest to southeast alignment prevails to the east. A secondary element is oriented east-northeast to west-southwest. The grain, well-illustrated in Figure 1, is the physiographic expression of faulting and major fractures in the granite. It is manifested in the shape and orientation of hills and steep slopes, identified by Waters [1957] as positive components, and valleys, basins and depressions, which he termed negative elements.

Structurally influenced alignments are further expressed in the shape of some tors, reversed gradients near the end of some spurs, in the patterns of watercourses and 'dry valleys', the distribution of ground-water gley soils at lower levels and in basin peat on the moor. The blue of the ground-water gley soils on the soil map and Figure 2 illustrate these alignments. Where stream and rivers breach Waters' positive features they develop abrupt gorges and steepened gradients, as with the North Teign between Teign-e-ver [653871] and Gidleigh Park [677879], or the Bovey above Batworthy [715853]. Often these gorges contain tors, crags and clitter on their flanks. Where negative or basin features are entered the valleys broaden out and the thalwegs' gradients ease. In places this change from narrow valley or gorge to open basin form is abrupt and contrasting, as along the Taw valley as it enters Taw Plain north of Steeperton Tor [618888], again at Batworthy in the Bovey valley and along the North Teign at Gidleigh Park.

In most cases the flanks of valleys aligned along the dominant grain are broadly linear, with limited development of tributary side valleys. This is well expressed in the east of the district northwest of the Kennick [805843] and Tottiford [810833] reservoirs. However in much of Mercer's [2009] Middle East the density of drainage and dry channel lines is increased [Figure 2] with many short re-entrants, commonly accompanied by rounded spur ends, which often display reversed gradients. Such ground forms along the Teign valley between Leigh

**Plate 9. The spur end between Huntingpark Wood and Wray Barton.**

This shows an abrupt reversal of gradient, most probably indicating variable decomposition of the granite. Features like this, perhaps an incipient tor, are common on some of the in-bye. The soils here are in the Moretonhampstead / Furlong map unit. In the background oak woodland cloaks the steep, rocky slope of Wray Cleave, mapped as the Moretonhampstead Old Woodland phase soil unit. Several unnamed tors are concealed by the trees along the Cleave.

Bridge [683876] and Easton Cross [719888], the Forder-Wray vale running from northwest to southeast through Moretonhampstead, including along the Wadley Brook's valley, around Lustleigh village and along the River Bovey between Lustleigh Cleave [770810] and North Bovey [740839]. Similar terrain occurs in more restricted form on the moorland, on the slope between Great Varracombe [628842] and Quintin's Man [621839], also south-southeast of this, possibly on the same 'grain line', on the east facing valley side of the Lade Hill Brook [636823] between the East Dart elbow at 637814 and Sittaford Tor [633830], east of Manga Hill [635850] and along the south side of the Broad Marsh basin [616818]. These landforms might be conveniently thought of as landscape-scale versions of the mineralogist's reniform or botryoidal morphology.

At a more detailed scale many slope facets display convexo-concave undulations of varying amplitude and wavelength, frequently within a single field, occasionally resulting in low conical mounds on interfluves, spur ends and close to valley floors. The junction between the moorland and the enclosed in-bye, commonly follows a fairly abrupt east or northeast facing slope, as east of Buttern Hill [653885], Kestor [666863], Shapley Common [697826], King Tor [709816] and Hameldown [703800], all at around 350 m O.D.

On the moor, particularly north of northing $^{0}84$, east-facing slopes are higher and steeper, giving the land a stepped aspect and emphasising the terrain's north-south texture. Within Mercer's [2009] Middle East [between the moor and the prominent southwest facing scarp just east of the A382 between Parford [713899] and Slade Cross [799812], relief is relatively subdued. Although the grain dominated patterns of relief, along with those of the soils, remain broadly evident, this is the main area with rounded spurs and short re-entrants. Here there is a gradual overall descent across the interfluves to the northeast, punctuated by isolated, often tor-crowned hills and ridges at Meldon Hill [696861] and Nattadon [705866], Easdon [730823] and Hunter's Tor [760825] on Lustleigh Cleave. Except for small areas near Lustleigh and Sandy Park [712896], the lower parts of the Middle East stand above 150 m O.D. The eastern limit of this subdivision follows the 100-150 m high Parford-Slade Cross scarp. Below the scarp is the vale running through Moretonhampstead, drained to the northwest by the Forder Brook and southeastwards by the Wray Brook.

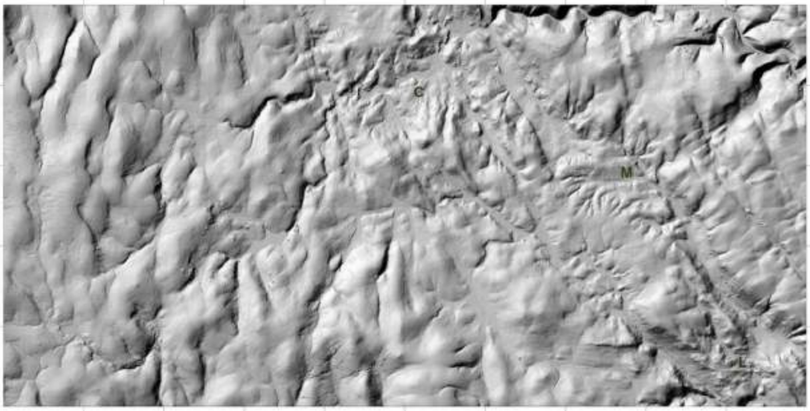



**Figure 1. LiDAR terrain, after NERC Tellus Southwest, [Ferraccioli *et al*., 2014]. C = Chagford, L= Lustleigh, M = Moretonhampstead.**

The LiDAR imagery contains freely available data supplied by Natural Environment Research Council [Centre for Ecology & Hydrology; British Antarctic Survey; British Geological Survey]. ©NERC [Centre for Ecology & Hydrology; British Antarctic Survey; British Geological Survey]. Much of the terrain shows strong structurally controlled grains, as for example southeast of Moretonhampstead, which break down within the Sticklepath Fault Zone around Moretonhampstead and Chagford, where the landforms are more akin to those on less resistant, unstructured rocks, such as clays or shales.

Above and to the east of the Parford-Slade Cross scarp stands the Far East of Mercer, a rolling, dissected plateau, its summits gradually descending to the southeast from the highest point, over 350 m O.D., on Mardon Down. The Teign Gorge [Plate 10] at 723896 near Castle Drogo marks the only substantial break in the southwest facing scarp, with the northward fall into the Gorge from Mardon Down [768870] and Butterdon Down [753883] being the subdivision's main departure from the predominant physiographic grain of the granite country. In the extreme northeast of the district, outside the granite's metamorphic aureole, there are about 100 ha of rolling land on the outcrop of Carboniferous shales of the Crackington Formation. This outcrop extends north to Crediton, having the local name of the Dunland.

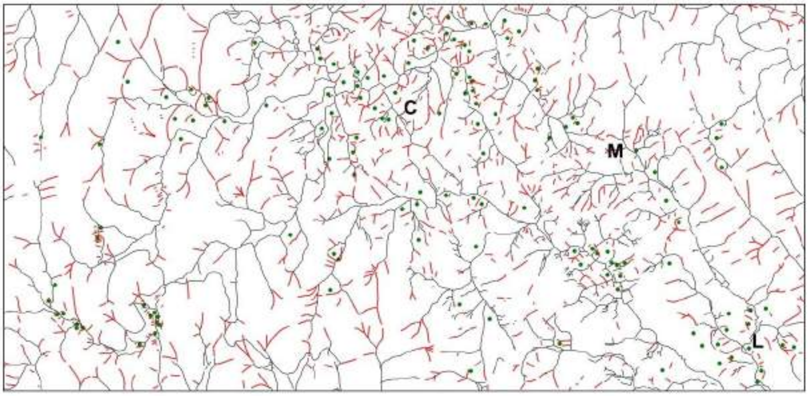



**Figure 2. Drainage.** Black lines indicate watercourses, red lines dry channels.
Green dots are spur ends with reversed gradients. **C** = Chagford, **L**= Lustleigh, **M** = Moretonhampstead.

Tors and clitter are well known components of Dartmoor's landscape. In addition less dense scatters of surface boulders or outcrops of *in situ* granite mark much of this district. The distribution of these features is variable, with some areas having little or no surface rocks. On farmed land some of this absence is attributable to boulder clearance for agricultural purposes, which accelerated in and after the Second World War as both machinery and grant-aid were available. Tors, crags and screes are also present on the steeper slopes on the Carboniferous rocks of the metamorphic aureole. In the area north of Mardon Down there are surface scatters of large boulders of quartz-tourmaline and tourmalinised hornfels, sufficiently concentrated in one or two places to merit description as clitter.

Unlike on much of Dartmoor's moorland, tor development in a good deal of this district is relatively subdued. There are prominent exceptions, including Oke Tor [612900] and East Mill Tor [600897] [both near to the sheet's margins], and Kestor [666863] and Heltor Rock [799870]. Tors usually form on the crests of ridges or on the shoulders of gorges and steep bluffs. However, a few, such as Castle Rock, Hurston [683835], rise from the valley floor. Many of the named tors shown by the Ordnance Survey are in fact minor features, Scorhill Tor [659871], Flat Tor [609816] and Hameldown Tor [703806], as examples. With the few exceptions of Hunt's Tor [722897] below Castle Drogo, Sharpitor [772814] and Raven's Tor [761819], both in Lustleigh Cleave, where secondary woodland has regenerated rapidly since the cessation of grazing and swaling [the traditional annual burning of vegetation to encourage fresh growth] in the late twentieth century, the many tors concealed by woodland go un-named. Such hidden features are numerous along the tree-clad sides of valleys in the eastern, enclosure-dominated parts of the survey district, the in-bye, as around Lustleigh and along Wray Cleave [775843].

## 1.4 GEOMORPHOLOGY

Following the retreat of the Cretaceous sea, the district's rocks have been subject to long periods of weathering and erosion. Some understanding of these processes and events help explain the nature and distribution of the various soils, the subject of this Record. While gradual erosion and dissection of the terrain by fluvial processes have been the principal mechanisms, climatic conditions have ranged from the sub-tropical, leading to intense chemical weathering of the rocks, to severe, periglacial cold with frozen ground. Occurring during the last two million years, the physical processes associated with frozen ground were important in the evolution of the landscape and its soils because of this relative recency. Climatic amelioration over the last ten thousand years has seen peat development on the high ground in the west of the district. Subsequent to the peat's growth, the deposit has suffered erosion in many places.

### 1.4.1 DENUDATION

Durrance and Laming [1982] argued that the generalised upper surfaces of Dartmoor represent levels close to the original roof of the granite pluton. Granitic material in the breccias around Crediton indicate that breaching of that roof had started by the Permian, with minerals in rocks in east Devon showing its erosion continuing in the Lower Cretaceous. It is widely considered that strong west to east elements of the pattern of drainage in this country were initiated on the freshly exposed upper surface of the Chalk as the Cretaceous sea retreated eastwards [Hancock, 1969, Loveland, 1981]. There is support within the survey area for this interpretation, with the incongruous alignment of the Teign Gorge east of Castle Drogo cut along the granite's metamorphic aureole. Similarly the North Teign's course between Scorhill [660869] and Gidleigh Park [677879] where that gorge is effectively cut along a ridge without tributaries, yet both north and south there is falling ground with branching networks of minor streams. Dartmoor-derived materials, including kaolinitic clay, in the Eocene and Oligocene Bovey Beds, just beyond this survey area southeast of Lustleigh, and in Eocene beds on the Haldon plateau, 8-10 km east of this sheet, may attest to continued degradation of the granite under a prolonged tropical or sub-tropical climate.

The strong preference for broadly southerly heading drainage patterns in the region was first interpreted by Jukes-Browne [1904] as a response to a tilting, most probably during the Alpine orogeny, of the formerly easterly slope left on the sea's withdrawal after the Chalk's deposition. Locally the orientation can be seen in the several rivers, although arguments favouring strong structural controls by faulting and jointing in the granite must not be overlooked. The substantial down warping in the Bovey Basin [Vincent [1974] estimated a depth of 1,100 m, Fasham [1971] 1,245 m] plus the lowering of around 200 m of the Greensand base from the Haldon plateau, must have had a substantial effect on drainage development in the region, particularly the southern part of the Forder–Wray vale. As noted in Section 1.2 this vale has aspects of a northwestward extension to the Bovey Basin. Durrance and Lamming [1982] say that the lignite members in the Bovey Beds are largely detritus of *Sequoia* swept down in floods from the uplands to the north and west, while part of the Basin's ball clay is derived from the hydrothermally altered granite. Some, however, appears derived from deep weathering of the granite and country rocks. Interestingly the Teign crosses the Sticklepath fault zone and the Forder-Wray vale with negligible deviation in its course.

The region's denudation chronology discussed by many authors, was summarised by Shorter *et al.* [1969]. Various surfaces of low relief have been described, along with their possible origins. An alternative to the interpretation of the broad accordance of summit levels around Hangingstone [617861] and Cut Hills [598827] as marking the pluton's roof, lies in a planation surface, with a 7 m per km southward tilt. Separated from this summit plain by steep east facing ground are remnants of a surface in the Upper Teign catchment standing between 315 and 395 m O.D. A third planation level between 225 and 285 m O.D. occurs around Dartmoor, affecting much of Mercer's [2009] Far East and the gentler interfluves of his Middle East. The consensus among geomorphologists is that these surfaces formed under Tertiary subaerial conditions, perhaps related to the sources of Tertiary rocks nearby to the southeast and east, leaving a subdued landscape. Whether this is consistent with the highest surface's approach to the pluton's roof is a question.

Late in the Tertiary the north Atlantic experienced a rise in sea level, probably to the Calabrian maximum of around 210 m O.D., indicated by flattened spurs. This transgression was followed by fluctuating falls and rises of sea level linked with the climatic changes around glacial and interglacial episodes. There is little or no recognisable record of these eustatic events in this survey area, although the landscape, the valleys and hills, were being eroded out by subaerial, fluvial and periglacial agencies, under a regime here dominated by stream incision and dissection of the formerly subdued landscape.

**Plate 10. The Teign Gorge.**

Between Castle Drogo [the grey building to the left] and Drewston Common. The view looking northwestward from Upacott Down. Sharp's Tor (of metamorphic rocks rather than granite), is at the centre. There are numerous crags and screes along this gorge, particularly on its northern side, in the Drogo soil map unit. The northern limit of this survey runs very close to the top of the far side of the gorge. This section of the Teign's course is incongruous, as it follows the granite's metamorphic aureole for several kilometres.

The long term denudation of the district brought about the patterns of hills and basins recognised by Waters [1957], described above in Section 1.3. The marked physiographic grain of Dartmoor reflects structural controls, primarily joints and faults. More resistant elements produce hills and ridges [positive components in his terminology], while less resistant, [negative] elements have been picked out as valleys and basins. These contrasts not only come about through the varying frequency of joints and faults, but where more closely spaced they are likely to have provided greater opportunities for formation of the less resistant, kaolinised saprolite, whether by pneumatolysis and hydrothermal alteration as the pluton cooled, or by Tertiary deep weathering. The concentration of discharges of groundwater, consequent on the closer fissuring in the basins, may compound these effects.

The influence of the varying resistance to erosion of the granite is not confined to the broad grain of the valleys and ridges. Tors, whether on ridges, some of which, like Watern [629868] and Steeperton [618888] Tors, are elongated along that grain, on valley sides or even their floors, and whether explained by periglacial mechanisms alone [Palmer and Neilson, 1962], or by multiple stages, as Linton [1955] proposed, are extreme demonstrations of the differential rates at which granite is denuded. Furthermore parts of the landscape have undulations over a few tens or hundreds of metres. The landforms described above in Section 1.3 that invite scaled-up comparison with reniform or botryoidal forms appear to be associated with sites of accentuated saprolite development. This is evident both from exposures and detailed soil examination. Around Moretonhampstead there are numerous very small patches of hydromorphic soils and springs, often in anomalous locations quite high in the landscape, again pointing to bodies of less permeable, kaolinised material in the granite. Plate 8, photographed in the drought of 1975, appears to elaborate on this by showing differences in soil and regolith /saprolite depths picked out by contrasts in grass growth**.** Further southeast around Lustleigh the high incidence of unnamed tors and outcrops, shown as ‘rock dominant’ on the soil map, may represent residuals of sound granite, exposed following the preferential denudation of saprolite.

### 1.4.2 PERIGLACIATION

Dartmoor is widely recognised as a relict *periglacial* landscape from episodes in the Pleistocene when this district endured a tundra-like climate with permafrost penetrating deep into the ground. It is clear that periglacial processes operated down to very low altitudes during those times, when ice sheets, generated far to the north, extended into the Bristol Channel and Irish Sea. Periglacial processes, of which *solifluction* and frost action were particularly effective, modified the pre-periglacial landscape. The development and movement of head deposits [described in Section 1.2.4], the formation of tors, the enhancement of long, rounded slopes, the scatterings of boulders and clitters, are all seen as evidence of periglacial action.

Under a periglacial regime the upper layers of the ground, comprising already partly weathered regolith, thaw in the spring and summer, forming a slurry-like *active layer*. This moves downslope over the still frozen permafrost, including on gentle gradients, by the process of *solifluction,* even transporting very large boulders. In flat sites frost working, or *cryoturbation,* affects the active layer. Periglacial solifluction and cryoturbation account for much of the character of the district’s principle soil parent material, head or growan, which is described in Section 1.2.4. This mixture of fine earth [particles less than 2 mm in diameter], gravel, stones and boulders, in a layer between 0.3 m and more than 4 m thick, mantles much of the survey area.

Frost action’s part as a periglacial process, include the riving and heaving of regolith, both involving an inevitable downslope gravitational component upon thawing. Moist silt and fine sand-sized fractions weathered from granite readily produce needle ice during a single overnight frost under contemporary conditions, the needles continuing to grow if freezing endures. Crystallisation of the ice exerts forces of several tonnes over a very small area, quite capable of lifting large granite boulders and blocks.

The supplementary Terrain phase map produced with this survey illustrates the scatter of surface boulders and rock outcrops, the boulders being often regarded as part of the Upper Head of Waters [1964, 1965, 1971]. Such boulders are widespread across the granite landscape. Their size is highly variable, from very large stones [20-60 cm] to that of a house. As well as the inclusion of dense clitter in the soil map's Rock Dominant map unit, the Terrain phase map shows three phases of boulderiness / outcrops, including a boulder-free state. The latter might support Green and Eden's [1973] view regarding the Upper Head, but alternatively may reflect differential jointing and weathering in the granite, as discussed in the final paragraph of Section 1.4.1. Among the rocks indicated by the phase mapping there are included small outcrops of *in situ* granite, not always distinguishable from detached boulders, others are upstanding blocks, isolated after the surrounding ground was eroded away, some having the form of miniature tors.

Frost riving of fragments from the free faces of crags and tors has also affected the rocks of the metamorphic aureole in the Teign Gorge, particularly on its north side. Rocky outcrops are more numerous on that side of the Gorge, reflecting the steep northerly dips of the Carboniferous. Instead of clitters of boulders, as found on the granite, a line of screes developed on the lower slopes. In places between rock buttresses, as below Sharp's Tor [729899], talus cones have formed. Some screes also formed on the south side of the Becka valley below the Falls. Structural patterns of jointing and cleavage in the hornfels and slatey rocks produced a regolith of angular clasts of the large and very large stone size [6-60 cm] of Hodgson [1997] with very little fine earth. Many of the screes north of the Teign remain unvegetated.

Periglacial processes are accepted as being major agents in the production of tors, although various mechanisms have been called upon. Linton [1955] suggested that tors were formed by the removal of rotted granite saprolite from around *in situ* sound granite and corestones by solifluction and other mass movements, the saprolite having been deeply weathered during the Tertiary. Subsequently Palmer and Neilson [1962] argued for a single stage, purely periglacial, origin for the tors. A product of periglacial action recognised on parts of high Dartmoor by Te Punga [1957], but not widespread in this district, has been the formation of altiplanation terraces.

In much of east Devon, thin head of loamy material with siliceous stones from the Greensand and Budleigh Salterton Pebble Beds can mantle the landscape of the Marl vales for several kilometres from the source outcrop [Findlay *et al.* 1984]. However, fine earth derived from the granite does not appear to pass any distance onto the outcrop of the metamorphic aureole. On some of the south side of the Teign Gorge, including Whiddon [728896] and Hannicombe [735896] Woods, granite boulders, however, have moved over the steep metamorphic outcrop. In places they are mixed with boulders of tourmalinised rock. Lobes of boulders also extend down the floors of some minor valleys in the Gorge side.

**Plate 11. Heltor Rock.**

This is one of the in-bye's most striking tors, situated close to the survey district's eastern boundary.

While it is generally accepted that in the Pleistocene the ice sheets reached the north coast of Devon and Cornwall, recent claims [Evans *et al.,* 2012a, 2012b] that an ice cap formed on northern Dartmoor, thereby producing ice marginal features in Great Varracombe [628842], Gallaven Mire [632885] and as far south as the East Dart elbow at 637814, have been met with some scepticism. The transverse ridge there, at about 400 m O.D., interpreted as a terminal moraine by Evans *et al.,* is mirrored at much lower altitude by similar features in areas where landforms seem influenced by the common development of altered granite saprolite.

Such landforms occur north of Great Weeke, Chagford at 713881 [140 m O.D.] and 710880 [150 m O.D.] in the Teign valley, and at 786821 and 786816 [both about 110 m O.D.] in the Wray valley. Active ice reaching that low down might have been expected to carry substantial amounts of distinctive granitic material onto the country rocks surrounding Dartmoor, yet there is no evidence of this.

### 1.4.3 PEAT EROSION

Large parts of the Winter Hill and Hepste soil map units on the blanket peat have been degraded by water erosion, with gullies and channels ranging from scarcely perceptible examples to at least 3 m deep and several metres wide, [see Plates 12 and 13]. Some are actively exposing bare peat, others are completely vegetated. The terrain phase map supplementary to this survey's soil map shows three categories of erosion: *Pristine,* that is uneroded, *Slightly Eroded* and *Severely Eroded*. A full description of these phases is given in Section 3.28. Historically, peat has been removed for use as fuel in the more accessible locations. Often it is difficult to distinguish between peat cuttings and erosional features, so that erosion phases could only be mapped with confidence in the more remote parts of the Winter Hill map unit in the west of the map area.

The peat soils perform a number of functions for amenity and recreation, for ecology, archaeology, hydrology and geodiversity. They are used agriculturally, albeit with low density grazing by livestock, and by the military as training areas. They form major accumulations of carbon.

Erosion changes the peat and its functions, from some viewpoints the resource being degraded, from others diversified. The most immediate change is from a uniform or gently undulating surface into one with varying degrees of dissection, in extreme cases making for very difficult access. Channelling of the peat by erosion inevitably alters its hydrology from a state of perennial waterlogging in pristine sites to a more complex and intermittent wetness depending on the erosion's depth, extent and proximity. Further irreversible degradation then follows with drying, weathering and humification of preserved plant fibres, the bulk density of the peat increases, while porosity and water holding capacity decline and angular blocky aggregates form. Consequent chemical changes include the reduction of the ratio of carbon : nitrogen and oxidative loss of carbon.

Eroded material has various fates. Many gullies and channels are of short extent and become choked with redeposited peat and then may appear to merge back into the existing bog surface. At the other extreme the detritus is carried into watercourses causing discoloration at times of high discharge and adding to sediment loads. The connections between eroding sites and streams and rivers can be complex, with frequent and involved 'paternoster' sequences of erosional and deposition features, often without clear, continual lines of water flow. In places the flow is via tunnels formed underground in the peat, some of which eventually widen, resulting in substantial collapses.

Ecological impacts include changes to vegetation assemblages and to the habitats of a variety of animals. Drier and undulating ground compromise blanket bog vegetation, such as species of *Sphagnum* and sundew, which become eliminated or confined by erosion to isolated pockets. The wider range of conditions brought about by erosion provides opportunities for diversification of the vegetation, as well as shelter, although such changes are unlikely to be welcome in a Site of Special Scientific Interest with blanket bog one of its prime assets.

**Plate 12. Erosion of the blanket peat is widespread.**

The channels here are relatively shallow.

Changes from pristine blanket bog have consequences beyond those concerning vegetation. In its unaltered state blanket bog forms nesting grounds for dunlin and golden plovers, while the impact of erosion of peat may be felt miles down-stream in the suffocation of salmonid eggs in their redds. Among benefits of erosion is the exposure of bare, weathered peat providing sheltered niches for invertebrates, such as the digger bee. Harvey and St. Ledger-Gordon [1962], in discussing the cutting of peaty tops from mineral soil, demonstrate how it degrades the habitat for one species of grasshopper, but provides a new niche for another.

Turning to economic consequences, there is some minimal summer grazing of the blanket bog, primarily by sheep, so that erosion may change its nutritional value. Loss of vegetated surface area may be partly countered by the low grazing value [Bibby *et al.*1982] blanket bog vegetation being replaced by *Molinia,* which they rate as having moderate grazing value. Reduction in the accessibility, amenity and aesthetics of the high moorland through erosion of the peat may diminish its attractiveness to tourism, one of the region's economic staples. Attempts at control and remediation of peat erosion will have their costs.

Any impact on salmonid fisheries is economic as well as ecological, while changes to water quality, such as discolouration and increased sediment and dissolved organic carbon loads, are concerns for water abstracters. While ecologically it is possible to see some benefits from the erosion of peat, from the standpoint of carbon retention there are no positive aspects.

**Plate 13. Erosion can cut deep into the blanket peat.**

Vancouver [1808, p283] described “prodigious slips of several acres breadth……making frightful chasms from the surface to the bottom and former resting place of the bog.” He appears to have been referring to the areas of collapsed peat [what Mercer [2009] calls peat cliffs], which form both along the junction of the blanket peat with mineral soils on lower ground and with the valley bottoms of the upper reaches of rivers, and the often associated deep gullying. He might also have had in mind the occasional very narrow but deep, slot-like gullies often concealed by the growth of *Molinia.* Dixon, writing in 1830 and Crossing in 1888, both described eroded ground on the blanket bog. Similar features are present elsewhere on upland peat, for example in the Pennines and Mid Wales.

The features first described by Vancouver remained evident a hundred years later. Field maps by D.A. MacAlister of 1908, part of the Geological Survey’s Dartmoor Forest Sheet 338, confined south of National Grid northing $^{0}$860, contained 59 separate notes on the peat. They include numerous observations of cracked and broken peat and of channelling by streams well away from watercourses. His records on the field slips coincide with areas mapped in the eroded phases of the present survey. At several points he commented regarding “the edge of the peat sheet” [Mercer’s peat cliffs?] and how it was channelled and broken. There are several references to ‘washed out’ peat along the watercourses. The implication is that much of the gullying and the other features of the peat surface were evident over a century ago. MacAlister also reported on peat composition and thickness, noting 10 feet or more in places, [at 605820, 606813 [10feet +], 614809 [10 feet +]].

Clearly there is a strong historical element to peat erosion on Dartmoor. For example, comparison of aerial photography by the Ordnance Survey in 1975, of the severe erosion at Black Hill [604846] with contemporary Google Earth shows little change in the overall patterns of gullying. However the implication from Table 13b, columns 2, 3 and 4, is that active erosion continues in places. Photogrammetric comparison of existing aerial images taken decades apart might provide long-term measures of rates.

## 1.5 CLIMATE

Location on a peninsula produces a regional climate with relatively cool summers, mild winters and high rainfall amounts. Given that, the district’s climatic conditions are largely modulated by altitude. With the moorland in the west being the highest, coolest, wettest and windiest, the in-bye in the east benefits both through lower altitude and location in the lee of the higher ground, the latter resulting in a rain shadow [Mercer 2009, p219] and related föhn fair weather effects. In this section emphasis will be on the broad patterns of those climatic aspects which influence soil formation and how the soils, through their interactions with climate and weather, perform their economic, ecological and environmental functions. Those aspects are primarily rainfall, temperature and moisture balances. More detailed accounts of variations in the climatic conditions, both geographically and with time, are in the Appendix. To place the observations in the wider context, comparative values are reported for Exmouth [SY010810] and Rothamsted, Harpenden, Herts [TL132134]. A necessary aspect of this review is the consideration of the effects of climate change, summaries of recent regional trends being provided by Jenkins *et al.* [2008].

### 1.5.1 DATA SOURCES

While there are 33 sites within the survey area that have long-term rainfall records covering periods between 1950 and the present, plus seven others within 1 km of the edges of the mapped area, there are no stations with other climatic data. The nearest site for these is at Yarner Wood, [786783 and 198 m O.D.], 1.7 km south of the district, with the station at Princetown [583740 at 453 m O.D.] 5 km south of the sheet's southwestern corner. Extrapolation into this survey area may be possible using altitude and / or annual average rainfall as guides.

Long term average rainfall can be obtained from the map *"Average Annual Rainfall (Millimetres); International Standard Period 1941-1970; Southern Britain",* Meteorological Office [1977] [Figure 3]. Also from British Rainfall, [Meteorological Office 1952, 1963, 1979, 1984 and 1991], plus unpublished data from the Environment Agency, Dartmoor National Park Authority [2015] and from Smith [1976]. The latter gives monthly and annual average precipitation figures for Agroclimatic Area 43 North, the annual amount at that Area's average height [236 m O.D.] being 1449 mm. For Princetown [453 m O.D. and 1974 mm average annual precipitation] extrapolation using average annual rainfall is straight forward, as that amount broadly coincides with the generalised contour for 440 m O.D. across the western part of the survey area. However, such extrapolation for Yarner Wood, [at 198 m O.D., average rainfall of 1384 mm], presents difficulties. In this survey district land at or below 198 m O.D. is confined to parts of the Teign, Bovey and Wray valleys, whereas the 1384 mm isohyet is above 250 m O.D.

Smith [1976] provides areal averages of climatic variables of agricultural importance for his Agroclimatic Area 43 North. Bendelow and Hartnup's [1980] Climatic Classification of England and Wales includes a bioclimatic assessment based on climatic variables affecting soil development, plant growth and land use. Jones and Thomasson [1985] mapped various aspects of soil moisture balances for England and Wales, as with Smith, primarily from an agricultural viewpoint. In the absence of directly observed meteorological data, other than rainfall, Meteorological Office maps [2015] are useful. Smith [1976] lists area-based averages between 1941 and 1970 for a number of agriculturally, biologically and environmentally relevant meteorological factors. Included are those directly measured, such as rainfall, plus derived and agro-meteorological values, for example potential transpiration and dates of field capacity. Patterns of place-to-place variations about his area averages, temperature lapse rates with altitude as an example, are also given.

Some derived values have been developed further to characterise the interactions of climatic conditions with soils with different properties. These include soil droughtiness by Hall *et al.* [1977] and by Thomasson [1979], soil workability [Thomasson, 1982] and poaching risk and trafficability [Harrod, 1979]. Jones and Thomasson's maps of moisture balances are already noted. These derived assessments can have environmental significance. For example field capacity duration indicates periods when freely draining soils are transmitting water to aquifers and water courses, whereas during soil moisture deficits they act as temporary buffers to water flow. Workability, poaching risk and trafficability ratings can show when risks of pollution in enhanced runoff from damaged soils may be expected. Amounts of excess rainfall are of hydrological relevance and are a guide to the volumes of water passing through soils, either as lateral or vertical flows.

1.5.2 RAINFALL

Rainfall in this district rises from an annual average under 1000 mm in the extreme northeast, to over 2500 mm in the far west across the highest moorland. These contrasts are a reflection of both the effects of altitude and relative shelter from the prevailing southwesterly winds. The marked seasonal regime of peak rainfall amounts in the autumn and early winter, set against much drier conditions through late spring and early summer is typical of the region and of western Britain. This seasonal pattern contrasts with the more uniformly year-around regime of most lowland parts of the country. Imposed on these long-term, mean-based values are substantial year-to-year variations, both for annual amounts and for individual months.

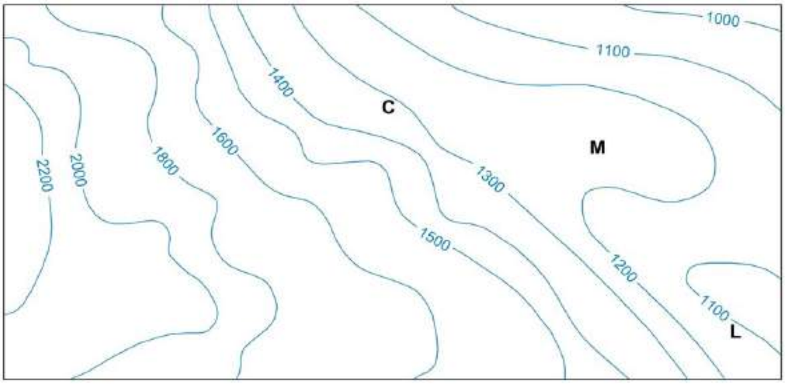



**Figure 3. Average annual rainfall [mm].**

After Meteorological Office [1977]. C = Chagford, L= Lustleigh, M = Moretonhampstead.
The map "Average Annual Rainfall (Millimetres); International Standard Period 1941-1970; Southern Britain", Meteorological Office [1977] [the source of Figure 3] shows isohyets broadly following the contours and mostly trending northwest to southeast, with spacings of 1 to 2 km per 100 mm interval. There is some deviation from this northwest-southeast trend in the east, as the interval widens, particularly around Moretonhampstead, where the 1200 mm isohyet bulges eastwards.

Although Smith [1976] offers approximate rates of change in precipitation with altitude, he specifically excludes their use in rain shadow sites. Figure 4 plots annual rainfall at all sites within the survey area, plus gauges within 2 km, for the first year of the each decade spanning 1950-2010. It indicates an overall increase in rainfall with altitude of around 3.2 mm/m. The highest rain gauge in the district is at 594 m O.D. on Cut Hill at 600829, with an annual average of 2513 mm, the lowest at Furlong Mill, 146 m O.D. [709895], averages 1208 mm. A gauge at

Tottiford, just east of the sheet at 807823 at 215 m O.D., is drier, averaging 1150 mm.

Rainfall amounts differ from year to year and with the seasons, Table 1 summarising their year to year variations. Autumn and early winter [October to January] is usually the wettest period. On average during 1977-2014 Cut Hill received 43% of the annual total in those four months, and Furlong Mill 48%, based on the period 1981-2014. This contrasts with the drier spring and early summer when Cut Hill's proportion only averaged 25% during April to July and Furlong Mill's 21%. In many years the switch from dry, summer weather to the autumn wet season is abrupt, as the North Atlantic Oscillation activates. 1976, remembered as a drought year, illustrates this: at White Ridge [650824, 488 m O.D., average annual rainfall 2061 mm], the June to August total was 103 mm, followed by 851 mm over the next 3 months.

At White Ridge continuous records [excepting 2001] began in 1926. Between 1961 and 2006 the year's precipitation was above the long term average in 23 years [52% of the time], among these nine years were in the wettest quartile. There were 21 years with less rain than average, 11 of which occupied the lower quartile. Between 1980 and 2013 annual rainfall exceeded the long-term average on 20 occasions [61% of the time], 10 of which were in the upper quartile. In 13 years amounts were below the average, with four years in the long-term's lower quartile.

**Table 1. Annual rainfall at Cut Hill [1977-2014] and Furlong Mill [1981-2014].**

| Long term | Mean | Max | Min | Upper Quartile | Lower Quartile |
|---|---|---|---|---|---|
| **Cut Hill mm** | 2511 | 3223 | 1751 | 2781 | 2330 |
| **“ “ %** | 100 | 130 | 71 | 112 | 94 |
| **Furlong mm** | 1208 | 1561 | 821 | 1360 | 1067 |
| **“ %** | 100 | 129 | 68 | 113 | 88 |

Regarding the effects of climate change on rainfall, Jenkins *et al.* [2008] state for the southwest of England that seasonal rainfall is highly variable, but appears to have decreased in summer and increased in autumn and winter, as Table 2 illustrates. Contributions by intense rainfall events have increased in winter, but have reduced in summer.

**Table 2. Percentage change in precipitation during the period 1961-2006.**

| Spring | Summer | Autumn | Winter | Year |
|---|---|---|---|---|
| +4.0% | -8.8% | +28.6% | +15.9% | +9.7% |

After Jenkins et al. [2008]

The district's range in annual average rainfall of 1000 to 2500 mm contrasts with the average at Exmouth of about 820 mm and that at Rothamsted of 700 mm.

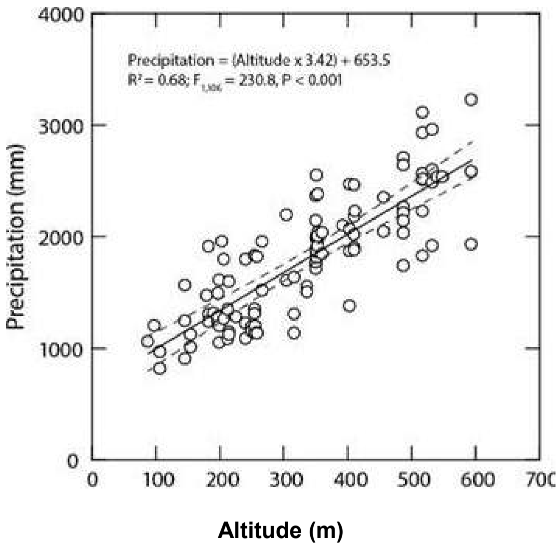



**Figure 4. Rainfall across survey area SX68/78**

Data are from for all gauges in the sheet area and within 2 km; for the first year of each decade 1950 -2010.

### 1.5.3 SUNSHINE

Under 'fair weather' skies contrasts in the day-time distribution of cumulus clouds across and near Dartmoor are often striking. While the high moor may be shrouded in clouds, which at times grow into cumulonimbus, the English Channel coast and its fringes can be highlighted by thinner cloud cover. At other times, particularly with moist winds from a westerly quarter, a föhn effect occurs, bringing breaks in the clouds and sunshine to the lee of the high ground. Annual mean sunshine hours across this district range from 1,300-1,450 hr/year [3.77 h/day] on the high moorland to 1,600-1,650 hours per year [4.45 hr/day] in the far southeast [Meteorological Office, 2015]. Place-to-place variations are characterised as a decline of 0.15 hr/day for each 100 m rise in altitude, and 0.024 hr/day for every 10 km distant from the coast. 20 km east of Lustleigh, Exmouth falls in the average band of 1,650-1,850 hrs/year [4.8 hr/day] with Rothamsted receiving 1,450-1,550 hr/year [4.11 hr/day].

### 1.5.4 TEMPERATURE

Within this district there are no sites measuring temperature directly. The nearest sites with measurements are Yarner Wood [786783] at 198 m O.D. and Princetown [583740, 430 m O.D.], with mean monthly and annual values shown in Table 3a & b. Table 2.3 in Jenkins *et al.* [2008] allows some adjustment of the Princetown values to take account of the different periods of the observations. The Yarner Wood figures cover the period 1981-2010, those for Princetown1971-2000. From Meteorological Office [2015] maps, the warmest part of the survey area is south of Lustleigh with annual averages of 10-10.5$^{O}$C, the coolest is the high moorland, averaging between 7 and 9$^{O}$C. In the wider view, Exmouth's mean occupies the range 10.5-12$^{O}$C, that for Rothamsted around 9.6$^{O}$C.

**Table 3a. Temperature: Princetown 430 m O.D. [1971-2000],**

| T $^{O}$C | J | F | M | A | M | J | J | A | S | O | N | D | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Max** | 5.8 | 5.7 | 7.3 | 9.7 | 12.9 | 15.6 | 17.7 | 17.5 | 14.9 | 11.6 | 8.4 | 6.8 | 11.2 |
| **Min** | 1.0 | 0.8 | 1.9 | 3.0 | 5.9 | 8.5 | 10.8 | 10.9 | 9.0 | 6.4 | 3.8 | 2.1 | 5.4 |
| **Ave** | **3.4** | **3.7** | **4.6** | **6.4** | **9.4** | **12.1** | **14.3** | **14.2** | **12.5** | **9.0** | **6.0** | **4.5** | **8.3** |
| * | ***3.8*** | ***4.1*** | ***4.9*** | ***6.7*** | ***9.7*** | ***12.4*** | ***14.6*** | ***14.5*** | ***12.8*** | ***9.3*** | ***6.3*** | ***4.9*** | ***8.6*** |

* Average adjusted for climate change to match Yarner period, following Jenkins *et al.* [2008], table 2.3.
Source: Dartmoor National Park Authority [2015]

**Table 3b. Temperature: Yarner Wood. 198 m O.D. [1981-2010]**

| T $^{O}$C | J | F | M | A | M | J | J | A | S | O | N | D | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Max** | 7.6 | 7.7 | 10.2 | 12.7 | 15.7 | 18.7 | 20.7 | 20.4 | 17.8 | 13.9 | 10.5 | 8.1 | 13.7 |
| **Min** | 2.5 | 2.2 | 3.6 | 4.5 | 7.4 | 9.9 | 12.0 | 12.0 | 10.2 | 7.8 | 5.1 | 3.1 | 6.7 |
| **Ave** | **5.0** | **5.0** | **6.9** | **8.6** | **11.6** | **14.3** | **16.4** | **16.2** | **14.0** | **10.9** | **7.8** | **5.6** | **10.2** |

Source: Meteorological Office [2015]

During January mean temperatures reach 5.5$^{O}$C in the extreme southeast, but only 2-4$^{O}$C on the high ground. July averages in the southeast are 16.5-18$^{O}$C, contrasting with 12-14.5$^{O}$C on the moorland. Clearly variations in temperature from site to site are primarily affected by altitude, Smith [1976] indicating an adiabatic lapse rate averaging about 0.6$^{O}$C per 100 m rise in altitude.

With additional detail on temperatures, other parameters reflecting the thermal regime, including soil temperatures, growing season length and air frost incidence are discussed in the Appendix.

In the context of the development and functioning of soils, the significance of temperature is through its effects on weathering processes, biological activity, growing conditions for plants and on moisture balances. This is particularly important in an area where organic soils are extensive and where concerns must be felt regarding their resilience at a time when significant climatic change is a serious prospect. Soil moisture conditions are discussed below.

While reviewing evidence for changes in climate, Jenkins *et al.* [2008] state that daily mean temperatures in central England have risen by about 1$^{O}$C since 1970. In the Southwest changes between 1960 and 2006 have been somewhat greater, as shown in Table 4. The increase in the annual mean temperature amounts to 0.297$^{O}$C per decade.

**Table 4. Change in daily mean temperature, 1960-2006, Southwest England**.

| Spring | Summer | Autumn | Winter | Year |
|---|---|---|---|---|
| 1.40$^{O}$C | 1.41$^{O}$C | 1.15$^{O}$C | 1.72$^{O}$C | 1.37$^{O}$C |

After Jenkins *et al.* [2008].

### 1.5.5 WIND AND EXPOSURE

Elevation and peninsular location exposes the district to winds, particularly those from westerly quarters. Above about 500 m O.D. annual average wind speeds are 15-20 knots [Meteorological Office, 2015]. Elsewhere in England such speeds are confined to Land’s End and higher ground in the Pennines and the Lake District. The lower moorlands and the ridge between Cranbrook Castle and Kennick experience average speeds between 10-15 knots, the more low-lying, sheltered valleys average 6-8 knots. Exmouth’s coastal location places it in the range 15-20 knots, while average wind speeds at Rothamsted are around 8 knots.

### 1.5.6 SOIL MOISTURE

The influence of climatic conditions on soil development is profound at the continental scale and can be evident at national and regional levels. Locally the soils of Dartmoor’s drier, eastern tracts are mainly freely draining, whereas in the west of this survey area rainfall doubles, bringing about blanket peat formation. Once established, peat has a strong tendency to be self-sustaining. More subtle are the climatically related changes in the mineral soils in the single parent material of granite-derived head at altitudes below the blanket peat. The combination of high rainfall and peaty topsoil encourages the development of stagnogley morphology in relatively porous materials, as is discussed below in the final paragraph of Section 2.1.2.

Meteorological considerations, both in the short-term as weather and over long periods as climate, have profound effects on the viability and productivity of plants and crops, on how readily land can be cultivated, stocked or trafficked, and on how it responds hydrologically. At the same time soils modulate these effects in ways determined by their internal makeup. For example, light textured, freely draining soils respond very differently to soils with impermeable horizons or high groundwater.

Transpiration by growing plants extracts water from the soil. Meteorological factors of temperature, humidity and wind speed condition the rate of removal, usually expressed as *potential evapotranspiration* or *potential transpiration.* Conventionally this is calculated for an established green crop, typically grass, completely covering the ground and well supplied with water. Smith [1976] states that place-to-place variation is primarily influenced by altitude, plus proximity to the coast. For the average altitude of 236 m O.D. in his Area 43 North, monthly averages of potential transpiration are in Table 5. His Table 10 shows expected interquartile ranges in year-to-year variations about those averages of plus or minus 17 mm and 1 in 10 years expected maxima of plus 42 mm and minima of minus 32 mm. Smith's Table 11 puts altitudinal lapse rates at 17.5 mm per 100 m for the summer half year and 10 mm per 100 m for the winter 6 months. While vegetation or crop covers will influence the rate of evapotranspiration, relative differences between sites locally are maintained by the controlling meteorological variables reflected in altitudinal changes.

**Table 5. Potential transpiration (mm) for 236 m O.D. in Agroclimatic Area 43 North.**

| J | F | M | A | M | J | J | A | S | O | N | D | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 8 | 32 | 49 | 75 | 84 | 83 | 70 | 42 | 20 | 4 | 0 | 467 |

After Smith [1976] p121.

The moisture state of a soil after gravitational drainage has ceased, following saturation, is termed *field capacity*. In a freely draining soil this drainage takes about 48 hours. However, in other soils with impermeable or peaty horizons gravitational losses are slower. In dry weather, as in early spring, field capacity exists in soils until evapotranspiration removes moisture from them. Once rainfall is exceeded by evapotranspirational losses, field capacity ceases and a *soil moisture deficit* develops. Its rate of development is a balance between evapotranspiration and rainfall. In autumn and winter, or during wet spells at other times, soils return to field capacity or wetter, with water draining from the soil. Meteorologically-defined field capacity, the balance between rainfall and evapotranspiration, is close to the field capacity of freely draining soil profiles, but differs from that in other soils.

In this district the wide differences in rainfall amounts mean the pattern of meteorologically-defined soil moisture conditions varies considerably. These variations are in both the magnitude of the soil moisture deficit and its duration, each mattering for a number of reasons. As a deficit develops moisture stress eventually inhibits plant growth and crop yields. Hydrophilous plants, such as Cotton grasses [*Eriophorum* spp.], which will thrive on porous granite soils where the soil moisture deficit is negligible, cannot survive where a deficit develops. Conversely, as such a deficit does develop, many soils become easier to cultivate and less susceptible to damage by stock or traffic. At dry times the soil can become a hydrological buffer, delaying drainage and runoff, with any rain reducing the soil moisture deficit as water is retained in the soil.

Later in the year the soil moisture deficit declines and a state of field capacity, or wetter, returns. In this district that usually happens during the growing season, while temperatures are sufficiently high for continued plant growth, resulting in an autumnal flush of grass for the farmer. Now the obverse of the soil moisture coin shows itself, ground conditions deteriorate for livestock, vehicle movements on the land and for cultivations, while water drainage through freely draining soils resumes. In most years the field capacity or wetter ‘wet season’ endures for much longer than the ‘dry season’ with its soil moisture deficit, even in the driest parts of this survey area.

In 1985 Jones and Thomasson mapped mean maximum potential soil moisture deficit [1961-75] and median duration of field capacity [1941-70] in England and Wales. More details on variations in both soil moisture conditions, both geographically and from year to year, are in the Appendix. In the driest parts of SX68/78 they show mean maximum potential soil moisture deficit reaching 100 mm, declining below 50 mm on the high moorland. The harshening of the climate from east to west again expresses itself in the duration of field capacity. The driest parts of the survey area average below 225 days per year, the high moorland more than 300 days.

### 1.5.7 BIOCLIMATIC CLASSIFICATION

The bioclimatic classification of England and Wales by Bendelow and Hartnup [1980] is an integration of data on thermal and moisture regimes, wind exposure and oceanicity. All are primary climatic components affecting plant growth, land capability and soil development. Within this district their 1:625,000 scale map shows four of the five classes of both the thermal and moisture regimes in their classification, as well as all three of their exposure categories. The classification qualifies the gradual warming and drying of conditions from the high moorland eastwards into the lower in-bye areas of the district’s southeast and northeast. Exposure declines in a broadly similar manner. The detailed properties and local distribution of the bioclimatic classes are summarised in the Appendix.

### 1.5.8 LOCALISED CLIMATIC PHENOMENA

Aside from the broad ranges and trends in the climatic properties described above, mostly reflecting altitudinal differences, some small-scale, localised conditions deserve comment. The strong dissection of this district, along with much of the rest of the southwestern peninsula, has its consequences. Particularly evident in the winter half-year is the development of inversions and frost pockets under calm, anticyclonic circumstances and contrasts in aspect and insolation across deeply incised west-east aligned valleys, as at Gidleigh Park [677879] and in the Teign Gorge between Clifford Bridge [781898] and Whiddon Park [723894]. Vancouver [1808, p242] comments that orchards in the valleys in his Granite Gravel district [equivalent to the in-bye] are more at risk from spring frosts and fogs and 'floating vapours' than those placed higher in the landscape. Figures in Harrod [1981, p10] around Chulmleigh 25 km to the north, make a similar point, showing that the higher standing interfluves experience more equable temperature regimes than the relatively sheltered valleys.

For the grassland farmer frost pockets are of little concern, but to the forester there is the risk of late spring frosts damaging new growth on conifers in such sites. Some of these locations are picked out by warnings of icing hazards on minor roads. In some old deciduous woodlands, particularly on very steep or precipitous ground, the effects of aspect and physiographic shade are apparent. There, on the north facing valley sides, growth of lichens, mosses and epiphytes is profuse, local demonstrations of the principle of *schattenseite* and *sonnenseite* or *ubac* and *adret.* Examples of such meso-climatic effects of aspect are hard to find from the agricultural landscape.

### 1.5.9 CLIMATE CHANGE

Viewed in terms of the climatic changes since the periods on which much agroclimatic data, as in Smith [1976] and in Jones and Thomasson's [1985] maps, are based, there is a scarcity of information, and consequently uncertainty, as to how much soil moisture conditions, for example, have changed. The regional changes in rainfall patterns described by Jenkins *et al.* [2008] with a nearly 10% increase, when applied locally have the effect of moving 100 mm interval isohyets 1-2 km east on the moorland and 4 to 5 km to the east over much of the in-bye. At the same time they note a decline in summer rain. They show that yearly mean temperatures in Southwest England have risen by about 1.4$^{O}$C since 1960. In terms of the lapse rates suggested by Smith [1976], that raises isotherms by around 230 m in altitude.

Beyond the observations of Jenkins *et al.* nothing is quantified. Some of the discrepancies between both directly measurable and derived parameters in Smith's [1976] agroclimatic values and those on Meteorological Office web sites, for example over growing season length, may be accountable by changes in climate, but at the best this will be inexact.

Possible effects of changes in rainfall and temperature regimes on soils and their functions deserve consideration. Soil moisture conditions and temperatures affect many physical, chemical and biological processes, also human use of the land. Interactions between the soils and changing temperature and rainfall regimes, as well as the wider environment, will not be easy to assess. Weathering rates and soil forming processes may be altered, although these processes act very slowly, as may water movement and balances and biological activity. The soil pattern on the granite [see Section 3.1] from freely draining Moretonhampstead series, through the wetter Hexworthy / Rough Tor and Princetown soils to the perennially waterlogged blanket peat, is essentially a climatically driven catena or hydrological sequence. Will climate change trigger further comparable soil developments? Degradation of peat soils could be a consequence of changing climate, with the irreversible changes of humification and shrinkage that follow drying, or will wetter conditions encourage peat growth? Changes in vegetation, in growth rates and biomass production, assemblages of species and ecosystems, may be expected.

In terms of economic use of the land, suitable and sustainable crop and tree species may change. Maize or vines for example may become attractive crops at higher altitudes than at present. Anticipated effects on soil moisture states would be that more spring rain might delay the onset of soil moisture deficits, which could then increase due to less rain and higher temperatures in summer, the latter raising evapotranspiration rates. Any increase in autumnal rain, as Jenkins *et al.* [2008] show, might, however, hasten the return of field capacity. A combination of better growing conditions with extension of the state of field capacity or wetter may have environmental effects, with increased soil damage by poaching and associated trafficking, which would be just one way in which runoff and pollution risks might increase. The MAFF's [1988] Agricultural Land Classification, an integral part of the planning process when rural, green field sites are involved, has a number of grade limits determined by annual average rainfall amounts. The eastward movement of rainfall's isohyets, implied by the work of Jenkins *et al.* [2008], may have implications for planning.

## 1.6 MAN AND THE LANDSCAPE

At first sight Dartmoor's moorland can appear as an unspoilt wilderness, yet in various forms it bears the marks of man's activities as much as, if not more than, most of rural Britain. These activities are of interest in this account because they have influenced the form and development of soils or are represented as disturbed ground over prominent parts of the soil map. The first stage, the clearance of the woodland that had grown up following the warming of the climate after the Pleistocene, was a slow and gradual result of people hunting and later farming, as pollen [Simmons, 1964] and other records reveal. About 3,000 B.C., at the start of the Sub-boreal [viib] climatic zone, the pedologically significant burgeoning of heather pollen began as Neolithic farming developed, continuing into the Bronze Age, which provided the first evidence of enclosure of the land. Across the in-bye this has produced the pattern of fields and woodlands, the latter in agriculturally unrewarding steep or rocky sites. Mineral working, particularly for tin, carried out at least since before the Conquest, has disturbed the ground across much of the district, while the pocking of the moorland during the cutting of peat and turves for fuel persisted into the mid 20$^{th}$ century.

The ranges currently used by the Ministry of Defence for small arms and mortar firing occupy about 2,000 ha of the high moor in the west of the district. Inevitably firing results in periodic restriction of public access. In the past the ranges have extended more widely and included artillery firing. The latter has had the most noticeable effect on the landscape in the form of a scatter of small, usually circular, craters, 2 or 3 m across. On the blanket bog they tend to be perennially flooded, whereas on the mineral soils and disturbed ground they are usually dry. Although the craters are mostly few and far between, there are denser concentrations, as on Black Hill [604846]. They are present well outside the existing range boundaries, for example on Broad Down [626804], northwest of Postbridge, relicts of wider military use. A small area of disturbed ground east of East Mill Tor [599897] marks the line of a movable target range. In the early 1940s Mardon Down [772879], Moretonhampstead was used by the U.S. Army Engineers as a training area. As well as trenching and foxholes, which remain open in places, a short railway line was built and operated at Headless Cross [771878] to train engineers prior to the invasion of Europe. The cuttings and embankments, including borrow pits, can be made out as disturbed ground on the soil map.

### 1.6.1 MINERAL WORKINGS

The Dartmoor granite contains veins carrying cassiterite [tin ore] which, in limited areas, notably around Headland Warren [685810] between Hookney Tor [699813] and Water Hill [671813], have been sufficiently concentrated to encourage mining. In the main elsewhere, workings, although widespread, have been smaller in scale. Much of the disturbed ground shown on the soil map represents old tin workings. Greeves [1981], Harris [1968] and Gerrard [1994] provide much detailed information on the archaeology and history of tin working on Dartmoor.

Along valley floors the alluvium has been dug over widely as *streamworks* in the search for placer deposits of tin, as have head deposits under many adjacent footslopes in *eluvial* [that is extending beyond the alluvium] workings. Typically streamworking is characterised by excavations with sinuous or arcuate, subparallel ridges of stony spoil a metre or two high, many now vegetated but some still bare, separated by troughs and gullies. Locally, as southeast of North Bovey [740839], the mounds on the floodplain are unusually large and high. The alluvial workings' upslope limits can form distinctive 'scarps' where they penetrated into the hill sides. Such eluvial workings exploiting tin-bearing head, termed *shode* [Durrance and Laming 1982], can be several metres deep, often accompanied by spoil mounds similar to those on the alluvium. These workings can pass some distance into the hillside, before ending abruptly. Along the Steeperton Brook, southwest of Wild Tor [623877], for example, the 'scarp' is 8 metres high with a slope over $40^{O}$.

Where the search encountered veins of *in situ* cassiterite in the underlying granite, ravines [*open works*, *beams* or *gerts*] were often excavated to follow the vein into higher ground. During the mid-twentieth century, when farming benefited from grant aid for land improvement, tin streamed lands on the floodplains of the Teign below Dogmarsh Bridge [713893] and the Bovey, immediately below North Bovey village, were levelled and restored, leaving little obvious trace of the exploitation.

In the most richly mineralised ground, between Headland Warren Farm [693811] and the Warren House Inn [674810], a complex of deep open works involves many tens of hectares, along with a number of deeper underground shafts and levels, spoil mounds and isolated ‘islands’ of undisturbed ground. Much of this was the Birch Tor and Vitifer Mine. The land around is dotted with smaller open works, trial holes and small funnel-shaped pits with spoil banks, often in a line, the surface expression of shallow *lode-back* mines. Although the larger parts of these workings follow an east-northeast to west-southwest alignment, there are offshoots with different orientations. Away from the Headland Warren area and the alluvial placer deposits there are several long-abandoned minor open works and mines. The largest area covered by these is on the northwest side of Mardon Down [765876], with several other open works between Chagford and Great Weeke [715876]. Among the adits with small spoil mounds are those at Batworthy [662869] and St. Thomas’ Cleave Wood [789881].

Many of Dartmoor’s tin works are on moorland and are recognisable by remote sensing, including aerial photography. However away from the moorland, ground disturbed by tin working often became of limited agricultural value and reverted to woodland, which obscures stream and open works. Several such areas are shown as disturbed ground on the soil map, with the chasms below Neadon Cleave [758818], Manaton, in Rushford Wood [701898], Chagford and north of Coombe Court [754870], Moretonhampstead as examples. In contrast there are numerous examples of very small, sometimes a few square metres, streamworks, eluvial workings and trial pits, too small to show on the soil map. Places where there is uncertainty as to whether features are natural or man-made have not been delineated.

There is no archaeological evidence of tin working on Dartmoor before Norman times. However, the same is not so for granite areas in Cornwall. The pros and cons regarding pre-historic tin works on Dartmoor were reviewed by Gerrard [1994]. While it seems possible, in view of the importance of the metal for millennia, that people would have been aware of its association with the granite and exploited it equally on Dartmoor, untroubled by local government boundaries set up in the Dark Ages or medieval times. Indeed Mercer [2009, p276] comments, while discussing farming and the landscape, that “throughout the 5,000 years that tin ore has been sought”. As yet direct evidence is not forthcoming.

However, work on the Erme floodplain in the South Hams by Thorndycraft *et al.* [2004] found enhanced tin content in alluvial silt dated to the late Roman or early

Post Roman period, indicating that tin streaming was taking place then on southern Dartmoor. Mercer also notes that before Domesday it was lawful to dig for tin. A Lord Warden of the Stanneries was appointed in 1197, with the Tinners' Parliament set up in the next year. Clearly tin working was thriving before the end of the twelfth century. The assaying, taxing and marking of tin at the four stannary towns, where it was sold, Chagford was one, was established in 1305. Production peaked in Henry VIII's reign. The Civil War saw the industry's decline until its revival with the Industrial Revolution. Working ended when the Golden Dagger Mine [683804] at the head of the West Webburn closed early in the twentieth century.

Prior to the development of industrial mining techniques in the late eighteenth century, methods of working were simple, with water both a hindrance and a necessity. Streamworks on floodplains and those low on hillsides had to deal with high groundwater and periodic flooding; where the tin ground extended into thick peat deposits, the works usually petered out. Water was needed in separation of the ore from other stones and earth, to power processing plants [tinners' mills], including stamp mills and blowing houses [smelters]. The configuration of the work area or 'tye' in the troughs between spoil mounds was used to regulate water movement as part of the processing. Many of the workings were serviced by leats.

With the Industrial Revolution, deep mining became practical. As well as excavation of the open works at Birch Tor and Vitifer and other sites, ground already tin-streamed centuries earlier could be reworked. The long, sinuous leat carrying water several kilometres from the North Teign to Birch Tor and Vitifer shows that the mixed relationship with water remained despite mechanisation, water wheels even providing the power for pumping in the mines. An additional consequence of the Industrial Revolution, competition from overseas sources in the metal markets, was the eventual death knell of tin mining on Dartmoor.

A striking feature of many of the open works is that the spoil dumps are not commensurate in size with the excavations. Where has all the spoil gone? There is both historical and contemporary evidence of downstream damage and nuisance by sediment released by tin working. An Act of Parliament in 1531 [Greeves 1981] sought to curb siltation of important harbours by sediment released into rivers by tin workers. Prior to that in 1512, the MP for Plympton Erle had been imprisoned by the tinners, following his complaints in Parliament about sediment from tin workings. The tinners, literally having laws unto themselves, did this legally, the case subsequently becoming the foundation of Parliamentary Privilege [Greeves and Newman, 2011].

It is clear from the condition of some peat deposits upslope from eluvial tin workings that the depth of excavations was often sufficient to radically alter the hydrology of the adjacent, unworked slopes. This commonly changes the peat soils from a state of perennial wetness to one of seasonal saturation, along with humification, weathering and other irreversible changes. The cutting of peat close to tin works further complicates this story. In perhaps extreme cases, drying of the peat by drainage is evident around 639882 between Rippa Tor and Gartaven Ford, where it has been sufficient to allow bracken growth, while 'dry, white' peat is present above workings near the confluence at 647873 of the Gallaven and North Walla Brooks.

As with both the erosion and cutting of peat, disturbance by tin working created a wider array of ground conditions than nature had provided. The stark, man-made variations in soil and regolith textures, hydrology, slopes and shelter, provide a range of ecological habitats and niches far greater than is found in the comparatively unvarying, adjacent, undisturbed land. While this may be unwelcome in specific areas of high scientific interest, such as the blanket bog, elsewhere such diversity will be valuable. To archaeologists and historians the workings have an intrinsic interest, something that cannot be overlooked in a region where tourism is so important.

Haematite veins are not uncommon in the granite. Small-scale mining of the soft, specular haematite, locally called shiny ore, was active in this survey area in Victorian times. Workings were largely confined to the wooded slopes east of the Wray Brook, at Kelly [795818], Lustleigh, including in the oddly-named Tin Copse [796818] and Tinhill Copse [797819], plus the Pepperdon mines [777837 and 772848 further northwest]. The workings, apparent as disturbed ground on the soil map, include the modern demonstration site at Kelly, plus Castor mine [799817] to the southeast and an adit and possible open works about 200 m northwest of Kelly Mine.

Granite has a popular reputation placing it among the hardest and most durable of rocks. Indeed there are numerous quarries in it across the area of this survey. Many date from times when labour costs were minimal and before machinery became widely available. Large quarries in sound granite of building quality operated well into the last century at Blackingstone [783858] [which provided stone for the Lutyens designed Castle Drogo], at East Wray Cleave [782831] and at Pixies' Rock [790873], Westcott. Interestingly all three are east of the Sticklepath Fault zone. Stone for the dam at Fernworthy [671843] was quarried close by. Other, smaller pits and quarries have been opened up in the era of the JCB, enabling a single man to excavate. With a handful of exceptions, these quarries have been to exploit saprolite or growan, as much as for durable granite, for aggregate and road stone rather than for building material.

### 1.6.2 PEAT CUTTING

While not as spectacular as many of the tin workings, peat and turf cutting has involved larger areas of moorland in this district than the tin streaming, open works and associated disturbance of ground put together. In many instances peat and turf cuttings are not immediately apparent or can be difficult to distinguish from erosional features. Many areas of peat have shallow, more or less linear and rectangular depressions, often only a few cm deep. As well as cutting from the blanket peat of the high moorland and that in basins at lower levels, the mixed peaty or humose tops of mineral moorland soils were stripped as *vags*, particularly over much of the Hexworthy / Rough Tor soil map unit.

The rights of commoners, forest tenants and tinners to cut turves or peat for fuel originated early in the last millennium, if not before. The fuel was used for domestic purposes, in nearby tin smelters [blowing houses] and, by the latter half of the 13$^{th}$ century, for sale, some of it to Cornish smelters [Fox 1994], whose peat sources were by then largely exhausted. Peat was cut during and after the Second World War and sold around South Zeal into the 1950s. Occasional relatively fresh faces in cuttings can be encountered.

Harris [1968] describes how domestic working of peat was in cuttings called *turf-ties*, each one worked exclusively by an individual or group. Ties were worked in the spring in strips or *journeys* traditionally 40 yards [36 m] long, two turves wide and 18 to 20 inches [45-50 cm] deep, with the cut slabs set out to dry through the summer. The surface turf was replaced to maintain the plant cover. With time the ties would become wider, and often, where the peat allowed, deeper. This overall pattern remains recognisable over much of the peat soil map units. Many of the ties are less regular than the ideal described by Harris; some are shallower while some seem to exploit sides of eroded gullies. Most are aligned more or less with the slope, an obvious solution to waterlogging, so that where the ground is completely flat, ties are rare or absent. Some have very abrupt margins, others long gentle slopes, possibly denoting the range of their ages and time since cutting. In places ties are closely grouped with only narrow baulks separating them, elsewhere appreciable reserves remain between the excavations. Ties are scarce on the more remote parts of the highest moorland. The location of some ties close to tin workings points to the tinners employing similar techniques to the commoners, although in places, as east of Watern Combe [625866] and southwest of the East Dart at Broad Marsh [618819], they seem to have used the edge of the blanket peat, along what Mercer [2009] termed peat cliffs, upslope from streamed and eluvial excavations. Harris [1968] noted that King John granted the privilege of ancient custom of digging turves to tinners in 1201.

The ground shown on the soil map as disturbed on the high moorland ridge crests southwards from Wild Tor [623877], through Hangingstone [617861] and Whitehorse [615852] Hills to Statts House [621825] and beyond, has had in excess of a metre of peat systematically removed, leaving a bare, often bouldery, pavement of mineral soil. Over 150 ha were stripped in such a way within this survey area alone. These areas are among those listed by Harris [1968] and Fox [1994], identified as having been worked by commercial charcoal burners, *carbonarii,* licensed by the King, then the Duchy of Cornwall from the 13th century onwards.

By 1400 there were often over 100 licensed carbonarii on Dartmoor, many of them Cornish. Woolner [1965] implies that peat charcoal was superior to that from timber or coal for metallurgical purposes because of its smaller content of impurities. South of Wild Tor there are numerous low [less than 1 m high], roughly circular 'peat mounds', around 10 m in diameter, often with hollow centres. Sheep scrapes in some of them show fragments of charcoal, supporting the interpretation [Newman, 2010] that these are the sites of charcoal kilns or meilers. Although there was a close association of the carbonariis' activities with the times of peak tin production, Woolner records that in the early 19th century peat charcoal was used by most of the smiths in and around Dartmoor.

Across much of the lower moorland below the blanket bog on the land dominated by mineral soils of the Hexworthy / Rough Tor and Princetown map units the ground surface is uneven due to the removal of peaty or humose surface horizons as vags. In many places cutting of vags resulted in stunted regrowth of the vegetation on acidic and nutrient depleted mineral subsurface horizons. Consequently many of these sites still remain visible both on the ground as slight but abrupt changes in the surface level, and from the air, as can be seen on the Google Earth imagery [Plate 97] of 2002 around 653856 on Shovel Down. It is likely that although the vags were taken from relatively accessible sites, they provided inferior fuel to the true peat because of their contamination by fine earth.

Cutting of the peat affected the hydrology and ecology of the adjacent peatland by drainage and lowering of water levels, although some waterlogged ties do occur. Also changes came through the uncovering, weathering and oxidation of the remaining deposit and by providing some shelter in an otherwise exposed landscape.

### 1.6.3 AGRICULTURE

From before the arrival of settled agriculture in the Neolithic, Man has been modifying the vegetation. At first felling and burning aimed to improve the hunters' and gathers' prospects. Pollen analyses at sites such as Taw Head [609859] [Simmons, 1964] suggest that at first such clearings were temporary. Then for the last 5,000 years farming has seen enclosures by reaves and hedgebanks, with patches of woodland, moorland and downland left aside, often on the least amenable ground. Mercer [2009] provides a comprehensive account of the development of settlement and land management over Dartmoor, both moorland and in-bye. Clayden's [1964] review of the history of agriculture in the middle Teign valley, some of which overlaps with part of the east of this survey area, is highly relevant to this account.

The moorland's Bronze Age heritage of hut circles, settlements, reaves and monuments is second to none across Europe. Pollen and other evidence indicates a pastoral agriculture with some cultivation, which appears, at individual sites, to have been short-lived before the poorly buffered and hungry soils succumbed, with heathy vegetation coming in and accentuating a downward spiral of infertility. Mercer [2009] says that by 4,000 years ago upland pastures were widespread. Bronze Age reaves, the enclosure boundaries, are found across substantial parts of the lower moorland, representing a topographic legacy second only to the hedgebanks set out on the in-bye as Saxon and later farmers enclosed the land. The reaves are largely aligned both northeast to southwest, and at right angles to that, northwest to southeast. In places, as near Teigncombe [672871] their influence can be seen in field boundary alignments east of the cornditch in the in-bye. How far the reave-based system of enclosure extended further eastwards is uncertain.

There are Bronze Age hut circles and kists in the in-bye, but with a density far below that on the moor. Whether that reflects an original disparity, or rather more than a millennium of disturbance, 'borrowing' of stones and reorganisation of the land, is uncertain. Many field boundaries and lanes in parts of the in-bye do have similar orientations to the reaves, but this may be a simple response to the district's dominant physiographic grain. How far the huts were occupied and the land used seasonally or around the year is also open to question. Seasonal use would have been casting the mould of transhumance, which was to dominate agriculture on the moorland until late Victorian times.

Climatic deterioration around 3,400 years ago and soil degradation were more serious for arable cropping than for livestock farming; the upshot was a retreat from the moor. Iron Age settlement was at lower altitude than in the Bronze Age, but with hill forts to the east 'guarding' the upper valleys. The Iron Age population was smaller, although summer grazing on the moor was probably still carried out. Roman influence on the area and its agriculture appears to have been negligible.

The conquest of Devon by the Saxons in the late seventh century was of a thinly populated area, on which they established an open-field agriculture with communal cultivation or an in-field out-field system around smaller settlements. The present pattern of villages, hamlets and manors, was largely set by the time of the Domesday survey of 1086. Clayden [1964] suggests that in the twelfth century less than half the in-bye land was farmed, although further enclosure of land across the in-bye, whether from woodland, downland, moorland and within the open fields, went on, particularly between about 1150 and 1350. Field bounding hedgebanks often pick out major soil changes, indicating that the form and density of the vegetation and the type of ground was appreciated by the colonisers, influencing the selection of land for enclosure. Little is known of medieval farming, except that arable cultivation had more of a role than in modern times, although the developing local cloth industry must have depended on a substantial sheep flock in the area.

According to Historic Landscape Character maps of Devon [Devon County Council, 2016] and Turner [2007], the most extensive category across the in-bye is *medieval enclosures based on strip fields.* Turner's Chapter 3 discusses the evolution of Devon's fields. Much of the enclosing took place between the 13th and 16th centuries, partly in response to a declining rural population. The slightly sinuous, 'reversed S' shape of many boundaries, sometimes repeated in parallel across several fields, along with sporadic 'dog-legs' in the hedgebanks, support the conclusion of enclosure of groups of strips. Apart from the lynchets at the north end of Challacombe [693803], there is little visible evidence of individual strips within the enclosures in this district, unlike the striking ridge and furrow, fossilised following parliamentary enclosures, present across parts of midland England. This may indicate different cultivation practices between Devon and 'up country' on the strip fields prior to enclosure, or that, after several centuries of cultivation here, evidence of individual strips has been obliterated.

By contrast with the in-bye, the moor itself went unmentioned in the Domesday Book. All of Devon had been an early Saxon royal hunting forest, which eventually shrank to the high moorland of Dartmoor Forest. Medieval summer grazing there became well established, with the Duchy of Cornwall charging an agistment of three ha'pence for each beast grazing by 1345. Rules of levancy and couchancy controlled stock numbers. This system of transhumance was used by farmers from the immediate in-bye and from further afield. It had the advantage for the lowland farmer of releasing home farm land for cultivation of domestic food crops, of forage and hay for winter stock feed, or for fallowing the land. An additional benefit was that moor-bred young stock came to the in-bye in the autumn for fattening and finishing.

Between 1260 and 1560 the Crown, then the Duchy of Cornwall, assarted moorland, that is it allowed small farms to make inroads into the Forest, as the Ancient Tenements. Walna, the most northerly of these, situated on the western flank of the Walla Brook south of the Warren House Inn [674809], is defunct and has reverted to heather moor, but enclosures of the Ancient Tenements at Merripit [656801] and Hartland [645800], north of Postbridge, reach onto this survey area's southern edge. Assarting confined fields to 8 acres [3.25 ha] and often meant they were bounded by stone walls rather than hedgebanks. Mercer [2009] makes the point that from the Dark Ages onward there has been fluidity about the moorland-in-bye boundary due to climate change, economic conditions and population fluctuations, as came about with the Black Death. He gives the example of sporadic medieval occupation, including cultivation, of the reaves on Holne Moor [675715]. Possible examples of products of this are the small detached enclaves of the Moretonhampstead soil map unit noted in Section 3.2.1 below. However, over much of its length in this survey district, the cornditch does mark an abrupt change of soils, their characters either side reflecting the contrasting nature of the land's management.

By Elizabethan times there was sufficient surplus agricultural produce to victual the Navy, as well as merchant and fishing fleets [Clayden, 1964]. The late sixteenth and early seventeenth centuries saw a golden age of Devon's farming and a new episode of enclosing, which continued into the eighteenth century. By the middle of that century Milles' manuscripts [Stamp, 1941, Hoskins, 1954] describe more extensive forms of agriculture following consolidation of some small farms. In preparing old grassland for tillage the sward and any root mat was pared, dried and burned, a process [denshering or beat burning], described by Colpresse [1667], which originated in the thirteenth century or earlier. Originally it was a means of reclamation of heath and moorland. The ashes were spread, mixed with lime, dung, road scrapings and domestic ash, as a fertiliser, also ameliorating soil pH. The land was then ploughed and harrowed, and the seed broadcast, with three or four arable crops being taken before reversion to grass.

**Plate 14. Medieval lynchets at Challacombe.**

After abandonment these cultivation features were disrupted by tinners' openworks running up and down the slope at two points. The valley floor was tin streamed, probably broadly contemporaneously with the use of the lynchets. This land was also later exploited as a rabbit warren. Both the foreground and the slope opposite have Moor Gate soils. In the valley floor, alongside the ground disturbed by the tinners, is a ribbon of basin peat mapped as Crowdy soils.

During the Napoleonic wars Vancouver [1808] indicated that about one fifth of the land was permanent grass, the rest being 'occasional tillage ground' with crops of wheat, barley and oats, followed by clover and ryegrass, the pasture then being left from ten to fifty years before breaking again. Denshering continued on this land, a custom that was condemned by Vancouver when practiced on sound, dry soils. Tanner [1848] reported cattle rearing as the main farming enterprise across the county, most farms having a flock of sheep too. He stated that turnips commonly preceded the corn crops in the rotation outlined by Vancouver. According to Tanner, potatoes had been grown as a field crop in the Moretenhampstead area soon after their introduction [late in the sixteenth century], both for human consumption and stock feed. Potato growing must have been well established by 1765, as the potato market near Two Bridges at 606747 shown on Donn's map of that date, implies. Although he did not mention potatoes as a crop in describing his Granite Gravel district, Vancouver's account of lazy bed working for potatoes [p197] is instructive. [See Section 3.3.2 below].

In the eighteenth and nineteenth centuries large, stone walled enclosures, newtakes, were made by the Duchy of Cornwall in the moorland of the Forest below the blanket peat. There are examples surrounding the derelict Teignhead Farm [635843], itself, with the neighbouring ruin of Manga Farm [639848], Victorian in origin, the newtake on Manga Hill [630850] and Hawthorn Clitter [633862] being around 150 ha in extent. The newtakes' boundaries are roughly linear and tend to have angular corners. They mostly support moorland vegetation, although Mercer [2009] says some occasionally were dressed with lime until the middle of the twentieth century. Elsewhere newtakes were created following Acts of Parliament, that at Challacombe Down being the only one in this survey district.

Clayden [1964] recorded that arable acreages were their largest in 1872. After that came the agricultural depression, so that grassland and rough grazing increased. Progressively oats were partly replacing wheat and barley. By 1913 Hall showed that wheat had almost disappeared, with oats and dredge corn the staple cereals, being used as stock feed. At the same time liquid milk sales began to supplant farmhouse butter making. Stamp's [1941] Land Utilization Survey reports that main crop potato growing was a major farming activity in the Chagford-Bridford area. He shows the crop taking more than 2% of the acreage in Chagford, Moretonhampstead and Bridford parishes, with adjacent in-bye parishes having 1-2%.

Stamp also emphasised the amount of land in these and adjacent parishes that was under the plough, with comparatively little [permanent] grassland. How far that was a robust conclusion deserves consideration. The category on the map key of 'arable land' included rotational grass, often not easily distinguished by the surveyor from permanent pasture. Oats took up about 20% of the county's arable land, with turnips, mangolds and swedes grown for winter fodder. Grassland was generally in a poor state, with bracken on dry fields and rushes on the wet ones. The Second World War saw ploughing up of rough grazing and permanent pastures, with a balancing increase in the acreage of leys.

After the war dairy farming continued to develop, serving the liquid milk market. Improved varieties meant that barley was replacing oats as the chief corn crop. In the same period farmers were required to grow specified acreages of crops for human consumption. At the time there was free agricultural advice from MAFF's NAAS/ADAS. Potatoes remained a significant cash crop around Moretonhampstead into the 1960s, but subsequently, later in that decade [Clayden, 1971], their acreage declined. A similar reduction affected forage root crops, with strip-grazed kale coming into favour, saving the labour-intensive need to lift and store the roots in clamps, locally known as caves. Clayden [1964] commented that more fields on the light Moretonhampstead series soils were in temporary grass than on the other soils within his Middle Teign survey area.

The contemporary farming scene is one dominated by livestock rearing, primarily on the in-bye's grasslands, but with grazing on the moorland still important to some farms. The mixed farming of the past has largely disappeared, the Moretonhampstead area's reputation for potato growing but a memory, here and there prompted by a long-unused 'spinner' in a barn or hedge bottom. Most farms are small family businesses, a mixture of tenancies and freeholdings. Mercer [2009] says Dartmoor farms with owner occupiers average 63 ha, those that are tenanted 50 ha. Many supplement their acreages by renting grass keep from non-farming neighbours, others by part-time work away from the farm. Rearing of store cattle and sheep are the main enterprises, some being finished locally, some being sold on for fattening.

Many holdings have relatively low in-puts and out-puts, with substantial acreages having received neither lime nor fertilisers for years. Much of the grassland is permanent or long ley pasture for grazing or conservation, these days usually in big round bales of silage. The extensive freely draining Moretonhampstead soils [Section 3.2] are widely stocked year round, some of them used for winter grazing of sheep withdrawn from the moorland. The wetter Laployd soils [Section 3.9], often picked out by rushy pastures, are only suited to summer grazing, often proving useful when the grass on the freely draining land has started to burn off. Over most of the in-bye there are only occasional tillage fields of re-seeded grass or cereals and forage crops grown for consumption on the farm, but in the driest, northeastern corner of the district some more intensive arable farming, with cereals and rape, takes place on the Dunland away from the granite.

In recent decades farming here has seen changes reflecting both agricultural and social developments, not least the impacts of diseases, the shock of the foot and mouth outbreak in 2001 and the longer running bovine TB epidemic. In the in-bye potato growing, for which the Moretonhampstead district had a long established reputation, ceased with the mechanisation of the cropping. The decline of mixed farming is exemplified by the reduction of cultivated ground implied in previous paragraphs. The scatter of small dairy farms that existed across eastern

Dartmoor into the late twentieth century has all but disappeared. The sole farm in this district still milking cows had, until recently, a niche market and produced high quality ice cream. For the rest the ageing population of farmers, half of whom Mercer [2009] reports as having no successor, coupled with the economics of dairying, has seen them cease milking. In the past generation after generation stoically accepted the hardship of life on small family farms, whether milking twice daily, day in and day out or sleeping out on the moor to lear a new flock. Education and the distractions of modern life reduce the number in the rising generation who will follow such paths.

Diversification has become a watchword in farming; for many the income it provides is crucial to the survival of their enterprise. It has taken many forms, some have endured, others have come and gone. Organic cropping and horticulture, agricultural contracting, provision of accommodation or camping, supplying meat to local butchers and restaurants, farm shops, selling logs, growing blueberries, livery, the keeping of ponies and horses, hosting giant compost heaps from nearby urban recycling centres, providing stacking space for felled timber, leading moorland walks, industrial scale pheasant shoots, all are local examples.

According to Mercer [2009] in 2002 almost half the full-time farms in the National Park were making use of common grazing, most of it being on open moorland, although places like Mardon Down and Lustleigh Cleave must be included. Many more had rights that were not exercised. The grazings are used for raising cattle and sheep for finishing away from the moor. The most common cattle are Galloways, both belted, black and dun, but there are crosses of many breeds, with some South Devons present, echos of the old days of levancy and couchancy, when stocking was confined to the summer. Sheep breeds are dominated by Scotch blackfaces and their crosses with Texels and other breeds. Ponies include pure Dartmoors and the more mixed and vari-coloured Dartmoor Hill breeds. Good husbandry, backed by regulations, means that for at least two weeks in the autumn, moorland livestock are taken to the in-bye for compulsory disease and parasite treatment, frequently combined with tupping and bulling. Lambs start being marketed in early summer.

Agriculture's role on the moor has evolved over the years. The centuries old custom of the transhumance by in-country livestock and summer-only grazing died out with the arrival of hardy Scotch blackface sheep and Galloway cattle late in the nineteenth century, both readily able to out-winter on Dartmoor. The legacy of wartime insecurity over food supplies, with headage payments to livestock farmers, remained in place into the late 1980s, although by 1960 they had compounded the problems of year-around moorland stocking and over-grazing, along with the periodic swaling [burning], the latter aimed at freshening the vegetation for the sheep and cattle.

Poorly conducted swaling risks damage to heather and blanket bog ecosystems, encourages expansion of *Molinia* and reducing habitat diversity. Tractor traffic taking feed to out-wintered stock caused tracking and erosion, while poaching by the animals loitering in expectation of the next feed damaged the soil and vegetation. Although such practices ended before 1990, the marks of some feeding sites are still there to be seen. Since then agri-environmental management agreements have been the rule, recognising farmers' roles in maintenance of the moorland ecosystem and public asset as well as in food production. In these agreements not only are animal numbers a concern, but patterns, timings and locations of grazing are set.

The balance of grazing is crucial and often contentious. Under-grazing is now a major concern as the upland ecosystem, livelihoods of graziers, archaeological landscape and public access and amenity are all affected. At the simplest level, over-grazing suppresses some species, the heathers for example, and encourages *Molinia*, under-grazing can promote the growth of gorse. In more sheltered sites, such as on Lustleigh Cleave, Mardon Down and Hayne Down, the reduction of grazing and the withdrawal of swaling have allowed rapid expansion of woodland onto formerly open ground. As Mercer [2009] states [p309] “Dartmoor has always been farmed, it never needed to keep its farmers contentedly at work more than it does now”, a sobering thought when he also reports that half the farmers had no recognised successor to carry that work into the future.

Prior to the availability of mineral fertilisers and lime, farming on the in-bye's soils will have suffered from their ‘hungry’ nature and acidity associated with light textures and the district's humid climate. Apart from application of animal manures and domestic ash [the district boasts a number of surviving ash houses] denshering represented the main way of revitalising soils ahead of arable use. Baldwin *et al.* [1999] showed that these practises continued on such ground locally into the last century.

How long the history is of liming the land locally is uncertain. Limestone outcrops both to the south of the district in an arc from Chudleigh through Newton Abbot then onto Ashburton, and at Aller Quarry [731812],1 km north of Castle Drogo. There is at least one lime kiln in the district, near Rudge [783808], Lustleigh. It is said locally that pack animals carrying wool and textiles from the area to Newton Abbot used to return with loads of lime. During the mid-twentieth century public support of farming included free agricultural advice, along with subsidies on lime, the latter highly beneficial to agriculture in this district. In that era of prosperous farming fertiliser use was high, nitrogenous sources particularly being in favour as they promoted grass growth. In the last few decades their use has declined due to environmental schemes, costs and the reduced intensification of agriculture.

Morphology of the surface horizons of soils tells much about their past use and management. In the in-bye agriculture has been the dominant land use for a millennium and more, but was preceded by deciduous forest for most of the Post-glacial period. On what is now the moorland downslope from the thick peat, the Bronze Age saw agriculture for a period before soil exhaustion, caused by that farming, in combination with climatic change, introduced acidic, heathy vegetation. Within the in-bye soils of the Moretonhampstead series [see Sections 3.2 and 3] predominate, but the landscape is diversified by wetter soils, mostly in valleys, and by dark, humic topped, free draining soils on downs or on relatively recently enclosed former downland.

Under forest, the annual autumnal fall of leaves produced characteristic soil horizons with freshly fallen litter overlying a few cm of material in the process of being broken down by soil fauna and other biological agencies, in turn resting on a seam of well-rotted humus. Together these horizons may be 10 or 15 cm thick over mineral horizons. Only relatively small remnants of that forest survive, most often on steep and rocky ground. On the main freely draining agricultural soils of the in-bye cultivation quickly mixed the litter and humus horizons, often with the upper subsoil, creating a ploughed horizons, which persist even after many years under unbroken pasture.

Throughout much of the district many such ploughed horizons approach 30 cm in thickness, indicating the depth of working, at least on some occasions. Their widespread distribution shows that the area's dominant crop, grass, has at the least been subject to periodic breaking of the pastures, and most probably more frequent cultivation in the past when mixed farming was the rule. Change to the ploughed horizon comes about only slowly, whether in reverted woodland or long-term permanent pasture. Absence of well-developed litter and humus horizons immediately distinguishes soils of secondary woodland from those of long established woodland. In old permanent pasture a few cm of stoneless soil at the surface, the accumulation of many years of worm action, plus a thin mat of roots, can mark a slow start in modifying cultivation's impacts.

Across the in-bye there are several areas of Moor Gate soils [see Section 3.5], distinguished primarily from the Moretonhampstead series by having dark, humus-rich topsoils. Some remain unreclaimed, as at Mardon [772879] and Hayne [740800] Downs. Where enclosed these soils tend to be in larger, more rectangular fields of post-medieval origin, for example southeast of Pepperdon Down [778851]. At many sites the abrupt boundary between the two soils follows field boundaries, further suggesting strong management contributions to their different morphologies. Part of their reclamation would most probably have included denshering. Within the moorland there are small areas of non-humose Moretonhampstead soils around Berry Pound [713803], at 647860 near Stonetor Hill and at 651898, between Kennon Hill and Shilstone Tor. Denshering seems likely to have also played a role in development of these anomalous patches.

The hedgebanks around most fields are themselves a record of considerable human labour, both in the amount of soil mounded into them and as repositories of many boulders cleared from the fields and incorporated there. Along either side of many hedgebanks there is a barely perceptible, shallow, gutter-like gradient towards the bank, which presumably marks the source of the soil making up most of the bank. Seen in the Tellus Southwest LiDAR images, field boundaries often appear as depressions rather than ridges, showing that such gutters can occupy greater overall areas, than the hedgebanks, indeed they can be double the width [Dr E.C. Freshney *priv. com*].

**Plate 15. Hedgebanks, earthen banks topped by a range of plant species.**

These are the in-bye's predominant field boundaries. Usually about 1.5 m high and of similar or greater width, in places they incorporate rocks and boulders and may have stone facings.

A striking feature of many hedgebanks on sloping ground is their asymmetry, with soil built up on the higher sides and abrupt drops downslope. This is a clear demonstration of downslope soil movement, which most probably came about following cultivation and erosional washing of the soil. This colluvial build up further confirms that, since enclosure, much more of the district has been in arable use than is now the case. Such one-sided banks are present in some woods, revealing their reversion. It has been suggested [Hoskins, 1943] that hedgebanks constitute around 7% of the area of the Devon countryside.

The incorporation of cleared boulders at the time of enclosure would have been achieved by manpower or, at most, using draught animals and must have had limited scope. Occasionally, as during the Napoleonic Wars, activity was greater. With French prisoner of war officers billeted in Chagford, labour was available to build the fine array of field walls at West Combe [683871]. The arrival of machinery encouraged an increase in clearance. This was both through having the means to remove rocks, but also mechanisation of the farm brought about the need for uninterrupted working space for tractors and other machinery.

**Plate 16. The earth forming the hedgebanks was dug from a strip 3 to 4 metres wide, immediately alongside.**

In many cases the evidence, in the form of a linear depression, seems to have survived the effects of cultivation since the construction of the bank in medieval times.

Older farmers talk of fields, where formerly driving in a straight line had been impossible, being converted into usable ground for mechanised hay making, if not for ploughing, once rocks were removed At first somewhat piecemeal, but come the siege economies during the twentieth century's World Wars, boulder clearance intensified. U.S. army engineers, training locally in the 1940s, are known to have used their equipment, including bulldozers, to clear boulders near Mardon Down and North Bovey. The post-war public support of agriculture that continued into the 1970s subsidised boulder clearance and, where needed, land drainage, as part of farm improvement schemes. As a consequence, many fields have lines or mounds of cleared rocks along their downslope edges, or less often as heaps well within the enclosure. Subsequently priorities in the countryside have changed and boulder clearance has largely ceased.

**Plate 17. One-sided hedgebanks are commonplace on many hillsides.**

They are evidence of mixed farming in the past, the colluvial build-up of soil on the banks' upslope sides having come about after numerous years of arable cultivation encouraged soil creep and erosion. Asymmetrical banks are not uncommon in woods, indicating a reversion from farmland.

This is an eye-catching area, which a century ago occasionally attracted wealthy incomers to buy estates and build mansions, as Castle Drogo [723901] and the Manor House [732845], North Bovey [lately Bovey Castle], both constructed then, confirm. Over the last few decades a combination of declining farming activity with fewer youngsters staying in agriculture, rising property prices and increased wealth 'up country', particularly in and around London, has had its impacts on a scale not seen before. Many farms and rural properties have been bought by wealthy non-farmers, few of whom do more than keep a few animals and rent out their grass to the remaining full-time livestock farmers. One such informal tenant in the survey district, among the handful of serious farmers still active in his parish, has 14 such landlords. On the positive side this has led to money being spent on some scale in maintaining and renovating buildings, walls and hedgebanks, excavating lakes and ponds and planting hardwoods. All these provide work for local craftsmen such as builders, thatchers and machinery contractors.

### 1.6.4 SILVICULTURE

In the subsistence economy that characterised much of life in the district for hundreds of years, woodlands had a part to play. Mercer [2009] notes that the acreage of woods in Moretonhampstead is essentially similar now to what the Doomsday survey revealed over 900 years ago. Much oak woodland, usually on steep slopes, was coppiced over the centuries for poles, for bark [a source of tannin], fuel and for charcoal. A clear upshot of centuries of removal of coppice crops was soil acidification, in some places with the accumulation of approaching 30 cm of acidic 'mor' humus, sometimes underlain by ashen, podzolic horizons. This outcome is widely reflected in the heathy vegetation, with *Calluna* and *Vaccinium* growing beneath the trees. How long coppicing was practiced is uncertain. One of its main products, charcoal, must have been in demand for metal working, as soon as smelting or blooming became common practices. While tin working and 'blowing' were specialised practices, working of iron at local smithies would have been an everyday activity, perhaps for many centuries, as it was well into the 20th century. So a strong demand for charcoal would have existed over those years until the Industrial Revolution saw it displaced by cheap coke.

In 1870 the district saw the beginnings of its first extensive commercial plantation of conifers at Heathercombe [719811], Manaton, although on former farmland. Pike [1993] notes that by 1947 the Douglas firs *[Pseudotsuga taxifolia]* there were particularly fine, eventually providing mining timbers for the nearby clay mines in the Bovey Basin. 20th century wartime depletion of timber stocks brought the need to replant former oak coppices, with fast growing conifers the favoured trees. Correspondence by W.E. Hiley, [Dartington Hall Archive] the eminent forester leading replanting by Dartington Woodlands in the Teign Gorge, disclosed their difficulty in establishing tree seedlings in the peaty mor humus, sufficient in places to have a contractor harvest it as horticultural peat. Whether at the time the risk of cropping conifers, with their acid litter, on already degraded, acidic ground was appreciated is uncertain. Recently, restoration of the deciduous woods in the Gorge has begun, which will need to take account of the impoverished and acidic state of many of the soils.

There are conifer plantations on former farmland at various places, near Clifford Bridge [781898] and Bowda [740831], North Bovey, as well as Heathercombe, as examples, where acidification is a more distant prospect. However, much of the land planted by the Duchy of Cornwall, subsequently in Forestry Commission care, in Fernworthy Forest [650830] falls on inherently acidic soils. As well as likely consequences for the chemistry of the soils, and of the water discharging from them, particularly when trees are being harvested, large scale forestry impacts in other ways. Drainage ditches dug to improve the rooting environment have inevitably modified the hydrology and physical properties of basin peat in the forest. Higher in the landscape, where surface wetness is a feature of the soils, sizeable swathes have been deep-ploughed to improve tree establishment and production. In places substantial areas of ground have been disturbed in bulldozing roadways and rides. Heavy machines used in harvesting on wetter sites, both low lying and on and near flat ridge crests, rut the ground, not only compacting the already vulnerable soils, but create channels for the acidic runoff.

The district's largest plantation of nearly 500 ha at Fernworthy predominantly comprises Sitka spruce [*Picea sitchensis]* on Hexworthy / Rough Tor soils [Section 3.6]. Other conifers planted there include Norway spruce *[Picea abies]*, Western Hemlock *[Tsuga heterophylla]*, Lodgepole pine *[Pinus contorta]*, Larch *[Larix* spp*]* and Douglas fir *[Pseudotsuga taxifolia]*. The compartments containing Douglas are confined to freely draining, sloping sites on the lower ground and include well-formed trees, despite their location close to the species' climatic, wetness limit. There are small areas of broad-leaved trees, including beech and a few open areas around ancient monuments. The oldest trees at Fernworthy date from the 1920s, with much of the plantation in its second rotation. The profusion of seed from the Sitka, coupled with soil wetness and acidity inhibiting weeds, means that since the turn of the century natural regeneration of Sitka has taken the place of replanting on the higher, wetter soils.

# Chapter 2 The Soils and Map

## 2.1 THE SOIL PROFILE

The purpose of soil survey is to describe and characterise soils and map their distribution. The unit of study is the soil profile, comprising horizons or layers more or less parallel to the land surface, down to bedrock, little altered unconsolidated material or to 1.5 metres depth, whichever is the shallowest. Soil profiles are observed in purposely dug pits, by augering and by observation of casual exposures. Observations are recorded, with soil horizon designated by letters and numbers in accordance with international usage, as described in the Soil Survey Field Handbook [Hodgson 1976, 1997]. Horizons, and assemblages of horizons with particular properties, which are diagnostic when differentiating soils in the classifications of Avery [1980] and Clayden and Hollis [1984], are defined in Section 2.2 below. Horizons recognised in this survey are noted below in Section 2.1.1. They are usually identifiable in the field, though precise identification sometimes depends on laboratory data. Soil colours are described using the standard Soil Color Chart [Munsell Color Company, Baltimore, Maryland, USA or Oyama and Takehara, Japan].This is done by recording the *hue* [for example 10YR], followed by the *value* and *chroma* separated by a solidus, [for example 5/4], with names attributed to particular combinations, as an example 10YR 5/4 being designated *yellowish brown.*

### 2.1.1 SOIL HORIZON NOTATIONS

*Litter layers*

L Fresh, little altered litter accumulated during the previous annual cycle.

*Organic horizons*

F Partly decomposed plant remains from earlier years in which some original plant structures can be recognised with the naked eye.

H Well decomposed litter often mixed with mineral soil, in which the original plant structures cannot be seen.

O Peaty horizon accumulated under wet conditions.

- Of Horizon composed of mainly fibrous peat. Normally H1-3 in the version of the von Post [1924] scale of decomposition modified by Hodgson [1997] p 24.
- Om Horizon composed of mainly semi-fibrous peat, H4-6 in the modified von Post scale.

Oh Uncultivated horizon in which the organic fraction is mainly amorphous and is termed humic peat [H7-10 in the modified von Post scale].

Op Peaty surface horizon mixed by cultivation. The organic matter is mainly amorphous.

*Mineral horizons*

A A mineral horizon at or near the surface with incorporated humified organic matter.

Ah Uncultivated humose or distinct horizon, often dark coloured and containing more than 1 per cent organic matter [0.6 per cent organic carbon] if the soil were mixed, as during ploughing, to 15 cm depth.

Ap Surface horizon evidently mixed by cultivation.

Ahg As Ah above but with common or many ferruginous mottles caused by reduction and segregation of iron due to periodic saturation with water. Mottles are normally associated with root channels.

E Light-coloured subsurface mineral horizon depleted of organic matter, sesquioxides and /or silicate clay.

Ea E horizon without ferruginous mottles and lacking well developed coats on sand and silt particles.

Eg E horizon with greyish colours and ferruginous mottles caused by reduction and segregation of iron during periodic saturation with water.

Eag E horizon with Munsell chroma of 2 or less and few or no ferruginous mottles as occur in an Eg horizon; often lies between an O horizon and a Bg, Bf or Bs.

B Altered mineral horizon without rock structure, distinguished from A or E above and C below by colour, structure or particle-size class [distribution of mineral soil particles formed by weathering of parent material *in situ* or by illuvial concentration] or by some combination of these features.

Bf A sharply defined black or reddish brown, brittle or cemented B horizon less than 0.5 cm thick and enriched in iron, carbon and often aluminium. It is generally referred to as an ironpan.

Bg B horizon with colours resulting from the reduction and segregation of iron caused by periodic saturation with water [*gleying*]. Peds are blocky or prismatic with greyish colours and common or many ferruginous mottles.

Bh Dark coloured [moist Munsell value and chroma 3 or less] B horizon at least 2.5 cm thick and containing translocated organic matter which coats sand grains.

Bs A brown or more often ochreous [Munsell chroma of 6 or more] B horizon with accumulated sesquioxides of iron and aluminium, having more than 0.3% pyrophosphate extractable Fe + Al, amounting to more than 5% cent of the clay content.

Bw A brownish horizon of oxidative weathering.

C Unconsolidated or weakly consolidated mineral horizon retaining rock structure and little altered except by gleying and fragipan properties.

Cu Unconsolidated horizon without evidence of gleying or fragipan properties.

Cr Weakly consolidated, little altered bedrock.

Cg C horizon with greyish colours resulting from reduction and segregation of iron caused by periodic saturation with water. Ferruginous mottling can be present as coats on skeleton grains or as tubules associated with root channels.

Cx An additional lower case suffix used for a horizon with *fragipan* characteristics i.e. uncemented, compact and dense [Sol Survey Staff 1975].

R More or less continuous hard or very hard bedrock.

Horizons transitional in character are indicated AB, BC, etc. with the appropriate suffixes e.g. BCg as required. Where two horizons qualify for the same designation, an Arabic numeral is added thus; Bg1, Bg2. Some profiles are in stratified parent material. Horizons comprising the uppermost parent material are not specifically designated in profile descriptions, those comprising succeeding layers are prefixed 2, 3 etc. consecutively with depth.

Six example profiles in Sections 3.2.2, 3.9.2, 3.15.2, and 3.16.2 of Chapter 3, described by Clayden [1964, 1971] prior to Hodgson's versions [1976, 1997] of the Field Handbook, follow the methods of Soil Survey Staff [1960]. This involves some differences in the original descriptive terminology. Where appropriate and supported by laboratory measurements, for example with particle-size analyses, conversion to Hodgson's terminology has been carried out.

### 2.1.2 SOIL FORMATION

Soil formation takes place on the parent materials which, in the study area, comprise granite, slates, mudstones, shales and sandstones of differing degrees of coarseness, along with their weathering and re-distribution products. Cold episodes in the Pleistocene, which ended about 10,000 years B.P., provided conditions favouring both physical weathering, which formed *regolith* [rock detritus], and the re-distribution and transportation of that material. With climatic amelioration after the Pleistocene, the redistribution of regolith largely ceased. Weathering has continued, but with a greater emphasis on chemical actions, and with the stabilisation of the land surface, distinctive soil forming processes got underway.

**Weathering** encompasses a range of processes, the most important of which in the study area are:

a] *mechanical breakdown* into smaller and smaller fragments of the parent rocks *in situ*. Much of this is brought about over long periods by the action of freezing and thawing. Further comminution of the regolith occurs during its transport and redistribution by water, or by solifluction, or by gravity acting alone. In some circumstances biological agents, particularly plant growth, play parts in the breakdown and movement of soil material and rocks.

b] *physical weakening of rocks by the chemical alteration* of their constituent minerals under the influence of both rain [which is very slightly acid] and the acidic components released by decaying organic matter, particularly from ericaceous plants, also by the metabolic products of *Sphagnum* growth. In the study area, this applies particularly to the large feldspar crystals and the micaceous minerals that are major components of the granite.

c] *chemical weathering per se*. As noted in b], the parent materials of the study area have been and are affected by acidic inputs from natural sources, certainly since the end of the last, Devensian, glacial stage. Minerals react to acidic inputs by releasing so-called basic ions [sodium, potassium and calcium dominate in the minerals of this mapped area]. This release of basic ions can maintain the pH of the weathering zone at reasonably high values [above about 5], the so-called ‘buffering effect’, for quite long periods if there is a sufficient store of such minerals. However, once the buffering from this store is exhausted, the pH can drop significantly [to around 4.5 to 4] and other ions such as iron and aluminium will be released. There is also evidence that similar processes went on at times under subtropical climates before the Pleistocene and during interglacial episodes, some of this material being still present in the landscape. Within the study area, there is the additional factor that some chemical weathering also occurred due to the acidic nature of the hot water and gases associated with the emplacement of the Dartmoor granite pluton and related mineralisation. This kind of chemical attack on the feldspars in some parts of the Southwest has been responsible for the extensive development of deposits of kaolin.

**Transportation and re-distribution** of the regolith, once it is weathered, either by comminution or softening, proceed by a number of mechanisms.

*Solifluction* has been the most important of these. Under Pleistocene periglacial conditions [see Section 1.4.2] solifluction and cryoturbation formed head, the principal parent material of the survey area. It is made up of regolith, mixtures of fine earth, stones and boulders which occur variably as confused melanges, in places almost stoneless, elsewhere with bedding, in layers from a few centimetres to several metres thick. Granite-derived head is commonly termed *growan* in the Southwest, particularly when few boulders are present.

**Plate 18. A wind-thrown oak still holding large granite boulders in its root ball.**
The largest boulder to the right of the auger handle is at least 1 m above the ground. Bioturbation of the soil can take place on this dramatic scale, or more subtly by 'Darwin's plough', as shown in Plate 20.

Other mechanisms *transporting* and *reorganising* regolith are more restricted in their distribution and effects. Material riven from rock faces fall and form screes or clitter spreads, which are important in some localities. Alluvial material along floodplains is eroded and redeposited as rivers and streams meander and gradually change their courses, while scour channels are evident on some floodplain sections. Some redeposition of sediment takes place within the stream channel, some across the floodplain. In the latter sites coarser, usually sand-sized material is deposited close to the watercourse on weak levees, the finer grained clay and silt in backlands further away from the river. The widespread working of tin deposits in this district was an additional source of sediment to streams and floodplains. On slopes, freezing and wetting / drying both tend to displace regolith perpendicularly to the surface. Any compensatory return movement, as when an ice crystal thaws, is, however, vertically due to gravity, and the net movement is a downslope creep, which can affect both fine earth and boulders. In severely eroded parts of the blanket bog scouring of gully floors causes localised working of the regolith.

Plants and animals can play parts in disturbing regolith. Wind-throw of large trees redistributes quantities of soil material and can also result in the raising of sizeable boulders held in their root balls, as in Plate 18. Burrowing animals too, from earthworms [Plates 19 and 20] to badgers and foxes, have visible, often extensive, effects.

**Soil forming processes.** Following the Holocene or post-glacial geomorphological stablilisation of most of the district's land surface, the regoliths have been subjected to a number of biological, chemical and physical processes, including:

1. addition and accumulation of plant residues.
2. biological activity, bioturbation [the disturbance of weathering rock and soil by growing plant roots and burrowing animals], secretions by biota, ingestion and excretion of fine earth and plant residues by fauna.
3. solution and / or [re-]deposition of mineral components, hydration, oxidation and / or reduction of some chemical elements, especially iron, hydrolysis and physical comminution.
4. processes involving the downward movement in percolating water of dissolved or suspended material, e.g. leaching, podzolisation and mechanical movement of very fine particles [eluviation].
5. gleying, which involves mobilisation and redistribution or removal of compounds, particularly of iron, under anaerobic conditions associated with waterlogging.
6. aggregation of fine earth into soil structures replacing fine stratification or structure of geological origin.

Importantly, these soil forming processes are influenced by factors, including the kind of parent material and external influences, the environment, [comprising climate, vegetation and hydrology], the age and stability of the site and the activities of man. These factors have interacted with the listed biological, chemical and physical processes to produce the different soils described in Chapter 3 and delineated on the accompanying map. In many soils the soil forming processes also proceed concurrently and add further levels of interaction. It will be helpful to consider the more important of these interactions' contributions in the formation of soils across northeast Dartmoor. This will also form a useful context for Section 2.2 below on the soil classifications of Avery [1980] and Clayden and Hollis [1984] used in this survey.

**Plate 19. Earthworm castings on permanent pasture.**

*Addition and accumulation of plant residues.* Once vegetation has established a cover on soil, the remains of dead plants either accumulate or are incorporated into the soil by the action of earthworms and other soil fauna. Perennial waterlogging and low temperatures, along with strongly acid soils, retard the breakdown and incorporation of residues, so that organic matter accumulates. In the higher and wetter western parts of this survey area and in many basins, thick peat has formed under hydrophilous vegetation, dominated by plants such as *Sphagnum* and *Molinia.* Elsewhere thinner peats or organic-rich mineral horizons have formed under heath, grassland or woodland, some compounded by wetness, some freely draining, although strongly acidic.

Peat develops under prolonged, often perennial, wet situations where decomposition of plant remains is prevented or inhibited due to oxygen-poor conditions brought about by almost permanent waterlogging. The wetness comes about through high rainfall, through groundwater issuing from the granite along springlines in basins or as more isolated 'eyes', while the very presence of peat acting like a sponge can compound climatic and hydrological influences. Acidity from rainfall, plant litter and the mineral soil, also plays a part. The extent of decomposition varies, being slight in *fibrous* peat, [usually described as Of horizons, as in Section 2.1.1 above] which retains recognisable plant structures, but is more advanced in *humified*, amorphous peat [Oh horizons in Section 2.1.1], which lacks them.

**Plate 20. Topsoil in an old permanent pasture on Moretonhampstead series.**

The 6 cm of surface soil, unlike that below, is devoid of small stones, a product of decades of earthworm casting, sometimes referred to as 'Darwin's plough'.

Gradient plays its part in peat formation. Even in the highest, wettest parts of Dartmoor blanket peat does not normally develop on slopes above about $12^{O}$. Details of slope measurements on the moorland blanket and basin peat soils are in Chapter 5.

On Dartmoor the highest, thickest peat, the Winter Hill unit of the soil map and Section 3.10 below, is dominated by fibrous peat, with the more marginal parts of the blanket bog being mostly humified peat of the Hepste map unit [Section 3.11].

It should be noted here that in mapping the Soil Survey's convention of peat soils' arbitrary limiting thickness at 40 cm has been applied. Thinner peat horizons are treated as parts of mineral soils. Downslope from the blanket bog such thinner surface horizons of humified peat have formed widely on the Hexworthy / Rough Tor [Section 3.6 below] and Princetown soils [Section 3.8] at lower levels on the moorland, also on Laployd soils [Section 3.9] on the in-bye, confirming that peat formation is not solely a product of overwhelming wetness, that acidity plays its part. Soils do occur having podzolic horizons beneath humified peat thicker than 40 cm, as commented in the footnote to the example profile in Section 3.12.2 and shown in Plate 34.

There are different processes operating in the formation of the peat, while some alteration of the blanket bog's fringes may have taken place after the peat formed. On the one hand the remains of *Sphagnum* and *Eriophorum* accumulate largely undegraded, mostly higher on the blanket bog, on the other humification of plant remains is more often the rule at its lower levels. Humification may be a natural development to the peat bog, perhaps caused by long-term climatic change affecting the bog's more vulnerable fringe. Alternatively erosion, whether spontaneous or encouraged by man's actions, along with peat cutting, both compromising peat hydrology etc., may be part of this story.

Gullying of the peat by erosion inevitably alters its hydrology from a state of perennial waterlogging in pristine sites to a more complex and intermittent wetness, depending on the erosion's depth, extent and proximity. Peat cuttings have similar effects. As can be seen along the walls of erosion channels and peat workings, drying then follows, along with weathering and humification of preserved plant fibres, accompanied by an increase in the bulk density of the peat, with commensurate reduction of porosity and water holding capacity. Chemical changes also ensue, notably the ratio of carbon : nitrogen is reduced where humification is advanced. Oxidative loss of carbon is a further aspect. Where the drying and humification is most advanced angular blocky structural aggregates develop. None of these changes are reversible.

In contrast, on some freely draining soils on the in-bye, peaty and organic-rich soil horizons have formed where acidity alone is the cause. The associated vegetation is heath, acid grassland, bracken and gorse on downland, old woodlands and coppices. The soils of the in-bye can be considered to have originated under deciduous forest. There the annual autumnal fall of leaves produced characteristic soil horizons with freshly fallen litter [L horizon in Section 2.1.1] overlying a few cm of material in the process of being broken down by soil fauna and other biological agencies [F horizon], in turn resting on a seam of well-rotted humus [H horizon]. Together these horizons are often 10 or 15 cm thick over mineral horizons, although considerable variation does occur. In the example profile in Section 3.4.2, the humus is described as 3 cm of black, humose sandy silt loam, whereas other soils have thicker organic-rich tops, notably the Willingstone series [Section 3.22.2], which has 27 cm of peat above the mineral soil, along with Moor Gate [Section 3.5.2] and Drogo [Section 3.20.2] series.

*Leaching, oxidation and podzolisation.* Once chemical weathering has begun, percolating rainwater releases basic ions into the soil solution, then leaching moves them down the profile, or laterally from it. Less soluble weathering residues, such as quartz, and notably ferric iron oxides, at least in all but the most acidic environments, remain despite leaching. The importance of ferric oxides is that in well aerated, and in all but very acid soil horizons, they impart the uniform brownish or reddish colours [Bw or Bs in Section 2.1.1] indicative of free drainage and thorough aeration that characterise the most extensive subsoils of the in-bye of this district.

Where acidic humus accumulates, particularly that associated with heathy vegetation, podzolisation can result. In this organic acids from the humus [H or O horizons] react with iron and aluminium in the soil and their mobile complexes migrate down the profile, leaving a bleached, greyish horizon [E in Section 2.1.1] which is depleted of iron and aluminium. Lower in the soil precipitation produces relative diffuse horizons enriched in iron and aluminium [Bs in Section 2.1.1], which are usually ochreous in colour, in others with translocated humus [Bh in Section 2.1.1], or as a thin ironpan [Bf].

Bs horizons typically are ochreous in colour, are often of loose or weak soil strength, sometimes being described as having ‘fluffy’ consistence. They can be diagnostic of the podzolic soils major soil group of Avery [1980]. They can form in soils with or without the bleached E horizon characteristic of many podzolised soils. Where overlain by an E horizon the implication is that some at least of the iron and aluminium in the Bs is derived by leaching from above. In the absence of an E horizon the Bs may be a product of *in situ* formation of iron and aluminium compounds meeting Avery’s chemical definition [given in Section 2.1.1]. His definition applies to many, but not all, ochreous profiles without E horizons above them. Those with insufficient iron and aluminium qualify as Bw horizons, soils lacking Bs horizons falling in the brown soils major soil group [Section 2.2]. Many Bw horizons have drabber brown, less ochreous colours, still characteristic of the *in situ* oxidative weathering of ferric iron.

*Gleying.* Waterlogging, by excluding air, results in distinctive soils, as iron compounds are chemically reduced, mobilised and removed or segregated. These reduced [ferrous] forms of iron are grey or colourless. Seasonal or periodic aeration allows some re-oxidation and localised development of yellow and ochreous colours, giving gleyed soil horizons their characteristic mottling, [signified in Section 2.1.1 by the suffix g to major horizon notations A, E, B or C]. Gley soils can form in permeable materials where there is groundwater [ground-water gley soils], or where surface water drainage is impeded by impermeable horizons [surface-water gley soils]. The predominance of surface wetness is emphasised by the use of the stem 'stagno' in groups and subgroups of Avery's [1980] soil classification, not just in stagnogley soils, but also among podzolic and brown soils. In wetter sites surface horizons with humus or peat accumulations are termed humic gley soils and stagnohumic gley soils; less gleyed soils in drier locations are termed gleyic and stagnogleyic.

Over much of England and Wales soils with very slightly porous soil horizons [with air capacity of less than 5%] are treated as impermeable in soil classification. This cut-off is generally mirrored morphologically by gleying in stagnogley soil classes. The Princetown series [Section 3.8 below] displays such morphology consistent with stagnohumic gley soils, but has measurements of air capacity in its Bg horizon of 16.4%, classed as very porous Hodgson [1997, p50]. Here the high amounts of precipitation are unable to drain through the relatively porous profile fast enough to prevent significant waterlogging, and hence the development of stagnogley morphology. The presence of surface peat horizons may compound the reducing conditions. A climatic threshold appears to have been crossed, the analogy of a quart into a pint pot coming to mind.

## 2.2 SOIL CLASSIFICATION

Soil profiles are classified into categories according to the arrangement and kinds of horizons present. These horizons are defined by properties which can be observed or measured in the field, or inferred by reference to analysed samples. Excluded as differentiating characteristics are ephemeral features such as thin surface horizons readily destroyed or altered by cultivation, or chemical properties which cannot be measured in the field and can change significantly in a relatively short time. The system of classification used is that described by Avery [1980] in which soil profiles are classed together as *major soil groups,* subdividing into *groups* and then *subgroups,* each named using words describing features which distinguish them. Within subgroups *soil series* are defined following Clayden and Hollis [1984], as soils having the same combination of parent material [*substrate type*], particle-size distribution *[textural grouping]* and mineralogical properties.

Soil classifications, as following Avery [1980] and Clayden and Hollis [1984], apply with precision to individual profiles of a cubic metre or so. The defining properties of the higher categories, down to soil subgroup level, are set out in Section 2.2.1 below, those for soil series definition are in Section 2.2.2. Examples include the critical cut-off at 40 cm for the presence or absence of gleyed horizons that separates brown soils from gley soils, the threshold of organic carbon content that distinguishes humic soil groups and subgroups, or the 40 and 80 cm depth limits on mineral and peat soils being designated as 'over lithoskeletal'.

Conventionally soil series are given a geographical name indicating the place where they were first described or are commonly found. In the current survey examples with local origins are the Moretonhampstead and Princetown series, while Winter Hill and Denbigh series are from further afield. As soil surveying extended across the country and classification became more precise it became necessary for Clayden and Hollis [1984] to amalgamate some soil series concepts. A rule equivalent to primogeniture was followed. Consequently the concept of the Dunsford series, established in Devon by Clayden [1964], was merged into the Denbigh series originated by Ball [1960]. Although in this survey Avery's [1980] classification is followed, the modifications established by Hollis [1991] have been incorporated regarding soils in disturbed ground and urban areas. The properties of the relevant higher categories, Avery's major soil groups, soil groups and subgroups, are now described, followed by criteria for differentiating soil series within subgroups set out by Clayden and Hollis [1984].

### 2.2.1 HIGHER CATEGORIES OF SOIL CLASSIFICATION

**Major Soil Group – Lithomorphic soils**

These soils have a distinct, humose or peaty topsoil over a little-altered mineral substrate [C or R horizon] starting at or within 40 cm depth, and no diagnostic B horizon. They are found scattered throughout the district and mixed with deeper soils with brown or ochreous Bs and Bw horizons and within areas mapped as *Rock Dominant*. Some occur among both surface- and ground-water gley soils and in eroded or cut-over sites on the peat soils. C horizons are usually in stony head, with R horizons formed where *in situ* rock approaches the surface.

*Group - Rankers* Loamy, non-calcareous shallow soils; *humic* [with peaty or humose soil] and *brown rankers* being present locally as minor components of many map units.

**Major Soil Group – Brown soils**

Brown soils predominate in the extreme northeast of the district, in a small area south of Lustleigh and sporadically on river floodplains. They have a brownish A horizon over a weathered Bw and have no diagnostic gleyed horizon at 40 cm or shallower.

*Group – Brown earths* These are loamy or clayey with a brownish, friable subsurface Bw horizon with no horizon of translocated clay. The *typical brown earth* subgroup is brownish throughout the profile, with little or no mottling within 70 cm depth. The usual arrangement of horizons is A, Bw, BC and C or R. A common variation in such soils in this area is the development of brighter, ochreous colours in the B horizon, along with well-developed fine granular structure and 'fluffy' consistence and greasy feel, all features analogous to those in the Bs of podzolic soils described below. However, such horizons often fail to meet the chemical requirements for Bs horizons [pyrophosphate extractable iron and aluminium greater than 5% of the clay content] and are treated as Bw in consequence. Brown earths with gleyed horizons with mottling below 40 cm have A, Bw, B[g] or Bg and BC[g] or BCg horizons. They are in the *gleyic brown earths* subgroup when relatively pervious, or s*tagnogleyic brown earths* if impermeable horizons occur.

*Group – Brown alluvial soils* These differ from brown earths, being formed in loamy alluvium more than 30 cm thick. *Typical brown alluvial soils* have brown A, Bw, Cu and 2C horizons with little or no mottling above 70 cm and river gravel at depth. *Gleyic brown alluvial soils* have gleying below 40 cm, indicating a free watertable low in the pervious profile at wet times. Typical horizons are A, Bw, Bg or B[g], Cg, 2C.

**Major Soil Group – Podzolic soils**

Podzolic soils, the district's most extensive major soil group, are characterised by the presence of a podzolic B horizon in which aluminium and / or iron have accumulated in amorphous forms, sometimes associated with organic matter. An overlying peaty or humose topsoil or bleached subsurface horizon, or both, may or may not be present.

*Group – Brown podzolic soils* These are loamy or sandy soils with friable, at times 'fluffy', ochreous or brownish subsurface Bs horizons beneath the surface A horizon. The *typical brown podzolic soils* subgroup has a brownish topsoil with little or no mottling in the upper 70 cm, indicating unimpeded drainage. The subgroup *humic brown podzolic soils* differs in having a dark, humose A horizon. While the ochreous, fluffy subsoils often have the chemical characteristics of a podzol Bs horizon [pyrophosphate extractable iron and aluminium greater than 5% of the clay content], there is not a consistent relationship of colour and Bs chemistry. Horizons not meeting that criterion are Bw rather than Bs, so such a soil might be better regarded as a typical brown earth.

*Group – Podzols* Well drained, podzolic soils with a bleached subsurface horizon thicker than 5 cm. Such soils are of very limited extent here, being represented by the humo-ferric podzol subgroup with a thin seam of accumulated humus between the bleached Ea horizon and the brightly coloured, iron-rich podzol Bs horizon.

*Group – Stagnopodzols* There are indications of wetness in the upper part of these soils, taking the form of peaty or humose topsoils and a gleyed E horizon. These rest over a thin ironpan or Bs horizon, in turn formed over a BC horizon. Two subgroups are widely developed, one *ferric stagnopodzols* with the horizon sequence of Oh or Ah, Eag, Bs, BC and *ironpan stagnopodzols* with a thin, continuous ironpan on the Eag / Bs boundary.

**Major Soil Group – Surface-water gley soils**

These are non-alluvial soils with an impermeable horizon at least 15 cm thick starting above 80 cm depth, which impedes natural drainage. A diagnostic gleyed subsurface horizon is present within 40 cm and any pervious Cg horizon affected by free groundwater is absent.

*Group –Stagnogley soils* Profiles have distinct [with relatively small organic matter content] topsoils and are gleyed within 40 cm of the surface. Typically assemblages of horizons are Ag, Bg, BCg. The *pelo-stagnogley soils* subgroup has clayey horizons, while that of the *cambic stagnogley soils* comprises profiles without clay-enriched subsoils.

*Group – Stagnohumic gley soils* Soils of this group have a peaty or humose topsoil. In this district they are represented by the *cambic stagnohumic gley soils.* These mostly form on gentler sites on the moorland, downslope from the blanket bog where peaty topsoils are less than 40 cm in thickness. Profiles often become browner at depth, with a usual array of horizons of Oh or Op, Eag, Bg , BC[g].

**Major Soil Group – Ground-water gley soils**

Diagnostic gleyed subsurface horizons form within 40 cm of the surface of these permeable soils, which overlie a shallow, fluctuating groundwater-table. They have humose or peaty, occasionally distinct topsoils, no podzolic B and no slowly permeable subsurface horizon. They form in concave basins across the granite outcrop away from the high moorland and on floodplains.

*Group – Alluvial gley soils* Formed on floodplains in Recent alluvium at least 30 cm thick, these soils often overlie gravel. Most common is the loamy *humic alluvial gley soils* subgroup with Oh, Ag, Bg, 2Cg horizons, at lower altitude the Oh often giving place to an Ahg horizon.

*Group – Humic gley soils* Loamy non-alluvial soils with peaty or humose topsoils over pervious, diagnostic gleyed horizons, which have a usual profile with Oh or Ah , Bg, BCg and Cg horizons.

**Major Soil Group – Peat soils**

These soils are composed of at least 40 cm of peat, formed under waterlogged conditions, both as blanket bog at higher altitudes, and in spring-fed basins on lower ground. Peat has been cut for fuel in both types of sites, while in places the blanket bog has suffered erosion.

*Group – Raw peat soils* Soils of this group have unripened topsoils developed in oligotrophic [with pH below 4] peat, composed of the remains of *Sphagnum* spp*.* and *Eriophorum* spp*.* Two subgroups are represented in this district. The *raw oligo-fibrous peat soils* subgroup is fibrous or semi-fibrous in the reference layer, i.e. between 30-90 cm beneath the surface. The *raw oligo-amorphous peat soils* subgroup has an amorphous layer at least 30 cm thick in the reference layer. Where the peat is less than 90 cm deep, which is not uncommon within mapped areas of the latter subgroup, the reference layer is truncated accordingly.

**Made-ground soils and Man-modified soils**

Hollis' [1991] proposals for the classification of soils in urban areas involves a revision of Avery's major soil group 9 [*man-made soils*], which is now termed *made-ground soils*, with an 11$^{th}$ major soil group created as *man-modified soils*. Avery's soil group 1.5 [*man-made raw soils*] is removed from the *terrestrial raw soils* major group and is incorporated in made-ground soils.

*Major group – Made-ground soils* Soils formed in a significant thickness of either artificial, man-made material or former soil material or geological substrate that has undergone mechanical removal, transport and replacement make up this major group. Included are the *dense* and *well-aerated* subgroups of the *Raw made-ground soils* group.

*Major group – Man-modified soils* This major group comprises soils with characteristics drastically modified by human disturbance or the addition of material. Three soil groups are represented: *truncated soils, disturbed soils* and *deepened soils,* each by a single subgroup. These are *raw acid humose truncated soils, disturbed raw skeletal gley soils* and *compost-deepened soils.*

**Rock dominant**

Bare rock occurs across the district as outcrops of *in situ* granite forming Dartmoor's iconic tors. These are found not only on the moorland, for example Kes Tor [666833], but in the lower eastern parts, both prominently, as at Heltor Rock [799870], and concealed in woodlands. However, boulder-dominated aprons of loose clitter below tors, or quite separate from the tors, are more extensive, if visually less striking. On the metamorphic aureole, there are tors and crags of resistant hornfels and other altered sediments, such as Sharp's Tor* [729899], while much of the lower slopes along the north side of the Teign Gorge are cloaked with angular scree.

*Shown on the O.S. map as Sharp Tor. Traditional local use [G.H.V. Scott and D. Hawke *personal communications*] is for Sharp's Tor. This form is also preferable as it distinguishes this outcrop from Sharp Tor at 686729. Similarly the locally favoured term for the nearby feature at 722898 is Hunt's Tor rather than the Hunter's Tor of the O.S.

### 2.2.2 DIFFERENTIATION OF SOIL SERIES

**Nature of the parent material**

There are six broad types of parent material [*substrate type*] recognised nationally, with subdivision according to lithological or, in the case of organic soils, botanical properties, within specified depths. In this district only *lithoskeletal* [those with bedrock or very stony rubble within 80 cm] and *peat* substrates are important.

Soils with lithoskeletal substrates are either:

*Lithoskeletal* in which at least half of the upper 80 cm of the profile is angular skeletal material or bedrock [i.e. normally very or extremely stony material or rock is present by 40 cm depth]

*Over lithoskeletal* where angular skeletal material or bedrock makes up less than half of the profile's upper 80 cm [normally having very or extremely stony material or rock only below 40 cm depth]

Of limited extent in the survey area are mineral soils in other parent material types. They are: soils *passing to soft weathered rock* and soils in *river alluvium*.

Among mineral soils further division is based on the lithology of the stones or bedrock, [lithological grouping]; those occurring locally are:

*acid crystalline* [granite]

*soft weathered acid crystalline*

*shale / slate / mudstone / sandstone* [on the Carboniferous]

*river alluvium*

Peat subtypes present in this survey are:

*mixed* Eriophorum *and* Sphagnum *peat*

humified peat

humified peat over lithoskeletal material

**Textural characteristics**

The texture [particle-size distribution] of the soil material [*textural grouping*] is defined by the predominant or 2 main contrasting textural groups within standard reference depths. Groups occurring locally are:

*loamy*

*coarse loamy*

*fine loamy*

*clayey*

**Distinctive mineralogy or colour**

Soils with distinctive *mineralogical properties* are unimportant in this survey area.

### 2.2.3 DISCUSSION

The land's cover of soil is largely a continuum, on which soil classification places appropriate, sometimes arbitrary, boundaries. Consequently, some soils with morphological similarities can be placed in different major soil groups, groups, subgroups or soil series. There are several relevant arbitrary limits which affect this survey. They include the thickness and depth of horizons, soil colour, including gleying and mottling, texture or soil particle-size, the composition of peat, chemical properties such as organic matter content and pyrophosphate iron and aluminium amounts.

A depth limit of 40 cm is relevant in several instances. It separates peat soils from mineral soils, so that a soil with a peaty top underlain by a bleached subsurface, an ironpan and a brightly coloured subsoil qualifies as a stagnopodzol, provided the peat is less than 40 cm thick. Should the peat exceed that thickness, it is classified as a peat soil, regardless of its podzolic features. Whether a gleyed horizon occurs above 40 cm or not, is diagnostic in differentiating ground-water and surface-water gley soils from gleyic and stagnogleyic subgroups of the brown soils major soil group. The cut-off at 40 cm also distinguishes lithoskeletal profiles from those *over* lithoskeletal material. In the typical brown earth subgroup of soils with lithoskeletal mudstone, shale, slate or sandstone parent material lithology, the Bridford series [Sections 3.15, 3.16 and 3.17 of Chapter 3 below] is lithoskeletal. It has more than 35% stone and rock above 40 cm, whereas the Denbigh series [Section 3.18] is over lithoskeletal, very stony material being confined below 40 cm. Locally, in this instance, the differences largely reflect the lithology of the underlying rocks. Bridford soils are over rocks hardened in the metamorphic aureole of the granite, Denbigh soils being on less altered Carboniferous shales and sandstones.

A critical content of topsoil organic carbon distinguishes humic subgroups from typical subgroups in a number of major soil groups. The most widespread example in this district involves the humic brown podzolic soils of the Moor Gate map unit [Section 3.5] and the typical brown podzolic soils of the Moretonhampstead map units [Sections 3.2, 3.3 and 3.4].

The chemical distinction between Bs and Bw horizons, based on pyrophosphate extractable iron and aluminium greater than or less than 5% of the clay content, is important. The available chemical analyses distinguish at major soil group level typical brown podzolic soils, the Moretonhampstead series [Section 3.2.2], from typical brown earths of the Bridford series [Section 3.15.2], despite their close morphological resemblance. A further twist to this is expressed on some of the Old Woodland phase of the Bridford series [Section 3.16.2]. There centuries of coppicing has acidified the soils, producing thin bleached seams above the soil's Bw horizon, described, in Section 3.16.3 below, as micropodzol features. Where this seam, or Ea horizon, exceeds 5 cm in thickness the profile has the morphology of soils of the podzol soil group.

## 2.3 THE SOIL MAP

The aim of soil mapping is to delineate, across the landscape, discrete areas, termed *soil map units*, in which particular soil series predominate. This is done in terms of the soil classification outlined in Section 2.2 above. Soils are mapped by observing how their distribution relates to the, at times complex, interactions of soil forming processes [described in Section 2.1.2] with landforms, geology and geomorphology, hydrology, vegetation and land use in the survey area. Initial observations in purposely dug pits, in casual exposures and by augering provide hypotheses concerning those relationships, which are tested across the district as the survey proceeds. That is done using auger and spade observations and exposures, supplemented by indicators from the lie of the ground and from vegetation. It then becomes a matter of mapping out facets of the landscape with particular soil properties, what the layman might recognise as ‘soil types’, and drawing boundaries where important changes occur, to delineate *soil map units*. As well as assiduously and systematically walking the ground, the soil surveyor also draws on any information available from geological and other thematic maps and from aerial and satellite photography.

Soil features critical to the soil surveyor are the arrangement of horizons [layers] within the top metre or so, particularly their thickness, colours, texture [particle-size of the fine earth fraction], organic matter content and stoniness. Soil colours are particularly helpful in indicating soil forming processes and overall hydrology. For example uniformly brown horizons are inherently freely draining and well aerated, whereas mottling and greyish colours signify the anaerobic soil conditions brought about by persistent waterlogging.

Conventionally soil map units are named after their dominant soil series; units without a single dominant series are labelled appropriately e.g. Hexworthy / Rough Tor. Soil variability is such that units usually include a proportion of subsidiary soils differing from the main series mapped, reflecting geomorphological, hydrological and pedological changes at scales too small to be represented by mapping. Such heterogeneity is part of the natural landscape, analogous to the range of species in a plant community, such as an oak woodland, where perhaps birch and holly also may be growing, rather than the uniformity of a wheat field or Sitka spruce plantation. Added to that natural variability are limitations imposed by the map scale, where small inclusion of other soils are present but are too restricted to be shown on the map.

Soil map units can be subdivided where necessary into *phases* on the basis of particular properties of the soil or site. A *variant* is recognised where a soil differs from a defined soil series by some feature of taxonomic significance, but is not sufficiently extensive to merit separation as a named series.

The map legend shows the classification of the dominant or co-dominant soil series of each map unit, along with summary descriptions of the map units. Soil series classification is by soil group, soil subgroup and definition in terms of textural grouping and parent material [substrate] type. Each map unit's characteristics are listed, along with its geology, landscape position and soil water regime. In this survey a steep phase [slopes greater than 11$^{O}$], phases of boulderiness and erosional phases for fibrous peat soils, are also mapped on the supplementary terrain phases map.

## 2.4 SOIL MAP UNIT DESCRIPTIONS

The descriptions in Chapter 3 provide information on the composition of each unit delineated on the soil and terrain maps, its main soil and minor constituents, along with their economic, ecological, environmental and other functions. The soil map unit descriptions follow a consistent numerical notation and sequence of headings. The terminology, including that used in profile descriptions, is that of the Soil Survey field handbook [Hodgson 1976, 1997]. Each soil map unit description is arranged as follows:

**3.N. SOIL MAP UNIT NAME [with its symbol on the soil map]**

3.N.1 A general statement is made on the main soils of the map unit.

**Distribution and site:** Areal extent and geographical location are stated with the range of slopes and elevations.

**Land cover:** A brief description of the principal crop[s] or vegetation type[s] of the map unit.

**Component soils:** The main and subsidiary soils are stated by frequency of occurrence of series, variants and phases using the following scale:

*0-15% rare, 15-30% occasional, 30-45% common, 45-60% frequent, 60-75% abundant, >75% dominant.*

3.N.2 MAIN SOIL

The name of the main soil series is given with its soil subgroup and the specifications of its textural grouping and parent material [substrate] type, which define the series in a national context. Also note is given of its previous use.

**Generalised soil profile:** The profile morphology is described by horizons with their most commonly occurring depth limits. Details are given of the range of colour, particle-size class, stoniness, structure and consistence.

**Example profile:** An example is given of the most commonly occurring profile class or classes within the map unit. The profile number is based on the six figure National Grid reference for the site. The index letters and numbers of the 1:25,000 Ordnance Survey [O.S.] sheet are followed by a solidus and then the ordinates of the site, within that O.S. map sheet, e.g. SX68/2837 [cp National Grid reference SX 628837].

**Analyses:** Data on the main physical and chemical properties of the example profile are tabulated.

*Comment:* Notes are given on the significance of selected properties and analyses where appropriate. Details of analytical methods and a general discussion of results are given in Chapter 6. In a few cases water retention measurements were made. Results are briefly discussed. The significance of water retention properties is outlined in Chapter 6.

### 3.N.3 SUBSIDIARY SOILS

Soil series, variants and phases of subsidiary importance are named and a brief description given, where appropriate, of important profile features and site. A statement of their frequency of occurrence is made, where the mapped area is large enough to allow sufficient observations to be recorded. A simple key for identifying component soil series, phases and variants is provided.

### 3.N.4 SOIL FUNCTIONS

Different soils have different internal properties and distinctive locations. Together these determine the ways in which they influence the environment and how man uses them. The overall soil and site properties of the map unit are considered, followed by a review of its functions under the headings of production, ecology, environment and amenity and engineering. Where appropriate, reference is made to systematic classifications of the land's potential, for example following Bibby and Mackney [1969] and Boorman *et al.* [1995]. An overview of soil functions for the district as a whole is the subject of Chapter 4.

*Soil properties:* Characteristics of the soil, particularly soil moisture properties, texture and organic matter content, depth, stoniness and acidity, interact particularly with the location's climate to influence most soil functions. The relationship between morphological expressions of gleying [e.g. mottling] and soil moisture regime [a succession of soil water states, and their disposition in the soil] is complex. Soil water regime involves soil properties together with rainfall, evaporation, site, land use and management history. It is described [Hodgson 1976 and 1997] in terms of wetness classes numbered I-VI and dryness subclasses *a-d* for the main soils of the map unit. Details of the wetness classes and methods of determining them and the dryness subclasses are given by

Hodgson [1976 and 1997]. Acidity is an important property of many of the district's soils.

*Site conditions:* Important among these are climate, particularly rainfall amounts, slope and rockiness as they, with the soils, strongly affect the character of natural and semi-natural vegetation, as well as the way in which the land can be used. High rainfall, exposure and low temperatures all have a bearing in parts of this district. Land use classification is conditioned by the high rainfall, most of the area receives annual average rainfall greater than 1200 mm, only declining towards 1000 mm in the extreme east. Slopes steeper than 11 degrees are shown on the terrain phase map, along with the occurrence of boulders and rock outcrops and peat erosion.

**Production:** Soil properties influencing production in agriculture and in forestry and woodlands are considered both in general terms and from the viewpoint of land classification systems. Fuller discussion of the methods involved in the latter are in Chapter 4 Section 4.3.1 below.

**Ecology:** Soil properties, particularly moisture conditions and relative acidity, along with the climatic setting, strongly influence vegetation patterns and the way that animals exploit the soil as a habitat. The main natural and semi-natural vegetation types of the map unit are described. For the moorland this applies to nearly all of the landscape, whereas across the in-bye patterns are more fragmented by agricultural land, woodland and plantations. Where appropriate there is comment on biological activity within the soil profile.

**Environment:** As important components of the physical and chemical environment soils modulate the movement of water across and through the land to aquifers and watercourses and play a role in the fate of pollutants. They are also significant as stores of carbon. Here the map units' hydrological properties are reviewed in terms of the HOST [Hydrology of Soil Types] scheme of Boorman *et al.* [1995], identifying the main pathways and conditions of water movement in and from the soil, along with broad, nationally based assessments of their impact on stream flows. The likelihood of the soils attenuating or transmitting pollutants to groundwater is considered following the methodology of Palmer *et al.* [1995]. An estimate of soil organic carbon content to 1 m depth, to rock, if that occurs before 1 m, or to greater depth in the case of peat soils, is made. In this horizon by horizon values given under 3.N.2 are weighted by horizon thickness, stone content and bulk density. Again fuller description is given in Chapter 4.

**Amenity and engineering:** The soils' physical properties affecting the 'soft' engineering involved in ground preparation for new farm buildings, landscaping toand use of the land for amenities, such as caravan parks and footpath construction, are reviewed. The relative aggressiveness of the soil to buried ferrous metal is assessed following the approach of Jarvis and Hedges [1994].

# Chapter 3 Description of the Soils

## 3.1 INTRODUCTION

Soil surveys apply soil classifications, as outlined in Sections 2.2.1 and 2.2.2 above, across landscapes, exploring the relationships of soil classes to the terrain, in the way described in Section 2.3. Soils differ depending on the environment, including pedological, hydrological, climatic, geological and geomorphological conditions and the influence of man. At the coarsest level in this district this variation is expressed as the contrast between mineral soil map units and those in peat. In mapping successively finer levels of distinction are made, for example those separating map units, such as typical and humic subgroups within the brown podzolic soils group. While broad relationships between soil subgroups and certain landscape facets can be determined and then mapped across the survey district, in almost all map units, changes do occur in geomorphological, hydrological and pedological circumstances which are too small to be mapped out. As noted in Section 2.3, a soil map unit's composition is more analogous to the concept of natural vegetation associations, rather than to uniform stands or monocultures such as arable crops or a plantation of a single species of conifers. In the following descriptions [Sections 3.2-3.23] attempts are made in subsections 3.N.3 to explain the nature of any internal variation in each map unit.

There are 22 soil map units shown on the legend of the accompanying soil map and summarised in Tables 6, 7 and 8, each being described in this chapter, while rock dominant, urban and disturbed ground are also delineated and their relevant features described. In addition, on the accompanying map of terrain, three phases indicating peat erosion, three showing rockiness / boulderiness, together with rock-dominated ground and a steep slope phase, are mapped separately. Figures 5 and 6 show schematically the relationships of map units to site, slope, altitude and parent material. The easternmost 20 $km^2$ of this district was mapped by Clayden [1964 and 1971] as part of the Middle Teign Valley and Exeter District surveys. Following later developments in soil classification by Avery [1980], some resurveying to separate humic brown podzolic soils was undertaken in that area during the current soil survey, along with contrasting stoniness of typical brown earths on Carboniferous rocks in the metamorphic aureole.

### 3.1.1 SOIL PARENT MATERIALS

Much of the soil in this district is developed in a stony, loamy or sandy material of comminuted granite, principally interpreted as soliflucted head. Exceptions are where either sound rock or decayed, that is *in situ,* but strongly weathered granite [saprolite] approaches the surface, where thick peat has developed over the granite, along floodplains where alluvium has accumulated and over the small areas of Carboniferous country rocks. Soil development within these parent materials is a response to site [notably hydrology and slope] and climate, particularly rainfall and temperature, which change progressively westward as altitude increases. The increase in rainfall with altitude presents greater opportunities for leaching and waterlogging, the latter with the concomitant development of peat. Biotic factors are additional considerations acting on soil formation, both directly by the vegetation's influence on soils and by man's management of the vegetation.

### 3.1.2 OUTLINE OF THE SOILS

The podzolic soils major group is the most extensive in this district. The range within it is from brown podzolic soils, often with weakly differentiated horizons and primarily recognisable within this major group by subsoil chemistry, which dominate the eastern half of the map, through to stagnopodzols, the latter reflecting the increased acidity and wetness on the intermediate levels of the moorland. The main distinguishing features of the subgroups present are summarised in Table 9. As the ground rises further westward the stagnopodzols are replaced on gentler slopes by surface-water gley soils and eventually higher still by peat soils, which mantle all but the very steepest slopes. This catena from brown podzolic soils to peat dominates the district.

In parallel, a minor catena is recognisable in soils in basin sites where groundwater hydrology controls soil development. In the drier eastern areas these basins contain ground-water gley soils, often, but not always, with humose or organic tops. Here thicker peat development is confined to relatively isolated perennial spring sites. To the west, with increasing altitude and rainfall, peaty tops become the rule on these ground-water gley soils and the full peat soils become more evident. On the moorland most of the ground in basin sites is dominated by peat soils, thinner peat cover over mineral ground-water soils being confined to basin margins, adjacent to stagnopodzols and surface-water gley soils on the drier, rising ground. It should be noted that in many places cutting for fuel has reduced the peat's thickness. Higher still, distinction between the basin sites and the blanket bog is only possible through the site's physiography, not soil morphology, with major concavities there shown on the terrain map by a blue line.

Over much of the district the land carries a variably dense scatter of granite boulders [see the terrain map], with occasional outcrops of *in situ* granite, some as named tors. On the pristine blanket bog and in some peaty basins, boulders are rarely encountered, although in peat cuttings and erosion gullies some are revealed. Otherwise the incidence of boulders and outcrops varies from tors and clitter that preclude normal soil development, through more modest scatters to substantial areas where boulders are absent.

## Table 6. Soil map units on granite and granite head.

| **SOIL MAP UNIT:** [***Soil map symbol***; COMPONENT SERIES]. | **SOIL PROPERTIES:** [E.g. texture, colours, natural drainage, organic matter]. | **SITE** | **ASSOCIATED MINOR SERIES** |
|---|---|---|---|
| ***Mr*** MORETONHAMPSTEAD SERIES: Typical brown podzolic soils; Coarse loamy material over lithoskeletal acid crystalline rock. | Dark brown gritty sandy silt loam topsoil over orange or brown gritty sandy silt loam subsoil, freely draining, seldom waterlogged; bouldery in places. | Gentle to very steep slopes. Mostly enclosed in-bye land. | Gunnislake<br>Moor Gate<br>Lustleigh<br>Furlong<br>Unnamed brown ranker |
| ***Mr / Fg*** MORETONHAMPSTEAD SERIES and FURLONG SERIES: Furlong series not classified; Coarse loamy material over lithoskeletal acid crystalline rock. | Furlong series:Thick [>40 cm, in places 1 m] dark brown gritty sandy silt loam topsoil over orange or brown gritty sandy silt loam subsoil; freely draining, seldom waterlogged. | Rocky in places; gentle to very steep slopes, not confined to colluvial sites. Mostly enclosed land in the in-bye. | Gunnislake<br>Moor Gate<br>Lustleigh<br>Unnamed brown ranker |
| ***Mr***$^{w}$ MORETONHAMPSTEAD OLD WOODLAND PHASE: | Under old woodland topsoil usually only a few cm thick and overlain by thin litter and humus layers. | Much steep and very steep ground in woodland. | Moor Gate<br>Unnamed brown ranker |
| ***mQ*** MOOR GATE SERIES: Humic brown podzolic soils; Coarse loamy material over lithoskeletal acid crystalline rock. | Black, humose, gritty sandy silt loam topsoil over orange or brown gritty sandy silt loam subsoil; freely draining, seldom waterlogged. | Gentle to very steep slopes, rocky in places. Enclosed land, in woodland and dry moorland and downland. | Moretonhampstead<br>Unnamed ferri-humic cryptopodzols<br>Bangor<br>Hexworthy<br>Rough Tor<br>Trink<br>Bodafon |
| ***Hx / rF*** HEXWORTHY SERIES: ironpan stagnopodzols; Loamy material over lithoskeletal acid crystalline rock and ROUGH TOR SERIES: Ferric stagnopodzols; Loamy material over lithoskeletal acid crystalline rock. | Black, humose sandy silt loam or peaty topsoil over grey, mottled subsurface horizon with thin ironpan in Hexworthy series, over orange or brown gritty sandy silt loam subsoil; seasonally waterlogged in surface and subsurface; freely draining, seldom waterlogged in subsoil. | Rocky in places. Rolling moorland with level to steep slopes. | Princetown<br>Moor Gate<br>Trink<br>Bodafon |
| ***Hwh / Dn*** HALFWAY HOUSE SERIES: Stagnogleyic brown earths; Coarse loamy material passing to soft weathered acid crystalline rock and DREWSTON SERIES: Cambic stagnogley soils; Coarse loamy material over lithoskeletal acid crystalline rock. | *Halfway House:* Dark brown gritty sandy silt loam topsoil over gritty sandy silt loam, subsoil mottled below 40 cm; some slight seasonal waterlogging. *Drewston*: Mottled grey or dark brown gritty sandy silt loam topsoil over mottled gritty sandy silt loam subsoil; seasonally waterlogged. | Gentle footslopes on enclosed in-bye land. | Laployd<br>Moretonhampstead<br>Hepste |
| ***pC*** PRINCETOWN SERIES: Cambic stagnohumic gley soils; Loamy material over lithoskeletal acid crystalline rock. | Black, humose sandy silt loam or peaty topsoil over grey, mottled subsurface horizon over mottled sandy silt loam subsoil; seasonally waterlogged. | Rocky in places, gentle or flat slopes mostly on ridges. | Hexworthy<br>Rough Tor<br>Hepste<br>Crowdy<br>Laployd<br>Unnamed humic ranker |
| ***Lp*** LAPLOYD SERIES: Typical humic gley soils; Coarse loamy material over lithoskeletal acid crystalline rock. | Black humose sandy silt loam or peaty topsoil, over grey gritty sandy silt loam mottled subsoil; seasonally waterlogged to the surface; many springs. | Lower slopes of basins and valleys and hill-side flushes, rocky in places. | Hepste<br>Crowdy<br>Drewston<br>Clayey and fine loamy variants |
| ***RD*** ROCK DOMINANT | Tors and clitter. | | |

While this range must reflect geological and geomorphological conditions in most cases, on the enclosed land boulder clearance has been carried out in the 20th century as grant-aided agricultural improvement and no doubt at earlier times in places purely on the initiative of farmers.

**Table 7. Soil map units in peat and alluvium.**

| **SOIL MAP UNIT:** [***Soil map symbol***; COMPONENT SERIES]. | **SOIL PROPERTIES:** [E.g. texture, colours, natural drainage, organic matter]. | **SITE** | **ASSOCIATED MINOR SERIES** |
|---|---|---|---|
| ***WH*** WINTER HILL SERIES:Raw oligo-fibrous peat soils; Mixed *Eriophorum* and *Sphagnum* peat. | Fibrous and semi fibrous peat usually > 1 m thick, perennially waterlogged. | Higher parts of the blanket bog. Eroded in places. | Crowdy<br>Hepste |
| ***Hps*** HEPSTE SERIES: Raw oligo-amorphous peat soils; Humified peat over lithoskeletal material. | Amorphous peat, 40-80 cm thick; usually waterlogged. | High interfluves on the lower parts of the blanket bog. Much eroded. Many cuttings. | Crowdy<br>Winter Hill<br>Mineral soils |
| ***CJ*** CROWDY SERIES: Raw oligo-amorphous peat soils; Humified peat. | Amorphous peat, at least 80 cm thick; perennially waterlogged. | Basin sites on the moorland and in some valleys of the in-bye. Many cuttings. | Winter Hill<br>Hepste<br>Princetown |
| ***tY / tF*** TAVY SERIES: Typical brown alluvial soils; Coarse loamy river alluvium and TY-GWYN SERIES: Gleyic brown alluvial soils; Coarse loamy river alluvium. | *Tavy:* Dark brown sandy loam or sandy silt loam over brown subsoil of similar texture over gravel at depth; freely draining, seldom waterlogged but with risk of flooding.<br>*Ty-Gwyn:* Dark brown sandy loam or sandy silt loam over brown subsoil of similar texture with mottling below 40 cm, over gravel at depth; slight seasonal waterlogging with risk of flooding. | Level ground on floodplains. | Alun<br>Teign<br>Unnamed variant of Ty-Gwyn over gravel<br>Eversley |
| ***Sj / Ey*** SULHAM SERIES: Typical humic-alluvial gley soils; Coarse loamy river alluvium and EVERSLEY SERIES: Typical alluvial gley soils; Coarse loamy river alluvium. | *Sulham*: Black peaty or humose sandy loam topsoil over mottled greyish sandy loam subsoil over gravel; waterlogged for much of the year with risk of flooding.<br>*Eversley:* Greyish or dark brown mottled sandy loam topsoil over mottled greyish sandy loam subsoil over gravel; seasonally waterlogged with risk of flooding. | Level ground on floodplains. | Kettlebottom<br>Ty-Gwyn<br>Crowdy |

### 3.1.3 SOILS IN THE LANDSCAPE

Most of the district can be divided conveniently into three: a] the enclosed lowland, the in-bye or Mercer's [2009] Middle and Far East, b] the rolling lower moorland, c] the blanket bog of the high moorland. Soils in alluvium are found in each of the divisions, as are areas of disturbed ground, principally tin workings, and the Rock Dominant map unit. The latter includes granite tors and clitter, the latter more extensive than the tors, and crags and screes on very steep to precipitous slopes on the metamorphic aureole.

The boundary between the main block of moorland and the enclosed farmland and woodland runs as a fairly abrupt line from in the north near Shilstone [702907], Throwleigh, just east of south to Hurston [685842] and Vogwell [722817], North Bovey. South and east of Vogwell the abruptness declines, with moorland outliers such as Easdon [730820], Cripdon [734805], Hayne [740800] and Trendlebeare [770801] Downs breaking up the sweep of enclosures.

**Table 8. Soil map units of the Carboniferous outcrop.**

| **SOIL MAP UNIT:** [***Soil map symbol***; COMPONENT SERIES]. | **SOIL PROPERTIES:** [E.g. texture, colours, natural drainage, organic matter]. | **SITE** | **ASSOCIATED MINOR SERIES** |
|---|---|---|---|
| ***Hw*** HALSTOW SERIES*:* Typical non-calcareous pelosols; Clayey material over lithoskeletal mudstone, shale or slate. | Brown or dark brown clay loam or clay topsoil, brownish clayey slowly permeable subsoil with marked mottling below 40 cm, shaley at depth; seasonally waterlogged. | Gentle slopes on ridge. | Denbigh<br>Tedburn |
| ***Dg*** DENBIGH SERIES: Typical brown earths; Fine loamy material over lithoskeletal mudstone, shale or slate. | Dark brown clay loam over brown clay loam, over shale or shaley rubble below 40 cm; freely draining, seldom waterlogged. | Moderate to steep slopes. | Powys<br>Bridford<br>Halstow |
| ***Bx*** BRIDFORD SERIES: Typical brown earths; Lithoskeletal mudstone, sandstone, shale or slate. | Dark brown sandy silt loam or clay loam topsoil over orange or brown sandy silt loam or clay loam subsoil, very stony; freely draining, rarely waterlogged; rocky in places. | Gentle to very steep slopes. | Drogo<br>Powys<br>Manod<br>Denbigh |
| ***Bx^w^*** BRIDFORD OLD WOODLAND PHASE: | Under old woodland topsoil usually only a few cm thick and overlain by thin litter and humus layers. Micropodzols in places. | Steep, very steep and precipitous slopes. | Bridford normal phase<br>Powys<br>Drogo<br>Manod<br>Willingstone |
| ***Bx+*** BRIDFORD WITH CRAGS: | | Very steep and precipitous slopes. | Skiddaw<br>Drogo |
| ***DR*** DROGO SERIES: Humic brown podzolic soils; Lithoskeletal mudstone, sandstone, shale or slate. | Black, humose sandy silt loam or clay loam topsoil over orange or brown sandy silt loam subsoil, very stony; freely draining, rarely waterlogged; rocky in places. | Gentle to very steep slopes. | Bridford<br>Skiddaw<br>Hafren variant |
| ***DR+*** DROGO WITH CRAGS: | | Very steep and precipitous slopes. | Skiddaw<br>Bridford |
| ***WS*** WILLINGSTONE SERIES: Humo-ferric podzols; Lithoskeletal mudstone, sandstone, shale or slate. | Black, humose sandy silt loam or clay loam topsoil over grey subsurface sandy silt loam over orange or brown sandy silt loam subsoil very stony; freely draining, rarely waterlogged. | Very limited area at Butterdon Ball [in Teign Gorge] with very steep and precipitous slopes. | Drogo<br>Skiddaw<br>Cuccurian |
| ***Tn*** TEDBURN SERIES: Pelo-stagnogley soils; Clayey material over lithoskeletal mudstone, shale or slate. | Greyish or dark brown mottled clay loam or clay topsoil over slowly permeable clayey mottled subsoil; waterlogged for long periods in the winter half year. | Level and gentle footslopes. | Hallsworth<br>Brickfield |
| ***RD*** ROCK DOMINANT | Crags and screes. | Very steep and precipitous slopes. | |

The junction of the blanket bog with the rolling moorland, although disrupted in places by steep slopes and valleys, runs roughly from Okement Hill [604870] to Wild Tor [623877] and Watern Tor [629868], by Manga Hill [635850] and Sittaford Tor [633830] to Broad Down [625804].

a] *The in-bye [See Figure 5]* Soils on the lower-lying farmland and in woodlands are dominated by gritty, loamy brown podzolic soils of the Moretonhampstead and Moor Gate series over granitic head, with Bridford series on the Carboniferous outcrop. These soils have rapid natural drainage; although the Moretonhampstead and Moor Gate soils are chemically designated among the podzolic soils major group, their horizon differentiation is subdued and profiles with bleached subsurface [E] horizons are rare. In the older enclosures, Moretonhampstead soils [typical brown podzolic soils] and Bridford soils [typical brown earths] have brownish topsoil A horizons over variably brown or ochreous B horizon subsoils, over increasingly stony lower subsoils. In parts of the old woodland and coppice, the thin surface litter, fermentation and humus layers rest at a shallow depth on the B horizon, being mapped as an Old Woodland phase.

**Table 9. Differentiating properties of podzolic soils in granite head.**

| Soil series | Moretonhampstead | Moor Gate | Hexworthy | Rough Tor |
|---|---|---|---|---|
| **Subgroup** | Typical brown podzolic soils | Humic brown podzolic soils | Ironpan stagnopodzols | Ferric stagnopodzols |
| **Topsoil** | Distinct [non-humose] | Humose | Peaty or humose | Peaty or humose |
| **Subsurface** | Undifferentiated | Undifferentiated | Gleyed Eag, variably mottled with rotten stones | Gleyed Eag, variably mottled with rotten stones |
| **B horizon** | Ochreous | Ochreous | Ochreous with thin ironpan above | Ochreous, sometimes with iron nodules above |

Humic brown podzolic soils of the Moor Gate series are separated where thicker humus layers [both substantial and relatively weakly expressed] provide dark or black topsoils. Moor Gate soils occur commonly on higher ground, often still open downland, as at Mardon [772879] and Easdon [730820] Downs, or relatively recently enclosed land, as southwest of Heltor [799870]. In the extreme northeast, a small area of shale outcrop outside the granite's metamorphic aureole carries typical brown earths of the Denbigh series.

Within the farmed in-bye the lower slopes of valleys provide a contrast in soils, with ribbons of ground-water gley soils of the Laployd and related series carrying rushy pastures and drainage ditches. Seasonal wetness is a marked feature of these soils, although varying, so that drier [non-humic] gley soils form, whereas occasional peat soils develop on persistent springs. Among these mineral soils, texture is more variable than on the freely draining neighbouring ground, with sporadic patches or pockets of both more clayey and sandy soil. In places, soils with this morphology form quite extensively on relatively high ground, as southwest of Wooston [765890] or east of Fursdon [752842], suggesting that their wetness is aggravated by the presence of bodies of saprolite [chemically degraded granite].

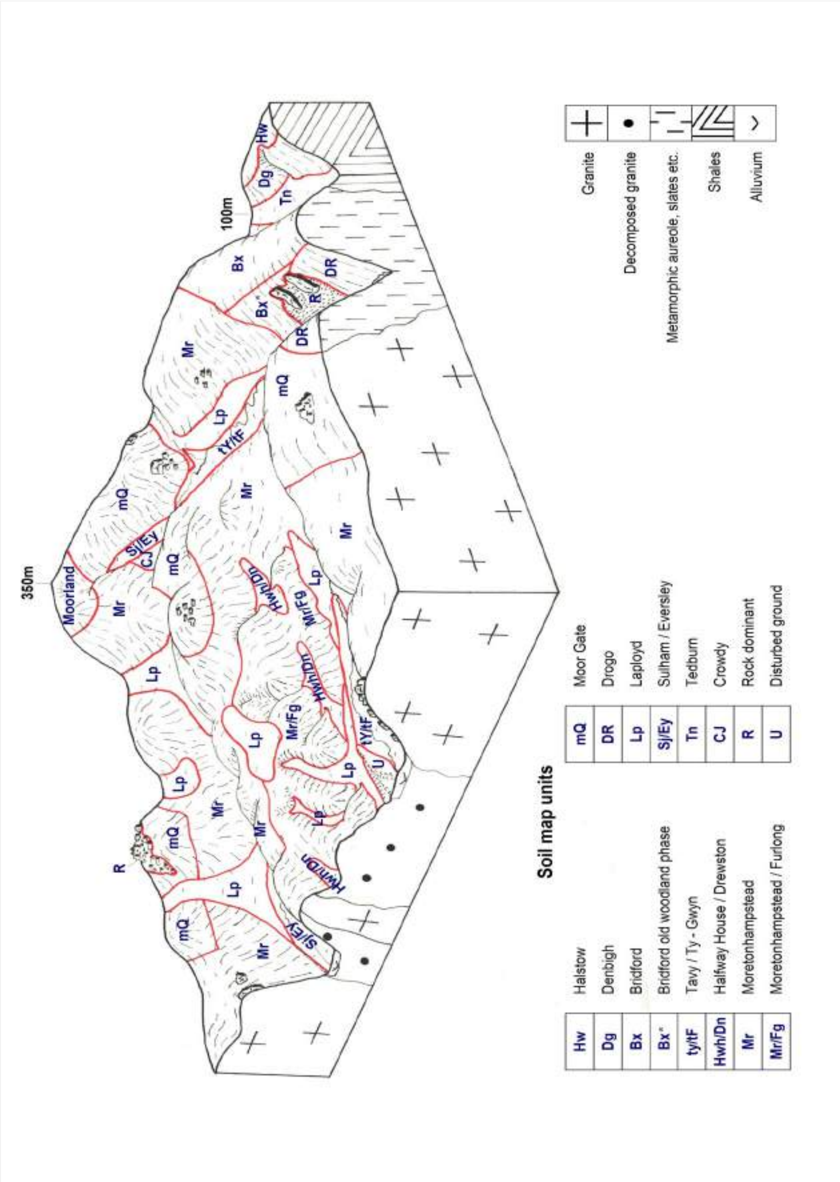



**Figure 5 Block diagram of soil map units on the Dartmoor in-bye**

In addition the area around Moretonhampstead, where aerial photography [Plate 8] suggest saprolite development, there are numerous very small, often rushy patches with ground-water gley soils high in the landscape. These may point to heavier, less permeable layers, which modify the movement of vadose and groundwater within the granite. This illustrates an important aspect of this group of soils, that they offer a strong insight into water movement within the granite and in the near surface layers of its head mantel.

Small areas of Carboniferous rocks in the northeast and southeast of the district add geological diversity, although within the metamorphic aureole of the granite the contrast in soils is slight. Stony brown earths of the Bridford series flank much of the Gorge of the River Teign. Bridford soils are excluded from the brown podzolic soil group [which includes the Moretonhampstead series over granite] largely by differences in subsoil iron chemistry. Only in the extreme northeast, beyond the effects of thermal metamorphism, does the hydrologically / physiographically controlled catena described by Clayden [1964] on shales begin to develop. As on the granite old woodland sites are distinguished by thin L, F and H horizons over the subsoils, here mapped as the Old Woodland phase of the Bridford soil map unit, contrasting with the thicker topsoils of sometime cultivated ground. Here the Drogo map unit picks out the thicker, humus-rich topsoils analogous with the Moor Gate soils over the granite.

b] *The lower moorland [See Figure 6]* On the rolling moorland between the enclosed ground and the blanket bog stagnopodzols of the Hexworthy and Rough Tor series predominate. Both series have humose or peaty upper horizons over a variably mottled and bleached subsurface Eag horizon, often containing softened granite stones. Beneath this the Hexworthy series [ironpan stagnopodzol] has a thin ironpan over an ochreous or reddish brown subsoil passing down into paler brown material below about 60 cm. The Rough Tor series [ferric stagnopodzol] differs principally by the absence of a continuous ironpan, which is replaced sometimes by a layer of ferruginous nodules. The two series form in close association, often both being evident in the same exposure. Their hydrology is complex, being seasonally waterlogged and anaerobic above the ochreous B horizon, but below that thoroughly aerated and lacking evidence of wetness. Overall across this section of moorland soil morphological expression of wetness [topsoil peatiness and intensity of gleying in the Eag horizon] pass from almost token at lower altitudes to being strongly expressed on higher ground where the peaty surface approaches the 40 cm minimum thickness for the peat soils major group.

Moor Gate series soil occupy some of the ground across the lower moorland, particularly on steeper slopes. Often the boundary between these soils and the Moretonhampstead soils on enclosed land is abrupt at the cornditch marking the moorland’s boundary, suggesting that the differences between these soils relates to vegetation and land use history.

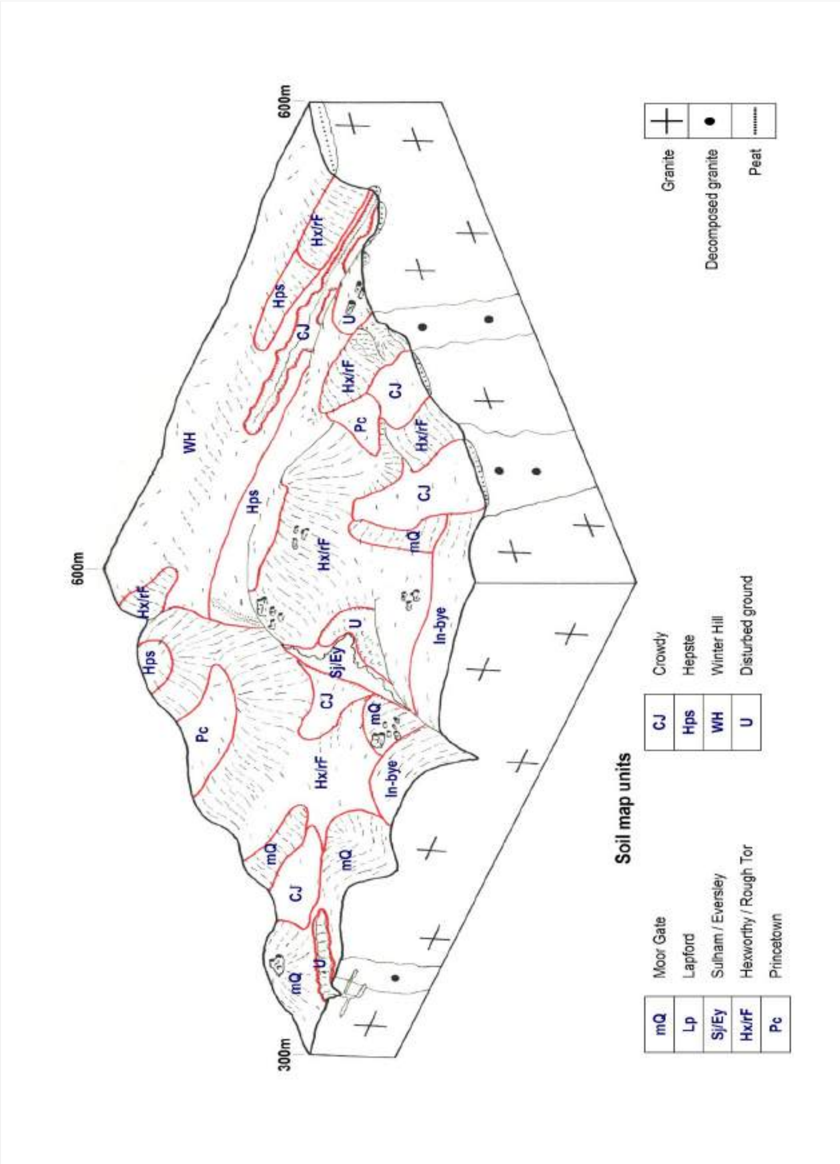



**Figure 6  Block diagram of soil map units on Dartmoor**

On gentler slopes adjacent to the Hexworthy / Rough Tor map unit there are mapped areas of soils with very thick gleyed subsurface horizons and no podzolic B horizon, the Princetown series, [stagnohumic gley soils]. Princetown soils are also found from time to time in closer association with the stagnopodzols in the Hexworthy / Rough Tor map unit.

Within basin sites on this section of the moor the Laployd series ground-water gley soils, which dominate such sites in the lower, in-bye country, are largely replaced by basin peat with the Crowdy and Hepste series [raw oligo-amorphous peat soils]. In places in these sites occasional pockets of fibrous peat give rise to Winter Hill series [raw oligo-fibrous peat soils]. Laployd soils are mostly confined to the margins of the basins here, although in places attenuation of the peat by cutting for fuel can produce Laployd-like soils in the workings.

c] *The high moorland [See Figure 6]* The blanket peat of the high moorland varies in thickness, in the extent of its humification and in its degradation by both erosion and cutting for fuel. Along the peat's lower, eastern flank the deposit is relatively thin and mostly humified and Hepste series soils predominate. Probably the lower altitude accounts for less vigorous peat growth and may have contributed periodically to its interruption. Being relatively close to settlements, commoners exploited much of this map unit for fuel, often with linear cuttings [ties] excavated almost down to the mineral substrate, leaving man-made variants of the Princetown series. It is likely that the drainage and exposure of peat in and near ties contributed to the humification of the peat in this map unit. To enhance drainage of the workings, ties were commonly aligned more or less with the gradient, often obscuring any clear evidence of erosion. A further consequence was that flat sites were exploited least.

At higher altitude the fibrous and semi-fibrous Winter Hill soils form in peat which can be several metres thick, only thinning naturally on the few steep slopes. Some attenuation of thickness, in more severe examples reaching the substratum of mineral material, is evident in erosion gullies. This is of varying severity and antiquity, affecting a proportion of the Winter Hill map unit, with two erosional phases being distinguished on the terrain map from the pristine blanket peat. Degradation of the peat by ties is less common here, partly attributable to the higher ground's remoteness, although some sites, as around Ockerton Court [602868], have tie-like cuttings. There are, however, several areas on the high summits, as between Hangingstone Hill [617861] and Quintin's Man [621839], where many tens of hectares, shown on the soil map as disturbed ground, have had peat removed. During medieval times peat was cut and burned for charcoal under license from the Duchy of Cornwall. These workings differ from the commoners' ties, both in their hill top locations and in the absence of linear, residual baulks between workings.

Mapped as ribbons of Crowdy map unit within the blanket bog areas are narrow strips along the valley floors close to the headwaters of several rivers, which are affected by erosion and reworking of the peat. At the upslope margins of this ground the edge of the undisturbed blanket peat forms bluffs, in places with gullying or with foundering masses of peat. Below the bluffs are gentle undulations down to the stream or small areas of floodplain. Redeposition of eroded peat and mineral material takes place on the valley bottoms and floodplain patches, while elsewhere there is secondary accumulation of peat.

**Table 10. Extent of the map units.**

| SOIL MAP UNIT | HECTARES |
|---|---|
| Moretonhampstead | 5246 |
| Moretonhampstead / Furlong | 1270 |
| Moretonhampstead Old Woodland phase | 78 |
| Moor Gate | 2656 |
| Hexworthy / Rough Tor | 3142 |
| Halfway House / Drewston | 366 |
| Princetown | 688 |
| Laployd | 1308 |
| Winter Hill | 1169 |
| Hepste | 589 |
| Crowdy | 1072 |
| Tavy / Ty-Gwyn | 161 |
| Sulham / Eversley | 265 |
| Bridford | 369 |
| Bridford Old Woodland phase | 371 |
| Bridford with crags | 26 |
| Denbigh | 96 |
| Halstow | 8 |
| Drogo | 170 |
| Drogo with crags | 25 |
| Willingstone | 6 |
| Tedburn | 12 |
| Urban and disturbed | 702 |
| Rock dominant | 177 |
| Water [Fernworthy reservoir] | 31 |
| | |
| **TERRAIN MAP UNITS** | **HECTARES** |
| **Boulders and rocks*** | |
| No boulders, no rocks | 6732 |
| Slightly bouldery or rocky | 6659 |
| Very bouldery or rocky | 2950 |
| | |
| **Peat erosion** | |
| Pristine | 246 |
| Slightly eroded | 412 |
| Severely eroded | 232 |
| | |
| **Steep** | 3,520 |
| *Urban & disturbed land, Crowdy & Hepste soil map units & parts of Winter Hill soil map unit affected by peat cutting, are unclassified. | |

On the moorland below the blanket bog, floodplain and alluvial soils are very limited, through both the small size of the streams and the activity of medieval tin streamers. This changes as the rivers cross the lower, enclosed in-bye where extensive but discontinuous ribbons of alluvial soils follow the Rivers Teign and Bovey and their tributaries. Both tin streaming and the granite's basin and hill physiography break up the alluvial tracts. Along the Teign from Gidleigh Park [677879] to Steps Bridge [805883] and the Bovey below Hisley Bridge [780800] much of the alluvium is freely draining, whereas alluvial gley soils are more evident along many tributary streams.

### 3.1.4 SOIL BOUNDARIES

The boundaries between soil map units range from abrupt to diffuse. The nature of the soils, their pedology, hydrology, geomorphology and management history, all affect how sharply soil boundaries are expressed. Adjoining units can merge over many tens of metres in a zone of transition, for example on some moorland interfluves between fibrous and humified peats. Within the blanket peat the change between Hepste and Winter Hill map units is gradual, both units containing a proportion of profiles of the other's leading soil series. Such diffuse soil boundaries are part of the natural landscape, although soil classification and mapping attempt to impose appropriate, albeit at times arbitrary, limitations on what, in nature, is a continuum. Elsewhere boundaries can be abrupt, for example where reflecting springlines, as on the upslope limits of basin peat and ground-water gley soils, abutting higher standing, more readily draining soils.

On the in-bye such sharp boundaries are commonly followed by a hedgebank, as between the freely-draining Moretonhampstead and Moor Gate map units and the Laployd ground-water gley soils, or at the upslope margins to the soils in alluvium, the Sulham / Eversley and Tavy / Ty-Gwyn map units. This pattern is repeated to a degree at boundaries to Halfway House / Drewston soils. On the open moorland marked, concave edges form around the basin peat of the Crowdy map unit at lower levels. In places the downslope limit of the blanket peat against mineral soils is marked by a sharp bluff, which can be bare peat or vegetated.

Other boundaries, such as those reflecting differing landuse histories, can be more varied. Examples of abrupt changes are among those between Moretonhampstead soils, sites of medieval enclosures, and the Moor Gate map unit, either still in semi-natural downland and moorland vegetation or reclaimed and enclosed from that in recent centuries. Where a cornditch, the medieval asymmetrical bank, separates enclosed fields from the open moor, the boundary can form a very sharp limit to Moretonhampstead soils where they adjoin the Hexworthy / Rough Tor map unit. A good example of this is on Gidleigh Common, north and south from Creaber [660879]. A similarly abrupt boundary follows the abandoned cornditch west of Hurston [686842], which marks an encroachment of the enclosed land into the moor. Elsewhere, where downland has been enclosed in post-medieval times and subjected to denshering [paring and burning of the surface soil], the boundary can be less abrupt. Junctions of the Moretonhampstead soils with the related Moretonhampstead / Furlong map unit are diffuse, as are those to the Bridford soils, which pick out a geological change that is not usually expressed physiographically.

## 3.2 - 3.28 DESCRIPTIONS OF THE MAP UNITS

---

### 3.2 MORETONHAMPSTEAD MAP UNIT [Mr on the soil map]

3.2.1 Stony typical brown podzolic soils in coarse loamy or sandy, stony head derived from granite [over lithoskeletal acid crystalline rock], with some humic brown podzolic soils, typical brown earths and humic cryptopodzols.

**Distribution and site:** Mantling much of the enclosed in-bye, [5,246 ha] on rolling, in places steep, ground between 80 and 450 m O.D. Bouldery in places. Beyond this survey district the National Soil Map [Sheet 5] shows these soils on other drier parts of the southwest's granite outcrops, from Dartmoor to Land's End, plus the Isles of Scilly and Lundy.

**Land cover:** Predominantly permanent pasture, with some leys and short term arable; woodland on much of the steep ground. There are small areas of open moorland, that east of King Tor [709815] contiguous with the in-bye enclosures, and detatched enclaves as southeast of Berry Pound [713803] and at 651898 on Throwleigh Common.

**Component soils:**

Moretonhampstead series *[common]*

Gunnislake series *[common]*

Moor Gate series *[occasional]*

Lustleigh series *[occasional]*

Furlong series *[rare]*

Unnamed brown ranker *[rare]*

3.2.2 MAIN SOIL

**MORETONHAMPSTEAD SERIES**

Stony coarse loamy typical brown podzolic soil over lithoskeletal acid crystalline rock / *in [granite derived] drift with siliceous stones*. The series was originally described by Clayden [1964], then around Exeter and Newton Abbot [Clayden

1971], on Bodmin Moor [Staines 1976], at Ivybridge [Harrod *et al.* 1976], in the Lake District [Jarvis *et al.* 1984] and North Wales [Rudeforth *et al.* 1984].

**Characteristics:**

Dark brown or brown topsoil

Gritty sandy silt loam textures

Brown or ochreous subsoil

**Generalised soil profile:**

*Ah and Ap horizons, [0-30 cm]:* Dark brown [10YR 3/3] or very dark greyish brown [10YR 3/2] gritty sandy silt loam; stony or very stony, gravel to small subangular granite stones; moderate or strongly developed fine and medium subangular blocky structure. There is some variation in topsoil colour, depending on organic matter content. Soils at lower altitude, as in the Wray and Forder valleys, often are less dark than those on the higher interfluves. An attempt was made to map out such differences, but was not successful as the pattern was not uniformly maintained. The range of colours may be attributable to slight climatic differences, lower sites being warmer. The equilibrium concentration of organic matter depends very much on temperature and smaller concentrations may reflect this effect at lower altitudes. Alternatively they may have a longer history of enclosure and cultivation with greater loss of organic matter resulting from that.

*Bs and/or Bw horizons, [30-60 cm]:* Brown [7.5YR 4-5/4] or strong brown [7.5YR 5/6] gritty sandy silt loam or sandy loam, often with pockets of A horizon; often the content of gritty particles in these and related granite soils hinders precise texturing in the field; stony or very stony with gravel to large [occasional boulders] subangular granite stones; moderate or strong fine subangular blocky structure or crumb under woodland and seminatural vegetation. Often such horizons have a loose, ‘fluffy’ consistence and greasy feel, common in Bs horizons; however note the caveat under *brown podzolic* soils in Section 2.2. In many profiles browner colours predominate in these horizons, colours becoming brighter below.

*BC or R horizon, [60-120cm]:* Brown to yellowish brown [7.5YR 5/4-10YR 5/4] gritty sandy loam; very stony to stone dominant with gravel to large, at times boulders or *in situ* blocks of subangular or subrounded granite; weak fine subangular blocky structure. In some places thin platy structures, characteristic of a Cx horizon are present. Depth of the soil in this map unit varies considerably and over short distances.

**Example profile:** SX88 /1934 under permanent pasture. 250 m O.D. [Clayden 1971, p 110].

**Horizons:**

*0-20 cm A:* Dark brown [10YR 3/3] gritty sandy loam; common small subangular granite stones, abundant quartz and feldspar grit; moderate fine crumb structure; very friable; moderate organic matter; abundant fine grass roots; earthworms common; narrow irregular boundary.

*20-36 cm ABs:* Brown [7.5YR 4/4] gritty sandy loam with darker brown material from above in pockets and following old worm channels; very stony with subangular granite fragments up to 5 cm diameter; weak very fine crumb structure; very friable; moderate organic matter; fine grass roots common, concentrated around stones; numerous earthworm channels; merging irregular boundary.

*36-51 cm Bs:* Strong brown [7.5YR 5/6] to yellowish brown [10YR 5/6] gritty sandy loam with occasional channels of darker material; very stony as above; weak very fine crumb structure; very friable; low organic matter; few fine roots; occasional earthworm channels.

> 51 cm C: Boulders dominant, rock flooring most of the pit.

**Analyses:**

| **Horizon** | **A** | **ABs** | **Bs** |
|---|---|---|---|
| **Depth cm** | 0-20 | 20-36 | 36-51 |
| | | | |
| **Sand 600 µm-2 mm %** | 63 | 52 | |
| **" 50-200 µm %** | 9 | 12 | |
| **Silt 2-50 µm %** | 19 | 29 | 28 |
| **Clay <2 µm %** | 10 | 7 | 6 |
| | | | |
| **Loss on ignition %** | 5.1 | 5.0 | 3.8 |
| **pH in water [1 : 2.5]** | 6.3 | 6.5 | 6.8 |
| **pH in 0.01M $CaCl_2$ [1 : 2.5]** | 5.6 | 5.7 | 6.0 |

*Comment:* This local profile from a little to the east of the survey area lacks detailed supporting chemical information to confirm the Bs designation of the 36-51 cm horizon and the soil's classification following Avery [1980]. The description of stone content in the same horizon, using the class limits noted by Clayden [1971], page 226, preclude confident attribution to either the *lithoskeletal* or *over lithoskeletal* categories of the lithological soil classification of Clayden and Hollis [1984]. The example below from Staines [1976] overcomes those shortcomings. The latter also has information on pyrophosphate Fe and Al [>5%] supporting designation of the B horizon as Bs. Calculating organic carbon by subtracting 10% of clay content from the loss on ignition amount, then dividing by 1.72, gives 2.4% in the A horizon, 2.3% in the ABs and 1.9 in the Bs.

**Example profile:** SX18/2336 under ley pasture. 410 m O.D. [Staines 1976, p 99].

**Horizons:**

*0-24 cm Ap;* Very dark grey to dark greyish brown [10YR 3/1-2] gritty sandy silt loam; stony with gravel to small granite fragments; weak coarse angular blocky breaking to fine angular and subangular blocky structure; very friable; abundant roots; narrow boundary.

*24-45 cm Bs:* Strong brown [7.5YR 5/6] sandy loam with medium and coarse tongues of above; stony; moderate fine crumb; very friable; merging boundary.

*45-75 cm BCx:* Brown to dark yellowish brown [10-7.5YR 4/4] gritty sandy loam; very stony to stone dominant at base with gravel to large stones; weak fine subangular blocky with some platiness apparent; hard to dig due to slightly compact nature.

**Analyses:**

| **Horizon** | **Ap** | **Bs** |
|---|---|---|
| **Depth cm** | 2-20 | 26-42 |
| | | |
| **Sand 600 µm-2 mm %** | 19 | 33 |
| **" 200-600 µm %** | 16 | 13 |
| **" 60-200 µm %** | 11 | 10 |
| **Silt 2-60 µm %** | 38 | 37 |
| **Clay <2 µm %** | 16 | 7 |
| | | |
| **Organic carbon %** | 3.0 | 0.8 |
| **pH in water [1 : 2.5]** | 6.2 | 6.2 |
| **pH in 0.01M $CaCl_2$ [1 : 2.5]** | 5.9 | 5.3 |
| | | |
| **Pyrophosphate extractable:** | | |
| **Fe%** | 0.80 | 0.28 |
| **Al%** | 0.28 | 0.27 |
| **C%** | 1.25 | 0.54 |
| **Fe + Al%** | 1.08 | 0.55 |
| **[ Fe + Al / clay] x 100** | 6.7 | 7.8 |
| **Residual dithionite extractable Fe%** | 0.87 | 0.54 |

### 3.2.3 SUBSIDIARY SOILS

**Gunnislake series** *[common]*: There are many profiles within the map unit with drab brown Bw horizons, probably lacking podzolic B properties. The distribution of Gunnislake soils [typical brown earth soils] in this map unit shows no clear pattern.

**Moor Gate series** *[occasional]*: Soils with very dark grey, very dark brown or black, humose topsoils. These occur on or near to former downland or moorland.

**Lustleigh series** *[occasional]*: These soils, along with related variants of the Moretonhampstead, Moor Gate and Gunnislake series are characterised by subsoils in undisturbed but decomposed granite saprolite. In the context of Clayden and Hollis' [1984] differentiating criteria, such soils are defined as 'passing to soft weathered acid crystalline rock'. Lustleigh soils are most common in the Sticklepath fault zone, in the area shown on the drainage / physiographic map [Figure 2] as having the relatively dense drainage network.

**Furlong series** *[rare]*: Soils with A horizons thicker than 40 cm are present sporadically across the map unit. They are more frequently found in the map unit 3.3 described below.

**Unnamed brown ranker** *[rare]:* Shallow brown topsoil with rock at 30 cm or less.

**Key to component soil series:**

| | | |
|---|---|---|
| | Soils with brown to very dark brown, distinct topsoil; coarse loamy | 1 |
| | Soils with dark humose topsoil; coarse loamy | Moor Gate |
| | | |
| 1 | Soils over decayed, *in situ* granite | Lustleigh |
| | Soils over granite or granite rubble | 2 |
| | | |
| 2 | Shallow soils with rock within 30 cm | Unnamed brown ranker |
| | Deeper soils | 3 |
| | | |
| 3 | With up to 40 cm of dark topsoil over brightly coloured subsoil | MORETONHAMPSTEAD |
| | With up to 40 cm of dark topsoil over brown subsoil | Gunnislake |
| | With thicker dark horizons | Furlong |

### 3.2.4 SOIL FUNCTIONS

*Soil properties:* Moretonhampstead soils are highly permeable and rarely wet, except briefly during and after very heavy rain. They are in Soil Wetness Class I *[rarely wet]*. Available water content varies with depth to rock and with the stoniness of profiles, with estimated averages of about 110 mm within a range of 65-150. Because of the grittiness and coarse texture most of the moisture is easily available, with little held at higher tensions. The rapid lateral variation in depth, noted above, produces scorched patches in grassland during droughts, alongside areas of continuing growth. For much of these soils' geographical extent mean maximum soil moisture deficit is around 75 mm, placing profiles of average depth in Dryness Subclass *b* of Hodgson [1976]. However for shallower soils, and those in the drier eastern part of the district, subclass c is more appropriate.

*Site conditions:* Land use is conditioned by the high rainfall. Most of the Moretonhampstead soils receive annual average rainfall greater than 1200 mm, only declining towards 1100 mm in the extreme east. Substantial areas of relatively high-standing ground suffer wind exposure. Slopes steeper than 11$^{O}$ are shown on the separate terrain map and affect a proportion of the map unit, mainly along valley sides. Angles are locally as steep as 30$^{O}$, with many slopes between 15$^{O}$ and 25$^{O}$. The occurrence of boulders and rock outcrops are mapped separately from the soils, and included with the slopes on the terrain map.

**Plate 21. The freely draining Moretonhampstead series [sections 3.2-3.4].**

It is the most extensive soil of the survey district, underlying much of the enclosed in-bye's small medieval enclosures. Its brown topsoil distinguishes it from the Moor Gate series shown in Plate 23. By contrast Moor Gate soils are found on commons of the in-bye, such as Mardon Down [772879], in comparatively large fields relatively recently reclaimed from downland, and also extend on to parts of the lower moorland.

**Production:** The permeability of Moretonhampstead soils makes them readily-worked, stocked and easily-trafficked at all but the wettest times. However, the area's climate discourages arable cropping and agricultural use is largely confined to grassland, with occasional cereals and forage break crops, maize included. In places steep slopes and rocks and boulders limit agricultural and silvicultural use of these soils. Prior to mechanisation Moretonhampstead soils were favoured for potato growing. Reductions in soil depth gives rise to droughty patches in drier summers, such scorched areas varying in extent from a few square metres to large parts of fields. Overall soil and climatic conditions are good or average for grass growth, and away from steep ground the land is suited or well-suited for grassland [Harrod 1979]. Being freely draining these soils encourage winter stocking, which, if badly managed, can cause poaching and soil damage.

Where rainfall is less than 1140 mm, it is not deemed a limitation for the purposes of the Land Use Capability Classification of Bibby and Mackney [1969]. In those dry eastern areas, Moretonhampstead soils on moderate slopes are classed as 3s, [grade 3a in the MAFF 1988, Agricultural Land Classification]. In wetter sites where annual average rainfall exceeds 1270 mm, there is relegation to class 4c [MAFF grade 4]. A further precipitation-determined cut-off at 1520 mm annual average rainfall down grades these soils around Fernworthy reservoir [666841] to class 5c or grade 5. Similarly, slopes between 11-15$^{O}$ [11-18$^{O}$ on the MAFF scale] are demoted to 4g [MAFF grade 4]. Steeper slopes of 15-25$^{O}$ are classified as 5g and over 25$^{O}$ as 6g. In the MAFF grading all slopes above 18$^{O}$ are grade 5. While the *very rocky* phase is penalised in the Land Use Capability Classification since it inhibits mechanised management of the land, such as mowing and reseeding, the less rocky, *slightly bouldery* phase is not seriously restricting. Combinations of boulders and steep gradients compound their inherent difficulties. Despite the limited profile-available water reserves, well-grown trees are commonplace in relatively sheltered sites and may be able to exploit moisture deeper in the growan substrate. In establishing trees in plantations weeds are likely to be a nuisance and there will be a need for phosphorus fertiliser. On steep and some rough, bouldery parts of the map unit potential for silviculture is restricted. Suited species include oak, beech, Southern beeches, Douglas fir, larches, Sitka spruce, Western hemlock and Grand fir.

**Ecology:** These naturally acid, freely draining soils have high biological activity throughout the profile and are favoured by burrowing animals. There is no surface water within the map unit. Semi-natural vegetation includes dry, acid grassland and oak-birch woodland. Open areas are susceptible to gorse and bracken invasion and reversion to scrub and woodland. The formerly savannah-like aspect of Lustleigh Cleave [770810], with acid grassland with bracken, interspersed with clumps of mature oak trees protected from browsing animals by patches of clitter, has been replaced over recent decades as immature oak-birch woodland colonised the former grassland, once grazing declined and swaling ceased. Whiddon Deer Park [723894] is a Site of Special Scientific Interest, a distinctive park-like area with mature oak, ash and beech trees among bent-fescue grassland with bracken, in which there are scatters of immature oaks and birches. Many steeper parts of the Moretonhampstead map unit are cloaked with mixed sessile and pedunculate oak woodlands with varied backgrounds, from abandoned enclosures, through coppice with standards to ancient woodland with high open canopy, as in Rushford Wood [703896].

**Environment:** In this map unit any groundwater is at depths below 2 m. Water moves by vertical unsaturated flow into the strongly consolidated, non- or slightly-porous granite substrate, in which by-pass flow may occur in fissures. Surface runoff is unlikely, apart from in exceptional conditions, or if serious soil damage is done, for example by excessive winter stocking. Moretonhampstead soils are in

HOST class 4, indicating that while standard percentage runoff is among the lowest in the district, their base flow index is one of the area's highest, the groundwater either directly recharging streams or first sustaining ground-water gley soils in the Laployd, Halfway House / Drewston or Sulham / Eversley map units. Stream water from Moretonhampstead series dominated catchments have a local reputation of being 'crystal clear' at all but times of high discharges. As coarse-textured, moderately shallow soils they readily transmit non-adsorbed pollutants and liquid discharges, but having some ability to attenuate adsorbed pollutants, qualifying as class H3 in the scheme of Palmer *et al.* [1995]. Estimated organic carbon content is small, broadly consistent with other freely draining, well-aerated mineral soils in this district. For the two example profiles in Section 3.2.2, it is 9 and 8 kg $m^{-2}$ to 1 m depth. When the calculation is applied to other published Moretonhampstead series profiles from adjacent areas the mean [from 6] equivalent value is 14 kg $m^{-3}$.

**Amenity and engineering:** These soils' physical properties make shallow excavations relatively stable and they are easily handled and moved at all but the wettest times. The material can be use as shallow fill. They are non-corrosive to buried ferrous metal. Apart from on slopes, they provide good conditions for footpaths and camp and caravan sites or other short-term or seasonal recreational use of the land. Unconsolidated, boulder-free B and C horizon material, 'Chagford Gold', is locally used for gravel pavings and dressings.

---

## 3.3 MORETONHAMPSTEAD / FURLONG MAP UNIT [Mr / Fg on the soil map]

3.3.1 Stony typical brown podzolic soils [Moretonhampstead series] and Furlong series [this soil is not as yet classified, due to uncertainty over its properties and genesis], in coarse loamy or sandy head derived from granite [over lithoskeletal acid crystalline rock], with some humic brown podzolic soils and typical brown earths. The Furlong series is characterised by dark horizons, substantially thicker than normal topsoils. Its distribution within the map unit is haphazard and not predictable, occurring on a range of slope facets, on straight slopes, on convexities and on concavities. Some steep slopes are included. In places it extends for several hundred metres.

**Distribution and site:** 1,270 ha around Moretonhampstead and Chagford on rolling ground between 90 and 320 m O.D. Bouldery in places. The map unit is separated from the modal Moretonhampstead map unit [Mr on the soil map] in polygons where the thicker topsoils' occurrence is rated *occasional, common* or *frequent* on the scale outlined in Section 2.4 above.

**Land cover:** Predominantly permanent pasture, with some leys and short term arable.

**Component soils:**

Moretonhampstead series *[common]*

Furlong series *[common]*

Gunnislake series *[occasional]*

Moor Gate series *[rare]*

Lustleigh series *[rare]*

Unnamed brown ranker *[rare]*

3.3.2 MAIN SOILS

**MORETONHAMPSTEAD SERIES** ***[See Section 3.2]***

**FURLONG SERIES**

**Characteristics:**

Dark brown or brown topsoil and subsoil to 40 cm or deeper

Gritty sandy silt loam or sandy loam textures

**Generalised soil profile:**

*Ah and Ap horizons, [0-40 cm, often greater]:* Dark brown [10YR 3/3], very dark brown [7.5 or 10YR 2/2] or very dark greyish brown [10YR 3/2] gritty sandy silt loam or sandy loam; stony or very stony, gravel to small subangular granite stones; moderate or strongly developed fine and medium subangular blocky structure.

*Bs and/or Bw horizons, [40-80 cm, often deeper]:* Brown [7.5YR 4-5/4] or strong brown [7.5YR 5/6] gritty sandy silt loam, often with pockets of A horizon; stony or very stony with gravel to large [occasional boulders] subangular granite stones; moderate or strong fine subangular blocky structure or crumb. In many profiles browner colours predominate in these horizons, colours becoming brighter below.

*BC horizon, [80-150cm, in some profiles deeper]:* Brown to yellowish brown [7.5YR 5/4 -10YR 5/4] gritty sandy loam; very stony to stone dominant with gravel to large, at times boulders, of subangular or subrounded granite; weak fine subangular blocky structure. In some places thin platy structures, characteristic of a Cx horizon are present.

**Example profile:** SX78/1096 under permanent pasture. 160 m O.D. Slope 15$^{O}$ W, just below convexity.

**Horizons:**

*0-10 cm Ah1:* Very dark greyish brown [10YR 3/2] sandy silt loam; slightly stony with very small stones; slightly moist; moderately developed fine granular structure; moderately porous with very fine fissures and macropores; moderately firm soil strength; moderately weak ped strength; slightly sticky; slightly plastic; abundant very fine fibrous and fine fleshy roots; earthworms present; abrupt smooth boundary.

*10-51cm Ah2:* Very dark brown [10YR 2/3] gritty sandy loam; moderately stony with very small to medium subangular and subrounded granite and quartz stones; slightly moist; strongly developed fine subangular blocky structure; very porous with very fine fissures and macropores; weak soil and ped strength; slightly sticky; non-plastic; abundant very fine fibrous and few fine fleshy roots; no earthworms seen; clear smooth boundary.

*Within Ah2 on right hand 50% of pit pocket as follows:*

*42-60 cm Ah3:* Very dark brown [7.5YR 2/2] gritty sandy loam; very stony with very small to medium angular, subangular and rounded granite, quartz and orthoclase fragments; slightly moist; moderately developed medium granular structure; very porous with very fine fissures, macropores uncertain; very weak soil strength, loose in places, very weak ped strength; non-sticky; non-plastic; many very fine fibrous roots; no earthworms seen but horizon crossed by worm channels to 7 mm diameter; clear smooth boundary.

*Beneath Ah2 and Ah3 on right hand 2 thirds of pit:*

*60[51] -72[58] cm bAh or Bh:* Lens [thinning from right to left] of dark reddish brown [5YR 2/2] humose gritty sandy loam; moderately stony with subangular and subrounded very small to medium granite stones; slightly moist; weakly developed fine granular structure; very porous with very fine fissures, no macropores seen; very weak soil and ped strength; many very fine fibrous roots; earthworms present; clear smooth boundary.

*72-86 cm [79 on left, 91 on right] BC:* Yellowish brown [10YR 5/6] with small and medium areas of very dark greyish brown [10YR 2/2] micaceous loamy sand; very stony with very small to medium subangular and subrounded granite stones; slightly moist; structure indeterminate; variable soil strength; few very fine fibrous roots; clear smooth boundary. Colour variation is from various components of decomposed granite.

*86-106 cm Cu:* Yellow [10YR 7/6] gritty loamy sand in coarse and medium near horizontal bands with dark greyish brown [10YR 3/2], the dark areas containing patches of black [N 2/0] [tourmaline?]; very stony, small to medium granite stones, some very soft.

**Analyses:**

| Horizon | Ah2 | Ah3 | bAh or Bh |
|---|---|---|---|
| Depth cm | 10-51 | 42-60 | 60-72 |
| | | | |
| Sand 60 µm-2 mm% | 78 | 76 | 76 |
| Silt 2-60 µm % | 10 | 11 | 11 |
| Clay < 2 µm % | 12 | 13 | 13 |
| | | | |
| Organic carbon % | 3.1 | 2.4 | 2.0 |
| pH in water [1 : 2.5] | 6.3 | 6.3 | 6.6 |
| Bicarbonate extractable [Olsen] P mg $kg^{-1}$ | 22.6 | 38.0 | 42.6 |

*Comment***:** Note the steep slope and site near a convexity; the uniformity of the particle-size distribution in the three analysed horizons, the absence of a clear Bs or Bw and the pH increasing at depth into what otherwise might be seen as a podzolic B horizon. The relatively high subsoil pH was not anticipated, particularly on ground that has not received lime in over 20 years. The textural uniformity suggests a common origin for the three horizons. The absence of an obvious B horizon is unusual and may contain clues as to the profile's evolution. Levels of extractable P are around or above national averages for topsoils and increase down the profile.

**Example profile:** SX78/1890 under permanent pasture. 175 m O.D. Slope $12^{O}$ N, just below convexity.

**Horizons:**

*0-5 cm Ah1:* Dark brown to very dark greyish brown [7.5YR-10YR 3/2] sandy silt loam to clay loam; very slightly stony with small angular granite fragments, not gritty; moist; few fissures, few pores; deformable; very weak; slightly sticky, slightly plastic; abundant very fine fibrous roots; earthworms present; abrupt smooth boundary.

*5-25 cm Ah2:* Very dark greyish brown to black [10YR 2/1-3/2] gritty sandy silt loam to clay loam; moderately stony with very small and medium angular and subangular granite, quartz and feldspar pieces; moist; moderately developed fine subangular blocky structure breaking to fine granular; vey porous with very fine and fine fissures and macropores; very weak ped and soil strength; moderately sticky, slightly plastic; abundant very fine fibrous roots; earthworms present; gradual smooth boundary.

*25-50 cm Ah3*: Very dark greyish brown to black [10YR 2/1-3/2] gritty sandy clay loam; moderately stony with very small to medium angular and subangular granite, quartz and feldspar pieces; moist; strongly developed fine and medium granular structure; very porous with very fine and fine fissures and pores, a few vertical pores, [earthworm burrows] to 5 mm diameter; very weak ped and soil strength; slightly sticky, moderately plastic; abundant very fine and fine fibrous roots; earthworms present; gradual smooth boundary.

**Plate 22. Furlong series with about 80 cm of dark brown, topsoil-like material.**
Such profiles are too extensive and often in inappropriate locations to be dismissed as colluvial.

*65-81 cm Ah5:* Dark brown [7.5YR 3-4/2] gritty sandy clay loam; moderately stony with very small to medium granite, quartz and feldspar pieces; moist; strongly developed fine granular and fine subangular blocky structure; very porous with very fine and fine pores and fissures; moderately weak ped and soil strength; slightly sticky, slightly plastic; common very fine and fine fibrous roots; earthworms present with 1 vertical burrow about 5 mm diameter and pocket c 3 cm top to bottom and 2 cm across full of very small stones 2-4 mm; clear smooth boundary.

*81-103 cm Bw:* Brown to dark brown [7.5YR 4/4] gritty sandy clay loam; moderately stony with very small to large subangular, subrounded and rounded granite stones, some of which are soft; moist; strongly developed fine subangular and granular structure; very porous with very fine and fine fissures and pores; moderately weak ped and soil strength; slightly sticky, slightly plastic; common very fine and fine fibrous roots; 1 grit filled chamber similar to that in Ah5 above.

## Analyses:

| Horizon | Ah3 | Ah4 | Ah5 | Bw |
|---|---|---|---|---|
| Depth cm | 20-50 | 50-65 | 65-81 | 81-103 |
| | | | | |
| Sand 60 µm-2 mm% | 57 | 51 | 56 | 52 |
| Silt 2-60 µm % | 21 | 25 | 24 | 28 |
| Clay < 2 µm % | 22 | 24 | 20 | 20 |
| | | | | |
| Organic carbon % | 2.0 | 1.3 | 1.4 | 1.3 |
| pH in water [1 : 2.5] | 5.9 | 6.1 | 6.2 | 6.3 |
| Bicarbonate extractable [Olsen] P mg $kg^{-1}$ | 5.9 | 7.3 | 8.1 | |

*Comment:* This profile, described and analysed to confirm the previously described example SX78/1096, has similar subsoil colours but larger clay and silt contents. Like that profile pH is only slightly acid, rising down the profile. In this case the Olsen P values are unexceptional for subsoil horizons. The deepest example seen in the survey was near Easton Cross at 718889, about 50 m from the described profile at SX78/1890, exposed in the water pipeline in October 2010, with 120 cm of topsoil. The anomalous depth there is further notable, but not alone, in being on a convexity on a $12^{O}$ slope. The profile was: 0-30 cm 10YR 3/2 gritty sandy silt loam, with many small and medium granite stones; 30-120 cm 10YR 2/2 gritty humose sandy silt loam. Around that site the thick topsoil [>50 cm] extends down slope to the concavity at 716897 and beyond to 30 m from the road [A382] and carries on northward into gley soils near Mill End.

Across southwest England topsoils are normally about 30 cm or less in thickness. A few exceptions are in colluvium [man-induced accumulations], on lynchets, along hedgebanks on sloping ground and on very localised man-made soils, as in the Ludgvan soils of West Cornwall [Staines, 1979]. The Furlong series' genesis is uncertain. Colluvial accumulation alone does not seem an adequate explanation as some examples are on pronounced convexities and on linear slopes of varying gradient. The Whiddon Down [690925] - North Bovey [742844] pipeline in 2010 showed such horizons up to a metre in depth in places and extending for some distance laterally. Also limited examination of fields containing thick A horizon soils shows that in at least some cases much of the field may be involved. The first example profile above [SX78/1096] has a dark reddish brown horizon at about 60 cm with colour suggestive, on initial field examination, of a podzol Bh. However its pH does not support this, while the subsoil horizon's Olsen P amounts are unusually large, closer to or above many topsoil levels.

If the Furlong soils are the *compost-deepened soils* of Hollis [1991] [formerly [Avery 1980] earthy man-made humus soils], they perhaps came about through lazy bed cultivation for potatoes, a practice commented on by Vancouver [1808, p193-8] as having "taken great root in Devonshire". As noted in Chapter 1, potatoes were an important crop in this area, probably over centuries. After winter ploughing the ground was 'seared' into beds about 1 m wide, spaced about 0.5 m apart. Manure was then spread on the bed surface and the setts [seed potatoes] spaced at about 20 cm apart. Soil was then dug from between the beds and spread over the seed potatoes, raising the beds' surfaces. This trenching and earthing up was carried out two or three times, adding a considerable portion of 'dead earth' [subsoil], which, Vancouver noted, suppressed weeds. The whole procedure he reports as being repeated over the two following years. Vancouver comments that the operation would be excellent preparation for nursery ground, little if at all inferior to 'close trenching'. It is not difficult to see how this deep digging into the subsoil, followed by its mixing with well manured topsoil, with the process repeated a number of times, might produce thick A horizons as are present in the Furlong series. The thorough mixing of the soil that seems implied may also explain the very uniform particle size distribution of the first example profile SX78/1096.

Among other possibilities are that they result from applications of urban wastes from Chagford and Moretonhampstead, perhaps including residues from those towns' long standing, historic woollen trades. The oddly high Olsen P of the first profile suggests anthropogenic contributions, although the relatively wide distribution of Furlong soils lessens that likelihood. However, unlike the compost deepened Ludgvan soils in West Cornwall, they do not appear to contain artefacts. Findlay *et al.* [1984, p 243] note that long periods of intense cultivation, possibly including Bronze Age spade digging [S.J. Staines *priv. comm.*], have produced similarly thick topsoils on the Land's End peninsula. Staines [1979] gives an insight into the medieval and later practices in forming man-made soils in the climatically favoured 'Golden Mile' between Penzance and Marazion. Elsewhere in the Southwest similar dark, compost-deepened or man-made soils are present on the Arne peninsula near Poole Harbour, in association with Iron Age sites [S.J. Staines *priv. comm.*].

In some cases a drab Bw horizon, feebly differentiated from the A, as in typical brown earths of the Gunnislake series [Hogan 1977], may be part of the answer. The loose geographical association of this map unit with areas underlain by altered granite saprolite may provide the explanation. *In situ* weathering of feldspar crystals is often such that they can be cut with a fingernail. Any release of base cations, particularly potassium, sodium and calcium, consequent on the dissolution of the feldspars, may account for the relatively high pH in the subsoils.

The limited resources available to this survey mean that the evolution and classification of Furlong soils are unresolved. These questions may be answered by thorough chemical, physical, micromorphological and archaeological investigations.

### 3.3.3 SUBSIDIARY SOILS

**Gunnislake series** *[occasional]*: Typical brown earth soils with drab brown Bw horizons lacking podzolic B properties. The distribution of Gunnislake soils in this map unit shows no clear pattern.

**Moor Gate series** *[rare]:* With very dark grey, very dark brown or black, humose topsoils, occurring on or near former downland or moorland and in some woods.

**Lustleigh series** *[rare]:* Lustleigh soils are weathered in undisturbed but decomposed granite saprolite, and are defined as "passing to soft weathered acid crystalline rock" for the purposes of Clayden and Hollis' [1984] differentiating criteria. They are most often formed in the area shown on the drainage / physiographic map [Figure 2] with a denser drainage network.

**Unnamed brown ranker** *[rare]:* Thin soils made up of dark brown topsoil over rock occur sporadically across the map unit.

**Key to component soil series:**

| | | |
|---|---|---|
| | Soils with brown to very dark brown, distinct topsoil; coarse loamy | 1 |
| | Soils with dark humose topsoil; coarse loamy | Moor Gate |
| | | |
| 1 | Soils over decayed, *in situ* granite | Lustleigh |
| | Soils over granite or granite rubble | 2 |
| | | |
| 2 | Shallow soils with rock within 30 cm | Unnamed brown ranker |
| | Deeper soils | 3 |
| | | |
| 3 | With up to 40 cm of dark topsoil over brightly coloured subsoil | MORETONHAMPSTEAD |
| | With up to 40 cm of dark topsoil over brown subsoil | Gunnislake |
| | With thicker dark horizons | FURLONG |

In the polygon delineated on the soil map around Moretonhampstead itself there is a scatter of small wet spots and springs, many only a few tens of square metres in extent. Whereas over most of the district mappable areas of gley soils, the Laployd [Section 3.9] and Halfway House / Drewston [Section 3.7] map units, are located on footslopes, many of these small wet patches are higher in the landscape. They broadly coincide with the distinctive patterning visible on Plate 8, which probably reflects the higher than normal incidence of kaolinised granite saprolite there. This interpretation is supported by the landscape's more complex dissection patterns and greater drainage and dry valley density.

### 3.3.4 SOIL FUNCTIONS

*Soil properties:* Both Furlong and Moretonhampstead soils are highly permeable and rarely wet, except briefly during and after very heavy rain. They are in Soil Wetness Class I. Varying profile depth and stoniness means that available water content ranges between about 60-150 mm, averaging around 110 mm. With moisture deficits of about 75 mm over most of the map unit Dryness Subclass *b* is appropriate for profiles with average depth, although replaced by subclass c in the drier climate of the east of the district and for shallower soils.

*Site conditions:* Rainfall over most of the map unit averages over 1200 mm a year, only the extreme east having about 1100 mm. There are steep slopes and bouldery areas over parts of the map unit.

**Production:** The area's high rainfall discourages sustained arable cropping and agricultural use of the map unit is largely confined to grassland, with occasional cereal and forage break crops, maize included. The soils are readily worked, stocked and easily trafficked in all but the wettest times. However in places steep slopes and rocks and boulders limit their use. Until the mid-20$^{th}$ century, potatoes were frequently cultivated on freely draining soils in this district. In drier summers the grass can scorch over shallower profiles; such drought effects can cover a few hectares or just small patches. In comparatively sheltered locations trees thrive, often rooting deep into the growan beneath the soil. The range of suitable tree species for this ground includes oak, beech, Southern beeches, Douglas and Grand firs, larches, Sitka spruce and Western hemlock.

**Ecology:** As with the modal Moretonhampstead map unit described above [Section 3.2] these are dry, freely draining acidic soils favouring biological activity throughout the profile and encouraging burrowing animals and deep rooting. There is no surface water. The limited semi-natural vegetation is mainly oak-birch woodland or grassland susceptible to bracken invasion or reversion to woodland.

**Environment:** Being in HOST class 4 of Boorman *et al.* [1995] indicates that water movement in these soils is by vertical unsaturated flow to groundwater that is at least 2 m beneath in the growan or in fissures in the granite. This indicates large contributions to stream base flow and very restricted runoff potential. For the purposes of assessing vulnerability of groundwater to pollution in terms of Palmer *et al.* [1995], Moretonhampstead soils are classified H3 as they have some ability to attenuate adsorbed pollutants, but readily transmit non-adsorbed pollutants and liquid discharges. The slightly larger content of soil organic carbon in the Furlong soils warrants their placing in the intermediate I2 category in the scheme of Palmer *et al.* [1995]. As with other well-aerated, porous soils, estimated organic carbon content is relatively small, amounts for the two representative profiles shown above being 18 and 13 kg $m^{-2}$ to 1 m depth.

**Amenity and engineering:** Shallow trenches and excavations in these soils are relatively stable and except under very wet conditions the soils can be handled and moved without structural damage and can be used as shallow fill. They are not chemically aggressive. Except on steep slopes they are well suited to short term or seasonal recreational use, camping and caravan sites and footpaths.

## 3.4 MORETONHAMPSTEAD OLD WOODLAND PHASE MAP UNIT [$Mr^w$ on the soil map]

3.4.1 These soils differ from the modal phase of the Moretonhampstead series in having thin surface horizons comprising decaying leaf litter underlain by a seam of humus resting on the mineral soil, features characteristic of soils in long established woodlands.

**Distribution and site:** 78 ha, on very bouldery, steep and very steep ground in Wray Cleave [775843] and Steward Wood [771850] and on strong to steep or very steep slopes in the southeastern part of Lustleigh Cleave [770810].

**Land cover:** Oak woodland.

**Component soils:**

Moretonhampstead series Old Woodland phase *[dominant]*

Moretonhampstead series normal phase *[occasional]*

Moor Gate series *[rare]*

Unnamed brown ranker *[rare]*

### 3.4.2 MAIN SOIL

**MORETONHAMPSTEAD SERIES OLD WOODLAND PHASE**

Moretonhampstead series soils having thin surface horizons produced by the gradual accumulation and acidic decomposition of leaf litter into amorphous humus, indicative of undisturbed old woodland.

**Characteristics:**

Thin [1-5 cm] fresh surface litter of leaves and twigs over decomposing material which rests on stoneless, black, amorphous organic matter a few cm thick over mineral soil

Gritty sandy silt loam or sandy loam texture

Brown or brightly coloured subsoil

Very stony with rock or very stony rubble by 80 cm

**Generalised soil profile:**

*L horizon, [8-6 cm]:* Litter of recently fallen leaves and other plant debris.

*F horizon, [6-4 cm]:* Layer of decomposing leaves etc.

*H horizon, [4-0 cm]:* Horizon of black, decomposed humus or peat. This horizon, along with L and F, varies in thickness. Unlike in the Old Woodland phase of the Bridford series [Section 3.16], micropodzol development seems very rare.

*Ah horizon, [0-15 cm]:* Dark brown [10YR 3/3] or very dark greyish brown [10YR 3/2] gritty sandy silt loam; stony or very stony, gravel to small subangular granite stones; moderate or strongly developed fine and medium subangular blocky structure.

*Bs and/or Bw horizons, [30-60 cm]:* Brown [7.5YR 4-5/4] or strong brown [7.5YR 5/6] gritty sandy silt loam, often with pockets of A horizon; stony or very stony with gravel to large [occasional boulders] subangular granite stones; moderate or strong fine subangular blocky structure or crumb under woodland. In many profiles browner colours predominate in these horizons, colours becoming brighter below.

*BC horizon, [60-120 cm]:* Brown to yellowish brown [7.5YR -10YR 5/4] gritty sandy loam; very stony to stone dominant with gravel to large, at times boulders, of subangular or subrounded granite; weak fine subangular blocky structure. In some places thin platy structures characteristic of a Cx horizon are present.

**Example profile:** SX78/7347 in oak woodland on 26$^{O}$ slope. 244 m O.D.

**Horizons:**

*7-5 cm L;* Litter of oak leaves, twigs and bracken fronds.

*5-3 cm F*; Dark reddish brown [5YR 2/2] mat of fibrous humus; stoneless; moist; no cube obtained, non-sticky, non-plastic; abundant fine fibrous roots; sharp, smooth boundary.

*3-0 cm H*; Black [N 2/0] humose sandy silt loam; slightly stony with occasional small granite pieces; moist; strongly developed ‘very’ fine granular structure; very porous with very fine macropores; loose soil strength; no cube obtained, non-sticky, non-plastic; abundant very fine to medium fibrous and woody roots; abrupt even boundary.

*0-15 cm Ah;* Dark brown [7.5YR 3/2] sandy silt loam; moderately stony with small subangular granite stones; moist; strongly developed fine granular structure; loose soil strength; no cube obtained; non-sticky, non-plastic; abundant fine to medium woody and fibrous roots; clear smooth boundary.

*15-39 cm Bw or Bs;* Brown to strong brown [7.5YR 5/4-6] sandy silt loam; moderately stony with small to large subangular granite stones; moist; strongly developed fine granular structure; loose soil strength; no cube obtained; slightly sticky, slightly plastic; common and medium fibrous and woody roots. Augered to 57 cm with no change, stopped by stone.

**Analyses:**

| Horizon | H | Ah | Bw or Bs |
|---|---|---|---|
| Depth cm | 0-3 | 0-15 | 15-39 |
| | | | |
| Sand 60 µm-2 mm% | 59 | 53 | 54 |
| Silt 2-60 µm % | 24 | 28 | 32 |
| Clay < 2 µm % | 17 | 19 | 14 |
| | | | |
| Organic carbon % | 16.9 | 3.9 | 3.6 |
| pH in water [1 : 2.5] | 4.0 | 4.3 | 4.8 |

*Comment:* The strongly-developed fine granular structure in the B horizon is typical of brown podzolic soils, in which micromorphological studies reveal a pellety microfabric, indicative of faecal material.

3.4.3 SUBSIDIARY SOILS

**Moretonhampstead series normal phase** *[occasional]:* Soils with distinct brown or dark brown topsoils, without significant development of L, F and H horizons.

**Moor Gate series** *[rare]:* Profiles with thick humose, sometimes peaty, topsoils.

**Unnamed brown ranker** *[rare]:* There are sporadic occurrences of shallow soils without a subsoil B horizon, where rock or very stony or bouldery material forms within about 30 cm depth.

N.B. Unlike the Bridford Old Woodland phase map unit [Section 3.16] this map unit contains few if any profiles with micropodzol horizons.

**Key to component soil series:**

| | | |
|---|---|---|
| | Soils with brown to very dark brown distinct topsoil | 1 |
| | Soils with dark humose topsoil | Moor Gate |
| | | |
| 1 | Shallow soils with rock within 30 cm | Unnamed brown ranker |
| | Deeper soils | 2 |
| | | |
| 2 | With up to 40 cm of dark topsoil over brightly coloured subsoil | Moretonhampstead normal phase |
| | With thin surface leaf mould | MORETONHAMPSTEAD OLD WOODLAND PHASE |

3.4.4 SOIL FUNCTIONS

*Soil properties:* These soils are very porous and permeable and are seldom wet. Moisture reserves accessible to plants [available water capacity] are variable depending on depth to rock. Where the rock or growan beneath the soil allow, tree roots can penetrate to several metres depth. Most of the surface horizons are moderately or strongly acid in reaction.

*Site conditions:* Steepness of slope dominates this map unit, which is also very rocky and bouldery.

**Production:** This is land of amenity and ecological value, part of it in Lustleigh Cleave [770810] being in the Bovey Valley Woodlands Site of Special Scientific Interest. This precludes productive use other than when commoners exercise their rights of grazing etc.

**Ecology:** Oak woodland; soil acidity reduces biological activity somewhat, but a good rooting medium and favoured by burrowing animals and soil living fauna such as springtails. No surface water is present apart from very small localised flushes.

**Environment:** Water percolates by vertical unsaturated flow to groundwater more than 2 m down. There is minimal runoff, nearly all percolation eventually adding to stream base flow. Although rated among soils of high leaching potential [sub class H3] by Palmer *et al.* [1995] application of pollutants is improbable. As with other freely draining soils described in this survey estimated organic carbon content is modest at 25 kg $m^{-2}$ to a depth of 1 m for the profile in Section 3.4.2, although this is somewhat larger than the amounts in the examples for the Moretonhampstead soils in the normal phase map unit [see Section 3.2].

**Amenity and engineering:** Slope and amenity status make it unlikely that soil disturbance or use appropriate to this subheading will take place, with the exception of comments below regarding footpaths. The soils are stable in shallow excavations and trenches and are amenable to digging, handling and storing under all but exceptional wet circumstances. They are not corrosive to ferrous metal. Ground conditions are suitable for footpaths and rambling, but not for other recreational use.

---

## 3.5 MOOR GATE MAP UNIT [mQ on the soil map]

3.5.1 Stony humic brown podzolic soils in coarse loamy or sandy, stony Head derived from granite [over lithoskeletal acid crystalline rock]. With some typical brown podzolic soils, and ironpan, humus-ironpan and ferric stagnopodzols.

**Distribution and site:** Covering 2,646 ha of this district, Moor Gate soils occur in the in-bye and on the lower moorland, from about 140 m O.D. to 450 m, on a variety of slopes. They are the main soils of downland in the otherwise largely enclosed in-bye, such as Mardon Down [772879] and the higher parts of Lustleigh Cleave [770820]. They are found in enclosures, which often are larger and more rectangular than on the Moretonhampstead map unit. Some fields carry the name element ‘down’, which suggests relatively recent agricultural reclamation. Some old woodland within the in-bye has Moor Gate soils, reflecting the accumulation and acidification of litter under long-term coppicing. On the moor the map unit is common on the relatively low parts, most often on steep or strong slopes. It is bouldery in places. Outside this district Moor Gate soils form around the margins of Dartmoor, on the Land's End peninsula and on the Carnmenellis granite of west Cornwall.

**Land cover:** The enclosed in-bye, has a mixture of grassland, arable and downland, the latter semi-natural dry, acid grassland with bracken, gorse and heath, plus some broad leaved and coniferous woodland. On the moor much of the dry, heath and grassland is similar in character to the in-bye's downland, although the heather moorland around Headland Warren [680810] is among Dartmoor's most striking.

**Component soils:**

Moor Gate series *[abundant]*

Moretonhampstead series *[rare]*

Unnamed ferri-humic cryptopodzols *[rare]*

Bangor series *[rare]*

Hexworthy series *[rare]*

Rough Tor series *[rare]*

Trink series *[rare]*

Bodafon series *[rare]*

3.5.2 MAIN SOIL

**MOOR GATE SERIES**

Stony coarse loamy humic brown podzolic soil over lithoskeletal acid crystalline rock, or in [granite derived] drift with siliceous stones. The first description of the series was from the Ivybridge area [Harrod *et al.* 1976]. Subsequently it was described on Bodmin Moor [Staines 1976] and in west Cornwall [Staines 1979], with Moor Gate soils mapped later in Snowdonia and on the Lleyn peninsula [Rudeforth *et al.* 1984].

**Characteristics:**

Humose, very dark grey or black topsoil

Gritty sandy loam or sandy silt loam textures

Brown or ochreous subsoil

**Generalised soil profile:**

*Ah or Ap horizon [0-25 cm, often thinner under moorland]:* Very dark grey or black humose coarse sandy loam, sandy silt loam or loamy sand, stony, gravel to small subangular granite stones; moderate or strongly developed fine and medium subangular blocky or granular structure.

*Bs and/or Bw horizons, [25-60 cm]:* Strong brown [7.5YR 5/6] or brown [7.5YR 4-5/4] gritty sandy silt loam, including lenses and pockets of material from above; stony or very stony with subangular granite stones up to boulder size; moderate or strong fine subangular blocky or granular structure.

*BC or C horizon, [60-100 cm]:* Brown or dark brown [7.5YR or 10YR 4/4] gritty sandy loam; very stony to stone dominant with stones to boulder size, of subangular or subrounded granite; weak fine subangular blocky or platy structure.

**Example profile:** SX68/9932 in unenclosed acid grassland with bent, fescue and bracken. 350 m O.D. [Findlay *et al.* 1984, p 400].

**Horizons:**

*0-7 cm Ah:* Black [N2/0] very slightly stony humose coarse sandy loam; very small subangular granite stones; strongly developed fine granular; low packing density; moderately weak soil strength; abundant very fine fibrous roots; abrupt smooth boundary.

*7-20 cm ABh:* Dark brown [7.5YR 3/2] humose coarse sandy loam; slightly stony small to medium subangular granite; weakly developed medium subangular blocky; low packing density; moderately firm soil; and ped strength; many very fine fibrous roots; abrupt irregular boundary; basal 2-3 cm is dark reddish brown [5YR2/2] across three quarters of section.

*20-30 cm Bs:* Reddish brown [5YR 4/4] coarse sandy loam; stony, small to large subangular granite; weakly developed medium subangular blocky, peds breaking readily into weakly developed medium granular; low packing density; moderately firm soil strength, moderately weak ped strength; many very fine fibrous roots; clear irregular boundary.

*30-44 cm BCu:* Brown to dark brown [7.5YR 4/4] coarse sandy loam; moderately stony, small subangular granite; weakly developed coarse subangular blocky; medium packing density; moderately weak soil and ped strength; many very fine fibrous roots; clear smooth boundary.

*44-100 cm BCx:* Brown to dark brown [7.5YR 4/3] coarse sandy loam; very stony, granite stones; strongly developed medium platy; high packing density;

moderately weak soil and ped strength; many very fine fibrous roots; clear smooth boundary.

*100-120 cm Cu:* Dark greyish brown [10YR 4/2] coarse sandy loam; extremely stony, granite stones; single grain; loose soil strength; many coats.

**Analyses:**

| **Horizon** | **Ah** | **ABh** | **Bs** | **BCu** | **BCx** | **Cu** |
|---|---|---|---|---|---|---|
| **Depth cm** | 0-7 | 7-20 | 20-30 | 30-44 | 44-100 | 100-120 |
| | | | | | | |
| **Sand 600 µm-2 mm %** | 23 | 31 | 36 | 31 | 39 | 28 |
| **“ 200-600 µm %** | 20 | 21 | 17 | 18 | 16 | 28 |
| **“ 60-200 µm %** | 7 | 10 | 9 | 10 | 10 | 19 |
| **Silt 2-60 µm %** | 35 | 27 | 26 | 31 | 28 | 16 |
| **Clay <2 µm %** | 15 | 11 | 12 | 10 | 7 | 9 |
| | | | | | | |
| **Organic carbon %** | 11 | 5.1 | 1.9 | 1.5 | 0.6 | 0.6 |
| **pH in water [1 : 2.5]** | 4.5 | 4.8 | 5.0 | 5.0 | 5.3 | 5.6 |
| **pH in 0.01M $CaCl_2$ [1 : 2.5]** | 3.8 | 4.2 | 4.4 | 4.6 | 5.0 | 5.1 |
| | | | | | | |
| **Pyrophosphate extractable:** | | | | | | |
| **Fe%** | 0.6 | 0.7 | 0.5 | 0.2 | 0.1 | trace |
| **Al%** | 0.2 | 0.3 | 0.4 | 0.4 | 0.3 | 0.4 |
| **C%** | 2.7 | 2.0 | 2.1 | 0.8 | 0.3 | 0.3 |
| **Fe + Al%** | 0.8 | 1.0 | 0.9 | 0.6 | 0.4 | 0.4 |
| **[Fe + Al / clay] x 100** | 5.3 | 9.1 | 7.5 | 6.0 | 5.7 | 4.4 |
| **Residual dithionite extractable Fe%** | 0.8 | 0.9 | 0.8 | 1.0 | 0.9 | 0.8 |

*Comment:* The Ah horizon, although containing an organic carbon percentage well above the threshold for a humose horizon, on its own is insufficiently thick to place the profile in the humic subgroup. The ABh [7-20 cm] horizon is just humose; were it mixed to 15 cm with the Ah, that would produce an horizon readily meeting the criteria for humose / humic.

**Micromorphology:**

*Clay coats and other clay concentrations:* None.

*Other coats, nodules and segregations:* None.

*Mineralogy and weathering:* Quartz, moderately weathered granite and biotite showing exfoliation. Fragments most strongly weathered at 63-69 cm.

*Plasmic fabric:* Asepic in all sections.

*Other observations:* Granular / coprogenic structure at 13-19 and 24-30 cm with fine [<50 µm] granules separated by compound packing voids. Some areas of more closely packed granules contain channels and chambers partly filled with pellets. At 63-69 cm sand and gravel particles bound by micaceous fine material form a subangular blocky structure.

### 3.5.3 SUBSIDIARY SOILS

**Moretonhampstead series** *[rare]:* Soils distinguished from Moor Gate series by having dark brown, non-humose material. This may reflect different land use and vegetation history. The process of 'denshering', or paring and burning of turf before arable use, described by Vancouver [1808] may have been part of this.

**Unnamed ferri-humic cryptopodzols** *[rare]:* In some profiles the lower part of the dark topsoil has features of a podzol Bh horizon, only readily confirmed by chemical and micromorphological analyses. Such horizons are readily destroyed by cultivation and are not identifiable in the field without supporting analyses.

**Bangor series** *[rare]:* These shallow soils occur where rock approaches the surface and no subsoil B horizon has formed.

**Hexworthy series** *[rare]:* This ironpan stagnopodzol is described fully below at Section 3.6. With the closely related Rough Tor and Trink series, it develops sporadically on the higher, gently sloping parts of the map unit on the moorland.

**Rough Tor series** *[rare]:* Distinguished from the Hexworthy series by the lack of an ironpan.

**Trink series** *[rare]:* Formed where a humus-rich Bh develops over the stagnopodzol's ironpan.

**Bodafon** *[rare]:* There are rare, sporadic occurrences of Bodafon soils in lower moorland sites soils. They are distinguished from Rough Tor series by the lack of mottling in the subsurface bleached horizon.

**Key to component soil series:**

| | | |
|---|---|---|
| | Soils with brown distinct topsoil or thin surface leaf mould | MORETONHAMPSTEAD |
| | Soils with dark humose topsoil | 1 |
| | | |
| 1 | Without bleached subsurface horizon | MOOR GATE |
| | With bleached subsurface horizon | 2 |
| | | |
| 2 | With thin ironpan | 3 |
| | Without thin ironpan | 4 |
| | | |
| 3 | With dark humus enriched subsoil | Trink |
| | Without dark humus enriched subsoil | Hexworthy |
| | | |
| 4 | With mottled bleached horizon | Rough Tor |
| | Without mottling in bleached horizon | Bodafon |

### 3.5.4 SOIL FUNCTIONS

*Soil properties:* Moor Gate soils are permeable and well drained, [wetness class I], readily absorbing winter rain, except where subject to structural degradation and on some steep slopes. Soil moisture reserves vary with profile depth and rockiness. In the example profile above, calculated available water is about 113 mm, largely held at low tensions, for most of the area placing it in Dryness Subclass *b* of Hodgson [1976]. Natural acidity is a further profile property, which may be ameliorated on agricultural land.

*Site conditions:* Apart from some land in the drier east of the district, the map unit falls west of the 1270 mm annual rainfall isohyet, so that climate is regarded as a limitation for land classification purposes. Other sporadic site conditions affecting soil use are steep slopes and bouldery areas, both of which are mapped on the accompanying terrain map.

**Production:** The soils' free drainage allows stocking, trafficking and working under most moisture condition, supporting grassland that can be stocked for much of the year. The humose topsoil means susceptibility to poaching is slightly greater than on the related Moretonhampstead map unit. Variations in soil depth and stoniness make for less productive patches in grass fields over shallow soils. Although Moor Gate soils are light and easily cultivated their arable use is restricted, the little there is being for cereals and forage crops, with occasional pastures broken for re-seeding. Bent-fescue grasses on this map unit provide the moorland's areas of highest grazing value. In the drier eastern areas these soils on gentle, non-bouldery slopes are rated as class 3s on the Bibby and Mackney [1969] scheme and grade 3a on MAFF's [1988] ALC. Further west they are relegated to class 4c and grade 4, with appropriate further down-rating on steep and bouldery land. The tradition of mowing and baling bracken for cattle bedding is still practised on commons such as Mardon Down. Tree growth can be vigorous away from exposed sites, given reasonable soil depth, offering suitable sites for oak, beech and Southern beeches and most conifers. Phosphorus fertiliser applications will be helpful for establishment of tree seedlings, as will control of bracken and other weed species in the early stages.

**Ecology:** On the open moor and on downland within the in-bye, Moor Gate soils carry mosaics of dry acid grassland mixed with heathland. The heath is composed of ling, bell heather, cross-leaved heath, bilberry and western gorse, the grasses include *Molinia*, mat grass, sheep's fescue, common and bristle bents. The map unit contains sections of the mixed oak species woodland in the Bovey Valley National Nature Reserve [767807], as well as parts of the oak woods along the Wray valley northeast of Lustleigh [785813]. There is moderately high soil biological activity, including burrowing animals. No surface water bodies occur. There are abandoned enclosures of various ages from the Bronze Age to the 19$^{th}$ century on moorland and downland across the Moor Gate map unit, the medieval lynchets north of Challacombe [695796] providing spectacular displays of bluebells in spring before the bracken rises beyond its fiddle head stage.

**Plate 23. Humic brown podzolic soils of the Moor Gate series.**

These soils have dark surface horizons over brightly coloured, very porous subsoils, which favour root development. Their subsoils usually contain vertical worm channels, here highlighted by the dark patches of topsoil material, carried down by the worms. This profile also has, on the left, a larger infilled burrow. Colour variations in the subsoil result from differential mineralisation of the parent material.

**Environment:** Water moves through Moor Gate soils [in HOST class 4 of Boorman *et al.* 1995] by vertical unsaturated flow to groundwater at depths greater than 2 m. There is very little runoff potential and water eventually finds its way through fissure and joint systems in the granite to feed stream base flow directly, or break out as groundwater that sustains Laployd, Drewston or Sulham soils downslope. Relatively high organic matter in surface horizons provides modest potential for attenuation of adsorbed diffuse-sourced pollutants, consistent with Palmer *et al.*'s [1995] subclass I1, although some penetration of the soils seems likely. Estimated profile organic carbon content of the example soil described in Section 3.5.2 above is modest at 20 kg $m^{-2}$ to 1 m depth, although the average of this and five other Moor Gate profiles from around Dartmoor, is 30 kg $m^{-2}$. This is comparable with values for Drogo series, the other humic brown podzolic soil in this district**.**

**Amenity and engineering:** As with other loamy, well aerated soil materials derived from granite, these soils can be disturbed and moved without damage and compaction under most moisture conditions. Shallow trenches and excavations in Moor Gate soils remain stable for long periods. Apart from the topsoil these materials are usable as shallow fill. Although naturally acidic near the surface, good aeration and free drainage prevent serious corrosion of buried metal. On flat or modest slopes conditions are favourable for short duration or seasonal recreational use, camp and caravan sites and footpaths.

**Plate 24. Moor Gate series under acid grassland on the lower moorland.**

The A horizon is replete with bracken rhizomes, but the profile lacks the earthworm activity seen in Plate 23. Photo by B Clayden.

## 3.6 HEXWORTHY / ROUGH TOR MAP UNIT [ Hx/rF on the soil map]

3.6.1 Stony stagnopodzols of this map unit are formed in sandy or loamy, stony granite-derived head or growan, [loamy material over lithoskeletal acid crystalline rock]. The distinction between the two components is the presence or absence of an ironpan. Hexworthy soils were first described by Clayden and Manley [1964] with Rough Tor series first recognised in the Ivybridge survey [Harrod *et al.* 1976] but named from Bodmin Moor by Staines [1976]. Although this survey shows Rough Tor profiles to be the more common, the map unit name Hexworthy / Rough Tor is retained as in previous use around Ivybridge and on Bodmin Moor.

**Distribution and site:** 3,142 ha of rolling moorland below the blanket bog and on the steeper sites on the high moors. The ground ranges between 300 m O.D. and 580 m, although most of it above about 500 m is on strong or steep slopes. Away from this immediate locality Hexworthy / Rough Tor soils are represented on the National Soil Map by Association 651b, occurring on some other parts of Dartmoor, on much of Bodmin Moor and the higher parts of the Land's End granite outcrop.

**Land cover:** Heathy moorland and *Molinia* grassland. Much of the conifer plantation in Fernworthy Forest [650830] is on these soils.

**Component soils:**

Hexworthy series *[occasional]*

Rough Tor series *[common]*

Princetown series *[occasional]*

Less gleyed phase of Princetown series *[rare]*

Trink series *[rare]*

Bodafon series *[rare]*

Moor Gate series *[rare]*

3.6.2 MAIN SOILS

**HEXWORTHY AND ROUGH TOR SERIES** Both soils are stony coarse loamy stagnopodzols soils over lithoskeletal acid crystalline rock, or in granite derived drift with siliceous stones. Hexworthy soils are in the ironpan subgroup, Rough Tor series in the ferric subgroup.

**Characteristics:**

Gritty sandy loam or sandy silt loam textures predominate

Peaty topsoil

Mottled greyish subsurface

Abrupt change to brightly coloured deeper subsoil

Depth of this change is very variable; normally at 30-40 cm, but can descend to 1 m

Ironpan at base of mottled subsurface horizon in Hexworthy series

**Generalised soil profile:**

*Oh horizon, [0-20 cm]:* Black [N 2/0] humified peat, sandy peat or loamy peat; stoneless; structureless massive. Some variation occurs in the make up and thickness of these horizons. There is a gradation from lower altitude sites where there is substantial mineral content and the horizon relatively thin, to high sites marginal to the blanket bog where the peaty horizon approaches the 40 cm cut off that would qualify it as the Hepste series oligo-amorphous peat soil. Indeed some peat soils show clear developments analogous to Eag, Bf and Bs horizons in Hexworthy and Rough Tor profiles. Elsewhere cutting of peat 'vags' for fuel, a long standing custom on Dartmoor, has truncated some profiles, leaving shallow but marked steps across the soil surface.

*Eag horizon, [20-45 cm]:* Greyish, mottled, stony, gritty sandy loam with common brownish and ochreous mottles, often associated with stones plus pipes and pockets of humose material from above; many stones are soft weathered; massive or weakly developed fine granular or subangular blocky structure.

*Bf horizon, [45 cm]:* In the Hexworthy series only: very dusky red [2.5YR 2/2] thin [1-2 mm] ironpan. The ironpan varies in depth considerably between about 30 cm and 90 cm, often over short distances, forming involuted lobes. As the ironpan changes level the Eag horizon thins or extends accordingly. The ironpan is not always continuous laterally, where absent Hexworthy series gives place to Rough Tor. The involuted fluctuations in thickness of the Eag, noted in the Hexworthy series, also occur in Rough Tor profiles.

*Bs horizon, [45-60 cm]:* Strong brown or yellowish red [5 or 7.5YR 5-6/6-8] gritty sandy loam; very stony with unweathered granite stones; fine subangular blocky, occasionally granular structure. In a proportion of Rough Tor profiles there are mottles in the top few cm, forming a narrow Bs[g] horizon.

*BCu horizon, [60-90 cm]:* Brown or yellowish brown [7.5 or 10YR 5/4 or 5/6] gritty sandy loam or loamy sand; very stony; structure often indeterminate.

*Cu horizon [90+ cm]:* Brown or dark greyish brown [10YR 4-5/2-3] gritty loamy sand; stony to very stony. In places the deeper subsoil horizons show relict fragipan features, platy structures and silty 'caps' on stones.

**Example profiles:**

**Hexworthy series** SX67/4079 plantation of Lodgepole pine and some Sitka spruce. 385 m O.D. [Hogan 1978, p 46].

**Horizons:**

*0-8 cm F:* Reddish black [10R 2/1] stoneless, laminated organic horizon of partly decomposed litter of grass, leaves and conifer needles; very moist; abundant fine woody roots; non calcareous; sharp wavy boundary.

*8-18 cm Oh:* Black [N 2/0] sandy peat; stoneless; very moist; massive; low packing density; moderately weak soil strength; abundant very fine woody roots; non calcareous; abrupt wavy boundary.

*18-22 cm Ah:* Black [10YR 2/1] coarse sandy loam; moderately stony, very small subangular granite; very moist; weakly developed fine subangular blocky; low packing density; moderately weak soil strength; abundant very fine fibrous roots; non calcareous; abrupt wavy boundary.

*22-33 cm A/Eg:* Dark reddish brown [5YR 2/2] moderately stony coarse sandy loam with common medium yellow [10YR 7/6] mottles, which become more numerous lower in the horizon and are usually centred on stones, many of which are soft and weathered small subangular granite; very moist; weakly developed fine subangular blocky; low packing density; moderately weak soil strength; many very fine fibrous roots; non calcareous; gradual wavy boundary.

*33-54 cm Eg:* Light brownish grey [2.5Y 6/2] moderately stony coarse sandy loam with many coarse yellowish brown [10YR 5/4] and brownish yellow [10YR 6/6] mottles; very small to medium subangular granite; very moist; weak fine subangular blocky; low packing density; moderately firm soil and ped strength; some dark reddish brown infillings; many very fine woody roots; sharp wavy boundary.

*At 54 cm Bf:* Very dusky red [2.5YR 2/2] thin ironpan; sharp wavy boundary.

*54-66 cm Bs:* Strong brown [7.5YR 5/6] very stony coarse sandy loam; very small to medium subangular and tabular granite; very moist; moderately developed fine subangular blocky; low packing density; moderately weak soil strength; common medium woody roots; non calcareous; common discontinuous ferri-manganiferous coats on stones and peds; clear wavy boundary.

*66-87 cm BCu:* Yellowish brown [10YR 5/6] very stony loamy coarse sand; very small to large subangular and tabular granite; moist; weakly developed fine subangular blocky; low packing density; moderately weak soil strength; common fine woody roots; non calcareous; clear wavy boundary.

*87-120 cm Cu:* Brown [10YR 5/3] very stony loamy coarse sand; very small to large subangular and tabular granite; moist; single grain; medium packing density; moderately weak soil strength; common very fine woody roots; non calcareous; many sand and silt coats on stones, the larger having silt caps and often underlain by very small stones.

**Analyses:**

| **Horizon** | **Oh** | **Ah** | **A/Eg** | **Eg** | **Bf** | **Bs** | **BCu** |
|---|---|---|---|---|---|---|---|
| **Depth cm** | 8-18 | 18-22 | 22-33 | 33-54 | At 54 | 54-66 | 66-87 |
| | | | | | | | |
| **Sand 600 µm-2 mm %** | 30 | 30 | 33 | 36 | 32 | 40 | 49 |
| **" 200-600 µm %** | 27 | 20 | 19 | 21 | 16 | 18 | 18 |
| **" 60-200 µm %** | 10 | 12 | 9 | 15 | 11 | 8 | 10 |
| **Silt 2-60 µm %** | 25 | 26 | 32 | 22 | 33 | 29 | 18 |
| **Clay <2 µm %** | 8 | 12 | 7 | 6 | 8 | 5 | 5 |
| **<0.2 µm %** | | | | 0 | | 0 | |
| | | | | | | | |
| **Organic carbon %** | 14 | 2.6 | 1.4 | 0.4 | 1.7 | 0.6 | 0.3 |
| **pH in water [1 : 2.5]** | 4.1 | 4.3 | 4.7 | 4.7 | 4.6 | 4.7 | 4.9 |
| **pH in 0.01M $CaCl_2$ [1 : 2.5]** | 3.2 | 3.5 | 4.3 | 4.3 | 4.2 | 4.3 | 4.5 |
| | | | | | | | |
| **Pyrophosphate extractable:** | | | | | | | |
| **Fe%** | | 0.1 | 0.1 | 0.1 | 1.1 | 0.2 | trace |
| **Al%** | | 0.3 | 0.3 | 0.3 | 0.4 | 0.2 | 0.2 |
| **C%** | | 1.4 | 0.9 | 0.3 | 1.0 | 0.4 | 0.2 |
| **Fe + Al%** | | 0.4 | 0.4 | 0.4 | 1.4 | 0.4 | 0.2 |
| **[Fe + Al / clay] x 100** | | 3.3 | 5.7 | 6.6 | 17.5 | 8.0 | 4.0 |
| **Residual dithionite extractable Fe%** | | 0.4 | 0.6 | 0.4 | 7.0 | 1.0 | 0.3 |
| | | | | | | | |
| **Bulk density g $cm^{-3}$** | | | | 1.25 | | 1.45 | 1.35 |
| **% by vol.** | | | | | | | |
| **<2 bar** | | | | 15 | | 15 | 15 |
| **<15 bar** | | | | 20 | | 20 | 19 |
| **Air capacity** | | | | 22 | | 18 | 22 |
| **Retained water** | | | | 29 | | 27 | 28 |

*Comment:* Organic carbon content in the Oh horizon is relatively small compared with the Rough Tor profile described below. Unlike the granite derived soils on the enclosed in-bye to the east, the pH remains below 5 throughout the profile. The pyrophosphate extractable Fe + Al / clay peaks in the ironpan [Bf] and Bs horizons, but levels are high in the A/Eg & Eg as well. With air capacity above 15% in the Eg as well as Bs and BCu none of these horizons would be seen as impermeable by lowland standards. So the gleying in the A/Eg andEg horizons may be attributable to wetness from the overlying Oh, the impermeability of the iron pan and the very wet climate.

**Plate 25. Hexworthy series.**

Acidic surface peaty horizons overlie a mottled, grey subsurface, from which iron has been leached. The iron has precipitated below as a thin iron pan [Bf] and beneath that as the brightly coloured subsoil.

**Plate 26. The thin ironpan of a Hexworthy profile.**

There is greyish E horizon material above and brightly coloured Bs horizon below.

**Micromorphology:**

*Clay coats and other clay concentrations:* None.

*Other coats:* Rare fine neo-organans at 41-47 cm.

*Nodules and segregations:* None.

*Mineralogy and weathering:* In addition to quartz and tourmaline there are variably weathered granite fragments and biotite particles.

*Plasmic fabric:* Asepic.

*Other observations:* Fine and medium subangular blocky structure with common channels and chambers containing pellets.

**Rough Tor series** SX67/4078 Coniferous plantation with Sitka spruce and Lodgepole pine. 390 m O.D. [Hogan 1978, p 50]

**Horizons:**

*0-15 cm Op:* Black [N 2/0] stoneless humified peat; slightly moist; moderately developed medium subangular blocky; low packing density; moderately weak soil strength; abundant fine to coarse fibrous and woody roots; sharp wavy boundary.

*15-28 cm Oh:* Black [N 2/0] stoneless humified peat; moist; strongly developed coarse angular blocky; low packing density; moderately firm soil and ped strength; abundant fine to coarse fibrous and woody roots; sharp smooth boundary.

*28-36 cm Eag:* Dark grey [10YR 4/1] moderately stony coarse sandy loam with common extremely fine dark reddish brown [5YR 3/2] mottles on root channels; very small to large subangular granite, some ochreous, soft and weathered towards base of horizon; slightly moist; massive; low packing density; moderately firm soil strength; root mat on some stone surfaces; some medium and coarse pockets and channels of organic matter; many fine fibrous roots; abrupt wavy boundary.

*36-45 cm Bs:* Yellowish red [5YR 5/6] moderately stony coarse sandy silt loam; small and medium subangular and tabular granite, some soft and weathered at the top of the horizon; moist; moderately developed medium angular blocky with yellowish red [5YR 4/6] faces; low packing density; moderately firm soil strength; moderately weak ped strength; many very fine fibrous roots; common dark reddish brown [2.5YR 3/4] sesquioxide coats on upper stone surfaces and ped faces near top of horizon; clear smooth boundary.

*45-75 cm BCu:* Brown [7.5YR 5/4] moderately stony coarse sandy silt loam; medium and large subangular granite; moist; massive; low packing density; moderately weak soil strength; many fine woody roots; gradual wavy boundary.

*75-95 cm BCx:* Brown [7.5YR 5/4] very stony coarse sandy loam; very small to large subangular granite; slightly moist; strongly developed medium platy with brown to dark brown [7.5YR 4/2] faces; medium packing density; moderately firm soil and ped strength; common very fine fibrous roots; patchy ferri-manganiferous coats on few stones; gradual wavy boundary.

*95-120 cm Cu:* Dark greyish brown [10YR 4/2] moderately stony coarse sandy loam with horizontal banding of light reddish brown [2.5YR 6/4]; very small to large subangular granite; moist; weakly developed coarse platy; medium packing density; weak soil and ped strength; few very fine fibrous roots.

**Analyses:**

| **Horizon** | **Oh** | **Eag** | **Bs** | **BCu** | **BCx** | **Cu** |
|---|---|---|---|---|---|---|
| **Depth cm** | 15-28 | 28-36 | 36-45 | 45-75 | 75-95 | 95-120 |
| | | | | | | |
| **Sand 600 µm-2 mm %** | 9 | 24 | 22 | 24 | 25 | 40 |
| **" 200-600 µm %** | 16 | 18 | 15 | 16 | 22 | 19 |
| **" 60-200 µm %** | 13 | 12 | 10 | 9 | 15 | 8 |
| **Silt 2-60 µm %** | 49 | 39 | 38 | 43 | 29 | 21 |
| **Clay <2 µm %** | 13 | 7 | 15 | 8 | 9 | 12 |
| **Clay <0.2 µm %** | | 0 | 0 | | | |
| | | | | | | |
| **Organic carbon %** | 35 | 2.8 | 2.1 | 0.7 | 0.3 | 0.2 |
| **pH in water [1 : 2.5]** | 3.8 | 4.5 | 4.7 | 4.8 | 4.8 | 5.5 |
| **pH in 0.01M $CaCl_2$ [1 : 2.5]** | 3.1 | 3.9 | 4.4 | 4.6 | 4.5 | 4.8 |
| | | | | | | |
| **Pyrophosphate extractable:** | | | | | | |
| **Fe%** | | 0.1 | 1.2 | 0.1 | 0.1 | trace |
| **Al%** | | 0.2 | 0.5 | 0.3 | 0.2 | 0.2 |
| **C%** | | 1.6 | 1.9 | 0.4 | 0.2 | 0.1 |
| **Fe + Al%** | | 0.3 | 1.7 | 0.4 | 0.3 | 0.2 |
| **[Fe + Al / clay] x 100** | | 4.4 | 11.5 | 5.0 | 2.9 | 2.0 |
| **Residual dithionite extractable Fe%** | | 0.2 | 0.8 | 0.8 | 0.6 | 0.5 |
| | | | | | | |
| **Bulk density g $cm^{-3}$** | | 1.20 | 0.80 | 1.30 | | 1.60 |
| **% by vol.** | | | | | | |
| **<2 bar** | | 19 | 18 | 14 | | 10 |
| **<15 bar** | | 31 | 24 | 19 | | 15 |
| **Air capacity** | | 10 | 22 | 21 | | 18 |
| **Retained water** | | 43 | 47 | 30 | | 21 |

*Comment:* Having peat surface and subsurface horizons with substantially more organic carbon than the Hexworthy profile above, together these two profiles illustrate some of the variation in peat development across this map unit, perhaps partly due to the way in which thinner surface horizons may be disturbed by bioturbation or human activities, such as vag cutting. The soil is acidic throughout, but with a slight rise in pH in the parent material of the Cu horizon. Air capacity of the Eag is much smaller than in the Hexworthy example, but rises appreciably in the better aerated horizons below. The pyrophosphate extractable

Fe + Al / clay amounts above 5% in this profile are concentrated in the Bs and BC horizons, this Eag horizon being close to expectations.

**Micromorphology:** Thin sections at 29-35, 31-37 and 40-46 cm.

*Clay coats and other clay concentrations:* None.

*Other coats:* Common fine and medium neo-organans often associated with voids containing pellets.

*Nodules and segregations:* Common distinct diffuse organic matter / ferruginous segregations at 31-37 cm. Segregations absent elsewhere and nodules absent throughout.

*Mineralogy and weathering:* Quartz, moderately and strongly weathered biotite and feldspar particles and granite fragments.

*Plasmic fabric:* Asepic.

*Other observations:* Common more or less decomposed roots at 29-35 and 31-37 cm with adjacent isotropic pellets up to 100 μm in diameter.

### 3.6.3 SUBSIDIARY SOILS

**Princetown series** *[occasional]:* These soils have grey mottled subsurface horizons becoming browner with depth; they lack brightly coloured subsoils. Some are recognised where involution of the Eag-Bf/Bs boundary in the stagnopodzols descends to depth. Princetown profiles are most frequent in higher, gently sloping sites.

**Less gleyed phase of Princetown series** *[rare]:* Profiles with peaty surface soil but with limited gleying below 30-40 cm and with fine and very fine rusty or ochreous mottles in the subsoil are distributed sporadically across the map unit.

**Trink series** *[rare]:* Soils analogous to Hexworthy series but with Bh horizons of translocated organic matter above the ironpan. The distribution of Trink soils is haphazard and has no clear pattern.

**Bodafon series** *[rare]:* The absence of ochreous or brownish mottling in bleached subsurface horizon distinguishes these soils from Rough Tor series and indicates drier overall ground conditions.

**Moor Gate series** *[rare]:* Soils with very dark grey, very dark brown or black, humose topsoils and lacking greyish, mottled subsurface horizons. They are most common on the lower margins of the map unit, often on sloping ground and are freely draining.

**Key to component soil series:**

| | | |
|---|---|---|
| | Soils with thin ironpan | 1 |
| | Soils without thin ironpan | 2 |
| | | |
| 1 | With dark humus-enriched subsoil | Trink |
| | Without dark humus-enriched subsoil | HEXWORTHY |
| | | |
| 2 | With bleached subsurface and brightly coloured subsoil | ROUGH TOR or Bodafon |
| | Prominently mottled or greyish above 40 cm, without brightly coloured subsoil | PRINCETOWN |
| | Without bleached subsurface | Moor Gate |

**Plate 27. Rough Tor series is very similar in morphology to Hexworthy series.**
Rough Tor profiles are differentiated by the absence of a thin ironpan.

### 3.6.4 SOIL FUNCTIONS

*Soil properties:* The hydrology of Hexworthy and Rough Tor soils is complex. Surface and subsurface horizons of stagnopodzols are waterlogged for long periods as consequence of the peaty topsoils, impedance to the percolation of water by ironpans, and climatic wetness. Acidity contributes to the development of peat at the surface, which generally thickens westward as altitude, rainfall and climatic severity increase. By contrast the B and C horizons are rarely gleyed and are porous and permeable. Findlay *et al.* [1984] place these soils in wetness class IV and V, [commonly wet or usually wet], although care is needed in the interpretation of their complicated hydrology. McHugh's [1989] study of similar soils on Exmoor confirmed the complexity of stagnopodzol hydrology and demonstrated related physicochemical aspects. Interpretation of plant available water in these soils is complicated by their complex hydrology. By standard calculations, the Hexworthy example profile has 139 mm in its 1 m profile, the Rough Tor example 199 mm. The greater amount in the Rough Tor profile is attributable to the thickness of its Oh horizon, supplemented by the thicker layer of moderately stony soil over very stony deeper horizons.

*Site conditions:* The climate is harsh with high rainfall, modest temperatures and exposure. There are some steep slopes, particularly at higher altitude in the west of the survey district, as well as bouldery and rocky tracts.

**Production:** These soils have little agricultural potential, most of the vegetation having moderate, or in heathy areas, small grazing value. The ground is readily poached wherever stock congregate. Land classification of Hexworthy / Rough Tor soils on non-steep sites is class 5cw in the Land Use Capability Classification of Bibby and Mackney [1969] and grade 5 in the MAFF [1988] ALC scheme, although non-agricultural land is not normally treated in the latter. Bouldery ground and steep slopes merit further relegation into class 6. Although the moorland provides grazing for commoners from the adjoining in-bye, and there were medieval and later attempts to enclose tracts [newtakes] of the map unit, no mappable areas of cultivated phases were identified, unlike on similar landscapes on Bodmin Moor [Staines, 1976] or Exmoor [Hogan and Harrod, 1982].

This map unit contains many reaves, Bronze Age enclosures, well preserved on Shovel Down [660859] and around Kes Tor [666863]. It is likely that much of the podzolisation of these soils followed the Bronze Age activity. Hexworthy and Rough Tor series are the most extensive soils within the High Dartmoor plantations at Fernworthy. Soil wetness, acidity, climatic harshness and, in a few places, surface boulders restrict choice of species to Lodgepole pine and Sitka spruce, the shallow rooting medium increasing the risk of wind throw in exposed sites and on coup margins. Some amelioration of soil conditions may be achieved by subsoiling to disrupt the ironpan in Hexworthy soils. Poor ground conditions, with the risk of runoff and sediment release, can be expected during felling and clearing in all but the driest seasons.

**Ecology:** Hexworthy / Rough Tor soils are extensive on the open moorland, carrying wet heathland of outstanding ecological, scenic and amenity value, along with *Molinia* dominated grassland. The area centred on south Chagford Common [675825] is the largest stretch of heather moorland on Dartmoor, making up an important part of the East Dartmoor Site of Special Scientific Interest. Ling, bell heather, cross-leaved heath, bilberry and western gorse are the main constituents of the heather moor, which forms mosaics with grassy swards of *Molinia*, matgrass, sheep's fescue, common bent and bristle bent. This land is characterised by severe surface wetness and acidity, the harsh climate compounding the soil wetness. The surface and subsurface horizons [O, A and E] are largely anaerobic, unlike the better aerated deeper subsoil, limiting soil biological activity. However, on the high moorland around the blanket bog several earths and setts exploit the relatively dry conditions in the lower subsoils of these soils.

**Environment:** The peaty surface horizons of Hexworthy / Rough Tor soils encourage runoff and saturated lateral flow within them. There is a proportion of vertical flow down the profile into the growan and granite beneath, which eventually emerges as groundwater sustaining much of the basin peat of the Crowdy map unit. Percentages of runoff contributing to streams are high and those to base flow reduced, in contrast to the freely draining land of the in-bye. Lateral water movement, coupled with large organic matter content capable of attenuating pollutants, makes these Soils of Low Leaching Potential in the Groundwater Vulnerability scheme of Palmer *et al.* [1995]. Estimated quantities of organic carbon in these soils are substantially larger than in the freely draining soils to the east, although within this map unit there is substantial variation. The two example profiles in Section 3.6.2 above, although only a short distance apart, differ substantially. The Hexworthy profile has 28 kg of organic carbon to 1 m depth over a square metre, thanks to its relatively thin and loamy top. In contrast there are 55 kg of carbon per square metre in the Rough Tor profile, where the surface peat is thicker and not diluted by mineral matter. For these and five other stagnopodzol profiles on the granite the mean organic carbon content to 1 m depth is 41 $kg\ m^{-2}$, from a span of 24 to 69. It should be kept in mind that Hexworthy / Rough Tor soils range from profiles with comparatively slight surface wetness and thin loamy peat moderately low on the moorland to ground adjacent to the blanket bog with peat approaching 40 cm thick.

**Amenity and engineering:** Long seasonal wetness and weak, peaty topsoil material reduce the stability of shallow cuts in these soils, with timeliness being essential in excavating, handling, moving and storing these soils. The peaty surface material is poorly suited for use as fill. Low pH, combined with overall profile wetness, makes Hexworthy / Rough Tor soils moderately aggressive towards buried ferrous metal objects. These soils are not suitable for camping and caravan sites, neither for short term 'events'; new footpaths may demand considerable preparation, while on established routes wear caused by to walkers or riders occurs at pinch points.

## 3.7 HALFWAY HOUSE / DREWSTON MAP UNIT [Hwh/Dn on the soil map]

3.7.1 This map unit is mixture of stony stagnogleyic brown earths in fine loamy material passing to soft weathered acid crystalline rock, the Halfway House series, and cambic stagnogley soils in fine loamy material over lithoskeletal acid crystalline rock of the Drewston series. It shows a range of wetness expressed as subsoil gleying, reflecting, at least partly, the reduced permeability of the decomposed granite that forms much of the substrate. This is compounded in many places by the low-lying position of the soils in the landscape, encouraging groundwater effects. In places there are relatively discrete areas of either series, elsewhere there is a close admixture. Although a small area of freely draining Lustleigh soils over decayed granite saprolite were mapped to the south by Clayden [1971], related soils with gley morphology were not encountered there.

**Distribution and site:** There are about 146 ha of these soils in lower valley side positions, particularly along the vale running southeastwards from Sandy Park [712896] to Moretonhampstead, where alteration of the granite to saprolite is commonplace.

**Land cover:** Most of this map unit is in permanent or long ley grassland with a few patches of woodland.

**Component soils:**

Halfway House series *[frequent]*

Drewston series *[common]*

Laployd series *[rare]*

Moretonhampstead series *[rare]*

Hepste series *[rare]*

3.7.2 MAIN SOILS

**HALFWAY HOUSE SERIES**, stagnogleyic brown earths; loamy material passing to soft weathered acid crystalline rock.

**Characteristics:**

Brown upper horizons

Mottled soil below 40 cm

Stony sandy silt loam or clay loam

Rotten granite in subsoil

**Generalised soil profile:**

*Ah or Ap horizon, [0-30 cm]:* Dark brown sandy silt loam or clay loam, at times with rusty mottles near roots; fine subangular blocky structure.

*Bw or Bw[g] horizon, [30-50 cm]:* Brownish gritty sandy silt loam or clay loam, sometimes with faint greyish or ochreous mottling; stony; fine subangular blocky or granular structure.

*Bg horizon, [50-90 cm]:* Mottled gritty clay loam with greyish and yellowish or ochreous colours; stony, often with softened *in situ* granite with 'cheesy' feldspar crystals; weakly developed prismatic structure.

**Example profile:** SX78/2778 under ley pasture, 155 m O.D.

**Horizons:**

*0-28 cm Ap:* Dark brown [7.5YR 3-4/2], dry colour 10YR 6/3, sandy clay loam, with few very fine, distinct rusty mottles on root channels in top 10 cm; common small subrounded and subangular tourmaline and quartz stones; slightly moist; moderately developed fine subangular blocky structure; very porous, very fine fissures and pores; moderately weak soil and ped strength; slightly sticky; non-plastic; many very fine fibrous roots; many earthworms, also 1 leatherjacket; abrupt wavy boundary.

*28-46 cm [38 cm in one part] Bw[g]:* Yellowish brown [10YR 5/5] sandy loam to sandy clay loam with common medium mottles of greyish brown [2.5Y 5/2] and few fine mottles of reddish brown [5YR 5/4] in the top of the horizon, also 'pipes' of dark brown, as in Ap, up to 5 cm wide around worm channels; micaceous, gritty, common to many small and very small stones, lithologies as in Ap; slightly moist; weak fine granular structure; very porous with very fine fissures and pores and worm burrows up to 5 mm diameter; moderately firm soil strength, moderately weak ped strength; moderately sticky; moderately plastic; many very fine fibrous roots; earthworms present; clear irregular boundary.

*46-63 cm BCg1:* Grey [5Y 5/1] gritty sandy clay loam with many medium and coarse prominent mottles of strong brown [7.5YR 5/6] plus some coarse vertical fissure faces of greyish brown [10YR 5/2], common pipes through horizon of material from Ap and Bw[g] up to 5 cm across around worm channels; gritty, micaceous with few medium subrounded tourmaline and quartz stones, also very soft ['cheesy', cuttable with finger nail] white feldspar crystals up to 10 mm long; moist; weakly developed coarse prismatic structure; estimated high packing density; slightly porous with very fine vertical fissures and fine and very fine macropores, also occasional earthworm burrows up to 5 mm diameter; moderately firm soil strength; slightly sticky; non-plastic; common fine fibrous roots; earthworms present; clear even boundary.

*63-87 cm BCg2:* Strong brown [7.5YR 5/8] gritty clay loam with very many medium black [N 2/0] mottles [?tourmaline or ferrimangans?] and common medium mottles of brown [7.5YR 5/3] and grey [5Y 5/1], N.B. black mottles in a near horizontal band c 3 cm deep across the face; gritty, micaceous with few medium subrounded tourmaline, quartz and sound granite [some reddened] stones, also very soft, white feldspar crystals up to 10 mm long; moist; structure indeterminate; moderately porous with very fine fissures and pores, some worm burrows as above; weak soil strength; moderately sticky; non-plastic; common fine fibrous roots; clear smooth boundary.

*87-120 cm Cu:* Grey [N 6/0] gritty sandy loam to sandy clay loam with many coarse linear [many sub-horizontal] mottles of reddish yellow [7.5YR 6/8] plus many very fine mottles of black [N 2/0]; stones as above, micaceous; moist; structureless massive; moderately weak soil strength; no roots; one worm channel seen filled with grit to 3 mm diameter.

**Analyses:**

| **Horizon** | **Ap** | **Bw[g]** | **BCg1** | **Cu** |
|---|---|---|---|---|
| **Depth cm** | 0-28 | 28-46 | 46-63 | 87-120 |
| | | | | |
| **Sand 60 µm-2 mm%** | 61 | 57 | 60 | 60 |
| **Silt 2-60 µm %** | 18 | 25 | 18 | 23 |
| **Clay < 2 µm %** | 21 | 18 | 22 | 17 |
| | | | | |
| **Organic carbon %** | 3.0 | | 0.8 | |

*Comment:* The BCg1 horizon at 46-63 cm has weakly developed prismatic structure and high packing density: stagnogleyic indicators. The presence of recognisable, but soft, feldspar crystals shows that the saprolite parent material has undergone negligible physical disturbance.

**DREWSTON SERIES**, cambic stagnogley soils; fine loamy material over lithoskeletal acid crystalline rock.

**Characteristics:**

Drab topsoil, often with fine rusty mottles

Greyish or pale brown, mottled subsoil

Often with rotten granite in subsoil

Stony sandy silt loam or clay loam

**Generalised soil profile:**

*Ahg or Apg horizon, [0-30 cm]:* Dark grey to very dark greyish brown sandy silt loam with common rusty mottles; fine subangular blocky or granular structure.

*Bg horizon [30- 60 cm]:* Strongly mottled often gritty clay loam with matrix and mottles of greyish and ochreous colours; stony; weakly developed prismatic or massive structure.

*BCg horizon [60-100 cm]:* Pale brown gritty clay loam with prominent ochreous and brownish mottles, with some vertical 'gleyed fissures'; very stony; massive or platy structure.

**Plate 28. The BCg horizon of the Drewston series profile described below.**
Within this strongly mottled horizon, vertically aligned, grey 'fissures' with ochreous linings, 'glossic' features, are clearly visible. They are interpreted as relicts of periglacial frozen ground.

**Example profile:** SX78/3466 under permanent pasture with rushes. Slope 3$^{O}$.

**Horizons:**

*0-10 cm Ahg:* Very dark greyish brown [10YR 3/2] dry colour greyish brown [10YR 5/2] sandy silt loam with common very fine dark reddish brown [5YR 3/4] mottles largely along root channels; intimate organic matter; very slightly stony with very small stones; slightly moist; strongly developed fine and medium granular structure; very porous with very fine fissures and macropores; moderately firm soil and ped strength; slightly sticky; moderately plastic; abundant very fine fibrous roots; single earthworm seen; abrupt smooth boundary.

*10-28 cm Apg:* Dark brown [10YR 3/3] dry colour greyish brown [10YR 5/2] sandy silt loam to sandy loam with many very fine and fine mottles of dark reddish brown [5YR 3/4] dry colour reddish brown [5YR 4/3]; intimate organic matter; slightly stony with very small to medium subangular stones; slightly moist; very weakly developed fine subangular blocky structure; moderately porous with very fine macropores; moderately firm soil strength, moderately weak ped strength; slightly sticky; moderately plastic; many very fine fibrous roots; a single small earthworm seen; sharp smooth boundary.

*28-63 cm Bg:* Pale brown to yellowish brown [10YR 6/3-5/4] sandy silt loam to clay loam with many medium and coarse mottles of strong brown [7.5YR 5/8]; moderately stony with small and medium subangular stones, micaceous; slightly moist; apedal massive; moderately porous with fine and medium macropores, some of the medium being vertically aligned and coated with material from Apg; moderately weak soil strength; common very fine fibrous roots and a single medium fleshy root seen; upper 5 cm of horizon contains soft ferruginous nodules of red [2.5YR 5/6] with in places black [N 2/0] flecks; clear smooth boundary.

*63-100 cm BCg:* Pale brown [10YR 6/3] clay loam with many fine, medium and coarse mottles of strong brown [7.5YR 5/6], many of the mottles are sub-horizontally extended; very stony with very small to medium angular and subangular stones; strongly developed medium to coarse platy structure; very firm soil strength, moderately firm ped strength; slightly sticky; moderately plastic; few very fine fibrous roots. In several places the horizon is crossed by ‘fissures’ 3-6 cm wide, mostly vertically aligned, light brownish grey to greyish brown [10YR 6-5/2] with margins lined with yellowish red [5YR 5/8]. Augered to 130 cm with little change of colour, texture or stoniness.

**Analyses:**

| **Horizon** | **Apg** | **Bg** |
|---|---|---|
| **Depth cm** | 10-28 | 28-63 |
| | | |
| **Sand 60 µm-2 mm%** | 49 | 38 |
| **Silt 2-60 µm %** | 37 | 46 |
| **Clay < 2 µm %** | 14 | 16 |
| | | |
| **pH in water [1 : 2.5]** | 5.4 | 6.2 |

*Comment:* The fine loamy skeletal BCg horizon at 63-100 cm, with its platy structure and light brownish grey ‘fissures’ with ochreous linings is clearly slowly permeable, despite its stony nature. These features qualify as ‘glossic’ in World Reference Base [FAO 1998] terminology and are viewed as having formed under periglacial [proto ice-wedge casts] and early post glacial [cold acid weathering] conditions. An alternative interpretation of this profile is that, like the Halfway

House profile above, it might be better described as passing to soft, weathered, acid crystalline rock.

### 3.7.3 SUBSIDIARY SOILS

**Laployd series** *[rare]:* There are rare, small inclusions of soils with humose or peaty topsoils.

**Hepste series** *[rare]:* Peat has developed at very localised springs.

**Moretonhampstead series** *[rare]:* A few small patches of freely draining ground, too small to delineate separately, are included.

**Related soils in Houndsmoor Wood [762895] and Seaman's Borough [766899]:** In the Teign Gorge about 13 ha of unnamed cambic stagnogley soils and stagnogleyic brown earths in very stony material over the metamorphic aureole slates are included in this map unit for cartographic convenience.

**Key to component soil series**

| | | |
|---|---|---|
| | Soils with peat or mottled throughout | 1 |
| | Other soils | 2 |
| | | |
| 1 | Soils with humose or peaty topsoil | Laployd |
| | Peat thicker than 40 cm | Hepste |
| | Other mottled soils | DREWSTON |
| | | |
| 2 | Unmottled soils | Moretonhampstead |
| | Soils mottled below 40 cm | HALFWAY HOUSE |

### 3.7.4 SOIL FUNCTIONS

*Soil properties:* Halfway House soils are Wetness Class III, Drewston soils are Class V. Effective drainage will improve the soils to Classes II and III respectively. Estimated plant available water for the Halfway House example profile is 132 mm, for the Drewston example 105 mm. With a mean maximum soil moisture deficit around 85 mm for much of the map unit, both series are placed in Dryness Subclass *b*. Both series have gleyed subsoils indicating slow permeability, which may supplement moisture reserves, while the map unit's physiographic location points to some groundwater influences which are likely to have similar effects on moisture reserves.

*Site conditions:* As over most of the district, rainfall averaging greater than 1150 mm per year represents a climatic limitation. Slopes on this map unit are flat to moderate. Over most of the map unit there are few or no outcrops or boulders.

**Production:** Effective drainage involves pipe drains with porous backfill, supplemented by well-timed subsoiling. Spot treatment of springs, particularly adjoining freely draining soils on rising ground, might be necessary. The slight wetness remaining following drainage in the Drewston series moderately limits the unit's agricultural potential, as the risk of soil compaction and poaching by stock and traffic remains. Arable cultivations are also restricted. However conditions for grass growth are good or very good. Although grade 4 in the MAFF [1988] Agricultural Land Classification, [class 4w in that of Bibby and Mackney, 1969], over most of the survey area it is rated as suited to pasture with only minor limitations. In woodland and forestry, damp ground conditions influence the range of species, with oak, sweet chestnut and most conifers suitable.

**Ecology:** This map unit is a mixture of damp pastures and wet woods, with some ditches and seasonal surface water. Profile wetness limits soil biological activity.

**Environment:** Although the Halfway House and Drewston soil series dominating this map unit involve different major soil groups [Avery 1980], hydrologically their differences are those of degree. They represent HOST classes 18 and 24 respectively. Both have lateral saturated flow in subsurface horizons over impermeable subsoils during field capacity and wetter soil conditions, but as the subsoils dry out in the summer there is the likelihood of by-pass flow to depth, a state that will persist until the profiles rewet in the autumn. While the Drewston soils qualify as low risk [class L] in Palmer *et al.*'s [1995] classification for groundwater vulnerability assessment, Halfway House soils as an intermediate [class I1] risk. Estimated reserves of organic carbon are small in both series, for depths to 1 m in the example profiles amounts are 16 and 14 kg $m^{-2}$.

**Amenity and engineering:** Seasonal wetness calls for some care regarding timeliness of excavating and handling these soil materials, while stability of shallow cuts and trenches may be unreliable. Slight or moderate corrosion of metal buried in these subsoils is anticipated as a consequence of their seasonal wetness. Similarly suitability for caravan or camp sites and brief but intense recreational use is reduced.

---

### 3.8 PRINCETOWN MAP UNIT [pC on the soil map]

3.8.1 Princetown soils are stony cambic stagnohumic gley soils in coarse loamy or sandy, stony head [growan] derived from granite. First described in the Ivybridge area [Harrod *et al.* 1976], these soils have been mapped on Bodmin Moor [Staines 1976] and in west Cornwall [Staines 1979].

**Distribution and site:** The map unit cloaks 688 ha on the gentler slopes of the moorland below the blanket bog, ranging between 375 and 520 m O.D. A two hectare separation is mapped at Wrayland [786811], Lustleigh below 100 m O.D. over what is either granite saprolite or an outlier of the Oligocene Bovey Formation. Further afield from this district, Princetown Association [721a] soils are shown on the 1:250,000 scale National Soil Map to flank much of the blanket bog on both north and south Dartmoor, as well as forming on the higher ground of Bodmin Moor.

**Land cover:** Predominantly *Molinia* moorland.

**Component soils:**

Princetown series *[dominant]*

Hexworthy series *[rare]*

Rough Tor series *[rare]*

Humic rankers *[rare]*

Peat soils: Hepste series and Crowdy series *[rare]*

Laployd series *[rare]*

3.8.2 MAIN SOIL

**PRINCETOWN SERIES** Princetown soils are stony coarse loamy cambic stagnohumic gley soils over lithoskeletal acid crystalline rock, or in [granite derived] drift with siliceous stones.

**Characteristics:**

Peaty topsoil

Gritty sandy loam or sandy silt loam textures predominate

Grey subsurface, becoming browner with depth

**Generalised soil profile:**

*Oh or H horizon, [0-25 cm]:* Black humose sandy silt loam or peat; stoneless or slightly stony; subangular blocky or massive structure. This horizon can vary from a few cm thick to 40 cm [thicker than that and the profile is considered a peat soil]. Variations in thickness and organic matter content reflect increasing wetness, either from the site's flatness and sluggish natural drainage, or climate, [increased rainfall and lower temperature], which becomes harsher with altitude. Thickness of the horizon has also been affected by the age-old custom of cutting of surface turves or 'vags' for fuel, leaving the surface of parts of the map unit with marked, shallow linear, rectangular or irregular depressions.

*Ahg horizon [25-40 cm]:* Very dark grey gritty sandy silt loam with some rusty mottles, humose in places; stony; weakly developed prismatic or massive structure.

*Bg horizon [40-60 cm]:* Grey or light grey gritty sandy silt loam, clay loam or sandy loam, with prominent mottles; stony or very stony; weakly developed prismatic or massive structure. The depth of this junction to the BCg / Cu beneath varies from place to place.

*BCg or Cu horizon [60-100 cm]:* Brownish gritty sandy silt loam, clay loam or sandy loam, mottling reducing with depth; very stony; structureless massive.

**Plate 29. The Princetown series has peaty surface horizons over mottled subsoils**
[Photo B Clayden.]

**Example profile:** SX57/9651 on heathy *Molinia* moorland. 421 m O.D. [Hogan 1978, p 52]

**Horizons:**

*0-21 cm Oh1:* Black [N 2/0] humified peat; stoneless; strongly developed fine subangular blocky; low packing density; abundant very fine fibrous roots; abrupt smooth boundary.

*21-27 cm Oh2:* Black [N 2/0] humified peat; stoneless; weakly developed medium subangular blocky; low packing density; abundant very fine fibrous roots; abrupt smooth boundary. Horizon contains occasional sand grains and small stones.

*27-41 cm Ah:* Very dark grey [10YR 3/1] coarse sandy loam; many very small subangular quartz stones; weakly developed fine subangular blocky; medium packing density; very slightly porous; many very fine fibrous roots; a few organic coats, patchy and distinct on vertical fissures; gradual smooth boundary.

*41-58cm Bg:* Light brownish grey [10YR 6/2] clay loam; a few prominent very fine yellowish red [5YR 4/8] and strong brown [7.5YR 5/6] mottles; many very small to medium subangular granite stones; weakly developed coarse prismatic; medium packing density; moderately porous; many very fine fibrous roots; abrupt smooth boundary. Clay content higher on the right side of the face.

*58-83 cm BC:* Light brownish grey [10YR 6/2] coarse sandy loam; common prominent extremely fine yellowish red [5YR 4/8] mottles; abundant subangular stones; single grain, some subsidiary weakly developed fine subangular blocky structure; medium packing density; extremely porous; many very fine fibrous roots; common sesquioxide coats which are red [2.5YR 5/8], patchy, prominent and particularly concentrated on stones; clear smooth boundary.

*83-118 cm Cu1:* Brown [7.5YR 5/4] loamy coarse sand; abundant subangular stones; single grain; common very fine fibrous roots; medium and large stones have many continuous prominent dark red [10R 3/6] sesquioxide coats; clear smooth boundary.

*118-150 cm Cu2:* Brown [7.5YR 5/4] coarse sand; extremely abundant small to large subangular granite stones; single grain; common very fine fibrous roots; many sesquioxide coats as above, biotite flakes appear not to be coated.

**Analyses:**

| Horizon | Oh1 | Oh2 | Ah | Bg | BCg | Cu1 | Cu2 |
|---|---|---|---|---|---|---|---|
| Depth cm | 0-21 | 21-27 | 27-41 | 41-58 | 58-83 | 83-118 | 118-150 |
| | | | | | | | |
| Sand 600 µm-2 mm % | | | 33 | 22 | 43 | 50 | 68 |
| " 200-600 µm % | | | 15 | 12 | 21 | 22 | 14 |
| " 60-200 µm % | | | 11 | 8 | 12 | 12 | 8 |
| Silt 2-60 µm % | | | 32 | 33 | 14 | 11 | 7 |
| Clay <2 µm % | | | 9 | 25 | 10 | 5 | 3 |
| | | | | | | | |
| Loss on ignition % | 90 | 32 | | | | | |
| Organic carbon % | 43 | 20 | 3.3 | 0.9 | 0.4 | 0.2 | 0.4 |
| pH in water [1 : 2.5] | 4.1 | 4.2 | 4.6 | 4.9 | 4.9 | 5.1 | 5.1 |
| pH in 0.01M $CaCl_2$ [1 : 2.5] | 3.1 | 3.2 | 3.8 | 4.1 | 4.3 | 4.6 | 4.5 |
| | | | | | | | |
| Pyrophosphate extractable: | | | | | | | |
| Fe% | | | 0.06 | 0.05 | 0.05 | 0.02 | 0.10 |
| Al% | | | 0.28 | 0.21 | 0.22 | 0.18 | 0.28 |
| C% | | | 1.91 | 0.44 | 0.20 | 0.07 | 0.16 |
| Fe + Al% | | | 0.34 | 0.26 | 0.27 | 0.20 | 0.38 |
| [Fe + Al / clay] x 100 | | | 3.78 | 1.04 | 2.70 | 4.00 | 12.67 |
| Residual dithionite extractable Fe% | | | 0.15 | 0.10 | 0.22 | 0.15 | 0.12 |
| | | | | | | | |
| Bulk density g $cm^{-3}$ | | | 1.18 | 1.27 | | | |
| % by vol. | | | | | | | |
| Total pore space | | | 54.3 | 52.2 | | | |
| Available water | | | 21.7 | 21.2 | | | |
| Air capacity | | | 21.6 | 16.4 | | | |
| Retained water | | | 32.7 | 35.8 | | | |

*Comment:* As with the stagnopodzols of the Hexworthy / Rough Tor map unit, pH is strongly or moderately acid at or near the surface, rising slightly at depth. Clay content peaks in the Bg horizon. The pyrophosphate extractable values show no evidence of podzolisation. Although the soil's morphology is that of a stagnohumic gley soil, the A and Bg horizons' bulk densities are low and air capacities are high in comparison with lowland soils in the surface-water gley major soil group.

**Micromorphology:** Thin sections at 30-36, 43-49 and 64-70 cm.

*Clay coats, nodules and segregations:* None.

*Other coats:* Few fine and medium organans associated with decaying root fragments in voids. Coats of micaceous silt and clay up to 500 μm thick around all coarse sand and gravel fragments.

*Mineralogy and weathering:* Sand and gravel sized particles mainly of quartz, mica, feldspar, tourmaline and granite. Particles, other than quartz and tourmaline, show moderate to strong weathering.

*Plasmic fabric:* Dominantly asepic.

*Other observations:* Blocky structure in the upper two sections, partly dissected by channels and chambers containing pellets. Large single grain structure at 64-70 cm.

### 3.8.3 SUBSIDIARY SOILS

**Hexworthy series** *[rare]:* This series, and the related Rough Tor series, have similar surface horizons over pale, mottled subsurfaces, over ochreous or brown deeper subsoils. In the Hexworthy series a thin ironpan separates the pale horizon from the browner subsoil. These soils form sporadically, particularly on minor steepenings of slope.

**Rough Tor series** *[rare]:* Distinguished from the Hexworthy series by lacking a thin iron pan.

**Peat soils: Hepste series and Crowdy series** *[rare]:* Where the peaty surface horizon thickens to over 40 cm Hepste soils have 40-80 cm of peat, Crowdy soils have peat thicker than 80 cm. These soils are most frequently developed higher in the map unit near to the blanket peat, as well as around the fringes of valley basins.

**Laployd series** *[rare]:* Soils where intense gleying persists deep into the subsoil; profiles which form in some concavities.

**Unnamed humic ranker** *[rare]:* Shallow peaty or humose soils, over rock within 30 cm.

## Key to component soil series

| | | |
|---|---|---|
| | Amorphous peat thinner than 40 cm; mineral soils | 1 |
| | Amorphous peat thicker than 40 cm | 5 |
| | | |
| 1 | Shallow peat or humic mineral soils over rock less than 30 cm deep | Humic rankers |
| | Deeper mineral soils | 2 |
| | | |
| 2 | Mottled soils becoming less mottled with depth | 3 |
| | Subsoil greyish and mottled throughout; in basins and flushes | Laployd |
| | | |
| 3 | Abrupt change in subsoil from mottled to bright colours | 4 |
| | Higher subsoil grey and mottled, deeper subsoil drab | PRINCETOWN |
| | | |
| 4 | With thin ironpan | Hexworthy |
| | Without thin ironpan | Rough Tor |
| | | |
| 5 | Peat 40-80 cm thick | Hepste |
| | Peat thicker than 80 cm | Crowdy |

### 3.8.4 SOIL FUNCTIONS

*Soil properties:* Princetown soils are waterlogged for most of the year [Wetness Class VI] due to the peaty topsoil and the area's high rainfall, where the subsoil is effectively only slowly permeable. In lowland areas subsoil air capacity of 16-21%, as in the example profile, would be considered permeable. However the long duration of the field capacity period [>300 days] here, coupled with high rainfall, radically reduces the effective permeability. For soils with this nature and location calculations of profile available moisture reserves are not relevant.

*Site conditions:* A harsh climate with average annual rain in excess of 1500 mm, exposure and short growing season affects all of the map unit except for the small 'outlier' at Lustleigh. There the climate is benign with rainfall about 1200 mm a year. Parts of the map unit, as south of Oke Tor and on some of Kennon Hill, are very bouldery.

**Production:** Most of the map unit is on open moorland of prime amenity value. While tracts of *Molinia* provide upland grazing of moderate value, heathy plant cover is rated as low in the scheme of Bibby *et al.* [1982]. In the Land Use Capability Classification [Bibby and Mackney 1969], Princetown soils are class 6cw. In the MAFF [1988] ALC scheme they are grade 5, or unclassified in non-agricultural sites. The land at Lustleigh is class 4w and grade 4. Several compartments in Fernworthy Forest's [644840] conifer plantations have Princetown soils. Species choice is very restricted [Lodgepole pine and Sitka spruce] and wind throw hazard high, aggravated by the soils' distribution on ridge crests. On these soils deep ploughing or drainage is advantageous, as are fertiliser at planting and checking of weed growth during establishment of new trees. The long-term wetness of Princetown soils makes for poor harvesting conditions underfoot and the likelihood of runoff and sediment movement.

**Ecology:** Wet heathland or grassland with much *Molinia,* ling and cross-leaved heath covers most of this map unit. Western gorse can be present at lower altitudes. There is little soil biological activity.

**Environment:** Princetown soils' hydrology is a combination of saturated lateral flow through the upper soil with surface runoff, the balance between the two components varying slightly seasonally, along with deeper vertical flow to the growan and granite in the substrate. Nationally derived values [Boorman *et al.* 1995] suggest contributions to base flow from these soils are about half those from the freely draining soils of the in-bye, while standard percentage runoff amounts are an order of magnitude greater. The peaty nature of the upper horizons of Princetown soils, with the frequent waterlogging, place them in the Soils of Low Leaching Potential class of Palmer *et al.* [1995]. Estimates of organic carbon reserves in these soils are large, 58 kg $m^{-2}$ to 1 m depth in the example profile in Section 3.8.2 above, mostly a consequence of the thick peat Oh surface horizons.

**Amenity and engineering:** The peaty nature of the upper parts of these soils, along with long seasonal wetness, makes any excavation and handling of these soils very dependent on timeliness, if structural damage is to be avoided. Peat content of the upper horizons also renders them unsuitable for use as fill. The stability of the walls of shallow trenches and cuts is uncertain. Wetness, in conjunction with low pH, makes Princetown soils aggressive to buried ferrous metals. The land is not suited for camping or caravan sites or short-term intense use by people or their vehicles. Frequent wetness and the peaty soil readily result in damage from walkers and animals at bottlenecks on paths and tracks.

---

### 3.9 LAPLOYD MAP UNIT [Lp on the soil map]

3.9.1 Stony typical humic gley soils in coarse loamy or sandy, stony Head derived from granite [over lithoskeletal acid crystalline rock]. There is some variation in soil particle size, both within individual profiles and with soils having overall coarse loamy, sandy, fine loamy or clayey texture. Stone content is also variable, as is the amount of organic matter in surface horizons and their thickness. Locally around perennial springs, the organic surface horizons thicken forming peat soils of the Hepste and Crowdy series. There is a gradual but erratic increase in the amount of organic matter with increasing altitude and from the drier, lower ground in the east, to the wetter areas in the west, eventually the Laployd soils being displaced in basin sites by Crowdy peat soils.

**Distribution and site:** 1,308 ha formed in valley floors and basins affected by springs and groundwater. There are occasional separations high on interfluves and in flushes running up valley sides. Height ranges from 90 m O.D. to 490 m. Much of the map unit is bouldery. Beyond this mapping area Laployd Association soils [871a on the National Soil Map] occur in valleys elsewhere on Dartmoor, on the St Austell, Carnmenellis and Land's End granite outcrops.

**Land cover:** A mosaic including heathy wet moorland often with much *Molinia*, rhôs pastures, improved, usually rushy, wet grassland and some carr or wet woodland and scrub.

**Component soils:**

Laployd series *[frequent];* within that the humose topsoil phase is *common*, the peaty topped phase *occasional*

Clayey and fine loamy variants *[occasional]*

Drewston series *[rare]*

Peat soils *[rare]*

3.9.2 MAIN SOIL

**LAPLOYD SERIES**

Laployd series comprises stony coarse loamy typical humic gley soils over lithoskeletal acid crystalline rock [in head derived from granite]. First described by Clayden [1964] in the Middle Teign Valley, subsequently in the Exeter survey, [Clayden 1971], at Ivybridge [Harrod *et al.* 1976], on Bodmin Moor [Staines 1976], with wider mapping on the National Soil Map on Dartmoor and in Cornwall [Findlay *et al.* 1984] and in north Wales [Rudeforth *et al.* 1984].

**Characteristics:**

Peaty or humose topsoil

Gritty sandy loam or sandy silt loam textures predominate

Grey subsurface over grey mottled subsoil

Stony

Mostly waterlogged

**Generalised soil profile:**

*Oh or H horizon, [0-25 cm]:* Black humose sandy silt loam or peat; stoneless or slightly stony; subangular blocky or massive structure. Above about 200 m O.D. around 25% of Laployd profiles have peaty tops, but below that altitude the percentage declines into single figures. It is likely that in the past peaty surface horizons were more prevalent. The technique of paring and burning, also known as denshering, was used into the 19$^{th}$ century to improve such topsoils for agriculture. Drainage and cultivation in the 20th century continued the degradation of these peaty horizons. Cutting for fuel may have also played a part.

*Ahg horizon [25-40 cm]:* Very dark grey gritty sandy silt loam with some rusty mottles, humose in places; stony; weakly developed subangular blocky or massive structure.

*Bg horizon [40-60 cm]:* Grey or light grey gritty sandy silt loam, clay loam or sandy loam, with prominent mottles; stony or very stony; weakly developed blocky or massive structure. Profiles often contain pockets and lenses of lighter and heavier subsoil material.

*BCg [60-100 cm]:* Grey, strongly mottled gritty sandy silt loam, clay loam or sandy loam, very stony; structureless massive.

**Example profile:** SX78/9939, ash plantation. 265 m O.D. [Clayden 1971, p 164].

**Horizons:**

*0-25 cm Ag:* Dark greyish brown to very dark greyish brown [10YR 4/2-3/2] humose clay loam; stoneless; weakly developed fine crumb structure; very friable; high organic matter; abundant fine fibrous and woody roots; occasional earthworms; narrow irregular boundary.

*25-30 cm Cg1:* Light brownish grey [2.5Y 6/2] gravelly gritty sandy loam; stony; structureless, massive; brittle - fragmentary; roots rare; merging boundary.

*30-51+ cm Cg2:* Light brownish grey [2.5Y 6/2] gravelly gritty sandy loam with abundant mottles of strong brown [7.5YR 5/8]; stony, micaceous haematite very common; structureless, massive; brittle – fragmentary; compact to dig; roots rare; little change with depth on auger.

**Analyses:**

| **Horizon** | **Ag** | **Cg2** |
|---|---|---|
| **Depth cm** | 0-25 | 30-51 |
| | | |
| **Sand 200 µm -2 mm %** | 24 | |
| **Sand 50-200 µm %** | 8 | |
| **Silt 2-50 µm %** | 41 | 30 |
| **Clay <2 µm %** | 27 | 16 |
| | | |
| **Loss on ignition %** | 15.9 | 3.1 |
| **pH in water [1 : 2.5]** | 4.9 | 5.6 |
| **pH in 0.01M $CaCl_2$ [1 : 2.5]** | 4.1 | 4.7 |

*Comment:* This profile, with a humose rather than peaty topsoil represents the most frequently encountered form of typical humic gley soils in this map unit, peaty topped cases being exemplified by the description below. Organic carbon, derived from loss on ignition via the formula loss on ignition minus 10% of clay, divided by 1.72, is 7.7% in the Ag horizon and 3.1% in the Cg2.

**Example profile:** SX78/9967, rough grazing, wet moorland of rush, purple moor grass [*Molinia*] and tufted hair grass with encroaching scrub. 285 m O.D. [Clayden, 1971, p164].

**Horizons:**

*25-24 cm L:* Grassy leaves and stems.

*24-23 cm F:* partially decomposed leaves and stems.

*23-0 cm H:* Black amorphous peat; very friable; root mat in upper 5 cm; roots abundant below, alive and dead; narrow boundary.

*0-13 cm Ag:* Dark grey [10YR 4/1] clay loam with 15% yellowish brown [10YR 5/6] concentrated around old root channels; occasional gritty fragments of quartz and feldspar; very weakly developed fine blocky structure; labile; moderate organic matter; abundant dead roots, living roots less frequent; merging boundary.

*13-20 cm C1g:* Light brownish grey [10YR 6/2] gritty sandy loam with 5% strong brown concentrated around old root channels; clay loam from horizon above along fissures and old root channels; abundant gritty fragments of quartz and felspar; structureless; brittle and pulverescent; dead roots common, few living roots; merging boundary.

*20-41 cm C2g:* Light brownish grey [2.5Y 6/2] gritty clay loam with numerous 3 mm diameter tubes of strong brown around grey of dead roots; occasional fragments up to 8 cm diameter of micaceous haematite, structureless, massive; labile and slightly sticky; dead roots and old channels common; merging boundary.

*41-71+ cm C3g:* Grey [2.5Y 6/0-6/2] gritty sandy clay loam, 5% blotched with greyish brown [10YR 5/2] and strong brown around old root channels as above, occasional coarse red [10R 5/8] mottles; fragments of micaceous haematite common; otherwise as horizon above.

**Analyses:**

| **Horizon** | **H** | **Ag** | **C1g** | **C2g** | **C3g** | **C3g** |
|---|---|---|---|---|---|---|
| **Depth cm** | 23-0 | 0-13 | 13-20 | 20-41 | 41-56 | 56-71 |
| | | | | | | |
| **Sand 200 µm -2 mm %** | | 18 | | | | |
| **Sand 50-200 µm %** | | 8 | | | | |
| **Silt 2-50 µm %** | | 48 | 18 | 39 | 34 | 21 |
| **Clay <2 µm %** | | 27 | 13 | 21 | 23 | 26 |
| | | | | | | |
| **Loss on ignition %** | 61.4 | 10.7 | 2.9 | 3.9 | 4.0 | 4.6 |
| **pH in water [1 : 2.5]** | 5.1 | 4.9 | 5.0 | 5.1 | 4.8 | 4.6 |
| **pH in 0.01M $CaCl_2$ [1 : 2.5]** | 4.5 | 4.2 | 4.3 | 4.2 | 4.1 | 3.9 |

*Comment:* This profile illustrates the peaty topsoils on Laployd soils on sites with semi-natural vegetation, much of it rhôs pasture. The clay content is such that the profile as a whole is a fine loamy variant of the Laployd series. Organic carbon percentages calculated by subtracting 10% of clay content from the loss on ignition amount, then dividing by 1.72, are 35.4 in the H horizon, 4.7 in the Ag, 0.9 in the C1g, 1.1 in the C2g and 1.2 in the C3g.

### 3.9.3 SUBSIDIARY SOILS

**Clayey and fine loamy variants** *[occasional]:* These occur without any obvious pattern. As with other variations of particle-size in the map unit the textural changes can take place laterally over very short distances. The variation may be attributable to sedimentological processes in what are likely to have been mostly depositional sites under a solifluction-dominated periglacial regime in the Pleistocene, or variations in the lithology of the granite regolith. Often displaying prismatic subsoil structures, they have hydrological affinities with stagnohumic gleys of the Princetown series, particularly where in relative elevated locations, as around 762885 southwest of Wooston and 755842 east of North Bovey, where physiographic location make it less easy to explain wetness in terms of groundwater.

**Drewston series** *[rare]:* The map unit contains some profiles where topsoils are distinct [non-humose] with dark greyish brown colours rather than black. Many, but not all, such profiles are peripheral to the map unit, near boundaries to freely draining soils.

**Peat soils** *[rare]:* Where springs persist year-round forming ‘eyes’, peat soils develop, both fibrous and humified forms. They vary from around 50 cm to over 2 m in depth, amorphous peat 40-80 cm being Hepste series, thicker than that Crowdy series, with thick fibrous peat constituting the Winter Hill series. In rhôs pastures and other open areas where drainage and agricultural improvement has not taken place, they are often picked out by head high clumps of tussock sedges [*Carex* sp.]. In carr woodland the unstable ground on the peat can result in a tangle of moribund, wind thrown tree trunks and limbs.

**Hendraburnick series:** Several valley floors and flushes over the metamorphic aureole rocks on the southern side of the Teign gorge between Castle Drogo and Steps Bridge have been included in this map unit for cartographic convenience, in the light of their restricted extent. Where formed in non-granitic material these are coarse loamy stony typical humic gley soils over lithoskeletal slate and mudstone of the Hendraburnick series [Staines, 1976].

**Key to component soil series:**

| | | |
|---|---|---|
| | Mineral soils | 1 |
| | Amorphous peat thicker than 40 cm | 4 |
| | | |
| 1 | Humose or peaty topsoil | 2 |
| | Distinct brownish topsoil | Drewston |
| | | |
| 2 | Mottled soils becoming browner with depth | Princetown |
| | Subsoil greyish throughout | 3 |
| | | |
| 3 | Coarse loamy | LAPLOYD |
| | Fine loamy | Variant of Laployd |
| | | |
| 4 | Peat 40-80 cm thick | Hepste |
| | Peat thicker than 80 cm | Crowdy |

### 3.9.4 SOIL FUNCTIONS

*Soil properties:* The combination of soil wetness fed by groundwater with the area’s high rainfall characterise this soil. The soils are permanently wet [Wetness Class VI] unless artificially drained. While such drainage was carried out on some scale prior to the 1980s, many of the drainage works have since degraded. Calculation of profile available water reserves is not relevant for these soils.

*Site conditions:* With a few exceptions these soils are mapped on subdued, if in places irregular, slopes. Some of the map unit is very bouldery. In view of soil wetness’s overriding role, climatic conditions are not significant.

**Production:** The map unit’s agricultural use ranges through wet, often rushy, summer pasture and meadow, to residual moorland with *Molinia* and heath and encroaching scrub. While the better managed grassland has potential to produce heavy yields, utilisation can be difficult. On the residual moorland grazing value is moderate or low in the upland grazing scheme of Bibby *et al.* [1982], depending on the proportions of *Molinia* and heath. Many fields on the map unit were drained in the mid 20$^{th}$ century and degraded open ditches remain in evidence. Little drainage work has been undertaken since then. The limited effectiveness and degradation of the drains, the latter in places due to unstable light pockets in the subsoils, plus the enduring effect of peaty or humose topsoils, ensure that the wetness limitation remains. This land is grade 5 in the MAFF [1988] Agricultural Land Classification, class 5w following Bibby and Mackney [1969]. Potential for trees is confined to a few species, notably Sitka spruce, Lodgepole pine and birch, with wind throwing of grown trees remaining as a hazard. Almost year-long wetness means that timber harvesting poses the serious risk of sediment generation and transport along wheelings, the risk accentuated by these soils’ frequent proximity to watercourses.

**Plate 30. Laployd series in rushy permanent pasture.**

The organic surface horizon overlies strongly mottled mineral soil affected by a high groundwater-table for much of the year. The irregular base to the topsoil may be an artefact of ill-timed traffic or cultivation, partly concealing the relatively uniformly grey subsurface Eg horizon characteristic of these soils.

**Ecology:** Areas of semi-natural vegetation are widespread with wet heathland, *Molinia*-dominated grassland, species-rich rhôs pasture or willow-birch woodland. The ground is often boggy with pools, sluggish watercourses and ditches, many of the latter largely silted up or degraded. There is limited soil biological activity as a consequence of the near perennial waterlogging. The limited agricultural and forestry potential that the soil and climate combination presents means that wet rhôs grasslands remain commonplace, even if reduced and fragmented from their one-time extent. Traditionally land of this type was known as 'snipe moor'. The distribution of the Laployd map unit is an indicator of the former coverage and potential for restoration of acid wet grasslands. The sporadic patches of peat soils, particularly in the drier parts of the in-bye, provide potentially useful records of past environments through pollen records.

**Environment:** Hydrological responses on Laployd soils are predominantly by saturated lateral flow at shallow depths in the profile and by surface runoff, with groundwater within the lower horizons. Boorman *et al.* [1995] indicate that large standard percentage runoff contributions to stream discharges are to be expected, countered by small inputs to base flow. Long seasonal waterlogging high in the soil profile with perennial groundwater below, presence of peaty or humose topsoils, together minimising pollution risks to groundwaters, place these soils in Palmer *et al.*'s [1995] Soils of Low Leaching Potential category. Laployd soils have substantial organic carbon content, most of it in the surface horizons, although as noted above in Section 3.9.2 for several reasons there is considerable variation. In profile SX78/9939 estimated amounts total 28 kg $m^{-2}$ to a depth of 1 m, in SX78/9967 rising to 59 kg $m^{-2}$.

**Amenity and engineering:** These soils are unstable in trenches and cuttings and demand extreme care and timing if handled and moved if soil structural damage is to be avoided. They are not well suited to use as fill. Potential for corrosion of buried ferrous metal is moderate. The soils are unsuitable sites for camping, caravanning and recreational gatherings. Wear and erosion along tracks and paths are concerns, particularly at crossings of ditches and watercourses. Any new footpaths will need careful planning and the expense of causeways and their upkeep. Rambling and riding away from paths can be difficult in tussocky, *Molinia* dominated grassland. Numerous artificial amenity lakes and pools have been built on the Laployd map unit in recent decades.

---

### 3.10 WINTER HILL MAP UNIT [WH on the soil map]

3.10.1 Raw, very acid, oligo-fibrous peat soils dominate the high summit plain's blanket bogs, where the peat can be several metres thick. Parts have been degraded by erosion, delineated on the terrain map accompanying the soil map as *slightly* and *severely eroded* phases; substantial areas of undamaged *[pristine phase]* blanket peat remain. Some humified peat soils are intermixed with the raw peat. Several substantial tracts of peat cuttings occur among the high blanket bog, shown on the soil map as Urban and Disturbed and described in Section 3.24 below. Smaller peat cuttings, too small to map separately and often inextricably mingled with erosion channels, occur within the lower, more accessible parts of the Winter Hill map unit. Most of the land has been in use as military ranges for decades. There is further description of the erosional phases below in Section 3.28.

**Distribution and site:** Winter Hill soils occur between 510 and 600 m O.D., occupying about 1,169 ha on flat or gently sloping sites, very locally steepening to as much as $10^{O}$. Outside the boundaries of this survey, Winter Hill peat soils form on other high summits of Dartmoor; also on the Chains on Exmoor.

**Land cover:** Blanket bog vegetation with *Trichophorum, Sphagnum* and *Eriophorum,* accompanied by bog asphodel and sundew dominates on the mapped uneroded, pristine phase and remains as residual patches within the eroded phases. However in and around erosion gullies hydrological change, bared peat and partial shelter have degraded the vegetation with incursion by *Molinia* and heathy species.

**Component soils:**

Winter Hill series *[dominant]*

Crowdy series *[rare]*

Hepste series *[rare]*

Unnamed oligo-fibrous peat soils over lithoskeletal material *[rare]*

Mineral soils *[rare]*

3.10.2 MAIN SOIL

**WINTER HILL SERIES**; raw oligo-fibrous peat soils; mixed *Eriophorum* and *Sphagnum* peat. The series was first described in Lancashire by Crompton [1966] and subsequently more widely in the uplands of England and Wales, the Winter Hill Soil Association being the most extensive peat soil association on the National Soil Map [Mackney *et al.,*1984]. 145 ha of Winter Hill soils are mapped on the high blanket peat of Exmoor [Hogan and Harrod, 1982].

**Characteristics:**

Fibrous peat, weakly decomposed with recognisable plant structures, or semi-fibrous peat, throughout the 30-90 cm depth reference section

Clear or slightly turbid liquid expressed on squeezing fibrous peat

Turbid or muddy liquid squeezes from semi-fibrous peat

Perennially waterlogged

More than 80 cm of peat over mineral material

Stoneless

**Generalised soil profile:**

*Oh horizon, [0-10 cm]:* Black humose peat, often containing a mat of roots.

*Of horizon, [10-100+ cm]:* Very dark reddish brown to dark brown [5-10YR 2/2] fibrous peat, mostly remains of *Sphagnum.* In places there are interbedded bands of more humified peat.

**Example profile:** SX68/008161 at 543 m O.D. on $8^{O}$ slope on blanket bog.

**Horizons:**

*0-12 cm Oh:* Black [N 2/0] humose peat; stoneless; wet; strongly developed fine granular structure; no fissures; 10% very fine macropores; very weak soil strength; deformable; non-sticky; slightly plastic; abundant fine and very fine fibrous roots; abrupt even boundary to:-

*12-55 cm Of1:* Dark reddish brown [5YR 2/2] fibrous peat, modified von Post H3, rubbed fibre 80%; wet; stoneless; apedal; no fissures; porosity obscured by water; very weak soil strength; slightly fluid; non-sticky; non-plastic; many fine fibrous roots; gradual smooth boundary to:-

*55-74 cm Of2:* Very dark brown [10YR 2/2] fibrous peat, modified von Post H3, rubbed fibre 50%; wet; stoneless; apedal; no fissures; water obscures porosity; very weak soil strength; slightly fluid; non-sticky; slightly plastic; few fine fibrous roots; diffuse smooth boundary to:-

*74-125 cm Of3:* As Of2, but horizon on right side of face contains an inclusion about 50 cm wide and 20 cm high of black [N 2/0] semi fibrous peat, modified von Post H6, 10% rubbed fibre; wet; stoneless; apedal; no fissures; no macropores; very weak soil strength; slightly fluid; non-sticky; non-plastic; no roots. Diffuse smooth boundary to:-

*125-192 cm Of4*: Dark reddish brown [5YR 2/2] fibrous peat, modified von Post H3, 60% rubbed fibre, in places fibres include woody twigs mostly <2 mm but 1 fragment 1 cm across seen; very moist; stoneless; apedal; no fissures; no macropores; very weak soil strength; deformable; non-sticky; non-plastic; no roots; probed to 257 cm depth where mineral soil met.

**Analyses:**

| **Horizon** | **Of1** | **Of2** | **Of3** |
|---|---|---|---|
| **Depth cm** | 12-55 | 55-74 | 125-192 |
| | | | |
| **Loss on ignition %** | 85.9 | 81.3 | 87.8 |
| **Organic carbon %** | 49.5 | 47.3 | 51.1 |
| **Total nitrogen** | 1.53 | 1.91 | 1.43 |
| **C:N ratio** | 32.4 | 24.8 | 35.7 |
| | | | |
| **pH in water [1 : 2.5]** | 4.1 | 4.1 | 4.0 |
| **pH in 0.01M $CaCl_2$** | 3.8 | 3.9 | 3.8 |
| **Undried pH in 0.01M $CaCl_2$** | 3.2 | 3.2 | 3.1 |
| | | | |
| **Bulk density g $cm^{-3}$** | 0.08 | 0.11 | 0.12 |

**Thickness of peat:** Chapter 5 describes how peat thickness was measured on linear traverses across the peat soils. Table 11 summarises the thickness within this map unit, for all sites and within the phases discussed below in Section 3.28 and mapped on the terrain map. Thickness of the peat averages 269 cm across the map unit as a whole, 347 cm on the pristine phase but somewhat thinner on the eroded phases, 251 cm on the slightly eroded phase and 152 cm on the severely eroded phase. In the undegraded parts of the two erosion phases average amounts are 263 cm on the slightly eroded phase and 227 cm on those parts of the severely eroded phase. A maximum of 740 cm was measured south of Cranmere Pool [603858]. 35% of all Winter Hill sites had more than 3 m of peat and 29% of the Pristine phase more than 4 m.

**Table 11. Thickness of peat [cm] on Winter Hill map unit from traverses.**

| | All Winter Hill sites | Winter Hill Pristine phase | Winter Hill Slightly Eroded phase | Winter Hill Severely Eroded phase |
|---|---|---|---|---|
| **No. of observations** | 773 | 292 | 341 | 140 |
| **Mean** | 269 | 347 | 251 | 152 |
| **Median** | 260 | 320 | 250 | 135 |
| **Standard deviation** | 132 | 147 | 86 | 82 |
| **Interquartile range** | 145 | 180 | 120 | 112.5 |
| **Low quartile** | 180 | 245 | 185 | 90 |
| **Upper quartile** | 325 | 425 | 305 | 203 |
| **Minimum** | 10 | 45 | 10 | 20 |
| **Maximum** | 740 | 740 | 520 | 360 |
| **Range** | 730 | 695 | 510 | 340 |
| **% >80 cm** | 95 | >95 | 95 | 80 |

**Peat erosion:** Erosion of peat soils of the Winter Hill unit was mapped in this survey, shown as three phases, *Severely eroded, Slightly eroded* and *Pristine,* on the terrain map accompanying the soil map. They cover about 220, 390 and 260 ha respectively. Full discussion of this mapping is in Section 3.28 below. Only on its margins is there even slight erosion in the mapped Pristine phase. Depth, width and areas affected are greater on the severely eroded phase, as is hagg formation, than on the slightly eroded phase. The deeper channels commonly reach the mineral substrate. The channels are mostly dendritic, reticulate or linear following the slope on the more eroded sites, whereas reticulate networks predominate on the slightly eroded land. Active scouring was recorded on 39% of the severely eroded phase, but only at 10% of slightly eroded sites.

### 3.10.3 SUBSIDIARY SOILS

**Crowdy series** *[rare]:* Humified peat soils in peat deeper than 80 cm form sporadically. These form in areas of erosion where irreversible drying and humification of the peat has occurred; they are also evident approaching boundaries to Crowdy and mineral soil map units.

**Hepste series** *[rare]:* These shallow humified peat soils are found on eroded or cut over sites where the mineral substrate is 40-80 cm below the surface.

**Unnamed oligo-fibrous peat soils over lithoskeletal material** *[rare]:* Shallow soils analogous to Hepste series, but in fibrous peat, largely occurring in the severely eroded phase [Section 3.28]. Table 11 indicates that in that phase the frequency of occurrence of these soils, along with Hepste series and mineral soils, all less than 80 cm peat, is *occasional* rather than *rare,* unlike the map unit as a whole.

**Mineral soils** *[rare]:* Where erosion or cutting has totally removed peat, lithoskeletal variants of Princetown, Hexworthy and Rough Tor series are exposed. Alternatively these might be seen as *acid-humose truncated raw oligo-fibrous soils,* subgroup 11.13 in the scheme of Hollis [1991]. These soils are limited to eroded phase areas.

**Key to component soil series:**

| | | |
|---|---|---|
| | Peat thicker than 40 cm | 1 |
| | Peat less than 40 cm | Mineral soils |
| | | |
| 1 | Peat thicker than 80 cm | 2 |
| | Peat 40-80 cm thick | Hepste |
| | | |
| 2 | Amorphous | Crowdy |
| | Fibrous or semi-fibrous | WINTER HILL |

3.10.4 SOIL FUNCTIONS

*Soil properties:* Winter Hill soils in pristine locations are permanently waterlogged, Soil Wetness Class VI. However where gullied some 'freeboard' modifies the hydrology. Being situated where a meteorological soil moisture deficit occurs only during dry summers, soil dryness is not a concern. Acidity is an important property.

*Site conditions:* Rainfall averages around 2200 mm *per annum*, combining with low temperatures and exposure, as the district's most severe climatic limitation. In the severely eroded phase ground form, as gullies, sedimented pans and pools, impedes access and movement by people and animals.

**Production:** The scientific, conservation and amenity importance of the perennially waterlogged blanket bog precludes any thought of productive use. Lightly grazed by sheep, the vegetation is of low nutritional value [Bibby *et al.,* 1982], although in some of the gullied area in slightly drier conditions there is vegetation of moderate grazing value. In Bibby and Mackney's [1969] Land Use

Capability Classification these soils are class 6w, but are grade 5 or unclassified in the MAFF [1988] ALC.

**Plate 31. Very thick fibrous peat soil of the Winter Hill series mantles much of the highest moorland.**

At this site the peat was 257 cm thick, close to the Winter Hill map unit's average, although a maximum of 740 cm was encountered in the survey.

**Ecology:** The pristine blanket bog is a core feature of the North Dartmoor Site of Special Interest. Its flora comprises abundant bog mosses, notably *Sphagnum capillifolium, S. papillosum and S. auriculatum*, with purple moorgrass *[Molinia caerulea]*, hare's-tail and common cottongrass *[Eriophorum vaginatum* and *E. angustifolium]*, deergrass *[Scirpus cespitosus]*, cross-leaved heath *[Erica tetralix],* ling *[Calluna vulgaris]*, sundew *[Drosera anglica]* and bog asphodel *[Narthecium ossifragum]* in association. Pools in the blanket bog contain *Sphagnum cuspidatum* and *S. auriculatum*. In the severely eroded phase the ground's broken form degrades the blanket bog, but adds diversity of habitat and terrain through hydrological changes and shelter.

**Environment:** The pristine phase of Winter Hill soils qualifies as HOST [Boorman *et al.* 1995] class 29 in which hydrological response is through saturated flow high in the profile, combined with surface runoff. The large volumes of water contained in the great thicknesses of peat make significant contributions to base flow in the catchments' headwaters. In eroded sites HOST class 28 is appropriate where, although overall responses are broadly similar, flow becomes concentrated in any erosional channels. In deeper gullies breaching the base of the peat, some vertical movement into the mineral substrate takes place. Some, but not all, gullies have direct connection with permanent watercourses. In the classification of Palmer *et al.* [1995] wetness and organic matter content place Winter Hill soils as Soils of Low Leaching Potential. Estimated reserves of organic carbon in these soils are extremely large, even when calculated for a 1 m deep profile at 95 kg $m^{-2}$, whereas the mean thickness of peat on this map unit is 269 cm [indicating soil organic carbon of 257 kg $m^{-2}$] and in the pristine phase 332 kg $m^{-2}$, where mean peat thickness is 347 cm. In the eroded phases, mean peat thickness and estimated carbon amounts are 251 cm and 240 kg $m^{-2}$ in the slightly eroded state, 152 cm and 145 kg $m^{-2}$ in the severely eroded phase.

**Amenity and engineering:** It is difficult to imagine any of the soil functions treated elsewhere under this heading being a practical consideration in a Site of Special Scientific Interest. However, use of the land as a military training area continues. During excavation and handling the soils are extremely unstable and vulnerable. Waterlogged acid peat is aggressive to ferrous metal. The peat soils are extremely vulnerable to concentration of traffic, whether by walkers, ponies and horses, or vehicles of any sort, bicycles and quadbikes included. The eroded peat areas present hazardous ground conditions to ramblers and riders.

---

## 3.11 HEPSTE MAP UNIT [Hps on the soil map]

3.11.1 Raw, very acid, humified peat soils on peripheral and degraded blanket bog, much of which has been cut and or eroded. This peat is less thick than on the higher blanket bog mapped as Winter Hill, even where unaffected by erosion or cutting. It is an open question as to whether these soils are humified versions of the fibrous blanket bog peat, degraded by the hydrological change, aeration and exposure brought about by erosion, peat cutting and environmental change, or are thicker versions of the humified peaty tops of mineral soils, as in the Princetown and Hexworthy / Rough Tor map units.

**Distribution and site:** The Hepste map unit covers 589 ha, mostly between the Winter Hill soils of the high summit plains and the mineral Hexworthy / Rough Tor and Princetown soils developed downslope on lower moorland. Most of the ground stands between 400 and 540 m O.D. on slopes between flat and moderate [$7^{O}$ or less, with the majority $4^{O}$ or less]. There are a few steeper [8-$11^{O}$] strips, as on the eastern flanks of Black Hill [604846], where the unit reaches about 570 m O.D. Beyond the limits of this mapped area humified peat soils situated towards the edges of the blanket bog and akin to this map unit occur across wider parts of Dartmoor and a small part of Exmoor. They are shown on the National Soil Map as 1013b Crowdy Association.

**Land cover:** Wet moorland with ling and *Molinia,* with wetter vegetation including *Sphagnum, Eriophorum and Trichophorum* in parts of the floors of peat cuttings and gullies, as well as on areas of unconsumed peat. This land provides rough grazing for sheep, cattle and ponies. Parts of the unit fall in the military ranges.

**Component soils:**

Hepste series *[frequent]*

Crowdy series *[rare]*

Winter Hill series *[rare]*

Unnamed oligo-fibrous peat soils over lithoskeletal material *[rare]*

Mineral soils *[occasional]*

3.11.2 MAIN SOIL

**HEPSTE SERIES** Raw oligo-amorphous peat soils; humified peat over lithoskeletal material. Hepste soils were originally described in Dyfed by Clayden and Evans [1974]. On Dartmoor these relatively thin profiles mark where the peat has been truncated by cutting or by erosion, or where peat growth is less vigorous at the margins of the deposit.

**Characteristics:**

Amorphous peat, without recognisable plant remains

When squeezed, mud, but little or no water, extrudes

40-80 cm of peat over very stony mineral soil

Stoneless

**Generalised soil profile:**

*Oh1 horizon, [0-10 cm]:* Black [N 2/0] humic peat; fine granular structure; many fine fibrous roots.

*Oh2 horizon, [10-40 to a maximum of 80 cm]:* Black [N 2/0] amorphous peat; stoneless; structureless. In places pockets or bands of fibrous or semifibrous peat may be present.

*2Cg horizon, [40 to 80+ cm]:* Mottled, gritty sandy loam; very stony.

**Example profile:** *Profile no.:* SX57/8968 on *Molinia* moorland at 463 m O.D. on $1^{O}$ slope. [Hogan 1978, p 54-5.]

**Horizons:**

*0-27 cm Oh1:* Black [N 2/0] humified peat; stoneless; wet; massive; low packing density; fine macropores; very weak soil strength; deformable; non-sticky; abundant very fine and fine fibrous roots; abrupt wavy boundary.

*27-33 cm Om:* Dark reddish brown [5YR 3/3] semi-fibrous peat; stoneless; wet; low packing density; fine macropores; moderately firm soil strength; deformable; non-sticky; abundant very fine and fine fibrous roots; abrupt wavy boundary.

*33-77 cm Oh2:* Black [5YR 2/1] humified peat; stoneless; wet; massive; low packing density; fine macropores; very weak soil strength; deformable; non-sticky; abundant very fine and fine fibrous roots; abrupt smooth boundary.

*77-96 cm Ah:* Very dark brown [10YR 2/2] humose coarse sandy loam; many very small to medium subangular granite stones; very moist; massive; high packing density; very slightly porous, very fine macropores; very firm soil strength; slightly sticky; moderately plastic; abundant very fine mostly dead fibrous roots; clear wavy boundary.

*96-104 cm Cu:* Greyish brown [2.5YR 5/2] coarse sandy loam; many very small subangular granite stones; very moist; massive; high packing density; very slightly porous; very fine macropores; moderately firm soil strength; semi-deformable; moderately sticky; very plastic; abundant very fine fibrous roots.

**Analyses:**

| **Horizon** | **Oh1** | **Om** | **Oh2** | **Ah** | **Cu** |
|---|---|---|---|---|---|
| **Depth cm** | 0-27 | 27-33 | 33-77 | 77-96 | 96-104 |
| | | | | | |
| **Sand 600 µm-2 mm %** | | | | 40 | 38 |
| **“ 200-600 µm %** | | | | 19 | 22 |
| **“ 60-200 µm %** | | | | 9 | 9 |
| **Silt 2-60 µm %** | | | | 24 | 22 |
| **Clay <2 µm %** | | | | 8 | 9 |
| | | | | | |
| | | | | | |
| | | | | | |

| Horizon | Oh1 | Om | Oh2 | Ah | Cu |
|---|---|---|---|---|---|
| Loss on ignition % | 96 | 97 | 98 | | |
| Organic carbon % | 50.0 | 46.3 | 51.7 | 4.7 | 2.0 |
| Total nitrogen | 1.30 | 1.78 | 1.63 | | |
| C:N ratio | 38.4 | 26.0 | 31.7 | | |
| | | | | | |
| pH in water [1 : 2.5] | 4.0 | 3.9 | 3.9 | 4.7 | 4.7 |
| pH in 0.01M $CaCl_2$ [1 : 2.5] | 3.0 | 3.0 | 3.0 | 3.8 | 4.0 |
| Undried pH in $CaCl_2$ | 2.9 | 2.9 | 2.9 | | |
| | | | | | |
| Rubbed fibre % | 23 | 23 | 5 | | |
| Pyrophosphate extractable C% | 5.7 | 5.6 | 3.0 | | |
| Pyro. Extr. Absorbance, 550 nm | 3.7 | 2.5 | 9.3 | | |

*Comment:* Being close to the maximum thickness of Hepste series this profile is intergrading to Crowdy, as it was originally described by Hogan [1978 p 54-5].

### 3.11.3 SUBSIDIARY SOILS

**Crowdy series** *[rare to occasional]:* These thicker raw oligo-amorphous peat soils in humified peat more than 80 cm thick are formed sporadically, many on the baulks between peat ties or on remnants unconsumed by erosion. The thickest peat in this unit nowhere approaches the depth on the Winter Hill map unit, only 2% of observations on traverses crossing the Hepste map unit exceeded 2 m in thickness.

**Winter Hill series** *[rare]:* Soils in fibrous peat thicker than 80 cm, occurring in similar positions to Crowdy soils.

**Unnamed oligo-fibrous peat soils over lithoskeletal material** *[rare]:* Soils in fibrous peat but of similar depth [<80 cm] to Hepste soils, often owing their depth to truncation by cutting or erosion.

**Mineral soils** *[occasional]:* In peat cuttings and on eroded ground, soils with less than 40 cm of peat can occur. These can resemble the Princetown series or could be considered as a*cid-humose truncated raw oligo-fibrous soils* after Hollis' [1991] classification.

**Key to component soil series:**

| | | |
|---|---|---|
| | Peat thicker than 40 cm | 1 |
| | Peat less than 40 cm | Mineral soils |
| | | |
| 1 | Peat thicker than 80 cm | 2 |
| | Peat 40-80 cm thick | HEPSTE |
| | | |
| 2 | Amorphous | Crowdy |
| | Fibrous or semi-fibrous | Winter Hill |

**Thickness of peat:** Chapter 5 shows that median [60 cm] and mean [70 cm] thicknesses of peat across this map unit are below the 80 cm taxonomic cut-off distinguishing peat soils from peat over lithoskeletal material [Clayden and Hollis, 1984]. Only the map unit's upper quartile exceeds that limit. In part this is a reflection of these soils location near the margins of the blanket peat. Other influences on overall thickness here include erosion and cutting for fuel and the likely consequent drying and shrinkage of the peat.

3.11.4 SOIL FUNCTIONS

*Soil properties:* In undegraded sites Hepste soils are permanently waterlogged, Soil Wetness Class VI, although indications from ground conditions and the vegetation are that they are less wet than the adjacent Winter Hill soils. In eroded or cut sites the hydrology is clearly ameliorated, in places radically, although the floors of some peat ties are wet enough for *Sphagnum* growth. Located where only dry summers see a meteorological soil moisture deficit develop, soil dryness is not a consideration. Low pH is an important property of these soils.

*Site conditions:* Climatic harshness as high rainfall, low temperatures and exposure, plus soil wetness and the widespread brokenness of the terrain following peat cutting and erosion, all present serious limitations.

**Production:** Although there is little pristine blanket bog in this map unit, considerations of amenity and nature conservation remain paramount for this land. The land is stocked but only provides grazing of low or moderate value in the scheme of Bibby *et al.* [1982]. For the Agricultural Land Classification [MAFF [1988] moorland is unclassified; were the scheme applied the Hepste map unit would be grade 5. In Bibby and Mackney's [1969] system it would fall in class 6w. A small area in Fernworthy Forest [643837] is in conifer plantation, where soil wetness restricts choice of species to Lodgepole pine and, with severe exposure, encourages wind throw. Poor ground conditions are highly likely for harvesting, with the associated risk of runoff and sediment generation.

**Ecology:** Vegetation on this map unit, as part of the high moorland peripheral to the blanket bog, is a melange of wet heath and grassy moorland in which *Molinia* is usually present. Like the Winter Hill and Crowdy map units [Sections 3.10 and 3.12], much of it has been cut for fuel, leaving rectilinear and irregular ties, shallow depressions with relatively abrupt margins rising to baulks of residual, uncut peat. Within the ties and on larger areas of uncut peat the vegetation is hydrophilous with *Sphagnum* and *Eriophorum*, while heathers highlight the slightly drier baulks. In many places this gives the vegetation a rectangular or linear mosaic, somewhat distended up and down slope, reflecting the peat cutters' need to avoid flooding their ties. This map unit is part of the North Dartmoor Site of Special Scientific Interest.

**Environment:** Most of the Hepste map unit has suffered surface degradation by erosion or peat cutting, and, in places, by both. Hydrologically it is better considered as eroded peat, HOST [Boorman *et al.* 1995] class 28. Water moves across its surface and by shallow saturated flow to erosional channels or peat ties. There it becomes concentrated, some directly entering watercourses, some passing into the mineral substrate and some diffusing across the peat surface. As peat soils organic matter content and wetness result in classification as Soils of Low Leaching Potential in the Groundwater Protection scheme of Palmer *et al.* [1995]. Reserves of organic carbon are large, although these soils are comparatively shallow, with a mean peat thickness of 70 cm and estimated amounts are 112 kg $m^{-2}$ to 1 m depth.

**Plate 32. Cut over peat in the Hepste soil map unit.**

The depression in the foreground is a tie or individual working, aligned up and down the gentle slope. Heather picks out the drier ground along the line of the half metre high cut edge. Groups of ties often produce a striated mosaic of vegetation patterns. The scarp in the middle distance is eight metres high, marking the upslope limit of medieval eluvial tin working.

**Amenity and engineering:** Falling within a Site of Special Scientific Interest, the likelihood of such use or disturbance considered in other map unit descriptions ever coming about seems inconceivable. Yet it remains part of the military training ground. The soil will be extremely unstable and vulnerable when excavated, moved or stored. They are very highly aggressive to ferrous metal. Concentrated traffic of any sort, by foot, animals or vehicles, will cause damage.

## 3.12 CROWDY MAP UNIT [CJ on the soil map]

3.12.1 As with much of the Hepste soils described above in Section 3.11, these raw, very acid peat soils have been cut for fuel across parts of the map unit, resulting in variations of thickness. A proportion of these soils [around 40%] are in fibrous or semi-fibrous peat.

**Distribution and site:** The map unit occupies 1,072 ha, largely in basin sites on lower valley sides on the moorland, east of the blanket bog of the highest ground, with some separations in valleys of the in-bye. Overall slopes are more subdued than on any other peat map unit, the median angle reported in Chapter 5 being $1^{O}$, with 90% of the unit's slopes being $3^{O}$ or less. This map unit includes watercourses, occasional small pools and areas of very soft, treacherous ground, some around spring 'eyes' and marked by bright green *Sphagnum.* With the exception of Raybarrow Pool [638900], the open water is usually confined to a few tens of square metres. About 70 ha of the unit are mapped in the higher moorland areas as narrow strips along the upper headwaters of the rivers, particularly the East Dart. Here mixed ground of valley floor bogs and small patches of alluvial gley soils mingles with peat derived from collapses and erosion of the blanket peat's marginal bluffs, much of which has undergone further erosion, weathering and reworking.

There are occasional upslope extensions of the unit as valley-side flush zones, as east of Watern Tor at 636836 and northeast of Buttern Hill [653885]. The small delineations of Crowdy soils in subdued positions in the in-bye, pick out sites where strong, perennial springs emerge. Examples of these are between Vogwell [722817] and Heatree Cross [799810], on the western edge of Mardon Down [761874] and Padley Common [699872]. Away from the district covered by this survey, Crowdy soils form elsewhere on Dartmoor, while the main occurrence of peat on Bodmin Moor is the Crowdy series in basin sites.

**Land cover:** Wet moorland valley bogs with *Molinia,* rush and heath, plus occasional open pools, some the products of tin working and peat cutting. Much of the unit is grazed by sheep, cattle and ponies. At lower levels on the moor small clumps of stunted willows occur, while in the in-bye the unit carries carr [wet] woodland, plus patches of tussock sedge and some planted conifers.

**Component soils:**

Crowdy series *[common]*

Winter Hill series *[occasional]*

Hepste series *[occasional]*

Unnamed oligo-fibrous peat soils over lithoskeletal material *[rare]*

Mineral soils *[rare]*

### 3.12.2 MAIN SOIL

**CROWDY SERIES** Raw oligo-amorphous peat soils; humified peat. Crowdy soils were first described on Bodmin Moor by Staines [1976], later on Exmoor by Hogan and Harrod [1982] and subsequently more widely in Wales [Rudeforth *et al.,*1984].

**Characteristics:**

Amorphous peat, no recognisable plant remains

When squeezed, mud, but little or no water is extruded

More than 80 cm of peat over mineral soil

Stoneless

**Generalised soil profile:**

*Oh1 horizon, [0-10 cm]:* Black [N 2/0] humic peat; fine granular structure; many fine fibrous roots.

*Oh2 horizon, [10- at least 80 cm]:* Black [N 2/0] amorphous peat; stoneless; structureless. Bands and pockets of fibrous or semi-fibrous peat occur in places.

*2Cg horizon, [80+ cm]:* Mottled, gritty sandy loam; stony.

**Example profile:** *Profile No.:* SX68/17680427 on *Molinia* moorland at 511 m O.D. on 7$^{O}$ slope.

**Horizons:**

*0-3 cm Oh1:* Black [10YR 2/1] amorphous peat; stoneless; moist; strongly developed fine granular structure; abundant very fine fibrous roots; sharp smooth boundary [but undulating with upper surface 10-15 cm.] to:

*3-45 cm Oh2:* Black [N 2/0] amorphous peat [modified von Post H8]; stoneless; very moist; structureless massive; one medium vertical fissure; 2% very fine macropores; very weak consistence; deformable; non-sticky, non-plastic; many very fine fibrous roots; clear even boundary to:

*45-65 cm Of1:* Black [5YR 2/1] fibrous peat, [modified von Post H6]; stoneless, but a 1-2 cm deep band at horizon base with 5% white sand grains; very moist; structureless massive; no fissures, slightly porous 8% very fine and fine pores; very weak; deformable; non-sticky, non-plastic; many very fine and fine fibrous roots; undisturbed fibre 80%, likewise after rubbing / neading, looks like *Molinia;* clear even boundary to:

*65-95 cm Oh3:* Black [N 2/0] amorphous peat [modified von Post H8]; stoneless; very moist; structureless massive; no fissures; 5% very fine pores; very weak strength; deformable; non-sticky, non-plastic; many very fine fibrous roots; 5% rubbed fibre; gradual smooth boundary to:

*95-140 cm Of2:* Very dark brown [10YR 2/2] fibrous peat [modified von Post H3]; stoneless; very moist; structureless massive; no fissures; 8% very fine and fine macropores; weak strength; deformable; non-sticky, non-plastic; few very fine fibrous roots; 40% rubbed fibre; clear smooth boundary [but one quartz boulder stands up 10 cm from mineral soil below] to:

*140-153 cm 2AC:* Very dark brown [10YR 3/2] gritty sandy silt loam; humose; abundant very small and small [plus a few large] stones; moist; structureless massive; no fissures; less than 2% pores; brittle; non-sticky, non-plastic; includes some ?grass? remains; gradual smooth boundary to:

*153-183+ cm 2Cu:* Brown to dark brown [10YR 4/3]; gritty sandy loam with few [2%] medium mottles of very dark brown [10YR 3/2]; moist; structureless massive; brittle; non-sticky, non-plastic; no roots.

**N.B.** 10 m to west peat thins to c 1 m on top of Eag, iron pan and BC horizons.

**Analyses:**

| **Horizons** | **Oh2** | **Of1** | **Oh3** |
|---|---|---|---|
| **Depth cm** | 3-45 | 45-65 | 65-95 |
| | | | |
| **Loss on ignition %** | 74.5 | 58.5 | 80.7 |
| **Organic carbon %** | 43.3 | 34.0 | 46.9 |
| **Total nitrogen** | 1.97 | 1.35 | 1.82 |
| **C:N ratio** | 22.0 | 25.2 | 25.8 |
| | | | |
| **pH in water [1 : 2.5]** | 3.9 | 4.0 | 4.1 |
| **pH in 0.01M $CaCl_2$ [1 : 2.5]** | 3.2 | 3.3 | 3.2 |
| **Undried pH in $CaCl_2$** | 3.1 | 3.1 | 3.1 |
| | | | |
| **Bulk density g $cm^{-3}$** | 0.20 | 0.12 | 0.24 |

**Thickness of peat:** Although much of the map unit has been cut over for fuel, the results from the traverses in Chapter 5 show there is thicker peat here than in the Hepste unit. Mean thickness is 102 cm and the median is 90 cm, with 60 percent of the peat being more than 80 cm thick. A maximum of 405 cm was recorded. The map unit contains a number of sites where vigorous peat growth is taking place into small pools and spring 'eyes', with quaking ground. Cutting has resulted in about 15% of the traverses' observations having profiles with insufficient thickness of peat [<40 cm] to qualify as peat soils.

### 3.12.3 SUBSIDIARY SOILS

**Winter Hill series** *[occasional]:* Peat soils with reference sections [40-90 cm] composed of fibrous peat.

**Plate 33. Crowdy series.**

About 1.4 m of predominantly humified peat over granitic head.

**Hepste series** *[occasional]:* Raw oligo-amorphous peat soils 40-80 cm in depth, truncated by peat cutting.

**Unnamed oligo-fibrous peat soils over lithoskeletal material** *[rare]:* Soils in fibrous peat of similar thickness to Hepste series.

**Mineral soils** *[rare]:* Soils with less than 40 cm of peat occurring in peat cuttings and in the narrow strips along some river head waters. These include the Laployd series, or, in cuttings, what could be considered as a*cid-humose truncated raw oligo-fibrous soils* of Hollis' [1991] classification.

**Key to component soil series:**

| | | |
|---|---|---|
| | Peat thicker than 40 cm | 1 |
| | Peat less than 40 cm | Mineral soils |
| | | |
| 1 | Peat thicker than 80 cm | 2 |
| | Peat 40-80 cm thick | 3 |
| | | |
| 2 | Amorphous | CROWDY |
| | Fibrous or semi-fibrous | Winter Hill |
| | | |
| 3 | Amorphous | Hepste |
| | Fibrous or semi-fibrous | Unnamed |

### 3.12.4 SOIL FUNCTIONS

*Soil properties:* These soils evolved under a regime of perennial waterlogging, a product of high groundwater levels, with parts of the map unit remaining in that condition. However, the widespread peat cutting that has taken place has partly drained the ground on baulks on the margins of cuttings. Soil hydrology and climate mean that dryness of these soils is not a concern.

*Site conditions:* Much of the map unit endures a harsh climate. However there is gradual amelioration from west to east, the small delineations, as on the western side of Mardon Down at 761875, for example, experiencing a much drier climate, yet severe soil wetness remains.

**Production:** Most of the map unit is moorland of great amenity and ecological value, but also provides upland grazing of low or moderate value for sheep, cattle and ponies. While in the past some attempts were made at drainage of Crowdy soils in basin sites in the in-bye, they were unsuccessful. Classed as 6w in the Land Use Capability Classification of Bibby and Mackney [1969], these soils fall in the lowest grade [5] of MAFF'S [1988] ALC, although moorland areas are not addressed in its application. There are small areas in conifer plantation in the in-bye where extreme soil wetness, even with ditch drainage and appropriate ploughing, restricts choice of species and makes wind throw likely when trees approach maturity. Ground conditions and proximity to watercourses mean that harvesting timber here demands special attention to avoid sediment generation and acidification of runoff.

**Ecology:** The vegetation includes valley mires and wet grassy heath. In the lowest parts of each basin and sporadically on the flanks, there are mires with watercourses, flowing surface water, occasional pools and patches of very soft, quaking ground. These areas have distinctive flora including *Sphagnum recurvum, S. palustre, S. squarrosum* and *Polytrichum commune*, soft rush *[Juncus effusus]* and sharp-flowered rush *[Juncus acutiflorus]*, bottle *[Carex*

**Plate 34. Humified peat of the Crowdy series, a few metres from that in Plate 33.**

Here the peat is about 1 m thick. The coarse blocky structure is a result of long term exposure of the section. Interestingly, beneath the peat there are Eag, ironpan and Bs horizons, typical of a stagnopodzol.

*rostata],* star *[Carex echinata]* and white-beak sedge *[Rhynchospora alba]* and bogbean *[Menyanthes trifolata]*. In the more stagnant sites the vegetation can be more akin to the blanket bog or the wet heathland. In the wetter sites are bog mosses *Sphagnum papillosum, S. auriculatum* and *S. capillifolium* and common cottongrass *[Eriophorum angustifolium]*, with *Sphagnum pulchrum* often a major constituent. In many places the effect of the widespread peat cutting is evident through distinctive, linear vegetation patterns in and around the peat ties. These excavations are largely aligned with the slope and have abrupt, straight edges up to 1 m high. The vegetation emphasises the hydrological consequences of the excavations; while the tie floors often remain waterlogged, sometimes flooded and containing *Sphagnum* and *Eriophorum,* the upstanding baulks between the ties are much drier with heathers and *Molinia.* The small separations of the Crowdy soils at lower altitude in the in-bye support some rhôs pasture and willow-alder carr.

**Environment:** Crowdy soils fall into class 12 of the HOST system of Boorman *et al.* [1995], having groundwater close to the surface perennially. Water movement is by saturated flow in the soil as well as by surface movement. The latter is often striking in the field, both as diffuse flow and in shallow channels. In the classification of soils for groundwater protection by Palmer *et al.* [1995], Crowdy soils qualify as Soils of Low Leaching Potential in consequence of their organic composition and waterlogging. Organic carbon amounts stored in Crowdy soils are substantial, despite their history of widespread cutting. Estimated content to 1 m depth in the example profile described above is around 115 kg $m^{-2}$. This is close to the value for the map unit's average depth of 102 cm, although for the median depth of peat on these soils of 90 cm a reduction in the overall estimate to 98 kg $m^{-2}$ is appropriate.

**Amenity and engineering:** Crowdy soils have little stability in shallow trenches and excavations and are extremely vulnerable when being handled, moved and stored, or if movement of machinery and vehicles takes place. This is most relevant in the in-bye's conifer plantations. On the moorland, amenity and conservation concerns will be overriding, although some of the map unit lies in the military training area. Ferrous metal is at very high risk of corrosion from Crowdy soils. They are not suited for camping or caravan sites or for short term events involving crowds or vehicles. While unsuited to footpaths according to George and Jarvis [1979], location of these soils can mean they need to be crossed. This will be with difficulty, resulting in erosion by traffic and may well justify the construction of causeways. On the open moorland pools, quaking ground and irregular terrain around peat ties are hazards for ramblers and riders.

---

### 3.13 TAVY / TY-GWYN MAP UNIT [tY/tF on the soil map]

3.13.1 Coarse loamy soils of variable depth in relatively dry, granite-derived alluvium; Tavy series [typical brown alluvial soils, coarse loamy alluvium over non-calcareous gravel] and Ty-Gwyn series [gleyic brown alluvial soils, coarse loamy alluvium]. Most frequently the alluvium overlies gravel of rounded and subrounded granite stones at 40-80 cm depth. In about half of the map unit gleying is absent within 80 cm, in the remainder some is evident between 40 and 80 cm.

**Distribution and site:** 161 ha, particularly along the wider parts of the Teign and Bovey floodplains. The altitudinal range is from below 50 m O.D. south of Lustleigh [785813] to about 270 m between Scorhill [662874] and Gidleigh Park [677879]. As on any floodplain gradients are subdued, however there is commonly a slight rise across the floodplain to the levee close to the river. In places there is a noticeable downstream slope on the floodplain, while elsewhere, as immediately north of Holy Street [689878], the floodplain imperceptibly merges into small terrace remnants. Elsewhere, for example as above Clifford Bridge [781898], shallow, linear scour channels, shown on the soil map as blue lines, diversify the ground. Over-all, the map unit is not bouldery.

**Land cover:** Pastures and meadows cover most of the ground, with some deciduous woodland and conifer plantation.

**Component soils:**

Tavy series *[common]*

Ty-Gwyn series *[occasional]*

Unnamed coarse loamy gleyic brown alluvial soil over gravel *[occasional]*

Alun series *[occasional]*

Teign series *[rare]*

Eversley series *[rare]*

3.13.2 MAIN SOILS

**TAVY SERIES**

Coarse loamy typical brown alluvial soils in alluvium over non-calcareous river gravel. First described by Hogan [1977] around Tavistock.

**Characteristics:**

Brown, unmottled soil colours

Sandy loam, less often sandy silt loam, textures

Weakly differentiated horizons

Gravel encountered by 80 cm

Few stones above the gravel

**Generalised soil profile:**

*Ah [0-25 cm]:* Dark brown [7.5 or 10YR 3-4/2-4] sandy loam or sandy silt loam, commonly with rusty mottles along root channels, stoneless; fine subangular blocky or granular structure.

*Bw [25-65 cm]:* Brown or dark brown [7.5YR 3-5/4] sandy loam or sandy silt loam; stoneless; subangular blocky structure; this horizon is slightly paler than the Ah and usually has darker vertical streaks along and around earthworm burrows.

*Cu [65 cm +]:* Gravel of small to large subrounded and rounded granite stones.

**Example profile:** SX47/9455 [Hogan 1977, p73] under permanent grass.

**Horizons**

*0-15 cm A:* Brown to dark brown [7.5YR 4/2] sandy silt loam with few fine rusty mottles in top 10 cm; slightly stony, gravel to medium subangular stones; moderately developed fine and medium subangular blocky structure; friable; common fine pores; moderate organic matter; abundant fine fibrous and few fine and medium woody roots; earthworms present; moist; merging boundary.

*15-42 cm Bw:* Brown to dark brown [7.5YR 4/3] sandy silt loam; slightly stony, gravel and small subangular and rounded stones; moderately developed fine and very fine subangular blocky structure; very friable; low organic matter; common fine fibrous roots; earthworms present; slightly moist; merging boundary.

*42-62 cm 2Cu:* Brown [7.5YR 4-5/4] sandy loam; stony, gravel and small subangular and rounded stones; strongly developed very fine subangular blocky structure and single grained; very friable; low organic matter; common fine fibrous roots; slightly moist; merging boundary.

*62-83 cm 3Cu1:* Dark yellowish brown [10YR 4/4] gravelly loamy sand; very stony, gravel and small rounded stones; very fine subangular blocky structure and single grained; very friable to loose; low organic matter; few fine fibrous roots; slightly moist; merging boundary.

*83-92+ cm 3Cu2:* Yellowish brown [10YR 5/4] sandy loam with common medium areas of brown to dark brown [7.5YR 4/4]; very stony, gravel and small stones; moderately developed fine subangular blocky structure; friable; few fine pores; low organic matter; few fine fibrous roots; slightly moist.

**Analyses:**

| **Horizon** | **Bw** | **2Cu** | **3Cu1** |
|---|---|---|---|
| **Depth cm** | 15-42 | 42-62 | 62-83 |
| | | | |
| **Sand 600 µm -2 mm %** | 15 | 13 | 13 |
| **“ 200-600 µm%** | 18 | 26 | 33 |
| **“ 60-200 µm %** | 12 | 18 | 26 |
| **Silt 2-60 µm %** | 42 | 34 | 25 |
| **Clay <2 µm %** | 13 | 9 | 3 |
| | | | |
| **pH in water [1 : 2.5]** | 5.7 | 5.6 | 5.6 |
| **pH in 0.01M $CaCl_2$ [1 : 2.5]** | 5.0 | 5.2 | 5.2 |

**TY-GWYN SERIES:**

Coarse loamy gleyic brown alluvial soils in alluvium over non-calcareous gravel.

**Characteristics:**

Brown, unmottled above 40 cm

Sandy loam, less often sandy silt loam, textures

Mottling below 40 cm

Gravel encountered below 80 cm

Few stones above the gravel

**Generalised soil profile:**

*Ah [0-25 cm]:* Dark brown [7.5 or 10YR 3-4/2-4] sandy loam or sandy silt loam, commonly with rusty mottles along root channels, stoneless; fine subangular blocky or granular structure.

*Bw [25-50 cm]:* Brown or dark brown [7.5YR 3-5/4] sandy loam or sandy silt loam; stoneless; subangular blocky structure; this horizon is slightly paler than the Ah and usually has darker vertical streaks along and around earthworm burrows.

*Bw[g] 50-80 cm]:* Brown or dark brown [7.5YR 3-5/4] sandy loam or sandy silt loam with greyish or ochreous mottles; stoneless; subangular blocky structure.

*Cu [80 cm +]:* Gravel of small to large subrounded and rounded granite stones.

**Example profile:** SX68/9780 In permanent pasture with much bracken, also creeping thistle and devil's bit scabious. Surface somewhat uneven with tussocks 3-15 cm high and up to 30 cm across, some crowned by cock's foot. 150 m O.D.

**Horizons:**

*0-5 [10] cm Ah1:* Very dark greyish brown [10YR 3/2] sandy loam; stoneless; slightly moist; strongly developed [very] fine granular structure; extremely porous with very fine fissures and macropores; very weak soil and ped strength; non-sticky; non-plastic; [extremely] abundant very fine fibrous roots; abrupt smooth boundary. Horizon is a mat of grass roots, thickening to 10 cm in tussocks.

*5-17 cm Ah2:* Dark brown [10YR 3/3] sandy loam; very slightly stony with very small to medium subangular, subrounded and rounded granite stones; slightly moist; strongly developed fine granular structure; extremely porous with very fine fissures and macropores; very weak soil and ped strength; slightly sticky; slightly plastic; abundant very fine fibrous roots, also some coarse, to 1 cm, fleshy [live] and fibrous [dead] bracken rhizomes; earthworms present, coiled in aestivation; diffuse smooth boundary.

*17-53 cm Bw:* Brown to dark brown [7.5YR 4/3] sandy loam to loamy sand; very slightly stony with very small to medium subangular, subrounded and rounded granite stones; moist; moderately developed fine angular and subangular blocky structure; extremely porous with very fine fissures and pores, also some coarse pores as earthworm channels and sites of dead bracken rhizomes; very weak soil and ped strength; non-sticky; non-plastic; many very fine fibrous roots and few coarse fleshy and fibrous bracken rhizomes; earthworms present mostly coiled; clear smooth boundary.

*53-88 cm Bw[g]:* Brown to dark brown [7.5YR 4/3] sandy loam with common fine, medium and coarse very pale brown [10YR 7/3] and few medium mottles of yellowish brown [10YR 5/6]; micaceous, very slightly stony with small to very large subangular, subrounded and rounded stones of granite, quartz and tourmaline, one large subrounded tabular granite stone with long axis vertical; moist; weakly developed fine subangular blocky structure; very porous with very fine and coarse macropores; slightly sticky; non-plastic; common very fine fibrous roots, few coarse fibrous bracken rhizomes; earthworms present; gradual smooth boundary.

*88-110 cm BCg:* Brown [7.5YR 5/2] sandy loam with many medium and coarse mottles of very pale brown [10YR 7/3] and many very fine mottles of yellowish brown [10YR 5/6]; micaceous, very slightly stony with small to very large subangular, subrounded and rounded stones of granite [one red], quartz and tourmaline; moist; apedal massive; very porous with very fine to medium macropores; weak soil strength; slightly sticky; slightly plastic; common very fine fibrous roots; earthworms present.

**Analyses:**

| **Horizon** | **Ah2** | **Bw** | **Bw[g]** |
|---|---|---|---|
| **Depth cm** | 5-17 | 17-53 | 53-88 |
| | | | |
| **Sand 60 µm-2 mm%** | 70 | 74 | 64 |
| **Silt 2-60 µm %** | 18 | 20 | 28 |
| **Clay < 2 µm %** | 12 | 6 | 8 |
| | | | |
| **Organic carbon %** | 3.9 | | 0.8 |
| **pH in water [1 : 2.5]** | 5.0 | | 5.8 |

### 3.13.3 SUBSIDIARY SOILS

**Alun series** *[occasional]:* Unmottled coarse loamy soils in alluvium thicker than 80 cm which occur sporadically across the map unit, particularly on levees closer to the river.

**Unnamed gleyic brown alluvial soils** *[occasional]: S*oils similar to the Ty-Gwyn series but with gravel between 40-80 cm.

**Teign series** *[rare]:* Coarse loamy unmottled brown ranker-like alluvial soils in alluvium over gravel are formed here and there. They lack any structural development in the subsoil. In places gravel approaches the soil surface.

**Eversley series** *[rare]:* Small patches of wet ground-water gley soils form locally in floodplain backlands and in linear scour channels. These backlands stand slightly lower than the riverside levees so that the long-term watertable and the associated gleyed horizons are closer to the surface. The subdued location also encourages longer lasting flooding and the deposition of finer sediment. Nearness to the rising ground of the valley sides makes such sites susceptible to both ground and surface waters from those slopes.

**Disturbed ground** *[rare]:* Small patches of ground disturbed during alluvial tin working may have been included, particularly where restoration has been carried out and levelled so that the worked ground is not readily apparent.

**Key to component soil series:**

| | | |
|---|---|---|
| | Soils brown and unmottled above 80 cm | 1 |
| | Soils mottled above 80 cm | 2 |
| | | |
| 1 | Unmottled soils thicker than 30 cm | 3 |
| | Shallow soils over gravel | Teign |
| | | |
| 2 | Soils mottled 40-80 cm | 4 |
| | Soils mottled above 40 cm | Eversley |
| | | |
| 3 | With gravel at 40-80 cm | TAVY |
| | Without gravel | Alun |
| | | |
| 4 | With gravel at 40-80 cm | Unnamed gleyic brown alluvial soil |
| | Without gravel | TY-GWYN |

### 3.13.4 SOIL FUNCTIONS

*Soil properties:* Tavy soils are readily worked, trafficked and stocked, although the Ty-Gwyn series is a little more restricted by slight wetness. Flooding, particularly during the field capacity period from October to April, periodically affects alluvial soils. These coarsely textured soils drain rapidly after inundation, particularly the unmottled Tavy and Alun soils, which are rarely wet [Wetness

Class I, Hodgson 1997] and freely draining. Floodplain deposits invariably contain groundwater at some depth, usually close to the river or stream's base flow level, which can be seen as a greyish mottled horizon in some river bank exposures. The lower subsoil of the gleyic brown alluvial soils [Ty-Gwyn series and unnamed gleyic brown alluvial soils with gravel at 40-80 cm] are affected intermittently by this watertable, so that they are Wetness Class III [occasionally wet], their recovery after wet weather or flooding being slower than in Tavy and Alun soils. Available water capacity varies depending on the profile depth over the gravel. Where there is about 60 cm of soil above the gravel, as in many Tavy profiles, estimates following Hodgson [1997], Table 19, are about 100 mm, placing such profiles in Dryness Subclass *b*. In deeper soils of the Alun and Ty-Gwyn series, 1 m of gravel-free soil can be expected to provide 165 mm of available water, well in excess of the area's mean maximum potential soil moisture deficit of around 80 mm, making for Dryness Subclass *a*. By contrast the shallower soils over gravel will have storage capacity somewhat below the 100 mm of the modal Tavy profiles, which becomes apparent during droughts as scorched patches in some parts of the map unit.

**Plate 35. Ty-Gwyn series in coarse loamy river alluvium on the Teign floodplain.**

The profile is brownish and unmottled in its upper half, slight mottling lower down indicates sporadic, short-term rises of the groundwater table in winter.

*Site conditions:* Flood risk is of some concern, particularly with Ty-Gwyn and related gleyic and gley soils, as is the high rainfall further west in the district. Some delineations are narrow and ribbon-like, restricting their use.

**Production:** Flood risk, most severe in winter, restricts agricultural flexibility, but the map unit provides grassland with large potential yields and low risk of damage by poaching and traffic. Risk of flooding results in the map unit being assessed as class 3w [4cw in the wetter western parts] in the Land Use Capability Classification [Bibby and Mackney, 1969], and grades 3 or 4 in MAFF's [1988] ALC. Suited tree species include oak, poplars, alder and Norway spruce.

**Ecology:** Where intensive agricultural use has been relinquished, as at the site of the example Ty-Gwyn profile above, moderately acidic dry grassland, often with bracken and gorse, with some blackthorn scrub, can quickly establish. Riverine deciduous woodlands in this map unit, as in Dunsford Wood [793887] in the Teign Valley Woods SSSI, are on somewhat better soils than under the oak woods on the adjacent valley sides. The floodplain supports more varied woodland with alder, ash and the wild service tree, with large colonies of wild daffodils attracting tourists in the spring.

**Environment:** These soils are situated on the floodplain with groundwater within 2 m depth. Most water movement is by unsaturated vertical flow. Overland flow is only likely at times of flooding, which although of short duration occurs frequently, particularly in the winter half year. These deep, permeable soils have small potential to attenuate pollutants and are classified as having High Leaching Potential [sub-class H2] by Palmer *et al.* [1995]. As with other freely draining mineral soils in this area, estimated organic carbon contents in 1 m profile depth are small, 9 kg $m^{-2}$ for the Tavy example profile given in Section 3.13.2 and 14 kg $m^{-2}$ for the Ty-Gwyn example. As no loss on ignition measurements were made on the Tavy profile [Hogan 1977], values from comparable horizons in the Ty-Gwyn and other similar profiles were used to arrive at the estimate.

**Amenity and engineering:** The walls of shallow excavations and trenches in Tavy / Ty-Gwyn soils are stable and they can be excavated, handled and stored under all but the wettest conditions without inducing structural damage. They are non-corrosive to ferrous metal. Apart from the concern over flood risk the map unit is well suited for footpaths, but because of that risk only moderately well suited to camping and caravan sites.

---

### 3.14 SULHAM / EVERSLEY MAP UNIT [Sj/Ey on the soil map]

3.14.1 A compound map unit of the Sulham series, typical humic-alluvial gley soils, coarse or fine loamy river alluvium, and the Eversley series typical alluvial gley soils, coarse loamy river alluvium. The Sulham series was first defined by

Jarvis [1968] in the Reading district, the Eversley series around Newent, Gloucestershire by Cope [1986].

**Distribution and site:** This map unit occupies tracts of wet alluvium between 55-490 m O.D. along many narrow valley bottoms, covering about 265 ha. The soils also develop in some backland strips on the wider floodplains. Small areas of drier brown alluvial soils can occur where weak levees form adjacent to the watercourse. Many of the floodplains have been tin streamed, with some of the map unit containing patches of disturbed ground which are too small to show on the soil map. With a few exceptions, this map unit is not bouldery.

**Land cover:** Most of the land is in wet, rushy pasture, including rhôs, or moorland and willow-alder carr.

**Component soils:**

Sulham series *[common]*

Eversley series *[common]*

Kettlebottom series *[common]*

Ty-Gwyn series *[rare]*

### 3.14.2 MAIN SOILS

**SULHAM SERIES**

**Characteristics:**

Humose or peaty topsoil over the mineral subsoil

Coarse or fine loamy texture

Mottled throughout

As with other soils in alluvium, profiles can show stratification and buried soil horizons

**Generalised soil profile:**

*Ahg or O horizons, [0-30 cm]:* Black [N 2/0] peat or humose sandy loam or sandy silt loam with very fine rusty mottles, slightly stony.

*Bg horizon, [30-70 cm]:* Grey or greyish brown silt loam or sandy silt loam with many mottles, stoneless, or slightly or moderately stony; weakly developed structure or apedal massive.

*BCg horizon [70-100+ cm]:* Grey mottled sandy loam or loamy sand, variably stony with water-worn subangular to rounded stones; usually waterlogged.

**Example profile:** SX78/3935 in permanent pasture with rushes and buttercups.198 m O.D.

**Horizons:**

*0-24 cm Ahg:* Black [N 2/0] humose clay to clay loam with many fine and very fine mottles of dark reddish brown [5YR 3/4]; intimate organic matter; very slightly stony with very small subangular stones; moist; weakly developed medium subangular blocky structure; moderately porous with very fine macropores; moderately weak soil and ped strength; non-sticky; non-plastic; many fine and very fine fibrous roots, [abundant very fine roots in top 1 cm]; 1 earthworm seen; 1 fragment of pottery at base of horizon; abrupt smooth boundary.

*24-35 [40] cm Bg:* Dark greyish brown [10YR 4/2] gritty sandy loam to loamy sand with many fine and medium mottles of dark reddish brown [5YR 3/3] on root lines and red [2.5YR 4/8]; very stony with very small to large angular and subangular stones of quartz-tourmaline and granite; moist; apedal massive; moderately porous with very fine macropores; moderately weak soil strength; slightly sticky; non-plastic; common very fine and fine fibrous roots; clear smooth boundary. Horizon reaches 40 cm depth on right of pit.

*35 [40]-47 cm 2Bg:* Greyish brown [2.5Y 5/2] silt loam with many fine and very fine mottles of dark reddish brown [5YR 3/4] on vertical root channels; stoneless; moist; apedal massive; moderately porous with very fine and fine macropores; moderately weak soil strength; slightly sticky; slightly plastic; common very fine and fine fibrous roots; sharp smooth boundary. N.B. horizon rises slightly to left in conjunction with horizon above.

*47-56 cm b3Ahg:* Dark brown [10YR 3/3] humose sandy silt loam with many very fine and fine mottles of dark reddish brown [5YR 3/4] on root lines; intimate organic matter; slightly stony with small and very small subangular granite and quartz-tourmaline stones; moist; apedal massive; moderately porous with very fine and fine macropores; moderately firm soil strength; many fine and very fine ?dead? roots; gradual smooth boundary.

*56-74 cm 3bABg:* Dark greyish brown [10YR 4/2] with gritty coarse sandy loam with fine and coarse mottles of grey to light grey [N 6/0] and fine and medium mottles of black [N 2/0]; very stony with very small to large angular and subangular granite and quartz-tourmaline stones [N.B. 1 well rounded medium stone seen]; very moist; apedal massive; moderately porous with very fine and fine macropores; moderately weak soil strength; deformable; slightly sticky; non-plastic; many very fine and fine fibrous roots plus 1 coarse [2 cm] woody root seen; also a few black woody fragments; clear smooth boundary. N.B. coarse mottles of N 6/0 appear to be discrete pockets of less stony soil. 1 soft weathered subangular granite pebble seen, which must have softened *in situ* here.

*74-95 cm 3bCg:* Light brownish grey [10YR 6/2] gritty loamy sand with many very fine mottles of black [N 2/0] [tourmaline etc] and white [2.5Y 8/2] [granite, quartz and feldspar fragments]; slightly stony with very small and small stones of granite and quartz-tourmaline; wet, water entering, [baled numerous times]; apedal single grain; extremely porous with very fine and fine macropores; very weak soil strength; deformable; non-sticky; non-plastic; common fine and medium fibrous roots.

## Analyses:

| Horizon | Ahg | Bg |
|---|---|---|
| Depth cm | 0-24 | 24-35 |
| | | |
| Sand 60 µm-2 mm% | 27 | 77 |
| Silt 2-60 µm % | 38 | 16 |
| Clay < 2 µm % | 35 | 7 |
| | | |
| Organic carbon % | 7.6 | 2.2 |
| pH in water [1 : 2.5] | 4.5 | 5.0 |

**Plate 36. Sulham series in wet, very stony alluvium.**

The profile has a dark, organic-rich topsoil over greyish, strongly gleyed subsoil horizons. As is commonplace in alluvial soils, there is evidence of buried topsoil material about halfway down the profile.

## EVERSLEY SERIES

**Characteristics:**

Dark brown or greyish brown mineral topsoil

Coarse or fine loamy texture

Mottled throughout

**Generalised soil profile:**

*Ahg horizon, [0-30 cm]:* Dark grey or dark yellowish brown sandy loam or sandy silt loam with very fine rusty mottles, slightly stony.

*Bg horizon, [30-70 cm]:* Grey or greyish brown silt loam or sandy silt loam with many mottles, stoneless, or slightly or moderately stony; weakly developed structure or apedal massive.

*BCg horizon [70-100+ cm]:* Grey mottled sandy loam or loamy sand, variably stony with water-worn subangular to rounded stones.

**Example profile:** SX78/1751 under rushy pasture. 215 m O.D.

**Horizons:**

*0-9 cm Ahg:* Dark yellowish brown [10YR 3/4] humose clay loam with very many very fine mottles of yellowish red [5YR 4/6] along roots; stoneless; slightly moist; strongly developed fine granular structure; extremely porous with very fine fissures and macropores; moderately firm soil and ped strength; slightly sticky; non-plastic; abundant very fine fibrous roots plus common medium fibrous [rush] roots, upper 2 cm of horizon comprises mat of very fine fibrous grass roots; earthworms present, some aestivating; clear smooth boundary.

*9-38 cm Bg1:* Brown to dark brown [10YR 4/3] clay loam with very many fine mottles of red [2.5YR 4/8]; stoneless, micaceous; moist; weakly developed fine subangular blocky structure; slightly porous with very fine pores; moderately firm soil strength, moderately weak ped strength; slightly sticky; very plastic; common very fine and medium fibrous roots; clear smooth boundary.

*38-49 cm Bg2:* Dark brown [10YR 3/3] clay loam with very many fine mottles of red [2.5YR 4/8]; stoneless, micaceous; moist; weakly developed fine subangular blocky structure; slightly porous with very fine pores; moderately firm soil strength, moderately weak ped strength; slightly sticky; very plastic; common very fine and medium fibrous roots; abrupt smooth boundary.

*49-63 cm 2Cg:* Pale brown [10YR 6/3] coarse loamy sand with many fine mottles of yellowish red and horizontal bands around 5 mm deep of brown to dark brown [10YR 4/3] finer soil; stoneless, micaceous; moist; apedal single grain;

extremely porous with fine macropores; loose soil strength; common very fine and fine fibrous roots; abrupt wavy boundary.

*63-72 cm 3Cg1:* Very dark greyish brown [10YR 3/2] humose sandy silt loam with common dark reddish brown [5YR 3/3] mottles along fine and medium roots; stoneless, micaceous; very moist; apedal massive; slightly porous with fine and medium macropores; very weak soil strength; deformable; slightly sticky; moderately plastic; common very fine, fine and medium fibrous roots, some of the larger ones woody; clear wavy boundary. N.B on left side of pit [c 20%] this horizon contains pocket with many small to large subangular and subrounded quartz-tourmaline and granite stones.

*72-95 cm 3Cg2:* Very dark greyish brown [2.5Y 3/2] humose sandy silt loam with common dark reddish brown [5YR 3/3] mottles on some roots; slightly stony with very small and small stones, micaceous; moist; apedal massive; slightly porous with fine to coarse macropores; very weak soil strength; deformable; slightly sticky; moderately plastic; common medium and coarse fibrous and woody roots, one 25 mm across, yellowish red [ 5YR 4/8] on excavation but grey [N 5/0] after 1 hour's exposure. Part of east side of pit has fine horizontal lamination, some finer laminae 2-3 mm deep. Water slowly entered from this horizon.

**Analyses:**

| **Horizon** | **Ahg** | **Bg1** | **3Cg1** |
|---|---|---|---|
| **Depth cm** | 0-9 | 9-38 | 63-72 |
| | | | |
| **Sand 60 µm-2 mm%** | 28 | 34 | 26 |
| **Silt 2-60 µm %** | 42 | 46 | 54 |
| **Clay < 2 µm %** | 30 | 20 | 20 |
| | | | |
| **Organic carbon %** | 8.9 | 3.1 | |
| **pH in water [1 : 2.5]** | 4.5 | 5.3 | |

### 3.14.3 SUBSIDIARY SOILS

**Kettlebottom series** *[common]:* Soils similar to Eversley series, but with gravel at 40-80 cm. Occasional humose or peaty topped [typical humic-alluvial gley soils] variants of this soil series occur.

**Crowdy / Hepste / Winter Hill series** *[rare]:* Peat soils have formed in some parts of floodplains, in abandoned channels or where perennial springs of groundwater reach the surface. The peat soils vary in thickness and in degree of humification. [See Sections 3.10, 3.11 and 3.12].

**Ty-Gwyn series** *[rare]:* Gleyic brown alluvial soils developed on small, slightly elevated levees close to the river bank. The slight elevation above the remainder of the floodplain results in the groundwater table being deeper in the soil.

**Key to component soils:**

| | | |
|---|---|---|
| | Soils mottled to the surface | 1 |
| | Soils with brown unmottled subsoil above 40 cm | Ty-Gwyn |
| | | |
| 1 | Soils over gravel at 40-80 cm | Kettlebottom |
| | Deeper soils | 2 |
| | | |
| 2 | With black peaty or humose topsoils | SULHAM |
| | With mottled mineral topsoil | EVERSLEY |

### 3.14.4 SOIL FUNCTIONS

*Soil properties:* Both main soil series are waterlogged for substantial periods each year, as a consequence of high groundwater, aggravated by the risk of frequent flooding. Wetness is more severe on the Sulham soils, as is indicated by the organic-rich surface horizons, the series falling in wetness class VI, the slightly drier Eversley series being class V. In the last century some enclosed land with these soils saw attempts at drainage, most of which eventually degraded, but can be seen in places as shallow linear furrows, sometimes mirrored by slight changes in the sward. Profile wetness and climatic conditions make both series non-droughty, although in many profiles stones may dilute the soil mass.

*Site conditions:* Flooding of these soils is frequent and continues for some time after river levels have gone back down, particularly in the winter months. The region's mild wet regime further constrains landuse on these soils. Much of the unit forms narrow, ribbon-like separations.

**Production:** Although these soils have the potential for large yields of grass, utilisation is held back to summer grazing by the ground's wetness. Similarly silvicultural options are limited to poplars, alder and birch, soil conditions encouraging wind-throw as trees mature. Location close to watercourses and the inherent wetness of these soils mean that any mechanised harvesting of trees carries the serious hazard of sediment generation and pollution. Evaluation in terms of the MAFF [1988] and Bibby and Mackney's [1969] classification are grade 5 and class 5w, respectively.

**Ecology:** Under semi-natural vegetation the Sulham / Eversley soils have interest, with some pockets of rhôs pasture surviving, with the potential for restoration in other sites. There are areas of willow-alder carr. Watercourses and ditches occur, many of them silted and sluggish, and on the wetter soils, pools. Soil biological activity and rooting are limited by waterlogging and the consequent anaerobic state. In much of the east of the district's in-bye, these ribbons of wet soils add diversity and contrasts to a landscape dominated by freely draining dry soils.

**Environment:** Sulham soils are in HOST class 12 of Boorman *et al.* [1995], Eversley in class 10. In Eversley profiles there is potential for seasonal saturated subsoil flow, both vertically to the fluctuating groundwater and laterally at wetter times. In Sulham soils saturated lateral flow takes place in the near surface soil. Flooding occurs frequently on this land and can persist for some time, particularly between September and April. Groundwater vulnerability classification of Sulham / Eversley soils following Palmer *et al.* [1995] is intermediate [class I2] for Sulham series with its relatively high content of organic matter. For the less organic soils of the Eversley series the risk of transmission of pollutants is greater and they are classed as category H1, soils of high leaching potential. Estimated organic carbon content of these soils is substantially more than on freely draining soils, both on the floodplains and more widely in the local landscape. For the example profiles in Section 3.14.2 above amounts to 1 m depth are 39 and 32 kg $m^{-2}$.

**Amenity and engineering:** Profile wetness means that timeliness is critical in excavating, handling and storing these soil materials. Unless such operations are carried out in dry summer weather, structural damage is likely. The stability of shallow cuts and trenches in Sulham / Eversley soils is only moderate. The organic surface horizons of Sulham profiles, coupled with fluctuating groundwater, makes them highly aggressive to buried ferrous metal. Eversley soils are slightly less [i.e. moderately] corrosive. The soils are unsuitable for camping and caravan sites and for short term events. Any footpaths being set out will require considerable investment to keep them serviceable, otherwise they are likely to suffer wear and erosion by walkers and riders.

---

### 3.15 BRIDFORD MAP UNIT [Bx on the soil map]

3.15.1 Well drained loamy, very stony typical brown earths, [in lithoskeletal, mudstone and sandstone or slate], the Bridford series overlies the thermally altered slaty rocks, including shales, mudstones, hornfels and cherts, of the metamorphic aureole of the Dartmoor granite. The abundant angular blocky stones from these rocks are locally termed ‘woodstone’ quite distinct from both the granite and the Carboniferous shales and slates [shillot] nearby. First described by Clayden [1964] as a *brown earth*, Bridford soils were subsequently [Clayden, 1971] classified as *ochreous brown earths*, soils having some properties in common with the *typical brown podzolic soils* of Avery [1973]. Subsequently Clayden and Hollis [1984] correlated them with either *typical brown earths* of the Denbigh *[fine loamy material over lithoskeletal mudstone and sandstone or slate]* or *brown rankers* of the Powys series *[loamy material, lithoskeletal mudstone and sandstone or slate]*. The name Bridford is retained here as a typical brown earth, developed in parent material intermediate between the Powys and Denbigh series, having very stony horizons above 40 cm.

**Distribution and site:** Much of the map unit falls on gentle to strong slopes on the ridges in the northeast of the district, overlooking the Teign Gorge. Smaller occurrences are in the southeast, often on steep slopes along the lower parts of the Bovey and Becka valleys. These soils cover around 369 ha in total.

**Land cover:** The gentler slopes above the Teign Gorge and east of the lower Bovey at Drakeford Bridge [789801] are enclosed, farmed land. There are some plantations above Clifford Bridge [781898] on former agricultural land, put to conifers in the 20th century and deciduous woodlands west of Drakeford Bridge. Grassland invaded by gorse and bracken cloaks some of the steep ground.

**Component soils:**

Bridford series *[abundant]*

Drogo series *[rare]*

Manod series *[rare]*

Powys series *[rare]*

Denbigh series *[rare]*

Willingstone series *[rare]*

Trusham series *[rare]*

3.15.2 MAIN SOIL

**BRIDFORD SERIES**

**Characteristics:**

Brown or dark brown topsoil

Brown or brightly coloured subsoil

Very stony with rock or very stony rubble by 40 cm

**Generalised soil profile:**

*Ap or Ah horizon, [0-15 cm]:* Dark brown sandy silt loam, sandy loam or clay loam; stony or very stony with small to large angular 'woodstone' stones; moderate fine granular or subangular blocky structure.

*Bw and or Bs horizon: [15-40 cm]:* Brown or strong brown sandy silt loam, sandy loam or clay loam; very stony; moderate or strong fine granular or subangular blocky structure, often with 'fluffy' consistence, greasy feel and weak soil strength.

*Cu or R horizon, [40+ cm]:* Angular blocky stones dominant, either as a rubble or *in situ* rock with cleavage or bedding.

**Example profile:** SX77/8457 in permanent grass. 160 m O.D. [Clayden 1971, p100].

**Horizons:**

*0-30 cm A:* Very dark brown [10YR 3/3] clay loam; stony, small black slate fragments; moderate to strong very fine subangular blocky structure; very friable; moderate organic matter; abundant fine fibrous roots; earthworms present; narrow irregular boundary.

*30-46 cm B:* Reddish brown [5YR 4/4] clay loam with patches of brown to strong brown [7.5YR 5/4-4/6] in upper 5 cm and with extremely common channels of very dark brown from above; very stony with black slate and large angular mudstone; weak fine crumb structure; very friable; moderate organic matter; common fine fibrous roots; earthworm burrows common; narrow boundary.

*46-71 cm C:* Light olive brown [2.5Y 5/4-4/4] sandy silt loam; extremely stony with slate and mudstone and abundant slate fragments of coarse sand and gravel size; weak fine crumb structure; very friable; roots common around stones.

**Analyses:**

| **Horizon** | **A** | **B** | **C** |
|---|---|---|---|
| **Depth cm** | 0-30 | 30-46 | 46-71 |
| | | | |
| **Sand 200 μm-2 mm %** | 22 | 33 | 36 |
| **“ 50-200 μm %** | 5 | 6 | 12 |
| **Silt 2-50 μm %** | 49 | 38 | 41 |
| **Clay <2 μm %** | 25 | 23 | 11 |
| | | | |
| **Loss on ignition%** | 10.1 | 7.3 | 6.7 |
| **pH in water [1 : 2.5]** | 6.1 | 6.3 | 6.0 |
| **pH in 0.01M $CaCl_2$ [1 : 2.5]** | 5.5 | 5.6 | 5.0 |
| | | | |
| **Pyrophosphate extractable:** | | | |
| **Fe%** | 0.58 | 0.64 | 0.24 |
| **Al%** | 0.26 | 0.30 | 0.22 |
| **C%** | 1.24 | 0.62 | 0.33 |
| **Fe + Al%** | 0.84 | 0.94 | 0.46 |
| **[Fe + Al / clay] x 100** | 3.4 | 4.1 | 4.2 |
| **Residual dithionite extractable Fe%** | 2.16 | 2.56 | 2.28 |

*Comment:* Although this profile has pyrophosphate extractable Fe + Al content above 0.3% in its subsurface horizons, when expressed as a percentage of the horizons' clay content the amount of pyrophosphate extractable Fe + Al is insufficient to qualify as podzolic Bs horizons. Also the B horizon's main colour is a drab brown. Rather the B horizon, as described above by Clayden [1971], is better considered a Bw and the profile as a typical brown earth rather than a typical brown podzolic soil. Organic carbon percentages estimated by subtracting 10% of clay from the loss on ignition value, divided by 1.72, are 4.4 in the A horizon, 2.9 in the B and 3.3 in the C.

**Example profile:** SX87/0647 in Douglas fir plantation. 100 m O.D. [Clayden 1971, p100].

**Horizons:**

*0-5 cm A1:* Very dark grey [5YR 3/1] sandy loam, very stony with gravel and small angular chert stones; moderately developed fine crumb structure; friable; high organic matter; abundant fine fibrous and woody roots; occasional earthworms; narrow boundary.

*5-13 cm A2:* Brown [8YR 5/4] clay loam; very stony with gravel and small angular chert stones; moderately developed fine crumb structure; friable; moderate organic matter; abundant roots, including bracken rhizomes; narrow boundary.

13-*53 cm Bs:* Strong brown [7.5YR 5/6] clay loam; extremely stony with gravel to medium angular cherts and occasional slate fragments; moderately to strongly developed fine crumb structure; friable; moderate organic matter; common fibrous and woody roots; earthworm casts abundant in old root cases; merging boundary.

*53-91+ cm C:* Yellowish brown to brownish yellow [10YR 5.5/5] clay loam; stone dominant, gravel and medium stones; structure indeterminate; friable; low organic matter; roots common.

**Analyses:**

| **Horizon** | **A1** | **A2** | **Bs** | **C** |
|---|---|---|---|---|
| **Depth cm** | 0-5 | 5-13 | 13-53 | 53-91 |
| | | | | |
| **Sand 200 µm-2 mm %** | 46 | 28 | 29 | 32 |
| **“ 50-200 µm %** | 10 | 8 | 8 | 8 |
| **Silt 2-50 µm %** | 29 | 35 | 32 | 26 |
| **Clay <2 µm %** | 16 | 29 | 31 | 25 |
| | | | | |
| **Loss on ignition%** | 18.4 | 7.3 | 6.3 | 4.6 |
| **pH in water [1 : 2.5]** | 4.2 | 4.5 | 4.5 | 4.4 |
| **pH in 0.01M $CaCl_2$ [1 : 2.5]** | 3.2 | 3.8 | 3.9 | 3.9 |
| | | | | |
| | | | | |

| Horizon | A1 | A2 | Bs | C |
|---|---|---|---|---|
| Pyrophosphate extractable: | | | | |
| Fe% | 0.17 | 0.22 | 0.21 | 0.06 |
| Al% | 0.10 | 0.11 | 0.18 | 0.08 |
| C% | 1.28 | 1.20 | 0.49 | 0.30 |
| Fe + Al% | 0.27 | 0.33 | 0.39 | 0.14 |
| [Fe + Al / clay] x 100 | 1.7 | 1.10 | 1.30 | 0.56 |
| Residual dithionite extractable Fe% | 2.18 | 2.80 | 3.20 | 3.58 |

*Comment:* The thin, humose surface horizon and low pH are typical of a woodland soil, the strongly acid reaction reflecting a background of coppicing. This profile has many features of a typical brown podzolic soil: prominent A horizon, bright subsoil colour, B horizon crumb structure, acid reaction and pyrophosphate extractable Fe + Al content above 0.3% between 5 and 53 cm. However, as a percentage of the horizons' clay content the pyrophosphate extractable Fe + Al is insufficient to qualify as Bs. The brightly coloured B horizon has only a weak link with the content of pyrophosphate extractable ions; see comment in Section 2.2.1 above. Two of the three Bridford profiles in Clayden [1971] have less than 5% Fe + Al / clay, the profile quoted below in 3.16.2 being the exception. Organic carbon percentages of 9.8 for the A1 horizon, 2.6 for the A2, 1.9 for the Bs and 1.2 for the C are estimated from the loss on ignition amounts using the formula: LOI minus 10% of clay, divided by 1.72.

### 3.15.3 SUBSIDIARY SOILS

**Manod series** *[rare]:* Fine loamy typical brown podzolic soils with brightly coloured subsoils, having greater depth than the Bridford series, with rock and or very stony rubble encountered between 40 and 80 cm. The Manod series tends to be associated with localised patches of more shaly rock, which are too restricted to map out.

**Drogo series** *[rare]:* Humic brown podzolic soils, similar to the Bridford series except that the A horizon has a substantial thickness of humose or peaty material. They occur on old downland and commons and in some coppice woodland.

**Powys series** *[rare]:* Brown topped soils [loamy brown rankers] with rock within 30 cm depth, lacking subsoil B horizons; they form on convexities and around crags, outcrops and screes.

**Denbigh series** *[rare]:* Typical brown earths with drab brown subsoil colours. Similar in depth to Manod. As with the Manod series, these soils form in small patches of shale.

**Willingstone series** *[rare]:* Podzols with a bleached horizon over ochreous subsoil.

**Trusham series** *[rare]:* Typical brown earths [fine loamy material over lithoskeletal basic crystalline rock] developed on a small outcrop of dolerite between Hatherleigh [796807] and Drakeford Bridge, Lustleigh [789801].

**Key to component soils:**

| | | |
|---|---|---|
| | Shallow soils, rock within 30 cm | Powys |
| | Deeper soils | 1 |
| | | |
| 1 | Rock or very stony rubble within 40 cm | 2 |
| | Rock or very stony rubble between 40-80 cm | 3 |
| | | |
| 2 | With thin surface leaf mould or brown distinct topsoil | BRIDFORD |
| | With dark humose or peaty topsoil | 4 |
| | | |
| 3 | With brightly coloured subsoil | Manod |
| | With brown subsoil | Denbigh |
| | | |
| 4 | With ashen subsurface over humus in turn over brightly coloured subsoil | Willingstone |
| | With brightly coloured subsoil | Drogo |

### 3.15.4 SOIL FUNCTIONS

*Soil properties:* Bridford soils are highly permeable and rarely wet, except briefly during and after very heavy rain. They are in Soil Wetness Class I. There are no direct measurements of available water content, which will vary with stoniness and profile depth. An estimate for profile SX77/8457, based on data in Hodgson [1997] Appendix 2, gives the small value of 84 mm available water for 1 m profile depth, a reflection of the profile's stoniness, placing it in Dryness Subclass *c* of Hodgson's [1976, p90] Table 21. A similar calculation for SX87/0647 produces a smaller available water value of 47 mm. The stoniness of Bridford soils, as well as limiting moisture reserves, can discourage cultivation.

*Site conditions:* In places steep slopes inhibit use. Small areas of the map unit remain rocky, [see the terrain map], although considerable clearance of boulders was carried out as part of agricultural improvement in the decades of the 1940s to '70s. The boulders and *in situ* rocks of the metamorphic aureole have a reputation among farmers as being more damaging and unyielding to ploughs and other implements. than granite. Occurring in the relatively dry eastern part of the district, climatic wetness is not considered a limitation to arable cropping in terms for the Land Use Capability Classification and the Agricultural Land Classification.

**Production:** Limited soil available water capacity and a relatively dry climate slightly restrict potential for grass growth, although good ground conditions on all but the steep land enable use of grass at all but the wettest times. Agricultural Land Classification grading [MAFF 1988] is 3b or 5 on the steeper slopes, class 3s or 5g after Bibby and Mackney [1969]. Although surface stoniness of Bridford soils can inhibit cultivation in places, there is some potential for arable use on gentler slopes, indeed prior to mechanisation, along with Moretonhampstead series, these soils were favoured for potato growing. The map unit suits a range of species for silviculture, although weed control is likely to be needed before and after planting. Phosphorus fertiliser may also be necessary. Likely species include oak, beech, Southern beeches, larches, Douglas and Grand firs, Western hemlock and Sitka spruce.

**Ecology:** There is some oak woodland and coppice, plus some conifer and hardwood plantations. Neglected pastures on this map unit quickly become dry acidic grassland, often with incursions of gorse and bracken, in places leading to establishment of scrub and eventually reversion to secondary woodland. Animal burrows are present and soil biological activity is at a moderately high level. Surface water is limited to a few sporadic small flushes.

**Environment:** Bridford soils, being in Boorman *et al.*'s [1995] HOST class 17, have vertical unsaturated flow and some by-pass flow in the substrate as their principal hydrological responses to precipitation. Surface runoff will be confined to exceptional conditions. Contributions to base flow will be substantial, but the soils also add to peak flows. Clay content means that there is some capability of adsorbing susceptible pollutants, but shallowness leaves a high risk of transmitting liquid discharges and non-adsorbed pollutants, so that in the classification of Palmer *et al.* [1995] they are Soils of High Leaching Potential, subclass H3. Estimated content of organic carbon is relatively small in these shallow, stony mineral soils, averaging about 14 kg $m^{-2}$ for 1 m depth.

**Amenity and engineering***:* Shallow trenches and the sides of excavations in these soils are highly stable. They can be dug, handled and stored at all but very wet times and are suitable for use as fill. Bridford soils are non-aggressive to buried ferrous metal. On level or gentle slopes they are suitable for camping and caravan sites and for short duration shows or events and their car parking needs. Footpaths are similarly suited and can be extended onto steeper ground.

---

## 3.16 BRIDFORD OLD WOODLAND PHASE MAP UNIT [$Bx^w$ on the soil map]

3.16.1 Soils of the Bridford series, differing from normal phase profiles [as in Section 3.15.] by having surface horizons indicative of the slow breakdown of leaf litter in acid conditions widely associated with undisturbed old woodland sites.

**Distribution and site:** The woodland phase occupies about 371 ha along the Teign between Castle Drogo [723901] and Steps Bridge [804883]. Most of the land is steeply or very steeply sloping, some precipitous. On the south side of the Teign gorge there are areas of boulders of soliflucted granite and tourmalinised rocks.

**Land cover:** Oak woodland, much of it old coppice with heathy field layers, is widespread. In the past it was even more extensive, blocks of conifers having been planted in the 1940s and 50s. Recent acquisition by the Woodland Trust and the National Trust holds out the prospect of future restoration of the deciduous woodland and the enhancement of what is already one of Dartmoor's most attractive valleys. Some of this phase is under more open vegetation with bracken, gorse and heath, as on Broadmoor Common [757898], north of the Teign between Clifford and Fingle Bridges.

**Component soils:**

Bridford series Old Woodland phase *[abundant]*

Bridford series Old Woodland phase with micro-podzol *[occasional]*

Bridford series normal phase *[rare]*

Drogo series *[rare]*

Manod series *[rare]*

Willingstone series *[rare]*

3.16.2 MAIN SOIL

**BRIDFORD SERIES OLD WOODLAND PHASE**

**Characteristics:**

Thin [1-5 cm] surface horizons of litter of leaves and twigs over decomposing litter, in turn resting on a few [1-15] cm of stoneless, black, amorphous organic matter

Brown or brightly coloured subsoil

Very stony with rock or very stony rubble by 40 cm, sometimes loose scree

**Generalised soil profile:**

*L, F and H horizons, [0-5 cm]:* Thin layer of fresh litter of leaves, and twigs [*L*] with comminuted, decomposing litter beneath in the *F* horizon, resting on a seam [*H* horizon] of black, amorphous humus without plant structures. The thickness of the H horizon in particular can increase to several cm.

*A horizon, [5-12 cm]:* Very dark grey to greyish brown sandy silt loam or silt loam; variably stony.

*Bw and or Bs horizon, [12-40 cm]:* Brown or strong brown sandy silt loam, sandy loam or clay loam; very stony with 'woodstone' [angular mudstone] pieces of various sizes; moderate or strong fine granular or subangular blocky structure, often with 'fluffy' consistence and very weak soil strength.

*Cu or R horizon, [40+ cm]:* Angular blocky mudstone fragments of various sizes with pockets of fine earth in places, or *in situ* rock.

**Example profile:** SX77/7587. Yarner Wood, 235 m O.D. [Clayden 1971, p 101].

**Horizons:**

*5-4 cm L:* Oak leaves and twigs.

*4-3 cm F:* Partly decomposed litter with an occasional earthworm.

*3-0 cm H:* Black amorphous organic matter, crumbly; abundant roots.

*0-5 cm A:* Greyish brown [10YR 5/2] silt loam with darker patches and 3 cm cube pockets of dark grey [N 4/0] bounded by reddish brown seams; just stony [7%]; weak fine subangular blocky structure; friable; very fine pores and fissures common; high organic matter; woody and fibrous roots common up to 1 cm diameter; moist throughout; narrow boundary.

*5-15 cm AB:* Brown [10YR 4/3] clay loam to silty clay loam*; just stony, mainly small flaggy spotted mudstone and some siltstone; moderate very fine subangular blocky structure; friable; abundant very fine pores and fissures; low organic matter; roots common; lower boundary marked by very thin ironpan for about 5 cm with a slightly greyer seam above it; narrow irregular boundary.

*15-30 cm B1s:* Strong brown [7.5YR 5/6] sandy silt loam*; stony; moderate to strong fine crumb structure; extremely friable; extremely abundant fissures and very fine to fine pores; roots common; merging boundary.

**N.B. Particle size class designation modified to comply with Hodgson [1997].*

**Analyses:**

| Horizon | AB | B1s |
|---|---|---|
| Depth cm | 5-15 | 15-30 |
| | | |
| Sand 200 µm-2 mm % | 10 | 23 |
| " 50-200 µm % | 12 | 11 |
| Silt 2-50 µm % | 59 | 53 |
| Clay <2 µm % | 20 | 14 |
| | | |
| Loss on ignition% | 7.3 | 7.0 |
| Organic carbon % | 2.4 | |
| pH in water [1 : 2.5] | 4.3 | 4.8 |
| pH in 0.01M $CaCl_2$ [1 : 2.5] | 3.7 | 4.2 |
| | | |
| | | |

| Horizon | AB | B1s |
|---|---|---|
| Pyrophosphate extractable: | | |
| Fe% | 0.78 | 0.45 |
| Al% | 0.37 | 0.45 |
| C% | 0.88 | 0.67 |
| Fe + Al% | 1.15 | 0.90 |
| [Fe + Al / clay] x 100 | 5.75 | 6.43 |

*Comment:* The thin L, F and H surface horizons and strongly acid reaction [pH<4.5], particularly in the horizons close to the surface of this profile, typify poorly buffered local soils in old woodland. The small [5 cm] section of ironpan and the slightly greyer soil at the base of the AB horizon portends the development of micro-podzol features noted by Avery [1958] and Clayden [1964] and listed in Section 3.16.3. below. The common association of profiles such as this with woodland indicates lack of disturbance by cultivation. Acidification in this profile, in others described by Clayden [1964 and 1971] and widely in this map unit, further witnessed by the widespread heathy ground flora, is likely to have been aggravated by centuries of coppicing, in the long-term a rapacious form of landuse. Using the formula loss on ignition minus 10% of clay content divided by 1.72, estimated organic carbon content in the AB horizon is 3.1% and 3.3% in the B1s. One cubic metre of this soil contains about 25 kg of organic carbon, stoniness, shallowness and low bulk density limiting the mass of fine earth.

Correspondence in the Dartington Hall Archive, plus articles in Soil Magazine [1948-1952] and personal communications from people‡ employed there at the time, show that substantial quantities of surface 'peat' were removed from woods owned by Dartington Woodlands between Hore Wood [749895] and Steps Bridge for horticultural use during the post-war years.

‡ *Messrs J.McClure, S.Mudge, K.Underhill, R. Peerdon, M.Treen.*

### 3.16.3 SUBSIDIARY SOILS

**Bridford series woodland phase with micro-podzol** *[occasional]:* Profiles with a thin, greyish and bleached Ea horizon a few [2-5] cm thick immediately beneath the L, F and H surface horizons, termed micro-podzols by Avery [1958], suggest the onset of podzolisation. This may indicate a further stage in the degradation and acidification of Bridford soils, beyond that noted in the comment on the example profile in Section 3.16.2 above. The distribution of the micropodzol phase is not uniform within the map unit. Its incidence is *frequent* in Bridford Wood [797881] and Cod Wood [787886], *occasional* in and around St Thomas' Cleave [790885], Whiddon Wood [727896] and Butterdon Ball [755896], but only *rare* over the remainder of the map unit.

**Example profile:** De 34. Thornwood Copse, Tedburn St. Mary. 95 m O.D. 20$^{O}$ west southwest. [Clayden 1964, p 82].

**Horizons:**

*15-9 cm L:* Oak leaves and twigs dominant; bracken fronds common, some pine cones and needles.

*9-8 cm F:* Very thin laminated layer of moderately decomposed fragments of oak leaves, numerous buds and oak twigs; numerous wood lice.

*8-0 cm H:* Black [5YR 2/1] amorphous organic matter with numerous brown buds and leaf fragments, moderate medium crumb structure; abundant fine tree roots; narrow boundary.

*0-5 cm Eag:* Greyish brown [10YR 5/2] clay loam*; slightly stony; massive; slow permeability; brittle - fragmentary; compact; moderate organic matter, concentrated along root channels and staining fissures; small and medium roots common, fibrous and woody; merging boundary.

*5-18 cm Eag/[B]:* Yellowish brown [10YR 5/6] clay loam* with duller yellowish brown [10YR 5/4] on the faces of peds and greyer staining from the horizon above along root channels; slightly stony with small and medium tabular sandstone and fine shale fragments; moderately weak fine to very fine angular blocky structure; slow permeability; crumbly and friable; low organic matter; few roots, small to large, mainly woody; merging boundary.

*18-38 cm [B]:* Yellowish brown [10YR 5/6] but slightly variegated, clay loam*; abundant fine shale fragments; otherwise similar to above; merging boundary.

*38+ cm [B]/C:* As above, but slightly greyer and shale fragments increase with depth.

**N.B. Particle size class designation modified from description by Clayden [1964] to comply with Hodgson [1997].*

**Analyses:**

| Horizon | H | Eag | Eag/[B] | [B] | [B]/C |
|---|---|---|---|---|---|
| **Depth cm** | 8-0 | 0-5 | 5-18 | 18-38 | 38+ |
| | | | | | |
| **Sand 50 µm-2 mm %** | | 29 | 31 | 32 | 32 |
| **Silt 2-50 µm %** | | 49 | 42 | 37 | 39 |
| **Clay <2 µm %** | | 22 | 26 | 31 | 29 |
| | | | | | |
| **Loss on ignition%** | 67.7 | 11.0 | 5.8 | 6.2 | 6.1 |
| **pH in water [1 : 2.5]** | 4.4 | 3.9 | 4.2 | 4.4 | 4.6 |
| **pH in 0.01M $CaCl_2$ [1 : 2.5]** | 3.5 | 3.3 | 3.6 | 3.7 | 3.9 |

**Plate 37. The Old Woodland phase of the Bridford series.**

Thin, dark acidic H horizons, over very stony mineral subsoils, weathered from Carboniferous rocks in the granite's metamorphic aureole, characterise much of the steep, wooded land in the Teign Gorge.

*Comment:* This soil has L, F and H horizons, like the profile described in Section 3.16.2 above, typical of old woodland soils, possibly never disturbed by cultivation. Here micropodzol features, expressed by the thin Eag horizon, are also present. Again this soil is strongly acid in reaction. Organic carbon content, estimated via loss on ignition and clay values, are around 39% in the L, F and H horizons, 5.1% in the E horizon, falling to 1.8% below that. Shallowness, stoniness and low bulk density mean that the profiles organic carbon content to 1 m depth is limited at around 14 kg $m^{-2}$.

**Bridford series normal phase** *[rare]:* Bridford soils with uniform, distinct A horizons rather than L, F and H occur sporadically through the map unit. Such profiles may be tokens of former cultivation or disturbance.

**Drogo series** *[rare]:* Soils with dark A horizons up to 25 cm thick, with humose or peaty textures, are encountered here and there in this map unit. Subsoils are similar to those of the Bridford series.

**Manod series** *[rare]:* Less stony soils usually with rock or very stony rubble only below about 50 cm, formed in small patches where the underlying rock is shaly rather than slaty.

**Willingstone series** *[rare]:* Fully developed humo-ferric podzols with well-expressed Ea and Bh horizons, weathered in the lithoskeletal regolith of the mudstones and slates, are encountered locally. However their lateral extent is insufficient to be shown separately on the soil map.

## Key to component soils:

| | | |
|---|---|---|
| | Shallow soils, rock within 30 cm | Powys |
| | Deeper soils | 1 |
| | | |
| 1 | Rock or very stony rubble within 40 cm | 2 |
| | Rock or very stony rubble between 40-80 cm | 3 |
| | | |
| 2 | With thin surface leaf mould | BRIDFORD OLD WOODLAND PHASE |
| | With brown distinct topsoil | Bridford normal phase |
| | With dark humose or peaty topsoil | 4 |
| | | |
| 3 | With brightly coloured subsoil | Manod |
| | With brown subsoil | Denbigh |
| | | |
| 4 | With ashen subsurface over humus in turn over brightly coloured subsoil | Willingstone |
| | With brightly coloured subsoil | Drogo |

**Plate 38. Micropodzol features in parts of the Bridford Old Woodland phase map unit**

These are shown by this thin, greyish horizon between the black surface and the ochreous subsoil.

### 3.16.4 SOIL FUNCTIONS

*Soil properties:* Highly permeable and seldom wet, these very stony soils have only limited moisture reserves, particularly where little-weathered rock remains high into the subsoil. They are acidic, particularly in the surface horizons, a property which determines much of the character of the vegetation, as does their very stony and somewhat droughty nature.

*Site conditions:* Steep, very steep and in places precipitous slopes characterise nearly all of this map unit.

**Production***:* Here amenity value is overriding. The steepness of the ground restricts most of it to grade 5 in the Agricultural Land Classification of MAFF [1988], and classes 5g and 6g following Bibby and Mackney [1969]. Silvicultural potential is likely to be constrained by slope, rockiness, amenity concerns and, in many places, the very acidic soil reaction. The most suited tree species are oak, beech, Southern beeches, larches, Douglas and Grand firs, Western hemlock and Sitka spruce.

**Ecology:** This map unit occupies sites of great value, with aesthetic, amenity and ecological considerations paramount. It carries oak woodland and coppice, with some conifer plantations. It includes much of the Teign Valley Woods Site of Special Scientific Interest where high forest dominated by pedunculate oak has been derived from the singling of former coppice. The uniformly closed canopy has discouraged any shrub layer, although the ground flora with bilberry, greater woodrush, bracken and creeping soft-grass is well developed. Burrowing by animals takes place and there is moderate soil biological activity. Surface water is confined to a few very narrow and restricted flushes.

**Environment:** As with the normal phase of Bridford soils described in Section 3.15, soil hydrology here is dominated by unsaturated flow through the profile into the substrate of head and fissured slate, where bypass flow will occur. Only under extremely wet conditions will any surface water run off. The map unit's main contribution to stream discharges is by way of base flow, although there also is some during event peaks. For the purposes of groundwater protection [Palmer *et al.*, 1995] they are graded as Soils of High Leaching Potential, subclass H3, with some ability to adsorb pollutants, but not to attenuate non-adsorbing materials or liquid discharges. Estimated organic carbon content to 1 m depth for the example in Section 3.16.2 is 25 kg $m^{-2}$, which although more than in the normal phase soils in Section 3.15, remains small in overall terms. That in the profile with micropodzol horizons is 14 kg $m^{-2}$, close to the normal phase's average.

**Amenity and engineering***:* Although these soils are amenable for shallow engineering works, trenching, excavating, moving and storing, steep to precipitous slopes largely rule out such works. Although acidic, the soils are non-aggressive to ferrous metal on account of their favourable aeration and water regime. Recreational uses, apart from footpaths and rambling, are precluded by the slopes.

---

## 3.17 BRIDFORD WITH CRAGS MAP UNIT [Bx$^+$ on the soil map]

3.17.1 This map unit is made up of the very stony, loamy and freely draining Bridford soils, particularly the Old Woodland phase, described in Sections 3.16 and 3.15, intermixed with small rock outcrops and scree material.

**Distribution and site:** It occurs on steep and very steep valley sides as patches along the Teign Gorge between Castle Drogo [723901] and Steps Bridge [804884], covering about 26 ha, between 80 and 260 m O.D.

**Land cover:** Oak woodland and areas of heath, bracken and gorse.

**Component soils:**

Bridford series Old Woodland phase *[common]*

Bare rock or scree *[common]*

Powys series *[occasional]*

Drogo series *[rare]*

Skiddaw series *[rare]*

### 3.17.2 MAIN SOIL

**BRIDFORD SERIES OLD WOODLAND PHASE** is described above in Section 3.16.2

### 3.17.3 SUBSIDIARY SOILS

**Bare rock or scree** *[common]:* numerous small outcrops of rock and scree, too small to separate individually as polygons of the Rock Dominant map unit [Section 3.25], are scattered across this map unit. While bare outcrops develop at all levels on the valley sides, screes are formed lower on the slope beneath crags and ravines. In some places a loose litter of dead vegetation cloaks the rock and scree.

**Powys series** *[common]:* very shallow soils without subsoil horizons. Some are developed in fissures in crags or over loose scree.

**Drogo series** *[rare]:* profiles with thick, dark humose topsoils.

**Skiddaw series** [Jarvis *et al.,* 1984] *[rare]:* very shallow humose soils, often little more than L, F and H horizons over rock or scree or in crevices in outcrops.

**Key to component soils:**

| | | |
|---|---|---|
| | Shallow soils, rock within 30 cm | 1 |
| | Deeper soils | 2 |
| | | |
| 1 | Loamy | Powys |
| | Humose | Skiddaw |
| | | |
| 2 | With thin surface leaf mould | BRIDFORD OLD WOODLAND PHASE |
| | With dark humose or peaty topsoil | Drogo |

## 3.17.4 SOIL FUNCTIONS

*Soil properties:* The highly permeable nature of the soils, combined with steep situations, make them seldom wet. However, a few crevices in rock outcrops can weep, the water rapidly diffusing in the adjacent soil without forming significant flushes. Soil moisture reserves expressed as available water capacity, apart from in patches of Bridford and Drogo profiles, are minimal. Acidity is an important property, particularly in the upper parts of the soil profiles.

*Site conditions:* Steep, sometimes precipitous slopes and rockiness characterise this map unit.

**Production:** The commercially non-productive character, coupled with the amenity and ecological value of this land, immediately outweigh considerations of agricultural or profitable forestry use. Slope and rockiness place the land in classes 5gs and 6gs of the Land Use Capability Classification [Bibby and Mackney, 1969] and grade 5 of the MAFF [1988] Land Classification.

**Ecology:** There is oak woodland and coppice, plus some conifer plantations, and dry acidic and heathy grassland, which is susceptible to gorse and bracken invasion. Where any depth of soil exists biological activity is fairly high, with burrowing by earthworms and mammals. Surface water is absent. Trees grow on parts of the rocky ground on this map unit, some rooting into bare scree, while grasses, forbs and shrubs of gorse and heath establish widely in rock crevices.

**Environment:** Vertical unsaturated flow through the soil into the substrate characterises the hydrology of the soils component of this map unit, combining with bypass flow in the substrate. Surface flow only takes place under unusually wet conditions. On the crags water movement is largely across the surface, but penetrates locally to emerge as small seeps in places. On the screes infiltration is immediate. The soils have limited capacity to attenuate pollutants and fall into subclass H3 of Palmer *et al.*'s [1995] Soils of High Leaching Potential class. Organic carbon content in Bridford soils is small and negligible on the crags and screes.

**Amenity and engineering:** Although shallow excavations and trenches in these soils have stable slopes and the materials' handling properties are favourable, steep slope makes their use unlikely. In the similarly improbable eventuality, excavations on the screes would prove highly unstable. Corrosion of ferrous metal is not expected in the Bridford soils. The land is unsuitable for any recreational use other than rambling.

---

### 3.18 DENBIGH MAP UNIT [Dg on the soil map]

3.18.1 Well drained fine loamy typical brown earths of the Denbigh series formed over Carboniferous shales; previously mapped here [Clayden 1964 and 1971] as Dunsford series.

**Distribution and site:** Denbigh soils are confined to 96 ha in the district's extreme northeast, mostly on strongly sloping or steeper slopes, although some gentler ridge crests are included. The unit stands between 90 and 200 m O.D. Away from this district the National Soil Map has Associations 541j and 541k, both dominated by Denbigh soils and widespread on the Southwest's Devonian slate outcrops, plus steeper land on the Carboniferous Crackington shales.

**Land cover:** There is a mixture of grassland and arable farming. The grass, predominantly permanent pasture, is grazed by sheep and beef cattle, while the arable land grows mostly winter cereals and rape. A small amount of deciduous woodland cloaks some steep ground. Grassland on the steeper ground can become invaded by bracken or gorse.

**Component soils:**

Denbigh series *[common]*

Powys series *[occasional]*

Bridford series *[occasional]*

Halstow series *[occasional]*

Tedburn series *[rare]*

### 3.18.2 MAIN SOIL

**DENBIGH SERIES** Typical brown earths; fine loamy over lithoskeletal mudstone and sandstone or slate.

**Characteristics:** Brown or dark brown topsoil

Brown subsoil

Clay loam texture

Shaley ['shilloty'] at depth [40-80 cm] over rock or very stony rubble

**Generalised soil profile:**

*Ah or Ap [0-25 cm]:* Dark brown [10YR 3-4/3] clay loam; stony with shale ['shillot'] and sandstone fragments; fine subangular blocky structure, but easily damaged by ill-timed stocking, traffic or cultivation.

*Bw horizon, [25-50 cm]:* Brown to strong brown [7.5YR 4/4 or 5/6] clay loam; stony with shale and sandstone fragments; fine subangular blocky structure; very friable.

*Cu or Cr horizon, [50+ cm]:* Stone dominant, either as a rubble of variably sized platy shale fragments or *in situ* shale with subsidiary sandstone bands. Some profiles have fragipan features in the C horizon.

**Example profile:** SX69/5467 under permanent pasture. 168 m O.D. [Hogan 1978, p32]

**Horizons:**

*0-11 cm Ahg:* Dark yellowish brown [10YR 3/4] clay loam to silty clay loam; common prominent very fine yellowish red [5YR 4/6] mottles with sharp edges; a few small subangular and tabular micaceous sandstone and shale stones; moderately developed fine subangular blocky with dark yellowish brown [10YR 3/4] faces; low packing density; very porous, very fine fissures; fine macropores; moderately firm soil strength; moderately weak ped strength; slightly sticky; very plastic; abundant very fine fibrous roots; abrupt smooth boundary.

*11-32 cm AB*: Dark reddish brown [5-7.5YR 3/4] clay loam; common medium subangular and tabular micaceous sandstone and shale stones; moderately developed fine subangular blocky with dark reddish brown [5YR 3/4] faces; medium packing density; slightly porous, very fine fissures; fine macropores; moderately weak soil strength; moderately weak ped strength; moderately sticky; very plastic; many very fine fibrous roots; abrupt wavy boundary.

*32-61 cm Bw:* Strong brown to brown [7.5YR 5/4-6] clay loam; many small angular clay shale stones and some sandstone pieces; moderately developed fine subangular blocky with strong brown [7.5YR 5/6] faces; medium packing density; slightly porous, very fine fissures; very fine macropores; moderately weak soil strength; moderately weak ped strength; very sticky; very plastic; many very fine fibrous roots; clear wavy boundary; negative NaF test.

*61-84 cm BC:* Brown [7.5 YR 5/4] clay loam; abundant small angular clay shale stones; very few fine fibrous roots; non-calcareous; gradual irregular boundary; horizon occurs as pockets between Bw and Cr.

*84-140 cm Cr:* Black [N 2/0] soft laminated clay shale with common discontinuous prominent 7.5YR 5/4 fine earth coats on partings.

**Analyses:**

| **Horizon** | **Ahg** | **AB** | **Bw** | **BC** |
|---|---|---|---|---|
| **Depth cm** | 0-11 | 11-32 | 32-61 | 61-84 |
| | | | | |
| **Sand 600 µm-2 mm %** | 5 | 9 | 13 | 27 |
| **“ 200-600 µm %** | 5 | 4 | 7 | 13 |
| **“ 60-200 µm %** | 8 | 7 | 5 | 7 |
| **Silt 2-60 µm %** | 50 | 49 | 43 | 32 |
| **Clay <2 µm %** | 32 | 31 | 32 | 21 |
| | | | | |
| **Organic carbon %** | 4.6 | 1.8 | | 0.9 |
| **pH in water [1 : 2.5]** | 5.0 | 5.7 | 6.2 | 6.2 |
| **pH in 0.01M $CaCl_2$ [1 : 2.5]** | 4.5 | 4.8 | 5.3 | 5.4 |
| | | | | |
| **Pyrophosphate extractable:** | | | | |
| **Fe%** | 0.57 | 0.25 | 0.29 | 0.14 |
| **Al%** | 0.18 | 0.13 | 0.15 | 0.10 |
| **C%** | 1.21 | 0.53 | 0.32 | 0.18 |
| **Fe + Al%** | 0.77 | 0.38 | 0.44 | 0.24 |
| **[Fe + Al / clay] x 100** | 2.40 | 1.23 | 1.37 | 1.14 |
| **Residual dithionite extractable Fe%** | 2.24 | 2.24 | 3.50 | 3.50 |
| | | | | |
| **Bulk density g $cm^{-3}$** | 0.91 | 1.18 | 1.29 | |
| **Packing density g $cm^{-3}$** | | 1.37 | 1.58 | |
| **% by volume** | | | | |
| **Total pore space** | 65.8 | 55.3 | 51.4 | |
| **Available water** | 25.0 | 13.2 | 8.6 | |
| **Air capacity** | 19.4 | 25.3 | 28.1 | |
| **Retained water** | 46.4 | 30.0 | 23.3 | |

*Comment:* This profile from Taw Green [654967], several km to the northwest of the study district, is the most comprehensively analysed Denbigh profile in comparable parent material in Devon. Overall the profile is clearly well aerated, highly porous and freely draining. The prominent fine reddish mottles in the Ah horizon are indicators of near-surface gleying occasioned by ill-timed stocking, a practice that the soil’s freely draining nature invites. Such degradation will compromise the soil’s surface hydrology and adversely affect crop growth, at least for a period. The particle size distributions in the Ah and AB horizons are marginal to silty clay loam. Although the combined pyrophosphate extractable Fe and Al in the upper three horizons is greater than 3%, it is less than 5% of the horizons' clay contents, confirming the profile's designation as a typical brown earth. The soil bulk density is classed as medium throughout. The profile is extremely porous but with moderate or small available water reserves below 11 cm, a condition exacerbated by the modest depth to very stony material and shale rock. The surface horizon's large retained water capacity is likely to be in excess of the upper plastic limit, so that it remains at risk of plastic deformation by stock or machinery until moisture has been removed by evapotranspiration.

**Micromorphology:** [Thin sections at 40-46 and 50-56 cm]

*Clay coats and intrapedal clay concentrations:* Common [2-4%] fine void ferriargillans at 40-46 cm and few [<1%] fine at 50-56 cm. Common [2-3%] fine intrapedal concentrations at 40-46 cm and few [<1%] at 50-56 cm. No other coats.

*Nodules and segregations:* Few irregular distinct clear and diffuse segregations at 40-46 cm, interpreted as weathered 'ghosts' of rock fragments rather than gleyed phenomena. No nodules.

*Mineralogy and weathering:* Sand and gravel-sized particles of quartz, moderately weathered shale, micaceous fine and medium sandstone and siltstone.

*Plasmic fabric:* Mixture of skel-insepic [40%] and in-masepic [60%] at 40-46 cm, ma-skel-insepic at 50-56 cm.

*Other observations:* Large number of smooth edged voids [probably associated with faunal activity], vughs, channels, chambers and skew planes.

### 3.18.3 SUBSIDIARY SOILS

**Powys series** *[occasional]:* Powys soils have rock within 30 cm and lack B horizons. Although most commonly found on convex 'knaps', these soils also occur without any clear pattern in other positions.

**Bridford series** *[occasional]:* Where a B horizon is formed with rock or very stony material within 40 cm of the surface. The distribution of this series is sporadic and not predictable.

**Halstow series** *[occasional]:* In places gleyed clayey subsoils of this series have formed following enhanced weathering of the shales. Halstow series forms a component of a hydrological sequence in the area to the north and east [Clayden 1964 and 1971] where it occupies ridge crests. Within the limited area of

Carboniferous shale outcrop in this district this sequence has not established and the series' distribution is haphazard. The curtailed occurrence of Halstow soils here may reflect mineralogical differences in the parent shale, resulting either from original sedimentary conditions or consequent on shearing of the rocks during folding etc.

**Tedburn series** *[rare]:* A more intense expression of the soil forming processes that produced the patchy development of Halstow profiles in this map unit, gives rare and sporadic occurrences of the Tedburn series.

**Key to component soil series:**

| | | |
|---|---|---|
| | Unmottled soils | 1 |
| | Mottled clayey soils | 2 |
| | | |
| 1 | Shallow soils with rock within 30 cm | Powys |
| | Deeper soils | DENBIGH |
| | | |
| 2 | Little mottled above 40 cm | Halstow |
| | Mottled above 40 cm | Tedburn |

### 3.18.4 SOIL FUNCTIONS

*Soil properties:* The Denbigh soils are permeable and often on pronounced slopes. Modal profiles are Wetness Class I *[rarely wet]*, although dip-well measurements by Clayden [1971, Appendix ll, p230] show a Dunsford series [the local name for these soils prior to Clayden and Hollis, 1984] site with a slightly wetter regime than a Denbigh soil [at that time called Highweek series] over Devonian slates. Moisture reserves on Denbigh soils here are modest, as is evident from scorched patches on this land in dry summer weather. Profile SX69/5467 [Section 3.18.2 above] provides about 90 mm of available water, placing such a profile in this district in Dryness Subclasses *c-d,* [*moderately to very droughty* in terms of Findlay *et al.*'s [1984] Table 13]. Over the map unit as a whole this is compounded by the common incidence of the shallower subsidiary soils noted above.

*Site conditions:* Denbigh soils occupy the driest part of the district, where a climatic wetness restriction is minimal. On the mapped steep phase gradient is a significant limitation.

**Production:** While these soils are readily cultivated and can be stocked under all but wet ground conditions, rusty mottling, commonplace in topsoils, as described in Section 3.18.2 in the Ahg horizon of the example profile, shows structural damage is incurred by extended grazing. Droughtiness of these often shallow soils is likely to impair yields in many years, a feature reflected in their rankings for land classification, grass growth and grassland suitability. The district's often early return to field capacity in the autumn makes sustained winter cereal cropping marginal on Denbigh soils here, while spring conditions are similarly restricting. In the Land Use Capability Classification of Bibby and Mackney [1969] Denbigh soils are class 3s or on steep ground 4g, in the MAFF [1988] Agricultural Land Classification grades 3a or 4. A wide range of tree species is suited to Denbigh soils including oak, beech, Southern beeches, Douglas and Grand fir, Western hemlock, larches and Sitka spruce. Phosphorus fertiliser may be advantageous and weed control prior to and after planting is likely to be needed.

**Ecology:** Dry, often steep, pastures are sites where moderately acid grassland with gorse and bracken can readily establish if they suffer agricultural neglect and are areas where secondary woodland may eventually take over. There is no surface water except as very small, localised flushes. Soil biological activity is high, with burrowing animals active. There is some oak woodland.

**Environment:** The principal hydrological pathway in Denbigh soils is unsaturated vertical flow into the substrate. They are representative of HOST class 17 of Boorman *et al.* [1995]. In very wet conditions surface runoff may be possible. Since the shale substrate has only limited fracturing there are moderate contributions to both base flow and to higher discharges. These are Soils of High Leaching Potential subclass H3 in the groundwater protection classification of Palmer *et al.* [1995], since there is the risk that liquid discharges and non-adsorbed pollutants will move through the soil, although substantial clay content will retain adsorbable pollutants. As with other freely draining mineral soils, estimated organic carbon content is small, the amount for Section 3.18.2's example profile is around 14 kg $m^{-2}$ to 1 m depth.

**Amenity and engineering:** Denbigh soils retain their stability when cut by shallow trenches and cuttings and are usable for shallow fills. Only under very wet conditions are excavation, handling and storage unadvisable. The soils do not corrode ferrous metals. They are suited for camping and caravan sites and venues for events and shows, where slopes are acceptable, as they are for footpaths, although the latter can extend onto stronger gradients.

---

### 3.19 HALSTOW MAP UNIT [Hw on the soil map]

3.19.1 A small area over Carboniferous Crackington Formation is occupied by clayey Halstow soils, [typical [stagnogleyic], non-calcareous pelosols].

**Distribution and site:** About 8 ha on a ridge crest in the northeast of the district. Beyond this survey's limits Halstow soils are commonplace on the Crackington Formation outcrop in a belt running west from Exeter to Bude Bay.

**Land cover:** Arable farming, cereals.

**Component soils:**

Halstow series *[frequent]*

Tedburn series *[frequent]*

3.19.2 MAIN SOIL

**HALSTOW SERIES**

Typical [stagnogleyic], non-calcareous pelosols; clayey material over lithoskeletal mudstone, shale or slate. The series was originally described by Clayden [1964], then mapped around Exeter and Newton Abbot [Clayden 1971], subsequently by Harrod [1978 and 1981] and Findlay *et al*. [1984].

**Characteristics:**

Clayey

Brownish topsoil with little or no mottling

Subsoil above 40 cm with little or no mottling

**Generalised soil profile:**

*Ap horizon, [0-25 cm]:* Brown or dark greyish brown [10YR 3-5/2 or 3] clay loam, silty clay loam or clay; stony, mostly angular sandstone fragments; weakly developed angular blocky structure. In established grass fine rusty mottling is a common feature. Where long arable use has degraded soil structure and depleted organic matter these soils pass rapidly from a vulnerable, sticky condition when moist, to a hard, difficult to till state upon drying.

*Bw[g] horizon, [25-45 cm]:* Clay or silty clay variegated with reddish yellow or strong brown [7.5YR 6/6-8 or 5/6-8] and light yellowish brown [10YR-2.5Y 6/4]; stony with angular sandstone pieces; moderately developed prismatic structure; firm consistence when moist, sticky and plastic when wet.

*Bg horizon, [45-65 cm]:* Clay or silty clay variegated with strong brown [7.5YR 5/6-8] and grey [10YR 6 or 7/1], with aggregate faces predominantly greyish; stony, with hard sandstone fragments and weathered 'ghosts' of small shale pieces ; moderately developed prismatic structure; roots tend to concentrate on structure faces. This horizon is absent over parts of the map unit.

*Cg horizon, [65+ cm]:* Shale dominated horizon, either *in situ* or as rubble with variable amounts of fine earth; the degree of weathering of the shale varies greatly.

**Example profile:** SS 61/4351 in weedy permanent pasture [Harrod 1981, p64]

**Horizons:**

*0-21cm Ah:* Dark greyish brown to very dark greyish brown [10YR 3-4/2] clay loam [dry colour very pale brown [10YR 7/3]], with few very fine distinct mottles of yellowish red [5YR 4/8]; intimate organic matter; slightly stony, small and medium angular and tabular hard Carboniferous sandstone fragments; fine blocky structure; medium packing density; very fine fissures; slightly porous, very fine and fine pores [root channels]; moderately firm soil and ped strength; moderately sticky, very plastic; abundant very fine, fine and medium fibrous and fleshy roots; earthworms present; non-calcareous; clear wavy boundary.

*21-34 cm Bw[g]1:* Reddish yellow [7.5YR 6/6] [dry colour yellow [10YR 8/6]] clay with many medium distinct mottles of dark yellowish brown [10YR 4/4] [dry colour very pale brown [10YR 7/4]]; moderately stony with small angular platy soft dark grey [N 4/0] and black Carboniferous shale and small to large angular, tabular very hard sandstone pieces; moist; weakly developed medium subangular blocky structure; high packing density; very fine fissures; very slightly porous with very fine pores; moderately strong ped strength; very sticky, very plastic; many very fine fibrous roots; earthworms present; non-calcareous; gradual smooth boundary.

*34-54 cm Bw[g]2:* Reddish yellow [10YR 6/8] [dry colour 7.5YR 7/8] and greyish brown to light olive-brown [2.5Y 5/3] [dry colour 5Y 7/3], the latter colour predominating on ped faces, clay; slightly stony with small angular platy shale fragments [dark grey and black] and small to large angular tabular very hard sandstone pieces; slightly moist; moderately developed coarse angular blocky structure; high packing density; very fine fissures; very slightly porous, very fine pores; very strong ped strength; very sticky, very plastic; many very fine fibrous roots; earthworms present; non-calcareous; common very fine patchy light brownish grey coats lining channels and fissures; gradual smooth boundary.

*54-78 cm BCg:* Light grey to light brownish grey [2.5Y 6-7/2] [dry colour 5Y 7/1] silty clay with many fine and medium prominent mottles in peds of reddish yellow [7.5YR 6/8] [moist and dry colour] and grey to light grey [10YR 6/1] [dry colour 10YR 8/1]; slightly stony with small to large angular and tabular very hard Carboniferous sandstone and small and medium angular platy dark grey and black shale pieces; slightly moist; weakly developed coarse sub-angular blocky structure; very fine fissure; very slightly porous, very fine pores; moderately strong ped strength; very sticky, very plastic; fibrous roots; common very fine patchy light brownish grey coats lining channels and fissures; gradual smooth boundary.

*78-130 cm Cr:* Greenish grey [5GY 5/1] and black [N 2/0] thinly bedded hard *in situ* non calcareous Carboniferous shale with occasional partings of more weathered mottled clay much as the horizon above. Bedding close to horizontal. Bedding planes have common distinct patchy coats of brownish yellow [10YR 6/6] fine earth and few patchy distinct sesquioxide coats [mangans]. On digging moisture films evident on partings.

**Analyses:**

| Horizon | Ah | Bw[g]1 | Bw[g]2 | BCg | Cr |
|---|---|---|---|---|---|
| Depth cm | 0-21 | 21-34 | 34-54 | 54-78 | 78-130 |
| | | | | | |
| Sand 600 µm-2 mm % | 5 | 9 | 4 | 4 | 8 |
| " 200-600 µm % | 4 | 5 | 5 | 4 | 8 |
| " 60-200 µm % | 10 | 8 | 5 | 3 | 7 |
| Silt 2-60 µm % | 47 | 39 | 43 | 48 | 41 |
| Clay <2 µm % | 34 | 39 | 43 | 41 | 36 |
| " <0.2 µm % | 4 | 5 | 8 | 7 | |
| Fine clay as % of total clay | 12 | 13 | 19 | 17 | |
| | | | | | |
| Organic carbon % | 3.6 | | | | 0.6 |
| pH in water [1 : 2.5] | 6.0 | 6.3 | 6.1 | 6.0 | 5.0 |
| pH in 0.01M $CaCl_2$ [1 : 2.5] | 5.4 | 5.6 | 5.4 | 5.2 | 4.1 |
| C.E.C of <2 µm fraction [me / 100 g] | | | | 24 | |
| $K_2O$ % in <2 µm fraction | | | | 4.6 | |
| | | | | | |
| Bulk density g $cm^{-3}$ | 1.16 | | 1.43 | 1.49 | |
| Packing density g $cm^{-3}$ | 1.47 | | 1.78 | 1.88 | |
| % by volume | | | | | |
| Total pore space | 54.9 | | 45.9 | 43.6 | |
| Available water | 21.5 | | 14.5 | 14.3 | |
| Air capacity | 7.2 | | 3.8 | 2.9 | |
| Retained water [% by mass] | 41.4 | | | | |
| Lower plastic limit [% by mass] | 32 | | | | |

### 3.19.3 SUBSIDIARY SOILS

**Tedburn series** *[frequent]:* Part of the map unit includes soils with greyer colours in the immediate subsoil. Although this marked gleying qualifies such profiles as Tedburn series, they are not as strongly mottled as the soils typical of the Tedburn map unit, described in Section 3.23.

**Key to component soil series:**

| | |
|---|---|
| Faintly mottled above 60 cm or distinctly mottled between 40 and 80 cm | HALSTOW |
| Prominently mottled or greyish above 40 cm | Tedburn |

### 3.19.4 SOIL FUNCTIONS

*Soil properties:* Halstow soils have dense subsoils with few pores and as a consequence are only slowly or very slowly permeable. Undrained they are Soil Wetness Class IV *[commonly wet]*, with suitable drainage improving to Class III *[occasionally wet]*. Soil moisture reserves are modest, particularly where shale rises higher in the profile. Available water capacity of the sampled profile in Section 3.19.2 above is 124 mm. Much of the available water is held at high tensions and so is less readily obtained. Given that the average potential soil moisture deficit in the northeast of the district is just under 100 mm, the profile is Dryness Subclass *b.*

*Site conditions:* Site presents no limitation to use of these soils. Slopes are, at their steepest, moderately sloping and the unit is confined to the driest part of the district.

**Production:** Surface wetness and heavy textures have to be contended with for both arable and grassland use of Halstow soils. For grassland, growth performance is favourable, but soil wetness restricts utilisation. Drainage improvement uses permeable fill to connect carrier drains to channels from well-timed mole ploughing. However comparison of the A horizon's high retained water capacity [41%] with the plastic limit [32%] demonstrates the soil's susceptibility to damage by stocking and traffic, needing a period of drying by evapotranspiration after drain flow has stopped before its vulnerability to compaction ceases. After that the interval before the soil dries and hardens, becoming difficult to cultivate, can be brief. Reduction in organic matter content and structural decline under continual arable cropping aggravate this dilemma. The land is not suited to sustained arable use and is grade 4 in the MAFF [1988] scheme of ALC, class 4ws after Bibby and Mackney [1969]. For silviculture some drainage or cultivation may be needed to improve rooting depth and avoid wind throw. Phosphorus fertiliser will be beneficial. Most conifer species are suitable [Findlay *et al.* 1984, p363]. Summer harvesting will minimise the risk of the generation of runoff and sediment.

**Ecology:** A very restricted map unit in damp grassland and arable fields.

**Environment:** There are seasonal changes in the hydrological pathways of Halstow soils, with the clayey horizons effectively impermeable while wet from about October until May, causing saturated lateral flow. As the soils dry the clay shrinks and fissures open, as between the blocky structural aggregates described in the example profiles subsoil horizons, allowing unsaturated and by-pass flow into the shale substrate. As with other soils on the Carboniferous there are contributions to both base flow and to higher discharges, although Halstow's contributions to the former are smaller and to the latter they are greater. Classed as Soils of Intermediate Leaching Potential subclass I1 in the scheme of Palmer *et al.* [1995], their clay content offers moderate attenuation of diffuse source pollution by adsorption. However the clay content also provides opportunities for bypass flow when the subsoil has dried out. Estimated organic carbon content of the example profile in Section 3.19.2 is small at 11 kg $m^{-2}$ for 1 m depth of soil.

**Amenity and engineering:** Clay content and seasonal profile wetness imparts some instability to these soils in shallow excavations and trenches, also meaning that timeliness will be needed to avoid structural damage during handling and storage. These soils are unsuitable for use as fill. They are slightly aggressive to ferrous metal and unsatisfactory for camping and caravan sites and short term intensive events. Any footpaths would need some paving and attention to wet spots.

---

## 3.20 DROGO MAP UNIT [DR on the soil map]

3.20.1 Drogo soils [humic brown podzolic soils from lithoskeletal mudstone, shale or slate] are freely draining, very stony and loamy with dark coloured, organic-rich surface horizons. Their distribution, along with similar soils in parts of the Moor Gate map unit [Section 3.5 above], suggests that the humose topsoils developed under heathy common grazings or 'downland', although a proportion is in steep oak woodland.

**Distribution and site:** Drogo soils occupy about 170 ha on steep valley sides and some gentler slopes above the Teign Gorge between Steps Bridge [804883] and Castle Drogo [723901], They also form on Trendlebere Down [770801]. The map unit ranges from 80-325 m O.D. A block of related soils, extending to about 4 ha, has been included in this map unit for cartographic convenience, involving loamy lithoskeletal humic brown podzolic soils in Higher Knowle Wood [793807], Lustleigh over Oligocene Wolley Grits.

**Land cover:** Part of the land is in rough grazing or heathland with gorse and bracken, some being encroached by birch scrub. A proportion of sites, as at St Thomas' Cleave [792885], are in oak woodland on very steep slopes. Some limited flatter sites, as on Prestonbury [747899] and Piddledown [733899] Commons, have been enclosed and sown as pastures.

**Component soils:**

Drogo series *[abundant]*

Skiddaw series *[rare]*

Bridford series *[rare]*

Variant of Hafren series *[rare]*

### 3.20.2 MAIN SOIL

**DROGO SERIES** humic brown podzolic soils; loamy lithoskeletal mudstone and slate.

**Characteristics:**

Black or very dark brown, humose topsoil

Brown or strong brown subsoil

Very stony throughout

Loamy texture

**Generalised soil profile:**

*H or Ah horizon, [0-20 cm]:* Black [N 2/0] or very dark brown [7.5 or 10YR 2/1] humose sandy silt loam; variably stony; strongly developed fine subangular blocky or fine granular structure.

*Bs horizon, [20-60 cm]:* Strong brown [7.5YR 5/6 or 8] or brown [7.5YR 4/4] sandy silt loam; very stony with small to large, angular mudstone [‘woodstone’] fragments; very strongly developed fine granular or subangular blocky structure; ‘fluffy’ consistence and greasy feel.

*Cu horizon, [60+ cm]:* Variably coloured, very or extremely stony sandy silt loam or sandy loam.

*Or ....R horizon: In situ* rock.

**Example profile:** SX78/3095 in oak woodland with *Vaccinium* and bracken. Slope 22$^{O}$, 207 m O.D.

**Horizons:**

*18-16 cm L:* Litter of oak leaves and bracken fronds.

*16-0 cm H:* Black [N 2/0] humose sandy clay loam to clay loam; slightly stony with small angular slaty mudstone and slate pieces; moist; very strongly developed fine granular; extremely porous; no fissures; pores <1 mm diameter; soil and ped strength very weak; slightly sticky; non-plastic; abundant very fine to coarse fleshy, fibrous and woody roots; gradual wavy boundary.

*0-8 cm Ah:* Dark brown [7.5YR 3/2] sandy silt loam; slightly stony with small angular mudstone and slate pieces; moist; very strongly developed fine granular; extremely porous; no fissures; pores <1 mm diameter; soil and ped strength very weak; slightly sticky; non-plastic; abundant very fine to coarse fleshy, fibrous and woody roots; clear wavy boundary.

*8-56 cm Bs:* Strong brown [7.5 YR 5/8] sandy loam; very stony [about 50%], stones small to large angular metamorphically altered mudstone and slate pieces; moist; very strongly developed fine granular; extremely porous with very fine fissures around stones and very fine pores; very weak soil and ped strength; non-sticky; non-plastic; greasy feel; abundant very fine to medium fibrous and woody roots; diffuse smooth boundary.

*56-102 cm BCs:* Reddish yellow [7.5 YR 6/6] coarse loamy sand to sand; very stony [about 50%], stones small to large angular meta mudstone and slate pieces; moist; structureless single grain; very porous with fine and very fine pores; very weak soil strength; non-sticky; non-plastic; abundant very fine to medium fibrous and woody roots; clear smooth boundary.

*102-129+ cm Cu:* Loose scree of very small to large angular mudstone and slate stones.

**Analyses:**

| **Horizon** | **H** | **Bs** | **BCs** |
|---|---|---|---|
| **Depth cm** | 16-0 | 8-56 | 56-102 |
| | | | |
| **Sand 60 µm-2 mm%** | 51 | 61 | 87 |
| **Silt 2-60 µm %** | 29 | 30 | 11 |
| **Clay < 2 µm %** | 20 | 9 | 2 |
| | | | |
| **Organic carbon %** | 13.2 | 2.4 | |
| **pH in water [1 : 2.5]** | 4.2 | 4.6 | 4.8 |

### 3.20.3 SUBSIDIARY SOILS

**Skiddaw series** *[rare]:* Shallow humose or peaty soil over rock without B horizon development.

**Bridford series** *[rare]:* Similar to Drogo series, but without a dark humose topsoil.

**Variant of Hafren series** *[rare]:* Weakly gleyed ferric stagnopodzols in very stony parent material occurring rarely on relatively gentle slopes on Trendlebere Down [773800].

**Related loamy lithoskeletal humic brown podzolic soils** in Higher Knowle Wood [793808], Lustleigh. About 4 ha of soils formed on gentle slopes over the Oligocene Wolley Grits, grey, hard, siliceous coarse and conglomeratic sandstones containing fragments of wood, have been mapped with Drogo soils, to avoid the establishment of a further map unit.

**Key to component soil series:**

| | | |
|---|---|---|
| | Shallow humose soil, rock within 30 cm | Skiddaw |
| | Deeper soils | 1 |
| | | |
| 1 | With dark, humose or peaty topsoil | 2 |
| | With thin surface leaf mould or brown distinct topsoil | Bridford |
| | | |
| 2 | With brightly coloured or brownish subsoil | DROGO |
| | With greyish slightly mottled subsurface over brightly coloured deeper subsoil | Hafren variant |

### 3.20.4 SOIL FUNCTIONS

*Soil properties:* These soils are rarely wet, being highly permeable and in Soil Wetness Class I. Available water content is moderately small in the example profile [115 mm]. Much of the map unit will have smaller reserves due to large stone content and relatively shallow profile depth.

*Site conditions:* Much of the land is steep or very steep.

**Production:** Most of this map unit falls on land with very high amenity and conservation value. Free drainage means that, where farmed, Drogo soils can be stocked, worked or trafficked at all but the wettest times.

**Ecology:** The map unit supports oak woodland, some conifer plantations, and mosaics of dry, acid heath and grassland, which bracken and gorse are infiltrating. The heathland, as on Trendlebere Down, is dominated by ling with bell heather, cross-leaved heath, western gorse, *Molinia* and scrub birch. There is no surface water. The soils are exploited by burrowing animals and soil biological activity is moderately high.

**Environment:** Drogo soils have vertical unsaturated flow through the soil profile during the field capacity period as their main hydrological pathway. This continues into the substrate and is supplemented by bypass flow in fissures in the head and rock. Surface runoff is only likely under extreme conditions. The greater proportion of these soils' contributions to stream discharges is as base flow. While topsoil organic matter is likely to adsorb certain pollutants, shallow depth means liquids and poorly adsorbing pollutants will penetrate Drogo soils. Consequently they qualify as Soils of Intermediate Leaching Potential, subclass I2, following Palmer *et al.* [1995]. The 1 m profile estimated organic carbon contents in the example soil [Section 3.20.2] are small, 25 kg $m^{-2}$, but larger than in most other freely draining soils in this district.

**Plate 39. Drogo series.**

The dark, humose topsoil overlies a brightly coloured, 'fluffy' subsoil, in which rooting is vigorous, despite the acidic pH and very stony nature.

**Amenity and engineering:** Shallow trenches and excavated cuts are stable in these soils, and they can be worked, moved and stored under most moisture conditions. Apart from the topsoil they are suitable for use as shallow fill. Although acidic they are well aerated and consequently are not aggressive to ferrous assets. On acceptable gradients conditions are moderately well suited for sites for short duration events, camping and caravan sites. Suitability for footpaths is rated similarly but extends to somewhat steeper slopes.

## 3.21 DROGO WITH CRAGS MAP UNIT [DR+ on the soil map]

3.21.1 In this map unit the stony, dark topped and freely draining soils of the Drogo series [Section 3.20 above] are intermingled with rocky crags and screes, which are too small to separate as discrete areas of map unit 3.25 Rock Dominant.

**Distribution and site:** The unit occupies 25 ha on steep to precipitous slopes in patches along the Teign Gorge from Castle Drogo [723901] to Steps Bridge [804883] and near the confluence of the Becka and Bovey valleys in Houndtor Wood [775804] [part of a National Nature Reserve] and on Trendlebere Down [770802]. The height range is from 80-200 m O.D.

**Land cover:** Oak woodland and patches of open heath.

**Component soils:**

Drogo series *[common]*

Bare rock and scree *[common]*

Skiddaw series *[occasional]*

Bridford series *[rare]*

3.21.2 MAIN SOIL

**DROGO SERIES** is described in Section 3.20.2 above

3.21.3 SUBSIDIARY SOILS

**Bare rock and scree** *[common]:* Outcrops of hard, metamorphically altered mudstones are dotted across the map unit from the higher ground down to just above the valley floors. Scree cones develop on the lower valley sides beneath crags.

**Skiddaw series** *[occasional]:* These shallow humose or peaty soils over rock, lacking any intervening subsoil B horizon, occur sporadically. They also form as small pockets in crevices in some of the crags.

**Bridford series** *[rare]:* Intermittently there are profiles with mineral rather than humose topsoils.

**Key to component soils:**

| | | |
|---|---|---|
| | Shallow soils, rock within 30 cm | Skiddaw |
| | Deeper soils | 1 |
| | | |
| 1 | With dark humose or peaty topsoil | DROGO |
| | With thin surface leaf mould or brown distinct topsoil | Bridford |

### 3.21.4 SOIL FUNCTIONS

*Soil properties:* Location on steep ground, coupled with the soil's permeability, ensures that these soils are seldom wet. Occasionally small amounts of water emerge from fissures in crags. Soil available water is at best limited.

*Site conditions:* The unit is dominated by steep to precipitous slopes and widespread rock outcrops and screes.

**Production:** Land in this map unit has outstanding ecological and amenity value, overriding any concerns regarding limitations of agricultural or silvicultural potential.

**Ecology:** Away from the rocks and screes there is oak woodland and dry, acid, often heathy grassland, susceptible to colonisation by gorse, bracken and scattered trees. There is no surface water. Soil biological activity is moderately high, the ground being used by burrowing animals. Trees do grow on some screes, where they appear to root to depth, while joints and crevices in the crags are often exploited by gorse, heathy plants and grasses.

**Environment:** Being in Boorman *et al.*'s [1995] HOST class 17, Drogo soils have vertical unsaturated flow and some by-pass flow in the substrate as their principal hydrological responses to precipitation. Runoff across the soil surface will happen only exceptionally. On the rocky outcrops water moves quickly across the surface, infiltrating fissures and emerging lower down as seepage. Infiltration on the scree is almost instantaneous. Classification as Soils of High Leaching Potential, subclass H3 in the scheme of Palmer *et al.* [1995], indicates the soil component of the map unit is unlikely to attenuate liquid discharges and non-adsorbed pollutants, but may detain adsorbed materials. Were pollutants or liquids applied to the crags and screes, attenuation would be negligible. On these shallow soils organic carbon content is small and on the screes and crags trifling.

**Amenity and engineering:** Gradient all but rules out excavation and working of the Drogo soils in this map unit, even though they are in themselves amenable. The crags are beyond excavation etc., while scree material by contrast is highly unstable. Ferrous metal is not corroded in these soils. Very steep to precipitous slopes preclude any recreational use apart from rambling.

## 3.22 WILLINGSTONE MAP UNIT [WS on the soil map]

3.22.1 Willingstone soils are humo-ferric podzols in lithoskeletal mudstone, slate, shale or sandstone. They are very stony, dark topped and weathered from mudstone and slate or very stony head derived from those rocks. Subsoils comprise a bleached layer over dark, humus rich and brightly coloured horizons, typical of podzols.

**Distribution and site:** 4 ha on steeply sloping, in places precipitous, ground between about 180 and 240 m O.D. in Butterdon Ball Wood [755893] on the south side of the Teign gorge. A further 2 ha of similar podzols, but formed over granite, Cucurrian series [Staines, 1979] are mapped with this unit, occurring 300 m south of Gidleigh Park [677876].

**Land cover:** Oak woodland and conifer plantation.

**Component soils:**

Willingstone series *[abundant]*

Drogo series *[occasional]*

Skiddaw series *[occasional]*

Cucurrian series *[see under Section 3.22.3 below]*

3.22.2 MAIN SOIL

**WILLINGSTONE SERIES**, humo-ferric podzols, loamy lithoskeletal mudstone and slate.

**Characteristics:**

Black, humus rich surface horizon

Bleached, grey subsurface horizon

Below that a thin seam of accumulated humus

Brightly coloured subsoil

Very stony throughout

Loamy textures

**Generalised soil profile:**

*H horizon, [30-0 cm]:* Black [N 2/0] humose sandy silt loam or peat, often covered by thin layers of fresh and decaying leaf litter; usually stoneless; fine granular or subangular blocky structure.

*Ea horizon, [0-30 cm]:* Greyish, particularly when dry [2.5Y 7/2], very stony sandy silt loam. There is some lateral variation in the thickness of this horizon, it thinning towards the boundaries to the Bridford Old Woodland phase map unit.

*Bh horizon, [30-35 cm]:* Black [N 2/0] or very dark red [2.5YR 2/2] very stony humose sandy silt loam.

*Bs horizon, [35- 60 cm]:* Strong brown or reddish yellow [7-5YR 5 or 6/8] very stony sandy silt loam; 'fluffy' consistence. The depth of the base of this horizon varies between about 40 and 90 cm.

*Cu horizon, [60+ cm]:* Brown [7.5YR 4 or 5/4] very or extremely stony sandy silt loam.

O*r ….*

*R horizon:* Rock.

**Example profile:** SX78/5492 in mixed woodland with heather and bracken. 35$^{O}$ slope. 213 m O.D.

**Horizons:**

*29-27 cm L:* Litter of bracken fronds and oak leaves.

*27-0 cm H:* Black [N 2/0] loamy peat; stoneless; moist; strongly developed fine granular structure, low packing density; extremely porous,>20% fine and very fine macropores; loose soil and ped strength [no cube obtained]; slightly sticky; non-plastic; abundant very fine to coarse fibrous and woody roots [coarse ones all woody]; amorphous peat but much root fibre; abrupt wavy boundary.

*0-28 cm Ea:* Dark yellowish brown [10YR 3/4], dry colour light grey [2.5Y 7/2] sandy silt loam to sandy loam; very stony [50%] with very small to very large angular stones of metamorphosed mudstone and hornfels; moist; structure indeterminate due to stones; porous with very fine pores and very fine fissures near stones; no cube obtained but fragments have very weak strength; slightly sticky; moderately plastic; common very fine fibrous roots and 1 coarse woody; no soil fauna seen; few patchy organic coats [organans] on stones; clear wavy boundary.

*28-35 cm Bh:* Very dark red [2.5YR 2/2] humose clay loam; very stony with very small to very large angular stones of metamorphosed mudstone and hornfels; moist; structure uncertain due to stoniness; porous with very fine pores and fissure; no cube obtained, fragments very weak; slightly sticky; non-plastic; common very fine fibrous roots; many organans on stones; gradual wavy boundary. Horizon is present over 75% of the face.

*35-64 cm Bs:* Reddish yellow [7.5YR 6/8] sandy silt loam; very stony with very small to very large angular stones of metamorphosed mudstone and hornfels; moist; very strongly developed fine granular structure [fluffy]; extremely porous, very fine macropores; no cube obtained, loose; non-sticky; non-plastic; common very fine and fine fibrous roots; gradual wavy boundary. In top 15 cm horizon contains 10% of Bh as coarse 'mottles'.

*64-155 cm Cu:* Brown [7.5YR 5/4] sandy silt loam; very stony with very small to very large angular stones of metamorphosed mudstone and hornfels; moist; structureless; very porous, very fine macropores; no cube obtained, fragments weak; non-sticky; non-plastic; few very fine fibrous roots.

**Analyses:**

| **Horizon** | **H** | **Ea** | **Bh** | **Bs** |
|---|---|---|---|---|
| **Depth cm** | 27-0 | 0-28 | 28-35 | 35-64 |
| | | | | |
| **Sand 60 µm-2 mm%** | 12 | 50 | 35 | 47 |
| **Silt 2-60 µm %** | 24 | 36 | 36 | 37 |
| **Clay < 2 µm %** | 64 | 14 | 29 | 6 |
| | | | | |
| **Organic carbon %** | 28 | 3.0 | 7.3 | 2.5 |
| **pH in water [1 : 2.5]** | 3.8 | 4.2 | 4.0 | 4.9 |

### 3.22.3 SUBSIDIARY SOILS

**Drogo series** *[occasional]:* Black topped soils, lacking the bleached subsurface horizon of Willingstone profiles.

**Skiddaw series** *[occasional]:* Very shallow soils with rock or very stony rubble close to the soil surface.

**Cucurrian series**: About 2 ha of humo-ferric podzols weathered from granite, 300 m south of Gidleigh Park, around 677876, are included in this map unit for cartographic convenience.

**Key to component soils**

| | | |
|---|---|---|
| | Shallow soils, rock within 30 cm | Skiddaw |
| | Deeper soils | 1 |
| | | |
| 1 | With bleached subsurface horizon underlain by a humus seam over brightly coloured subsoil | WILLINGSTONE |
| | Without a bleached subsurface and humus seam | Drogo |

### 3.22.4 SOIL FUNCTIONS

*Soil properties:* These acid soils are seldom wet on account of their permeability and situation on steep slopes. Although the large content of stones limits soil available water this is compensated by the peaty surface H horizons. In the example profile the calculated available water from that horizon alone is 95 mm.

*Site conditions:* Willingstone soils are confined on steep or precipitous slopes. The Cuccurian soils included in the map unit south of Gidleigh Park are also on very rocky and bouldery ground.

**Production:** Steepness, stoniness, plus the restricted moisture reserves that stem from that, and acidity, all limit the potential of these soils. However considerations of amenity and ecological value of these and adjoining woodlands are likely to supersede those of production.

**Ecology:** These soils are very acid with limited soil biological activity and there is no surface water.

**Environment:** Vertical unsaturated flow through Willingstone soils is the principal hydrological route into the substrate, where bypass flow also affects the head and fissured slate. Only extreme events will trigger surface runoff. They are placed in the I2 subclass, Soils of Intermediate Leaching Potential, in the classification of Palmer *et al.* [1995] with some capacity to attenuate readily adsorbed pollutants, but not more obdurate materials or liquid discharges. Estimated reserves of organic carbon as exemplified by the example profile in Section 3.22.2 are moderate at 51 kg $m^{-2}$ for a metre depth.

**Amenity and engineering**: While steepness, and near Gidleigh Park, rockiness, may be overriding, any shallow trenches or excavations in these soils will be stable. Handling, moving and storing can be carried out at all but very wet times. They are non-aggressive to ferrous metal as a consequence of good aeration, despite their podzolic character and low pH. The map unit's site conditions preclude any use as locations for camping, caravans or events.

---

## 3.23 TEDBURN MAP UNIT [Tn on the soil map]

3.23.1 Clayey soils in low lying receiving sites over the Carboniferous Crackington shales.

**Distribution and site:** These soils cover 12 ha in low lying, gently sloping footslope sites between 90 and 150 m O.D. in the extreme northeast of the district. Tedburn soils, with the related Hallsworth series, are extensive across the Carboniferous outcrop north of this survey area.

**Land cover:** Permanent pasture, with rushy patches in places, with a few small scrubby copses.

**Component soils:**

Tedburn series *[frequent]*

Hallsworth series *[occasional]*

Brickfield series *[rare]*

3.23.2 MAIN SOIL

**TEDBURN SERIES** Clayey pelo-stagnogley soils over lithoskeletal mudstone, shale or slate. Rationalisation of soil series names [Clayden and Hollis, 1984] resulted in the term Tedburn series applying to soils with shale present above 80 cm depth, i.e. to clayey material over lithoskeletal shale. Deeper soils are termed Hallsworth series. Tedburn soils, first described in the Middle Teign Valley [Clayden, 1964], have also been surveyed around Exeter [Clayden, 1971], Holsworthy and Chulmleigh [Harrod 1978 and 1981], the same soil landscapes being mapped more widely and described as Hallsworth Associations by Findlay *et al.* [1984].

**Characteristics:**

Clay or clay loam topsoil

Clayey subsoil

Topsoil finely mottled, subsoil strongly mottled with grey, yellow and orange

**Generalised soil profile:**

*Agh horizon, [0-20 cm]:* Dark grey [10YR 4/1] clay loam, silty clay loam, clay or silty clay with much rusty mottling along root channels; slightly or moderately stony, stones largely sandstone fragments; variably developed fine or medium subangular blocky structure.

*Bg horizon, [20-60 cm]:* Prominently mottled clay with areas of light grey to grey [10YR to 5Y 6/1] and strong or yellowish brown [7.5 or 10YR 5/6-8], greyish on aggregate faces; slightly or moderately stony, mostly sandstone fragments, some strongly weathered and softened; coarse prismatic structure, with roots concentrated on aggregate faces.

*BCg horizon, [60+ cm]:* Light grey or grey [10YR -5Y 6/1] clay with many prominent mottles of strong or yellowish brown [7.5 or 10YR 5/6-8]; very stony with shale fragments in varying degrees of weathering; massive structure.

*or …Cr horizon:* Clay shale.

**Example profile:** SS61/7859 in permanent [60 years old] pasture with perennial rye grass, timothy and rush [*Juncus* sp.]. 125 m O.D. [Harrod 1981, p 69].

**Horizons:**

*0-20 Agh:* Dark grey [10YR 4/1] silty clay loam to clay, with many fine prominent mottles of yellowish red [5YR 5/8]; slightly stony with medium angular olive grey [5Y 5/2] hard micaceous sandstone, siltstone and shale fragments; slightly moist; strongly developed fine subangular blocky, becoming moderately developed below 10 cm where mottles become common; low packing density; very slightly porous; very fine fissures; very fine pores; moderately firm ped strength; moderately sticky, very plastic; very fine fibrous roots, abundant in top 10 cm, many below; few earthworms, usually coiled; non-calcareous; roots in top 10 cm have yellowish coats; abrupt irregular boundary.

*20-46 Bg:* Light brownish grey [2.5Y 6/2] and yellowish brown [10YR 5/6] clay with pale olive [5Y 6/3] on ped faces, with few very fine mottles of light grey [10YR 7/1] in ped interiors; very slightly stony with small and medium angular platy hard micaceous Carboniferous shale; slightly moist; strongly developed coarse prismatic; high packing density; very slightly porous; very fine fissures; very fine macropores; very firm ped strength; common very fine fibrous roots, many in fissures; earthworm burrows on faces and corners of peds, one partially filled with coats of dark greyish brown [10YR 4/2]; few patchy prominent manganiferous coats on shale partings; non-calcareous; many discontinuous silt coats on stone surfaces; gradual wavy boundary.

*46-94 BCg:* Light grey to grey [5Y 6/1] clay with many fine prominent mottles of yellowish brown [10YR 5/8], common medium and coarse prominent dark red [2.5YR 3/6] mottles, with ped faces grey to light olive grey [5Y 6/1-2]; very stony, mainly small soft angular platy shale fragments; moist; weakly developed very coarse prismatic; high packing density; very fine fissures; very slightly porous; very fine pores; moderately firm ped strength; very sticky; moderately plastic; few very fine fibrous roots; vertical earthworm burrows present; many prominent patchy sand and silt and sesquioxide coats on shale; clear smooth boundary rising slightly to the west.

*94-132 Cr:* Dark grey to very dark grey [N 3-4/0] finely laminated [some laminae <1 mm] hard micaceous Carboniferous clay shale *in situ* dipping at $28^{O}$ to west; with many soft weathered bands of material as above horizon; many laminae have common prominent skeletans and ochreous sesquioxidic coats; very moist, wet on some laminae; non-calcareous; single 3 cm micaceous sandstone band present.

## Analyses:

| Horizon | Agh | Bg | BCg | Cr |
|---|---|---|---|---|
| Depth cm | 0-20 | 20-46 | 46-94 | 94-132 |
| | | | | |
| Sand 600 µm-2 mm % | 4 | 2 | 4 | 10 |
| " 200-600 µm % | 4 | 3 | 7 | 14 |
| " 60-200 µm % | 10 | 4 | 6 | 8 |
| Silt 2-60 µm % | 47 | 31 | 42 | 32 |
| Clay <2 µm % | 35 | 60 | 41 | 36 |
| <0.2 µm % | 6 | 14 | 7 | |
| Fine clay as % of total clay | 17 | 23 | 17 | |
| | | | | |
| Organic carbon % | 4.3 | | | 0.5 |
| pH in water [1 : 2.5] | 5.5 | 6.3 | 6.0 | 6.0 |
| pH in 0.01M $CaCl_2$ [1 : 2.5] | 5.0 | 5.8 | 5.3 | 5.3 |
| C.E.C of <2 µm fraction [me / 100 g] | | | 20 | |
| $K_2O$ % in <2 µm fraction | | | 4.4 | |
| | | | | |
| Bulk density g $cm^{-3}$ | 1.01 | 1.28 | 1.44 | |
| Packing density g $cm^{-3}$ | 1.32 | 1.82 | 1.81 | |
| % by volume | | | | |
| Total pore space | 59.5 | 51.8 | 45.5 | |
| Available water | 17.7 | 20.4 | 12.3 | |
| Air capacity | 12.0 | 0.0 | 0.2 | |
| Retained water | 47.5 | 52.8 | 45.3 | |
| Lower plastic limit % by mass. | 33 | | | |
| Hydraulic conductivity m per day 6 m away from pit | 0.18 | 0.002 | | |

*Comment:* Although from some distance north of the district, this Tedburn profile is extremely well documented and the analyses illustrate important properties of the series. Clay content is largest in the Bg. The proportion of fine [<0.2 µm%] clay to total clay is small compared with most clay soils. This, along with the C.E.C. and $K_2O$ amounts, point to micaceous clay mineralogy. Although total porosity is large, amounts of plant available water are modest. However, the very slow permeability shown by the very small air capacity in the subsoil and by the negligible hydraulic conductivity can supplement available water by retarding percolation of rain water. The coarsely prismatic structure in the Bg and BCg indicates some propensity to shrink and crack on summer drying, although with micaceous clay mineralogy this will be less than for many clay soils. The large difference between the retained water content [47.5%] and the lower plastic limit [33%] of the A horizon demonstrates that these soils need a substantial period of drying in spring and summer before they are strong enough to carry stock or machinery without structural damage.

### 3.23.3 SUBSIDIARY SOILS

**Hallsworth series** *[occasional]:* Essentially soils very similar to Tedburn series but with a greater [80 cm +] depth to rock or stony rubble.

**Brickfield series** *[rare]:* Soils with clay loam textures, but otherwise very like Tedburn and Hallsworth series.

**Key to component soil series:**

| | | |
|---|---|---|
| | Dominantly clayey soils | 1 |
| | Fine loamy soils | Brickfield |
| | | |
| 1 | Rock within 80 cm | TEDBURN |
| | Deeper soils | Hallsworth |

3.23.4 SOIL FUNCTIONS

*Soil properties:* The dense clayey subsoil makes the Tedburn series very slowly permeable. When undrained the soil is in Wetness Class V, since the profile is wet for much of the year. Effective artificial drainage for agricultural purposes can improve the water regime to Wetness Class IV [waterlogged for long periods in the winter half of the year]. While these soils show classic surface-water gley morphology, it should be pointed out that in places, particularly near the upslope boundary to freely draining soils, spring water can rise to the surface, complicating the soils' hydrology. Overall plant available water in this profile is 136 mm. Much of that is held at high tensions and so is released relatively slowly. How much limited impeded downward drainage supplements available water is uncertain. However following Hodgson [1997] the standard allowance of 50 mm for wetness class V soils is made. The soil moisture properties of Tedburn soils and techniques for land drainage are discussed at length in Harrod [1981].

*Site conditions:* Apart from limitations imposed by springs breaking out, particularly along upslope boundaries, there are no limitations attributable to site.

**Production:** Soil moisture conditions encourage grass growth. However soil wetness dominates use of the land, resulting in placing as grade 5 in the MAFF [1988] Agricultural Land Classification. Even after effective land drainage Tedburn soils under grass have a high risk of poaching by stock or damage by machinery. The soil's clay content and large retained water capacity contrasted with plastic limit, noted under the comments on analyses above, illustrates the slow drying properties of these soils. For similar reasons, neither are they easily cultivated.

Effective drainage centres on pipe drains covered with permeable backfill, the latter providing a connection for mole drain channels, which need to be drawn in a timely manner when the subsoil is plastic but not wet. A soil moisture deficit of about 50 mm is close to optimal for this, but will only exist for a few weeks in most summers. Trees offer an alternative productive use of these soils, but wetness similarly constrains choice of species to conifers; the shallow rooting encouraged by wetness and clayey subsoils raises the risk of windthrow. Unless harvesting of trees is carried out during dry, summer conditions, runoff and pollution will be generated and affect nearby watercourses.

**Plate 40. Tedburn series, a clayey surface-water gley soil.**

These soils are found in a few sites in the district's northeastern Dunland country, over Carboniferous shales. This profile, exposed under permanent pasture in dry, summer conditions, has fine blocky structural aggregates in the topsoil, with very fine, rusty mottles along roots. In the subsoil columnar aggregates several cm across are separated by vertical shrinkage cracks. These fissures have uniformly grey faces, while intense mottling characterises the aggregates' interiors. Each autumn, as the soil rewets, the fissures close and the soil returns to the impermeable state that endures for around 9 months of most years.

**Ecology:** Wet, rushy pasture or scrubby woodland with some ditches and seasonal surface water. Waterlogging limits biological activity to the surface Ag horizon.

**Environment:** Tedburn soils' clayey nature bring about changing hydrological character between that of the dry summer and early autumn and that from October to May in average years. Shrinkage of the subsoil at dry times opens vertical fissures between the prismatic aggregates described in the Bg and BCg horizons in Section 3.23.2, allowing unsaturated flow down the profile into the head and shale of the substrate. This by-pass flow continues until autumn when the clayey subsoil gradually rewets and, by swelling, closes the fissures. Then lateral saturated flow through the better aggregated, more porous topsoil and surface runoff become the pathways until the next summer. This involved soil hydrology ensures that Tedburn soils make differing seasonal contributions to stream discharges, to base flow in the summer and through runoff during the field capacity season. These are Soils of Low Leaching Potential [class L] [Palmer *et al.*, 1995] for the purposes of groundwater protection, largely on account of their clayey content. However their capacity for bypass flow during dry conditions should not be overlooked. Overall profile estimated organic carbon amounts in the Tedburn profile in Section 3.23.2 are small at 12 kg $m^{-2}$ to 1 m depth.

**Amenity and engineering:** Wet and clayey and subject to some shrinkage on drying, Tedburn soils are unstable in shallow slopes, require great care in excavation, handling and storing, if already difficult materials are not to be made worse. They are unsuitable as fill. Seasonal changes of wetness and aeration make them moderately aggressive to ferrous metal. They are unsuited to footpaths and sites for camping, caravanning and short term events.

---

### 3.24 URBAN AND DISTURBED GROUND [U on the soil map]

Within this map unit are over 700 ha with diverse forms and backgrounds, occurring from the low ground south of Lustleigh [785813] to the highest point on Hangingstone Hill [617861]. Included are about 100 ha of urban land, around 340 ha of ground disturbed by tin workings, 150 ha where blanket peat was stripped by medieval charcoal burners, more than 8 ha for stone quarries, while cuttings and embankments for the Moretonhampstead branch railway line and forestry rides involve about 20 ha. Many of them can be considered in terms of Hollis' [1991] amendments to Avery [1980], which deal with soils in urban areas. Three sub groups from both of the new major soil groups, *Made ground soils* and *Man-modified soils* [major soil groups 9 and 11] are present and listed in Table 12. Applying Hollis' reasoning to Avery's major soil group 1 [*Terrestrial raw soils*], soil group 1.3 [*Raw skeletal soils*], two informal, additional soil subgroups are described and included in Table 12. They are: *neutral, base-poor well-aerated raw skeletal soils* and *neutral, base-poor dense raw skeletal soils.*

The urban land can be summarised as buildings, paved areas, open spaces and areas of cut and fill, plus a few small, historic refuse disposal sites. Several of the other categories of disturbed ground listed involve cut and exposed rock, both as hard and soft forms. Hard rock exposure is mainly in granite quarries and some tin openworks, although there are also small workings in slates of the aureole. Softer rock exposures are otherwise undisturbed head, growan or saprolite, found in mineral workings, peat workings and ride and railway cuttings.

Workings of alluvial tin resulted in extensive tracts of dug over ground, punctuated with spoil mounds and pools. There is much made-up ground as spoil heaps from tin workings, quarries, embankments, sports and amenity landscaping, plus the numerous small heaps of agriculturally cleared boulders and levelled ground for farm buildings. There are strips of disturbed ground marking the railway to Moretonhampstead and bull-dozed rides on steep slopes in Fernworthy Forest [650830].

**Plate 41. Medieval tin streaming works on the East Dart below Sandy Hole Pass.**

The subparallel ridges and hollows are characteristic of the alluvial workings, as is the valley-side bluff marking their upslope limit. The failure, after centuries, of vegetation to establish on parts of the ridges suggests that this ground was rockier than elsewhere.

Easily the most extensive components of this map unit are those caused by tin working, areas varying from a few tens of square metres to tens of hectares, excavations with their spoil dumps, steep marginal bluffs, pools and ditches produced in the winning of cassiterite, locally termed tinstone, either as streamworks, openworks or mines. Many floodplains and valley bottoms, often locations where Tavy / Ty-Gwyn, Sulham / Eversley, Laployd or Crowdy soils might be expected, were dug over, particularly in medieval times, as streamworks for the placer tin deposits, with frequent 'eluvial' extensions into the adjacent hillsides as steep bluffs or ravines.

The fluvial processes operating on the floodplains tended to sort and concentrate the tin ore [heavier than the non-metallic, gangue rocks and minerals], low in the alluvium. By contrast the solifluction affecting the growan or 'shode' on the hillslopes was less effective in concentrating the ore. The larger streamworks characteristically have subparallel, linear, sometimes sinuous, spoil mounds a metre or two high and a few metres wide, separated by depressions, with abrupt scarp slopes marking the valleyside limits of most workings. The marginal bluffs of the eluvial workings are typically very steep or precipitous, $35^{O}$ or steeper and 7 m high or more in places. Many of the depressions appear to have been used to control the flow of water needed in the initial separation of the tin ore from the gangue. Where the placer deposits pass under thick basin peat the tinners showed some persistence before increasingly wet conditions precluded further working. There the spoil mounds can sometimes be picked out by ribbons of bracken within the bog vegetation, while some workings skirt the bog along its junction with the drier rising ground, visible on the map as horn-like extensions of the disturbed ground, as in the valley west of Bowerman's Nose [741805].

Other, often smaller, areas of streamworks, some shown on the soil map and some too limited to delineate, lack the pattern of linear mounds. Also there are places where it is uncertain whether features on the valley floor and abrupt concavities near its sides are natural or products of tin ore workings, for example along the floodplain edges of the Hayne Brook between Heatree [727807] and Water [759808]. Only those that appear unequivocal are shown on the soil map.

A common feature of most of the streamworks and their eluvial extensions is their proximity to water, either from natural sources or brought in by leats. An exception is on the northwestern side of Mardon Down [765876], where there are some 9 ha of disturbed ground, with the ridges and depressions aligned up and down the slope. Winning and processing the tin produced large quantities of fine tailings, which were discarded into the natural drainage network. Some accumulated in the worked valley floors in depressions between spoil ridges where there can be wet mineral material, or in places pools. Some fine tailings have penetrated valley bogs and alluvial tracts downstream of workings.

By and large the worked ground contains sufficient fine earth to support vegetation, on the moorland mostly heathy shrubs, with the occasional willow, or rowan tree in sheltered spots, although some exposures of bare ground are present on the marginal bluffs. Most spoil mounds are vegetated and are freely draining; a few, where the spoil is particularly coarse, as along the East Dart southeast of Sandy Hole Pass [621815], remain free of plant cover centuries on, whereas the depression floors are variably waterlogged and boggy, with open pools in places. At lower altitude on tinned ground of negligible agricultural value, mature trees cloak the excavations and spoil heaps.

**Plate 42. Much of Taw Marsh was dug over by medieval tin streamers.**
The darker green vegetation marks drier spoil mounds with gorse and heather, while the intervening low ground is waterlogged and supports hydrophilous vegetation.

Openworks, ‘beams’ or ‘gerts’, of a more recent origin than the streamworks, are particularly extensive west of Headland Warren [693811], with lesser versions scattered around the district. Many of these are linear, following the strike of the mineralisation, varying from almost imperceptible sags in the ground to steep, craggy sided ravines with widths of several tens of metres and depths up to around 10 m. In places, most notably south of the Warren House Inn [6744810], the linear openworks merge into larger areas of disturbance. Associated with them are mine shafts, spoil dumps and tailings, although the waste rarely appearing to be of an extent commensurate with the area of excavations. Many of the openworks have narrow, low mounds of spoil along their rims. In places the ground is pockmarked by trial holes and lines of lode-back workings and their spoil.

Most of the flanks of the openwork ravines are vegetated, similarly the spoil mounds, on the moorland with heathy plants, in the lower, in-bye country with secondary deciduous woodland. Some conifers have been established in the works in the plantation at Soussons Down [680800]. There are a few places where particularly coarse spoil remains free from plant cover. Most sites are freely draining, although occasionally in low-lying places groundwater flushes create perennially wet ground. A few localised adits with small spoil mounds, are scattered around the district, e.g. at 662869 [Batworthy], while several small adits have exploited specular haematite in the Wray valley, notably near Kelly [795818], leaving stony, earthy spoil banks. In addition to ground immediately disturbed in excavation for the ores there were numerous buildings, working sites and ancillary structures, such as water supply leats and buddles.

**Plate 43. Nineteenth century tinners' openworks, or gerts.**

These are part of the Birch Tor Vitifer Mine complex, near the Warren House Inn. Water, to power the mine and process the ore, was brought by a leat for several kilometres across the moor from the East Dart just below Sandy Hole Pass.

In places restoration of tin streamed ground for agriculture has been carried out by bulldozing, notably on the Teign floodplain below Dogmarsh Bridge [713893] and along the River Bovey southeast of North Bovey [740839] village. The land for several hundred metres downstream from the latter restored ground has particularly large spoil mounds. Mapping of reinstated floodplain sites is only shown where clear evidence of the work has been obtained, for example from early aerial photography or local knowledge. Within those areas the soil is clearly disturbed, with limited topsoil, very stony subsoils, and patches containing material such as brick, clinker and metal, derived from refuse dumping in the previous tinworks' depressions and hollows. There are areas, notably along the Bovey floodplain in the golf course at Bovey Castle [731845], where there are unconfirmed hints, in the form of buried builders' rubble and metal, that there has been restoration. It should be noted that tin workings have changed the hydrology of some sites, effectively draining the upslope ground, even to the point of producing dry peat with bracken growing on it, as at 639882, between Rippator and Gartaven Ford.

In terms of Hollis [1991], 'Proposal for the classification description and mapping of soils in urban areas', the main tracts worked for tin classify as *disrupted raw skeletal gley soils [11.22]*, the earthy sections of marginal bluffs and floors of gerts as *neutral, base-poor raw skeletal soils* [*soil group 1.3* of Avery, 1980] punctuated by hard rock, *[non-soil].* Spoil mounds fall into either earthy or rocky phases of *well aerated raw made ground soils [9.24]*, with the occasional water bodies being *non-soil*.

**Plate 44. Dry tin workings on the west side of Mardon Down.**
Unusually there appear to be no sources, natural or man-made, of water.

The urban land at Moretonhampstead, Chagford and Lustleigh, is a mixture of buildings with a range of functions, roads and other sealed surfaces, gardens and small open spaces, made ground and land that has undergone cut and fill. In addition there are scatted separations marking municipal and casual rubbish dumps, as at Waye Down [686891] and Nattadon [707866] near Chagford, while some former tin openworks, for example southwest of Drewston Cross [720876], Chagford, have been filled with waste materials. Disturbance following landscaping should be noted on the golf course at Bovey Castle and at Stockey Furzen [679880], Gidleigh Park.

The map unit includes small areas of unmodified natural soils, mostly Moretonhampstead series, in some larger gardens. In old, long-cultivated gardens there are *compost-deepened typical brown podzolic soils [11.41]* [formerly earthy man-made humus soils [9.12] of Avery, 1980]. Elsewhere there has been cut and fill and deposition of materials as made ground, producing *well aerated neutral, base-poor raw skeletal soils* [Avery's *soil group 1.3*], also *neutral, base-poor well aerated made ground soils [9.55]* and *dense raw made ground soils [9.23]*, proportions of which have been subsequently sealed by buildings and tarmac.

The district contains 4 sizeable granite quarries, all now closed, which produced masonry. Castle Drogo [723901] was built of granite from Blackingstone Quarry [784858] and Fernworthy dam [671843] from granite quarried near at hand. Other smaller quarries provided irregular, random building stone from the granite and the metamorphic aureole's slates. Some more accessible tors and crags have clearly been quarried, as just north of Outer Down [683865] near Chagford, Pixies' Rocks [790873], Westcott and Loxter Copse [793811], Lustleigh.

**Plate 45. Peat has been completely removed from many high moorland hill tops.**

This bouldery substratum was revealed by medieval carbonarii, who stripped and burned the peat for charcoal, under license from the Duchy of Cornwall. Charcoal production carried on for several centuries on an industrial scale, supplying tin smelters in Cornwall and Devon.

In addition to the now abandoned rock faces and ledges, quarrying resulted in substantial mounds and banks of rejected and discarded material, often very large, angular rocks, as well as heaps of stony, earthy overburden. Some quarry floors contain open water. Classification of the hard rock quarries following Hollis [1991] includes two *non-soil* elements, the exposed rock and open water, and two phases [*rocky* and *earthy*] of *neutral, base-poor raw made ground soils [9.42].* There are numerous, very small growan pits, excavations of weathered granite head or saprolite used for aggregate and road stone. Materials in the growan pits are *neutral, base-poor raw skeletal soils* [soil group 1.3 of Avery, 1980].

On several hill tops of the high moorland between Wild Tor [623877] and Statt's House [622825], working of the blanket peat for charcoal took place during medieval times by *carbonarii*, charcoal burners licensed by the Duchy of Cornwall, who supplied tin smelters locally and in Cornwall. Over 150 ha of peat was removed down to very stony mineral [2BCg or 2 Cug] horizons, leaving distinctive, often very bouldery, terrain, best characterised as *acid-humose truncated raw oligo-fibrous soils [11.13].* The thickness of peat removed can be partly gauged by the height of the bluffs around the workings, on White Horse Hill [615853] around 1.2-1.5 m high, although shrinkage following cutting may encourage under-estimation.

**Plate 46. Abrupt western edge of the large scale peat cutting on Whitehorse Hill made by medieval carbonarii.**

Both the bull-dozed rides in the plantations at Fernworthy and Soussons and the route of the abandoned railway to Moretonhampstead involve cuttings and embankments. The rides are lines of cut and fill, with exposed granite rocks and residues on the upslope side, with fill deposited downslope, supporting grassy and shrubby vegetation, plus a scatter of self-sown, Sitka spruce trees. After several decades of disuse much of the railway line's cuttings and banks are wooded, although the track bed remains largely free of growing trees. Classification of the rides and former railway following Hollis [1991] places the cut slopes as either *neutral, base-poor well aerated raw skeletal soils* [soil group 1.3 of Avery, 1980] or *non-soil* for the exposed rocks, *dense raw made ground soils [subgroup 9.23]* or *neutral, base-poor dense raw skeletal soils* under the track bed and roadways, with *well aerated raw made ground soils [9.24]* on the downslope fill and on embankments.

In places agriculture has produced disturbed ground of sufficient extent to be shown on the map. Piles of boulders cleared from fields are commonplace, some as substantial mounds within fields, sometimes termed clearance cairns, [*well aerated raw made ground soils [9.24]*, ro*cky phase* in Hollis' [1991] classification], of which a proportion were sited around immovable outcrops. Others form lines along field margins, most often at the lower end, while some were pushed into woodland and copses. The majority are the result of the coincidence of the availability of heavy machinery and grant aided programmes in the mid-20th century, although American army engineers in the 1940s played a part, [*priv.comm. Gordon Brock].* A well vegetated heap east of Wooston [765890], close to the Americans' camp on Mardon Down, is probably a result of this. Small heaps of stones and boulders picked by hand in earlier times remain here and there, for example on the abandoned newtake farms at Teignhead [635843] and Manga [638848]. Clearance of the boulders transformed some land where previously it had been impossible to drive in a straight line, when mowing grass, for example.

**Plate 47. A so-called clearance cairn near Linscott.**

Mechanisation and public support for agriculture encouraged boulder clearance during the mid 20th century. More frequently boulders were removed to the lower edges of enclosures, rather than grouped within fields.

Rocks also hindered cultivation, particularly the tourmalinised quartz and hornfels, which a plough would hook onto, whereas it would bounce off granite. Modern expansion of farm buildings and yards can be seen from the base map. Many farms have areas levelled for modern buildings, with *neutral, base-poor raw skeletal soils* [*soil group 1.3* of Avery, 1980], *well aerated* along cut back slopes, *dense* on the stripped 'pediment' and *dense raw made ground soils [9.23] o*n the made ground 'terrace' downslope. In other locations there has been cut and fill for landscaping, including a shooting range, a golf course, sports pitches and equestrian arenas / maneges, involving back slopes with *well aerated neutral, base-poor raw skeletal soils* [*soil group 1.3* ] and *neutral, base-poor well aerated made ground soils [9.55]* across the levelled ground. Several banks of *dense raw made ground soils [9.23]* have been built in the creation of amenity lakes and ponds.

Although not mapped as such, the hedgebanks that enclose most fields in the in-bye represent substantial areas of disturbed ground, *neutral, base-poor well aerated raw made ground soils [9.24]* in Hollis' [1991] scheme. They are typically 2-4 m wide at the base and 1-2 m high. Constructed of earth thrown up from the ground immediately alongside, they reflect the particle-size characteristics of the adjacent soil, albeit mixed, although their natural drainage is inevitably better. Many hedgebanks are flanked by shallow slopes towards the bank, two to four metres wide, from where the bank's soil was dug. LiDAR limages [see Section 1.6.3 above] suggest that these 'borrow gutters' can be wider than the hedgebanks. Within these narrow strips the upper parts of the soil profile have been removed, the soils in them being in Hollis' [1991] *slightly weathered truncated [11.12]* soil group in the *man-modified soils* major soil group. At subgroup level the profiles will be *slightly weathered truncated* versions of the adjoining natural soils, in this district the most extensive being *typical brown podzolic soils.* In many places large stones and boulders are incorporated in the banks, included by the original enclosers or subsequently removed from the fields. Mostly set out by Saxon settlers or medieval farmers, some close to the moorland appear to follow the alignments of Bronze Age reaves, themselves enclosure boundaries built of earth and stone.

Where boulders were relatively abundant earthen banks give way to stone walls and banks of boulders. Fields relatively recently enclosed from old downland within the in-bye are larger and rectangular. Stone walls were favoured in many of the newtakes enclosed from moorland in recent centuries, while the impressive walls around fields at West Combe [683871], Chagford are reputed to be the work of French officers, prisoners of war during the Napoleonic Wars, who were billeted in the town.

The hedgebanks and their flanking gutters enclosing most of the fields of the in-bye, when aggregated, represent a very substantial area of made ground. Estimates by Hoskins [1943] suggest that hedgebanks cover about 7 per cent of rural Devon, while it should be noted that field size on the Dartmoor in-bye is substantially smaller than on adjacent lower-lying land, so any figure for the county as a whole may understate the amount locally. The banks are important for reasons beyond simply enclosing the fields and providing shelter for livestock. Their vegetation, including shrubs and trees, commonly reflecting adjacent soil conditions, adds significantly to biodiversity and offers refuges, food sources and connecting corridors for wildlife. For these reasons, and for the way many of them pick out soil and terrain changes, hedgebanks greatly enhance the local landscape's character.

A few disturbed ground features of uncertain or archaeological or military origin were noted, some mapped, some not. These include the wartime railway constructed by the US Army engineers at Headless Cross [771878] and the Sand Path [621855] near Whitehorse Hill. Among those not mapped yet deserving mention are cairns, as at Quintin's Man [621839], the lynchets at Challacombe [693802], along with their numerous small scale colluvial equivalents at the lower ends of fields on sloping ground throughout the in-bye, and the asymmetrical cornditches, the boundaries between the moorland and the enclosed land of the in-bye.

**Plate 48. Stones picked during Victorian clearance of land in the newtake at the lost farm at Manga, near Teignhead.**

**Table 12. Summary of the soils in the Urban and Disturbed map unit [U on the soil map]**

| Sub-categories of the Urban and Disturbed Map unit | Urban soils classes, after Hollis [1991] |
|---|---|
| **A] Exposed 'soft' *in situ* 'rock':** Head, saprolite; in mineral workings & growan pits, substrate of peat workings, cuttings [including forest ride upslope part], part of cut and fill etc.<br>Such exposures on moorland tin workings have mixed hydrology, on lower ground there are more dry sites.<br>Steep [up to precipitous] slopes are the main component on margins of mineral workings, in growan pits and railway cuttings.<br>Cut and fill has small upslope bluffs with larger, flatter ground below. | **1]** ***Neutral, base-poor well aerated raw skeletal soils [Soil group 1.3 of Avery, 1980].*** In mineral workings and cut and fill sites, the steeply sloping 'face' component; small in area.<br>**2]** ***Neutral, base-poor dense raw skeletal soils [Soil group 1.3 of Avery, 1980].*** In mineral workings and cut and fill sites, the flatter 'pediment' component.<br>**3]** ***Dense raw made ground soils [9.23].*** On the made ground 'terrace' downslope of cut and fill.<br>**4]** ***Acid-humose truncated raw oligo-fibrous soils [11.13].*** On medieval peat workings. |
| **B] Dug over ground:** a] In streamworks around and between spoil mounds.<br>b] Floors of non-alluvial tin workings where clear of spoil dumps. | **1]** ***Disrupted raw skeletal gley soils [11.22]*** [seasonally or perennially wet] in streamworks around and between spoil mounds.<br>**2]** ***Raw skeletal soils [Soil group 1.3 of Avery, 1980].*** In floors of non-alluvial tin workings where clear of spoil dumps. |
| **C] Built over land:** Sealed & impermeable surfaces, cut and fill, natural soils, man-made soils, made ground. | **1]** ***Natural soils*** in some larger gardens.<br>**2]** ***Compost-deepened soils [11.41]*** In old gardens [formerly earthy man-made humus soils [9.12] of Avery, 1980].<br>**3]** ***Dense raw made ground soils [9.23]*** On fill.<br>**4]** ***Sealed surfaces***. Buildings, paved areas. |
| **D] Made ground –spoil heaps:** Tin workings, quarries, cut and fill, embankments, boulder clearance. Often on the in-bye spoil heaps are well vegetated with trees rooted in interstices. | **1]** ***Dense raw made ground soils [9.23***] On embankments and fill.<br>**2]** ***Well aerated raw made ground soils [9.24]***. ***Rocky phase*** on some tin and quarry spoil and all cleared boulders; ***earthy phase*** on some tin and quarry spoil. |
| **E] 'Levelled' ground:** Sports & amenity, farm buildings. | **1]** ***Neutral, base-poor well aerated made ground soils [9.55].*** Sports: cut as well as fill.<br>**2]** ***Dense raw made ground soils [9.23].*** Fill around farm buildings etc. |
| **F] Bulldozed forestry rides, railway cuttings and embankments:** On steep slopes, cut [both soft and hard rock] on the upslope side, made ground on the down slope. | **1]** ***Raw skeletal soils [Soil group 1.3 of Avery, 1980].*** On upslope side.<br>**2]** ***Exposed rock,*** *'non- soil'*. Also on upslope side.<br>**3]** ***Dense raw made ground soils [9.23].*** Under roadway.<br>**4]** ***Well aerated raw made ground soils [9.24].*** On downslope spoil. |
| **G] Exposed hard rock:** Quarries, tin works, railway cuttings, forestry rides. | ***Exposed rock,*** *'non-soil'.* |
| **H] Pools & flooded workings:** Among classes A], B] & G] above. | Open water, **'***non-soil'.* |

---

## 3.25 ROCK DOMINANT [RD on the soil map, solid red on the terrain map].

This map unit delineates land where soil cover has not established over tors and related rock outcrops and crags, clitter [concentrated spreads of granite boulders separate from *in situ* outcrops] and scree. Subsidiary accumulations of soil can occur in interstices in these rocks. Rock dominated land covers about 177 ha.

Tors, among the more iconic features of Dartmoor, include outcrops of undisturbed, variably jointed granite, also angular, subangular and subrounded boulders and blocks, some a few metres across, in all stages of detachment from the *in situ* rock. They range from strikingly castellated forms, as at Oke Tor [612900], to groups of boulders insufficiently dense to justify mapping as Rock Dominant, as at Easdon [729823] and Hameldown Tors [703806]. In places they are little more than random jumbles of boulders, elsewhere they form striking, if not bizarre landforms, such as Bowerman's Nose [741805], the Thirlstone at Watern Tor [629868], the Tolmen at 655871 and various logan stones [balanced, rocking boulders of granite]. The overall shape of the blocks in the tors is dictated by the joint patterns within the granite, which can be widely spaced, as in Heltor [799870], or show close pseudo-bedding, as at Watern Tor.

Tors occur on some hill crests, on valley sides and spur ends and occasionally in valley floors, as at Castle Rock [684834], Hurston. However not all hill tops, spur ends nor valley sides carry tors, indeed much of the granite outcrop in this survey district lacks them. Woodlands across the in-bye conceal a number of nameless tors and other outcrops, notably along the Wray valley. Several of these hidden outcrops are bigger and more impressive than many named tors on the open moorland. The term tor is also applied to some crags formed of altered Carboniferous sediments in the metamorphic aureole, notably Sharp's Tor [729899] on the Drogo estate, while the outcrop of Oligocene Wolley Grit at the south end of Loxter Copse [793811] would justify being named as a tor.

Downslope of some tors are spreads of clitter, granite boulders riven and soliflucted from the outcrops. However many clitters have no obvious *in situ* granite outcrop as their source. Some are chaotic in their shape and distribution, others are concentrated more or less along the contour in arcuate or serpentine lobes, in places, as near Wild Tor Well [627876], on very steep slopes, and some are in strips up and down slope. There are examples in valley floors, on steep slopes and some clitters rest higher in the landscape. Valley floor examples include Howsham Steps [768816] on the Bovey [where they occlude the river], at the foot of St Thomas' Cleave [790883] between Doccombe [776868] and Steps Bridge [804883] and at, and downstream of, Becka Falls [761801]. Isolated clitter on higher ground forms in a variety of situations, such as the Wild Tor Well example, in contrast sinuous lobes are developed on much gentler ground at 650899 on Throwleigh Common, while in Lustleigh Cleave [765818] there is an abundance of clitter.

The map unit, and the related 'with crags' phases of the Bridford [Section 3.17] and Drogo [Section 3.21] soils, occurs over rocks of the metamorphic aureole across the steep slopes along the Teign east of Castle Drogo [723901] and around the Bovey-Becka Brook confluence at 778801. In the Rock Dominant separations of the north side of the Teign Gorge, along the lower slopes there are coalescing screes of angular, large and very large stones spalled from Sharp's

Tor [729899] and other rock outcrops higher on the slope. In places the screes reach upslope in ravines between buttresses of projecting rock. In the Teign Gorge below Castle Drogo, the Rock Dominant map unit is mostly on the south facing side, where the rocks dip steeply to the north. While clitter is normally regarded as a dense collection of granite boulders, there are small mapped areas of tourmalinised boulders in similar concentrations north and northeast of Smallridge [782885].

In this map unit, many exposed rocks carry saxicolous flora and are partially covered by lichens and bryophytes, completely bare rock being the exception. Tors have joints, their openings varying from a few mm to tens of cm, often filled with accumulations of peaty organic matter, in places to depths of a metre or so. On the moorland this supports mosses, grasses and heathy shrubs, in the in-bye these joints are also exploited by mature trees. The rockiness of the ground, by discouraging grazing animals, has encouraged such trees. Many of their roots penetrate deep into the rocks' joints. It is not obvious how many, with their trunks perched on top of boulders and rocks, established as seedlings before their roots reached into the fissures. Sporadic wider openings between the rocks making up tors allow the formation of pockets of soils related to the surrounding map units. Similarly among the clitters interstices can be relatively wide.

**Plate 49. The embankment of the railway line built in 1943-4 by U.S. Army.**
This is near Headless Cross on Mardon Down, here picked out by the low sun of a January dawn.

**Plate 50. Blackingstone Rock.**

**Plate 51. Bad Rock.**
A substantial tor on metamorphosed sediments at the eastern end of
Broadmoor Common in the Teign Gorge, unnamed by the Ordnance Survey.
.

**Plate 52. Granite clitter on the steep ground [29$^{O}$] west of Wild Tor Well.**

The steep ground around the clitter is mapped as the Hexworthy / Rough Tor soil map unit, the foreground basin floor is peat of the Crowdy unit, while the flat ridge crest's blanket peat was removed for charcoal production hundreds of years ago. Wild Tor itself sits on the skyline.

**Plate 53. Granite clitter along the bank of the river Teign near Murchington.**

**Plate 54. Scree on the metamorphic aureole.**

Screes form on very steep and precipitous slopes below tors and crags along the Teign Gorge and Becka valley. The angular regolith is termed woodstone locally.

Some clitters span the hydrologically determined boundaries between freely draining ground and land affected by springs, as at 702895 [Rushford Wood]. Above Horsham Steps at 759817, at 643807 north of Postbridge and at 785874 northeast of Doccombe, clitter occludes the watercourses at times of normal flow. In the shelter of denser woodlands, particularly deeper in valleys and on steep, north facing slopes, boulders support cushions of mosses and leaf litter. Here and there tree seedlings grow on these cushions.

Unlike the often smooth aspect of granite surfaces, rock faces on the aureole slates are angular and uneven, jointing and cleavage being closer but less open. Small plants, grasses, forbs and shrubs, including gorse, cling on in fractures in more sheltered recesses in these crags. Parts of the screes are unvegetated, elsewhere a thin litter covers them. At a number of places trees have established on the screes.

## 3.26 STEEP SLOPE PHASE [Red hatchuring on the terrain map]

Land steeper than $11^{O}$, conventionally seen as the upper limit of slopes suitable for cultivation, is in Figure 7 below. It is also delineated on the terrain map by red hatchuring. In some sharply incised valleys it includes substantial areas of very steep [26-$35^{O}$] and precipitous [>$35^{O}$] slopes. The total area of this phase is 3,520 ha.

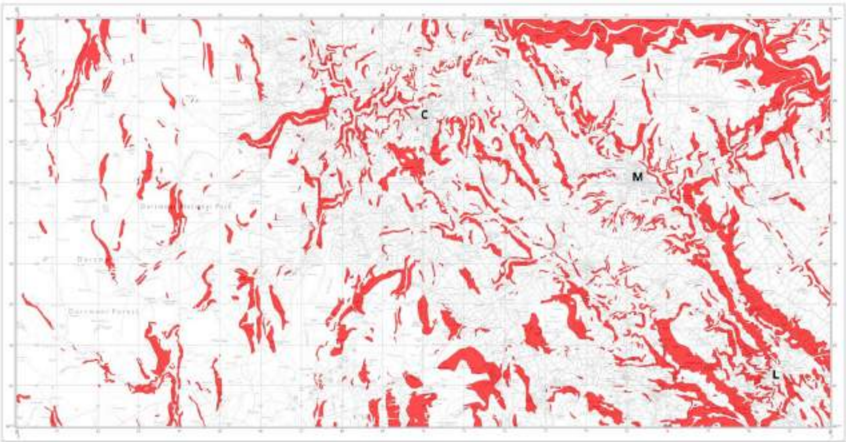



**Figure 7. Slopes steeper than $11^{O}$ shown in red.**

**C** = Chagford, **L**= Lustleigh, **M** = Moretonhampstead. The base map is © Ordnance Survey, licence 100024842, supplied by Dartmoor National Park Authority.

---

## 3.27 ROCKY / BOULDERY PHASES

Much of Dartmoor has a scatter of detached boulders or outcrops of granite breaking the surface, amounts varying from place to place. In addition to the Rock Dominant map unit on the soil map and described in Section 3.25, the differing lesser concentrations are shown on the accompanying terrain map as three phases: *No boulders, no rocks; Slightly bouldery or rocky* and *Very bouldery or rocky.* Mapping was based on the presence or absence of rocks and boulders visible above the ground surface. Among the rocks indicated by the phase mapping are small outcrops of *in situ* granite, barely distinguishable from detached boulders, others are upstanding blocks of *in situ* granite, isolated after the surrounding ground was eroded away, some having the form of miniature tors. Mapping was not extended into the peat soil areas because of the distorting effects of peat growth, erosion and fuel cutting.

**Plate 55. Boulders and outcrops of granite.**

Although adding to the charm of the landscape, frequency of boulders and small outcrops restrict the efficient use of machinery by those who have to wrest a living from the land.

The phases are defined as follows:

> *No boulders, no rocks*: No or very rare boulders or rock outcrops at the surface. Shown in yellow on the terrain map, 6,732 ha fall in this unit.
>
> *Sightly bouldery or rocky*: Occasional boulders or rock outcrops breaking the surface creating minor inconvenience to the user of the land. Marked in brown on the terrain map, this phase occupies 6,659 ha.
>
> *Very bouldery or rocky*: More than about 10% boulders or rock outcrops to the surface sufficient to seriously inhibit land use, affecting Agricultural Land and Land Use Capability Classifications. There are 2,950 ha of this phase on the terrain map, where it is coloured blue.

On the terrain map Rock Dominant from the soil map is shown in red. Land in the Urban and Disturbed Ground map unit [Section 3.24] and in the peat soil units [Sections 3.10, 3.11 and 3.12] was not classified.

In nature, the quantity of surface rocks and boulders is a continuum from none to the complete cover mapped in the Rock Dominant map unit [see Section 3.25].

However mapping is made practicable using categories of the above kind. Apart from on land where boulders have been cleared for agriculture, their incidence reflects variations in the granite, particularly joint spacing and its effect on decomposition by hydrothermal and pneumatolic alteration and subaerial deep weathering, which have produced corestones and growan. Subsequently roles have been played by processes affecting solifluction and the development and movement of the Upper Head, along with tor and clitter formation.

Conditions on parts of the limited outcrop of the Carboniferous aureole rocks, notably on the south side of the Teign Gorge between Whiddon Park [721892] and Steps Bridge [804883], must be included in this list. There not only do rocky and bouldery areas contain granite blocks, which have moved downslope onto the aureole, but large boulders of tourmalinised rock, in a few places, as northeast of Smallridge [782885], sufficiently dense to justify mapping as Rock Dominant clitter. On the north side of the Teign, there are many bare rocks high on the valley side, as at Sharp's Tor [729899], where the fluted crags produce broad ravines in which angular scree has deposited lower down the slope. In places, such crags and screes are concentrated enough to map as the Rock Dominant map unit, elsewhere they are more fragmented and are shown as the Bridford and Drogo with Crags map units [Sections 3.17 and 3.21]. Similar ground forms at 778801 southeast of Manaton.

**Plate 56. Casely Court, with rocky ground on Casely Cleave behind.**
Photographed in 1930. Photo courtesy of Mrs P.A. Jacoby.

**Plate 57. Casely Cleave in 2012.**

Comparison with Plate 56 demonstrates how readily rocks become hidden in woodland.

---

## 3.28 PEAT SOIL EROSION PHASES

Much of the Winter Hill and Hepste peat soil map units have been eroded by gullies and channels. These vary from scarcely noticeable to several metres across, up to 4 m in depth and over 100 m in length. While some are completely revegetated, others are suffering active erosion with substantial areas of bare peat exposed. Historically peat has been cut for fuel in the more accessible locations. Often it is difficult to distinguish between peat workings and erosional features, partly because gully sides were cut, so that erosion phases could only be mapped with confidence in the more remote, western parts of the Winter Hill map unit and shown in green and purple on the terrain map supplementing this survey's soil map.

It shows 3 categories of erosion*:*

*Pristine*, that is uneroded, [about 246 ha], coloured purple on the terrain map

*Slightly Eroded* [around 412 ha], light green on the terrain map

*Severely Eroded* [some 232 ha], dark green on the terrain map

The mapping was done by a combination of field observations and remote sensing. The latter involved the use of stereoscopic, vertical aerial photos and on-line sources, notably Google Earth and Bingmaps. Description of ground form in these phases is given below, with a summary of measurements in Table 13. In any mapping exercise considerations of scale, interacting with the spatial properties of the features mapped, mean that small enclaves of ground with properties of one phase are occasionally included within more extensive tracts of another category. Additionally it must be kept in mind that boundaries between map units are not always abrupt, but often mark zones of transition.

To characterise each of the three phases, the expression of peat erosion was described in the immediate vicinity of 226 evenly distributed points [approximately 1 per 3.9 ha] across the high moorland. This was carried out independently of the delineation of boundaries between the three phases. As with other 'free' soil mapping, the surveyor's experience and judgement decided on the observations' locations, these being chosen to be representative of the slope facets and other features being sampled. Relevant properties of erosional features were recorded in the field, including their form and pattern, their dimensions and the amount of ground affected. The following were recorded and are summarised in Table 13:

- Proportion of the ground affected *[as a percentage]* within a radius of 25 m
- Dimensions *[median and maximum]*
    - -depth *in centimetres (cm)*
    - -width *in metres (m)*
- Pattern
    - -dendritic
    - -consequent alignment
    - -network / haggs:
    - -uncertain
- Activity
    - -degraded / relict features
    - -fresh, active features
    - -uncertain
- Proportion [as percentage] of sides and floors vegetated
- Other properties, such as the length of channels and the spacing between them, were recorded where possible. However, often these were uncertain and so are not included in the Table 13.

The table shows the form and extent of erosion, principally on the slightly and severely affected phases. It indicates that, whereas around two thirds of the severely eroded areas are affected, less than half of the slightly eroded unit has been degraded.

Results from the traverses measuring peat thickness in Chapter 5 are of similar orders. Of the 140 observations falling within the severely eroded phase 96 [68%] were at sites eroded to a degree, in the slightly eroded phase 80 [24%] of the 341 were at eroded locations. Not only is the degradation more widespread in the severely eroded phase, but it is deeper and more acute, commonly reaching the mineral substratum. Dimensions of gullies and other erosional features are substantially greater. There depths average around 70 cm and widths 3-4 m compared with about 40 cm and about 2 m on the slightly eroded phase. Maximum depths and widths are similarly contrasting.

Channels with consequent alignment [i.e. directly down the slope] and dendritic patterns are more prevalent on the severely eroded phase. Reticulate or network patterns characterise over 60% of the slightly eroded phase, contrasting with the 45% for the combined network and hagged ground in the severely eroded ground. The presence of haggs on 15% of the latter land is a token of the more advanced, deeper erosion there, no such features being recorded on the slightly eroded phase. Similarly at 39% of sites in the severely eroded phase channels were clearly actively scoured in some part, compared with only 10% at slightly eroded sites.

Definition of the pristine phase may seem self-explanatory. Its usually featureless form observed in the field is consistent with that, with its 59 nil results excluded from Table 13. In places the pristine ground is diversified by shallow, often serpentine, pools / channels and in one or two others by low hummocks. The five 'anomalous' entries in the table are from sites close to boundaries to other phases or in small, un-delineated enclaves. These minor occurrences have some properties comparable with those in the slightly eroded phase, [proportion of ground affected and width of channels], although the latter are shallower.

Away from the uplands, such as Dartmoor, erosion on mineral soils is noticeable as re-deposited material from gullying, slipping and scarring. In arable fields often the most immediate sign of a season's erosion in a crop is the sizeable spread of fans of freshly deposited and sorted soil on lower slopes. However on the peat in this area similar clear evidence of deposition, commensurate with the scale of erosion, is not often apparent on footslopes. Deposits of freshly eroded peat can be evident within the floors of gullies, although, because of the similarity between them and the *in situ* peat, it is not always readily apparent and distinction can be difficult. The majority of the surfaces of gullies and channels are vegetated [Table 13], with much of the evidence of deposition consequently obscured. In places permanent or semi-permanent pools in channel bottoms add to this. The vegetation cover further indicates that the features are long standing, suggesting that annual losses to the drainage network are comparatively small.

Despite consequent and dendritic patterns of gullying being observed at a majority of the severely eroded sites, [reticulate patterns are prevalent on the slightly eroded phase], these appear to be mostly small scale and not systems integrated into the permanent drainage network. More often than not flow that is locally concentrated into channels gradually diffuses downslope, although there are exceptions. In places, such as at 605840, on the footslope south of Black Hill, runoff has been sufficiently concentrated to generate secondary erosion, shown on the soil map as a ribbon of the Crowdy map unit.

**Table 13. The form and severity of peat erosion.**
[Within 25 m radius of observation point]

**a] The dimensions of channels.**

| Phase | Severely Eroded n=63 | | | Slightly Eroded n=81 | | | Pristine n=64 of which 5 were eroded | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Range | Mean | SD | Range | Mean | SD | Range |
| | | | | | | | | | |
| **Affected[%]** | 68 | 22 | 20-100 | 46 | 24 | 5-100 | 44 | 30 | 10-80 |
| | | | | | | | | | |
| **Depth [cm]** | | | | | | | | | |
| Median | 70 | 27 | 30-150 | 40 | 23 | 10-150 | 10 | 8 | 10-30 |
| Max | 12 | 34 | 40-200 | 74 | 39 | 30-200 | 32 | 15 | 20-50 |
| | | | | | | | | | |
| **Width [m]** | | | | | | | | | |
| Median | 4.1 | 5 | 1-40 | 2.1 | 1.3 | 0.5-6 | 2 | 0.9 | 1-3 |
| Max | 9.8 | 12.9 | 3-100 | 4 | 3.9 | 1-20 | 4 | 1.4 | 2-60 |

**b] Patterns and activity of erosion.**

| Phase | Severely Eroded n=63 | Slightly Eroded n=81 | Pristine n=64 of which 5 were eroded |
|---|---|---|---|
| | | | |
| **Pattern** | Consequent 10 [17%]<br>Dendritic 21 [35%]<br>Haggs 9 [15%]<br>Network 18 [30%]<br>Uncertain 2 [3%] | Consequent 8 [10%]<br>Dendritic 15 [19%]<br>Network 51 [62%]<br>Uncertain 8 [10%] | Network 5 [8%] |
| | | | |
| **Activity** | Fresh 24 [39%]<br>Relict 18 [29%]<br>Uncertain 20 [32%] | Fresh 8 [10%]<br>Relict 52 [63%]<br>Uncertain 21 [27%] | Fresh 2 [3%]<br>Relict 3 [5%] |

**c] Vegetation cover on erosional features.**

| Phase | Severely Eroded n=63 | | | Slightly Eroded n=81 | | | Pristine n=64 of which 5 were eroded | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Range | Mean | SD | Range | Mean | SD | Range |
| | | | | | | | | | |
| **Sides %** | 77 | 17 | 40-100 | 91 | 14 | 50-100 | 100 | 0 | 0 |
| **Floor %** | 95 | 10 | 50-100 | 97 | 9 | 50-100 | 100 | 0 | 0 |

Where the main rivers, notably the East Dart, penetrate the blanket peat much of their upper reaches are flanked by narrow strips of the Crowdy map unit. This complex array of re-deposited peat and alluvium is commonly flanked on its boundary to the Winter Hill soils by a steep bluff or a peat ‘cliff’, with gullying and, occasionally, collapses of large blocks of peat.

**Plate 58. Farmland on Moretonhampstead and Laployd soils west of Chagford.**

The freely draining Moretonhampstead soils cover the rolling hills, with the groundwater-affected Laployd map unit in the rushy valley bottom. The nearer hedge follows the soil change exactly, that beyond the rushes broadly, if less precisely.Tthe Laployd map unit has potential for the restoration of rhôs pastures.

**Plate 59. View into the Forder-Wray vale, looking northwards from above Sloncombe, Moretonhampstead.**

This landscape, dominated by the freely draining Moretonhampstead soils, is diversified by strips of wetter ground of the Laployd soil map unit along valley floors, picked out here by the rushes in the middle ground.

**Plate 60. The view northwestward from Mardon Down to Butterdon Down.**

Most of the rolling farmland is underlain by freely draining Moretonhampstead soils. Moor Gate soils mantle the foreground slope and Butterdon Down, while the valley floor beyond the line of trees is affected by springs and groundwater, having Laployd soils with rushy and heathy rhôs pasture. On the foot-slope of the field on the left of the middle ground, the wet land has been enclosed, the dark green marking rushes and sedges, including those in Plate 81.

**Plate 61. On the northern flank of Broad Marsh 3 extensive moorland soils abut.**

In the foreground the flat basin floor carries the Crowdy map unit, while the hill top has blanket peat of the Winter Hill unit. A sinuous bluff, marked by the dark line, is the blanket peat's junction with the mineral soils of the Hexworthy / Rough Tor map unit, which occupies the stronger, lower slopes.

**Plate 62. The high moorland blanket bog, with cotton grass in flower.**

**Plate 63. A moorland gorge along the East Dart, southeast of Sandy Hole Pass.**

The steep slopes are cloaked with soils of the Hexworthy / Rough Tor map unit, with patches of Rock Dominant on the northern side. On the gentler slopes above the gorge blanket peat replaces the mineral soils. Part of the valley floor has a ribbon of the Sulham / Eversley soil unit in wet alluvium.

**Plate 64. Watern Tor, comprised of lamellar granite, in the foreground.**

Steeperton Tor sits at the centre of the skyline, with the broken outline of Wild Tor to its left. On the steep slope in the middle ground is the strip of granite clitter above Wild Tor Well, shown in Plate 52. Blanket peat around Watern Tor, and on much of the background's ridge near Wild Tor, was stripped by medieval carbonarii for charcoal production. Hexworthy / Rough Tor soils have developed on the steeper ground.

**Plate 65. Soils of the Crowdy map unit in the valley bog west of Statts Bridge.**

The bright green areas in this map unit are notoriously treacherous. Most of the sloping middle ground has Hexworthy / Rough Tor soils, interspersed with strips disturbed by tin workings.

# Chapter 4 Soil Functions

## 4.1 BACKGROUND

Soils matter for economic, environmental, social and scientific reasons. They play various roles in diverse ways depending on their properties and qualities. Blum's [1993] concept of *soil functions* can be summarised as follows*:*

- *Food, timber and biomass production*. This is the most immediately vital of soil functions, recognised since prehistoric times. Interactions of soils and climate strongly influence the land's fertility and productive capacity, unless moisture reserves are supplemented by irrigation. Furthermore those interactions affect whether land can be cultivated, some difficult soils having to stay in woodland or grass, some is 'boys' land', readily cultivated in all but the wettest times.
- *In the environment*. Soils influence the flow of water and the transfer of pollutants; they can affect flood risk. Soil organic matter and clay can adsorb contaminants.
- *Large amounts of carbon are stored in soils.* They also interact with the air; soils can be sources of nitrous oxide and ammonia. Peat soils can be sources of methane. Organic matter can also be a source of carbon dioxide by simple oxidation. Soils can store large amounts of carbon when managed appropriately, e.g. under forest or long-term grass.
- *Habitats and biodiversity.* Soils are the foundations and key components of terrestrial ecosystems. There is a great variety of organisms and bioactive substances within soils, much of it undiscovered. They are the bridge between biodiversity and geodiversity.
- *Cultural and archaeological heritage*. Soil has been a key part of rural economies for millennia, particularly providing food, fuel and timber, but also influencing farm and field names and patterns, the location of woodlands, footpaths, roads and even vocabulary. Because of their economic and environmental contributions, soils and their use and management are targets for substantial amounts of public funds. In consequence over the years 'cross compliance' has been conditional on aspects of soil management being implemented. The quality of soil is commonly a consideration in rental agreements for rural land. Soils can be repositories of pre-historical environmental, climatic and archaeological evidence, peat deposits furnishing particularly strong examples. Some battles have been decided by soil conditions. In forensics, application of soil information has considerable potential.
- *Sources of raw materials.* Although the historical exploitation of soils, peat for fuel, some soil horizons for glass-making sand, or cob for buildings,

has largely ceased, topsoil continues to be traded, while the thermal properties of soil have a place in planning ground-sourced heating systems. Soils are highly vulnerable during handling, quarrying and other abstractions of raw materials. Soil pigments, such as umber and ochre, have been used since the Stone Age. Microbes in the soil are diverse, over the years having been the origin of pharmaceuticals, with the possibility of more in the future.

- *Platform for buildings, roads and infrastructure.* Different soils have their own engineering properties, some are unstable, some corrosive to metals or timber, some are resistant to normal excavation methods. Once sealed and compacted by buildings, roads etc., most functions of soils are lost. Even for ‘soft engineering’ uses of land, such as refurbishing footpaths or short-duration festivals, soils conditions are pertinent. On better suited soils Glastonbury’s Festival would have a very different reputation.

Soil functions can interact, complement or conflict, so benefiting from sustainable management practices and suffering from the bad. For example waterlogging may encourage accumulation of plant residues and thus carbon storage, complementing the conservation of habitats like rhôs pastures, but conflicting with farmers’ needs and, by encouraging runoff, aggravating flood risk. Loss of organic matter or excessive cultivations can degrade the hydrology of soils; naturally freely draining light soils, sometimes over major aquifers, capable of accepting many millimetres of rain per hour when in good heart, widely generate runoff from rain of 1 or 2 mm per hour when capped or compacted, prejudicing surface waters.

## 4.2 BROAD PRINCIPLES OF EVALUATION

Broad assessment of soil functions is possible intuitively for some purposes, given an understanding of an individual soil’s properties as described in Chapter 3. For example the amount of carbon stored in a metre of peat is clearly much greater than in the same thickness of mineral soil, while a perennially waterlogged soil will induce very different hydrological responses to a freely draining profile. In some circumstances a more systematic analysis will be possible, with some of the listed functions ranked or semi-quantified, but others remaining less amenable to ordering. Given either approach the relevant soil properties, and their interactions, tempered by climatic considerations and in places slope and site, will include:

- texture [particle size distribution]
- wetness class
- organic matter content
- structure [aggregation] and porosity
- soil moisture reserves and release characteristics
- pH

- clay mineralogy
- nutrient status

The morphological expression of soil hydrology, indicated by the presence or absence of gleying, is at the heart of the soil classification of Avery [1980] and soil hydrology is a major consideration when addressing many of the functions of soils. Soil wetness classes [Hodgson, 1997, p106-7] provides a robust scale applicable to most soil profiles, indicating the duration and depth of waterlogging. As the opening statement of Boorman *et al.* [1995] says "*it is difficult to overstate the importance of soils in influencing hydrological phenomena at both the site and catchment scale".* In the HOST [Hydrology of Soil Types] approach, Boorman *et al.* classify soils on the presence or absence of groundwater or an aquifer, the porosity and permeability of both the underlying geology and of the soil, of any gleyed horizons and any peat; all hydrologically critical properties. Other systematic and environmentally relevant soil assessments, such as that used in groundwater vulnerability mapping by Palmer *et al.* [1995], similarly draw on soil properties.

The capacity of soil and land to produce food, timber and biomass, that is its natural or inherent fertility, is a concern for economic, strategic and planning reasons. It has been addressed in a number of ways. The Agricultural Land Classification [MAFF 1988] broadly assesses land into six grades, numbered 1-5, grade 3 being split into 3a and 3b. Properties of soil, climate and site, particularly slope, are integrated to derive the grading. As well as its primary purpose as a tool in the planning process, it is widely used in the assessment of farm rents and in prospectuses for farm sales. Land Use Capability Classification [Bibby and Mackney, 1969] adopts a similar but more detailed approach, characterising the site's restrictions in its class labels. It also elaborates beyond MAFF's agricultural constraints and grade 5, to denote land with very severe or extreme limitations via additional classes 6 and 7.

A method outlined in Findlay *et al.* [1984, p64-5] compares soil moisture reserves [available water] with climatically determined moisture deficits to rate degrees of *soil droughtiness*. This property has a dominating influence on crop or biomass productivity, and is a context within which to see the effects of fertilisers. Indeed MAFF [1982] uses a similar approach for nitrogen fertiliser use on grass. *Workability* and *trafficability* of the land, as assessed by Findlay *et al.* [1984, p62-4] ranks the other interacting soil moisture [notably soil wetness class and texture] and climatic constraints on the potential of the land. Suitability for grass production and various arable crops, the latter less relevant in this district, can then be assessed systematically, as in Findlay *et al.* [1984, p337-55].

A similar approach applied to silviculture and forestry is that of Findlay *et al.* [1984, p356-65] drawing on the classifications of Rowan [1977], Booth [1977] and Pyatt [1982]. This attributed soil series to suitability groups according to soil and site properties, along with considerations of likely management needs, with the best-suited broadleaved and coniferous species identified.

In an area with extensive peat soils, as blanket peat, in basins and as topsoils of acidic mineral soils on the moorland, as well as on some of the in-bye, carbon storage is an important soil function. Thicknesses of peat and its distribution are considered in Chapters 3 and 5. In places, notably on the Hepste map unit, erosion and cutting have not only depleted the peat but have changed its hydrology and might have caused humification. The latter may be in part a natural process, a response to environmental change affecting the fringes of the fibrous peat of the blanket bog's core. Alternatively the thinner peaty tops of the mineral soils downslope are humified, so that Hepste soils could represent a thickening of that rather than a degradation of the fibrous peat. Within the peat there are sources of greenhouse gasses, natural processes producing methane, while degradation and oxidation of the deposits release carbon dioxide.

Within this district, as with the rest of the southwestern granite outcrops, the radioactive gas radon is a public health concern. Derived from the radioactive decay of uranium in the granite, radon rises through fissures and pores in the rock and soil. Waterlogged and impermeable soil horizons may well play a part in attenuating radon emissions into buildings and the atmosphere.

Soils have a strong influence in ecology; conversely, indicator plants provide guides to soils. Classifications, such as that of Ellenberg [1974], address some of those relationships. Locally the pristine phase of the Winter Hill soil map unit on high Dartmoor supports blanket bog vegetation and, with that, the most southerly breeding ground of the dunlin. At lower altitudes, there is a link between rhôs pastures, key habitats for marsh fritillary butterflies, and the Laployd and Sulham / Eversley soils. The suitability of the freely draining soils of the in-bye for farming makes examples of soil and ecological links less obvious than on wetter sites. Nevertheless they are there wherever intensive agriculture relaxes its grip, as each Spring's carpets of bluebells at places such as Shapley [712834], Challacombe [693804] and Broadmoor Common [757898] display before the bracken takes over. Similarly a few hay meadows still come ablaze each June. The dry soils are favoured by burrowing animals from earthworms to badgers and foxes. Although parts of the Moor Gate soil map unit in the in-bye are now farmed in large, often rectangular fields, their humose or peaty tops clearly developed under heathy or bracken and gorse-dominated downland [as many field names imply] and- occasionally- moorland, being enclosed only relatively recently. Conversely there are small inclusions of non-humose soils in the open moorland. In both ways the soil map can provide records of former landuse and vegetation patterns.

Such links between soils and field boundaries are part of the cultural heritage. Examples are commonplace in the in-bye, particularly where freely draining

Moretonhampstead series give place, often abruptly, to the wet ground of the Laployd map unit, in many places along sinuous hedgebanks, the original enclosers of the land being alive to the differences in soils. At first sight longstanding footpaths across Lustleigh [767812] and Water [764811] Cleaves meander pointlessly, prolonging the journey between the two villages. However, with benefit of the soil map it can be seen that they avoid the worst of the Laployd soils and stick to the dry ground upslope. Until the arrival of motor transport such paths would have performed a real role in rural society. Indeed one of them was, until the turn of the century, the daily route of a farm worker living in Lustleigh [785813] and employed at Water [759808]. In recent years significant archaeological sites concealed by the area's soils have come to light. Outstanding among these was the Bronze Age kist on Whitehorse Hill [615853] containing tin beads, turned wood, fabric and fur. The stone circle discovered in the peat near Sittaford Tor [633830] in 2014 also deserves mention.

Locally peat soils were a source of fuel during most of the last millennium. Peat was cut by commoners, tinners and, on a near industrial scale, charcoal burners, the carbonarii. The scarring of the landscape by peat cuttings, in places more than a metre deep, is striking and of greater area than tin workings. Not only was peat taken from the blanket and basin bogs but the thin peaty tops of drier mineral soils were widely trimmed for vags, turves used as inferior fuel. The resulting unevenness of the ground, albeit slight, is readily noticed, while the cut areas reveal themselves on aerial and satellite photographs. The soil cover was an immediate casualty of both the streamworks and the openworks of the tinners. However in many places the disturbed terrain provides a greater diversity of ground conditions and habitats than on the adjacent untouched land. Across most of Devon soil, in the form of cob, was a traditional building material. On the granite it is less common, stone being in plentiful supply, if only as undressed, random blocks. Where used locally cob was mainly confined in the higher courses to finish stone walls with an even top. An interesting exception is at Jurston [696844], where cob walls abut one of granite ashlars, the latter hardly the poor man's building stone.

At a time when alternative uses of land are increasingly sought, soils matter for 'soft engineering,' undertakings associated with recreational use, such as campsites or new or restored footpaths. For the latter wet soils can present challenges demanding expensive solutions. George and Jarvis [1979] have ranked soil and site properties affecting suitability for footpaths, camping, caravan and picnic sites. Similar principles could be applied to short-term but intensive use of land for outdoor shows and festivals. For the walker on open moorland, the soil map reveals the difficult, sometimes dangerous, ground of the basin peat, the severely eroded blanket bog and the tinners' streamworks and gerts.

Instances of the varied influences of soils, and their interactions with weather and climate can be exemplified in terms of ground surface conditions. These may be seen in a range of circumstances, from ease of cultivation or trafficability for agriculture, through fitness of sports pitches or going for horse races, to their effects on outcomes of battles and military research and intelligence.

In the context of timeliness cultivation, the calculations in Findlay *et al.* [1984] and other Soil Survey Bulletins of that year, of 'good machinery work days' for a range soils and various localities, based on Thomasson [1982], refined systematic analysis of such interactions of soil and climate to a high degree.

Historically [Younger, 2012] it is known that defeat or victory on the battlefield has often hinged on soil conditions. Flodden [1513] was lost because an attack floundered on ground-water gley soils; at Prestonpans [1745] defences behind similar wet ground were outflanked, thanks to local knowledge of the ground. Come the era of mechanised warfare, the limitations of tanks on wet ground were soon demonstrated in Flanders. This lesson was not lost on German military intelligence in preparing for Operation Sealion in 1940 [Willig and Häusler, 2012]. Then ease of cross-country going in southern England was second only, as a mapping priority, to identification of potential water supplies.

## 4.3 SOIL FUNCTIONS IN DETAIL

### 4.3.1 PRODUCTIVE LAND USE

In terms of their capacity for production of crops, timber and biomass the district's soils divide primarily between the more or less freely draining and those with significant wetness. However, other influences, notably climate, slope and, on the moorland and in some of the valleys, considerations of amenity and conservation concern, come into play. Pertinent soil properties summarised in Tables 14 and 15 are wetness class, soil moisture characteristics, and workability and trafficability. These indicate that the freely draining group underlying easily used land, are readily stocked, cultivated and trafficked, although commonly subject to some moisture stress, whereas the wet soils are difficult to manage, although free from droughtiness. These contrasts are at the root of the agricultural ratings summarised in Table 15.

**Suitability of land for agriculture**

Critical climatic thresholds used by Bibby and Mackney [1969] in their Land Use Capability Classification involve balances of soil moisture and temperature along with rainfall amounts and altitude, increasing wetness and relative cold; all can trigger downgrading. Annual average rainfall amounts provide important class limits, so some consideration has to be given to balancing the available information in Section 1.5 and the consequences of any climatic change. As noted there an eastward shift of the isohyets since the 1970s seems likely. While the district's northeastern and southeastern parts are sufficiently dry for the 2 highest classes, conditions there, soil depth and stoniness, slopes and flood risk, generally rule them out from those classes. Land between 122 and 182 m O.D. with annual rainfall between 1143 and 1270 mm is not better than Class 3. Figure 4, the map of annual average rainfall, places this land in a strip about 2 km wide in the north near Rushford Wood [703896], running south eastwards to Moretonhampstead, where it bulges eastward to Mardon Down [772879] and Blackingstone Rock [786856], then narrows between Sanduck [768836] and Lustleigh [785813] to about 1 km across. The rainfall limits affecting classes 4 and 5 at 1270 and 1524 mm map out as a band 2-4 km wide, again with a strong northwest to southeast alignment. In the north, as far south as Frenchbeer [675857], its upper limit runs close to the moorland's boundary with the in-bye. Southeast from there it passes over Easdon Hill [733823], then swinging south to Cripdon Down [734805]. Within the 1270-1524 mm strip, land below 182 m O.D., given suitable soil and slope conditions, may qualify as class 4, as in the valleys of the Teign below Leigh Bridge [683876] and the Bovey below Foxworthy [757821].

**Table 14. Important soil properties for production and other functions.**

| *Soil* | **Wetness class** | **AP* mm** | **Dryness class** | **Steep slopes** | **Boulders & rocks** |
|---|---|---|---|---|---|
| **Moretonhampstead** | I | 110 mm but variable depths | *b*- varies, *c* in east | Common | Common |
| **Moor Gate** | I | 113 mm | *b* | Common | Common |
| **Furlong** | I | 110 mm | *b*- varies, c in east | Common | Common |
| **Hexworthy / RoughTor** | ? | | *a* | Slight | Common |
| **Halfway House / Drewston** | III & IV | 120 mm | *b* | No | A few |
| **Princetown** | V | | *a* | No | Common |
| **Laployd** | V | | *a* | No | Common |
| **Winter Hill** | VI | | *a* | No | |
| **Hepste** | V | | *a* | No | |
| **Crowdy** | VI | | *a* | No | |
| **Tavy / Ty-Gwyn** | 1& III | 100-165 mm | *a-c* | No | |
| **Sulham / Eversley** | IV & V | | *a* | No | |
| **Halstow** | III | 124 mm | *b* | No | |
| **Denbigh** | I | 90 mm | *c* | Many | |
| **Bridford** | I | 84 mm | *c* | Many | A few |
| **Drogo** | I | 115 mm or less | *b* and c | Predominant | A few |
| **Willingstone** | I | 150 mm | *a* | Throughout | |
| **Tedburn** | IV | 186 mm | *a* | No | |
| **Steep phases** | | | | Throughout | |
| **Very rocky / bouldery phase** | | | | | Many |
| **Rock dominant** | | | | | Dominant |

*AP denotes profile available water to 1 m depth

Ground higher than 183 m O.D. falls in class 5. This class can pass above the 1524 mm isohyet if the land is below 305 m O.D., examples being around Barramoor [717835] and Vogwell [722817] and in the Bovey valley above Jurston Bridge [697850]. Failing that, it cannot be better than class 6.

MAFF's [1988] Agricultural Land Classification defines its grades by accumulated temperature plotted against annual average rainfall. In this district the resultant grade boundaries fall in broadly similar positions to the numbered classes following Bibby and Mackney [1969].

For the freely draining soils, Moretonhampstead, Moor Gate, Denbigh and Bridford series, although easily worked, stocked and trafficked most of the year, shallow, stony profiles limit moisture reserves, particularly in the drier eastern parts, so that in favourable sites these series are class 3s in the Land Use Capability Classification of Bibby and Mackney, [1969] and grade 3a in MAFF's [1988] Agricultural Land Classification. Class 3 is *land with moderate limitations that restrict the choice of crops and/or demand careful management.* An additional climatic limitation affects these soils where annual average rainfall rises above 1143 mm and altitude above 122 m O.D. In wetter parts of the district where annual average rainfall exceeds 1270 mm there is relegation to class 4c [MAFF grade 4], class 4 being *land with moderately severe limitations that restrict the choice of crops and / or require very careful management.* This affects Moor Gate and Moretonhampstead soils roughly west of the Forder–Wray vale [followed by the A382 road]. A further downgrading to class 5c / grade 5 applies where annual rainfall exceeds 1520 mm, the isohyet following approximately the main moorland boundary between Buttern [657894] in the north and Natsworthy [721998] in the south. Class 5 is *land with severe limitations that restrict its use to pasture, forestry or recreation.* This takes in the moorland occurrences of Moor Gate soils, notably around Hookney Tor [699813], along with small tracts of Moretonhampstead soils, as around the Fernworthy reservoir [671843]. On steeper slopes relegation to class 4g comes between 12 and 15$^{O}$, 5g between 16 and 25$^{O}$, and 6g on slopes more than 25$^{O}$. The definition of class 6 is *land with very severe limitations that restrict its use to rough grazing, forestry and recreation.* In the MAFF scheme all slopes above 18$^{O}$ are grade 5. Much of the Drogo map unit is classed as 5g, while all of it falls in areas of overriding amenity and landscape value. Very bouldery ground seriously limits agricultural use and is class 6sg [Bibby and Mackney 1969], and grade 5 in the MAFF classification. Because of their greater depth and moisture reserves Furlong soils east of the 1270 mm annual average rainfall isohyet are class 3c in the Bibby and Mackney [1969] classification. Flood risk places the Tavy / Ty-Gwyn map unit in class 3w or grade 3b in the drier parts, but class 4cw / grade 4 higher in the catchments. There is a 7$^{th}$ class in the Bibby and Mackney [1969] classification, *land with extremely severe limitations that cannot be rectified,* represented here by the Rock Dominant map unit.

Among the wet soils the severity of the restriction varies. In the Halfway House / Drewston and Halstow map units rating is class 4w [grade 4 in MAFF's classification], with an added soil restriction placing Halstow soils in class 4ws. The severe seasonal wetness affecting Laployd, Sulham, Eversley, Hexworthy, Rough Tor and Tedburn soils puts them in Bibby and Mackney's [1969] class 5 and MAFF grade 5. Laployd, Sulham / Eversley and Tedburn soils are 5w, Laployd on account of high groundwater, Sulham and Eversley soils because of groundwater and flood risk and Tedburn because of surface wetness. Hexworthy / Rough Tor soils are classed as 5cw [grade 5] on account of the extreme moorland climate and their surface wetness, although other considerations [amenity, landscape and conservation] are overriding, except in the plantations. Similarly the extreme, permanent wetness of the peat soils in the Winter Hill, Crowdy and Hepste map units and the almost permanent wetness of Princetown soils results in classification as 6w [MAFF grade 5 or unclassified], which again is trumped by non-agricultural priorities throughout the moor.

**Plate 66. In a district dominated by grassland, there are occasional tillage fields.**

Mostly used for reseeding or forage crops, coarsely textured soils, together with the district's wet climate, mean that there is a frequent need for lime applications, if crops are to thrive.

### Crop suitability

Grass is the district's principal crop, the climate favouring its growth and discouraging sustained arable cropping. While the freely draining soils suffer some droughtiness in dry seasons, [exemplified by ratings of *b* and *c* for dryness and average for ADAS growth in Tables 14 and.15, the long growing season and the soils' readily trafficked nature compensate. Drought is no restriction for grass growth on the wet soils, but access and utilisation, summarised in Table 15, column 3, as trafficability and poaching risk, are. Unless damage to swards, and the consequent losses of quantity and quality of herbage are accepted, these soils are only suited to use during the summer. Furthermore Peel *et al.* [1988b] showed that grazing cattle spoil and reject substantially more herbage on wet soils than they do on dry ground.

**Table 15. Rating for production.**

| Soil | Work-ability | Traffic-ability & poaching risk | Land Use Capability class | Agricultural Land Class-ification grade | Grass-land suitability | ADAS grass growth | Upland grazing value | Forestry Comm-ission class |
|---|---|---|---|---|---|---|---|---|
| **Moreton-hampstead** | a | 2 | 3c or 4g | 3a or 4 | A | Average or good | High | 1,1d |
| **Moor Gate** | a | 3 | 3c, 4c or 4g | 3a or 4 | B | Average or good | High | 1u |
| **Furlong** | a | 2 | 3c or 4g | 3a or 4 | A | Good | | 1,1d |
| **Hexworthy / RoughTor** | | 5 | 5cw | 5 or U | D | | Moderate | 4, 4z & 4b |
| **Halfway House / Drewston** | c & d | 3 &4 | 4w | 4 | B & Cp | Good or very good | | 1bg & part 7b |
| **Princetown** | | 5 | 6cw | 5 or U | D | | Moderate | 6 |
| **Laployd** | | 5 | 5w | 5 or U | D | | Low or moderate | 5h |
| **Winter Hill** | | 5 | 6w | 5 or U | D | | Low | 9,10,11 |
| **Hepste** | | 5 | 6w | 5 or U | D | | Low | 9,10,11 |
| **Crowdy** | | 5 | 6w | 5 or U | D | | Low | 9,10,11 |
| **Tavy / Ty-Gwyn** | a & c | 2 | 3w or 4cw | 3b or 4 | A | Very good | | 1/v |
| **Sulham / Eversley** | | 4 & 5 | 5w | 5 | Cp | Very good | | 5/v |
| **Halstow** | d | 4 | 4ws | 4 | Cp | Good | | 7 & 7b |
| **Denbigh** | a | 2 | 3s or 4g | 3a or 4 | B | Average | | 1, 1d |
| **Bridford** | a | 2 | 3s or 5g | 3b or 5 | B | Average | | 1, 1d |
| **Drogo** | a | 3 | 3s or 5g | 3b or 5 | B | Average | | 1u |
| **Willingstone** | | 3 | 5g | 5 or U | D | | | 3 |
| **Tedburn** | e | 5 | 5w | 5 | Cp | Very good | | 7 & part 7b |
| **Steep phases** | | 4<br>5 | 4g *[12-15°]*<br>5g *[16-25°]*<br>6g *[>25°]* | 4 *[12-18°]*<br>5 *[>18°]* | C<br>D | | | |
| **Very rocky / bouldery phase** | | | 6sg | 5 or U | D | | | |
| **Rock dominant** | | | 7 | 5 or U | | | | |

NB: U in column 5 indicates land unclassified as non-agricultural on MAFF Agricultural Land Classification map.

The ratings of the wet soils for grassland suitability, following Findlay *et al.* [1984], are class Cp [with major restriction due to poaching risk] on the wet soils, and classes B [having slight yield or poaching risk restrictions] or class A [well suited] on the freely draining land. The steep slopes [over 11°] on parts of the freely draining land reduce trafficability and raise the risk of sward damage, consequently this land is placed in Grassland Suitability classes C [suited to seasonal pasture] and D [ill-suited to pasture] depending on whether occupying slopes over $25^{O}$ or not.

The assessment of upland grazing value following Bibby *et al.* [1982] is more appropriate in the moorland context, where agricultural considerations are subsidiary to those of amenity and landscape value. The ratings summarised in Table 15 reflect the nutritional value of the dominant vegetation of the soil map units, although in detail there can be some variation. The Moretonhampstead soils, with much of the Moor Gate map unit, supports bent-fescue grassland of high upland grazing value, although widely accompanied by bracken. In places the bent-fescue is replaced by bristle-leaved bent, a grass of low grazing category, while on parts of the Moor Gate unit the mosaic of vegetation is added to by dry heath with *Calluna*, also of low grazing value, which also occurs on parts of the Hexworthy / Rough Tor ground.

**Codes used in Table 15.**

| |
|---|
| **Workability:** after Findlay *et al.* [1984] p62-4; a = good, e = poor. |
| **Grassland suitability:** after Findlay *et al.* [1984] p 348-55; A = well suited, D= unsuited. |
| **Trafficability and poaching risk**: after Findlay *et al.* [1984] p62-4; 2 = good, 5 = poor. |
| **Land Use Capability class:** after Bibby and Mackney [1969]. |
| **Agricultural Land Classification:** after MAFF [1988]. |
| **ADAS grass growth:** after MAFF [1982]. |
| **Upland grazing value:** after Bibby *et al.* [1982]. |
| **Forestry Commission classes:** after Pyatt [1982]:<br>1, 1d, and part 1u = well drained, moderately acid, moist climate, much steep, some rough ground.<br>1bg and part 7b = seasonally wet loamy, most conifers.<br>1u = well drained, moderately acid loamy with peaty or humose surface, moist climate.<br>1/v = well drained alluvium.<br>3 = well drained, very acid loamy in moist areas, very steep.<br>4, 4z & 4b = very acid humose or peaty topped loamy soils, moist climate, seasonally waterlogged due to ironpan.<br>5h = Moderately acid, stony humose or peaty topped groundwater soils.<br>5/v = wet groundwater alluvial soils.<br>6 = severely waterlogged due to slowly permeable subsoil, moderately acid, peaty or humose top, stony.<br>7 & 7b = clayey, waterlogged with slowly permeable subsoil.<br>9, 10, 11= Permanently waterlogged peats, very weak ground conditions. |

On the wet soils of the Princetown, Hepste and Crowdy units and parts of the Hexworthy / Rough Tor map unit *Molinia* dominated grassland, of moderate upland grazing value is widespread, in places diversified by low grazing category wet heathland. On the Hepste, Crowdy and parts of the Winter Hill soils the latter pattern tends to be expressed on relatively dry sites in eroded areas and on the residual baulks around peat workings. Wetter ground on the peat soils, on pristine blanket bog, which is mostly on the Winter Hill map unit, in the floors of peat ties and in lower parts of the Crowdy basin peat areas, supports bog vegetation of low upland grazing value.

In terms of the Grassland Suitability classification, apart from the limited areas of Moor Gate and Moretonhampstead soils on the moorland, soils there classify as ill-suited to pasture on account of their wetness.

The district's moist climate means that land there is rated as unsuited to the sustained production of common arable crops, according to the scheme in Findlay *et al.* [1984] p337-47, where a mean potential maximum soil moisture deficit above 75 mm is a requirement. A small exception is northeast of the Teign between Clifford [781898] and Steps [804883] Bridges where Denbigh and Bridford soils on slopes under $12^{O}$ qualify as marginally suited for cereals, as that stipulation is met. Nevertheless the workability and trafficability ratings will be keys in assessing suitability for forage crops, such as maize, or fuel crops, particularly where harvested during the prolonged field capacity season, which lasts on average from early September to mid-May.

The balance between soil moisture reserves expressed in Table 14, losses due to evapo-transpiration and replenishment by rainfall, is summarised there as dryness class. As well as being a robust measure for assessing agricultural crop growth potential, it serves equally well as a guide to the different soils' potential for biomass production. The shallowness and stoniness of most of the freely draining soils, plus for a large part their dryer climatic location, results in dryness classes *b* and *c*. By contrast the wetter soils are rated as the more productive class *a*, mostly with an uncertain but substantial bonus from groundwater or tardy natural drainage.

The predominance of grass makes the risk of soil erosion on the district's farmland less than in much of the country. However the rapid drainage of the freely draining soils invites prolonged stocking and trafficking in the field capacity season, both cattle as well as sheep often being out-wintered. This induces sward damage and soil compaction, under severe conditions the latter encouraging runoff. In places compaction by out-wintered stock affects moorland soils too. Similar damage to the wetter soils, notably in the Laployd map unit, is a hazard for most of the year. Column 3 of Table 15 summarises the district's soils in terms of the risk of such damage.

As mentioned in this chapter's introduction, soil functions can overlap; issues around trafficability are a case in point. The ratings in column 3 of Table 15, as well as affecting agricultural production, have bearings on soil uses covering topics considered below under the headings 'amenity' and 'soil engineering'. Considering their use for, say, temporary vehicle parks or tracks, or storage of timber or hay and silage bales, the more amenable soils will be usable without significant damage during all but the wettest times. By contrast the wetter soils, rated 4 or 5 in column 3, are at risk permanently.

**Land suitability for woodlands and forestry**

The district's climate with its mild temperature regime, scarcity of frosts in the growing season and ample rainfall, favours tree growth. The comments below provide a local context for Findlay *et al.* [1984] p356-65.

The freely draining, moderately acid soils of the Moretonhampstead, Bridford and Denbigh map units, although often steep and bouldery, favour a wide range of species. The most suited broad leaved trees include oak, beech and Southern beeches, with among the conifers Western hemlock, Douglas fir, larches and Grand fir, plus Sitka spruce away from the dry eastern parts. Pike [1993] commented on the high quality of Douglas fir at Heathercombe [719810], a site on Moretonhampstead soils, where average annual rainfall is between 1500 and 1600 mm. Competition from weeds, particularly bracken and gorse, early in the life of plantations, can be expected. Local forestry experience is that the application of phosphorus fertiliser is not reckoned necessary when planting on this freely draining ground. Re-establishment of conifer crops using natural regeneration, as described 7 paragraphs below on Hexworthy / Rough Tor soils, is not feasible on these soils. Soil conditions encourage rapid weed growth, while Douglas firs are less suitable as seed sources.

The Moretonhampstead map unit has large areas of established broad leaved woodlands, usually oak dominated, and conifer plantations. Many of the oak woods are on steep, rocky slopes but contain hedgebanks, confirming their secondary nature following abandonment by farmers. Often the banks are asymmetrical, showing former cultivation. In the last century, there were extensive plantations of conifers by Dartington Woodlands, the Duchy of Cornwall and Torquay Corporation on farmland on Moretonhampstead soils, including around Bowda [740831], North Bovey, above the reservoirs at Fernworthy, Kennick [804843] and Trenchford [805825], at Heathercombe, in the latter case to provide timber for the clay mines in the Bovey basin, as well as on Bridford soils near Clifford Bridge. In recent years several small landowners have planted broad leaved trees on these soils. Establishment has often been patchy, in part reflecting variations in soil depth, and consequent droughtiness. Fencing against deer has been necessary.

The very acid soils of the Old Woodland phases of the Bridford and Moretonhampstead series are on very steep, in places rocky and bouldery ground, in oak woodland. On the Bridford unit this includes neglected coppice, interspersed with stands of conifers planted in the last century. On Lustleigh Cleave [765815] the Moretonhampstead Old Woodland phase map unit carries a mosaic of oak woodland, of long established mature trees in the denser rocky areas and rock dominated ground, intermingled with immature oak-birch woodland and a few small glades. The oak and birch have quickly colonised land that was open and swaled common grazing until late in the 20$^{th}$ century. Aerial photos from the mid-1970s show large areas of grassland with bracken. The transformation to this secondary woodland is an impressive indication of how rapidly woodland can develop, left to its own resources. Along with Moor Gate, Drogo and Willingstone soils, the Old Woodland phase map units form a group of acid, naturally well drained soils.

**Plate 67. A beech plantation on Clifford Hill.**

Shortages of home grown timber during two world wars, led to the widespread planting of trees, in this district Dartington Woodlands being particularly energetic. In many places conifers replaced old deciduous woods and coppices, although a few broad-leaved plantations were established, as here. A proportion of the planting, including at this site, which is on the Bridford soil map unit, was on former farmland, where trees have performed better than those planted on the acidic soils of the Old Woodland phase map unit.

Substantial areas of Moor Gate soils, much of them on farm land, were planted last century with conifers in the Trenchford catchment above the Torquay Corporation reservoir, with Dartington Woodlands doing the same in places on the Bridford Old Woodland phase soils in the Teign valley. There is correspondence in the Dartington Hall archive by W.E. Hiley indicating that difficulty was experienced in establishing seedlings transplanted into the surface humus of these soils. As a group these five soil map units may be suitable for most conifers, or for oak away from exposed locations. Fertilising with phosphorus may be necessary. As with other freely draining sites, following planting competition from bracken or heathy field layer plants must be anticipated. There is however the caveat of very acid soils as hinted by Hiley's comment, with centuries of coppicing, very much a cut and take regime, depleting nutrients and souring the soils. There is some support for this interpretation in comparing the girth of trees planted in the 1950s near Fingle Bridge [743903] and Eggesford, 22 km to the north. A memorial oak at Fingle, planted in 1952 is 93 cm around at 1.2 m above the ground, which stands about 130 m O.D., while that planted by the Queen at 75 m O.D. on former farmland at Eggesford in 1956 is 183 cm in girth.

Several ribbons of Tavy / Ty-Gwyn soils occupy more or less freely draining ground on the alluvium of the Teign and Bovey, where there is a risk of frequent but short duration flooding. Oak, poplars, alders and Norway spruce are the best suited species. Weed control may be needed. Loamy Halfway House / Drewston soils are seasonally wet; here trees will benefit from drainage. Oak, sweet chestnut and most conifer species are suitable.

Prolonged seasonal waterlogging due to restricted subsoil permeability and acid, peaty surface horizons characterise soils in the Hexworthy / Rough Tor and Princetown map units. Hexworthy / Rough Tor soils underlie a large part of the plantation at Fernworthy, while the flat crests of the higher ridges there are capped by Princetown soils. Subsoiling has successfully broken the ironpans in Hexworthy soils and loosened compact subsurface horizons, improving drainage and rooting.

On Princetown soils a forestry plough has been used to form ridges and raised planting sites. These soils are not suitable for broad leaved trees and options for conifers are limited to Sitka spruce and Lodgepole pine. Fertiliser will be needed when planting. The wet, peaty soil means that rooting is shallow and that windthrow risk is considerable. Also ground conditions are poor for heavy harvesting machinery during much of the year. Cultivation ridges and furrows are likely to channel acidic, turbid runoff and risk pollution of watercourses, some of which at Fernworthy drain into the reservoir. Furthermore this runoff, by following and scouring wheelings, has the potential to both gully rides and forest roads and choke them with sediment and trash.

Recent experience has shown that replacement of Sitka spruce on these soils by natural regeneration can be successful, partly thanks to the profuse supply of seed the species provides. In addition the difficult soil conditions discourage weeds and the competition they would bring. It can, however, be preferable to plant nursery grown trees to the windward of the trees providing the seeds.

Soils in the Laployd and Sulham / Eversley map units are acidic and severely waterlogged due to high watertables. Occupying floodplain sites the Sulham / Eversley soils undergo frequent flooding, which can persist for some time. There are limited areas of Laployd soils along valley floors in Fernworthy Forest, where despite the relative shelter, shallow rooting has resulted in windthrow of many trees. Choice of species is confined to Lodgepole pine and Sitka spruce among the conifers, with birch, plus alders and poplars on the alluvium of the Sulham / Eversley map unit.

While the acidic peat soil map units of this survey are largely located on the moorland where conservation interests are overriding, small areas of plantations and woodland are found, particularly on the Crowdy map unit. The largest block of conifer plantation over this basin peat is along the north bank of the South Teign below Tom’s Hill [647834] in Fernworthy. These permanently waterlogged soils have deep drains, but soil strength remains minimal, windthrow hazard is high and the establishment of trees uneven. Ploughing up into ridges provides some ‘freeboard’ for planting, at which time fertilising with phosphorus is essential. Options for suitable conifers are limited to Lodgepole pine and Sitka spruce. Location and difficult ground conditions mean that at harvesting there is serious risk of water pollution by acidic sediment above Fernworthy reservoir and its fishery. At lower altitudes in the in-bye there are small, deciduous wet woodlands, mainly willow carr with alder and birch, some of which are invaded by *Rhododendron,* plus some plantations of Sitka Spruce.

**Plate 68. Conifers planted on soils with impermeable horizons.**

As here on the Princetown soil map unit, or over high groundwater tables, trees fail to root to depth, making them susceptible to wind throw. Trees on Hexworthy / Rough Tor, Laployd, Sulham / Eversley, Crowdy and Hepste soil map units are similarly vulnerable.

The small areas of clayey, often waterlogged soils with only slowly permeable subsoils, making up the Tedburn and Halstow map units, are confined to the extreme northeast. There are a few clumps of scrubby deciduous trees. Any plantations would benefit from drainage and ploughing to maximise rooting depth, with phosphorus fertiliser additions desirable. Poor rooting conditions mean that mature trees become vulnerable to windthrow.

In the in-bye below the moorland the Rock Dominant map unit of tors, clitter, crags and screes is more often than not shrouded by trees, often in oak woods. Such land has been left untouched as unusable by farmers, much of it is inaccessible to animals and so any saplings that have germinated survive unbrowsed. Although the rocks dominate, there are substantial interstices in clitter and most tors in which soil material has accumulated. Trees not only establish in these openings, many thrive.

In the narrower fissures [joints] in tors seams of organic-rich material may accumulate. In wider openings soils similar to the surrounding less rocky terrain can be present. Most of the Rock Dominant map unit is in freely draining terrain. However a few clitters do extend over from the dry ground to areas affected by high groundwater. Although the tors and clitter of this map unit on the moor are largely without vegetation bigger than shrubs of heather and gorse, occasional stunted oak or rowan trees cling to the fissures in crags on valley sides. The highest of these, at 501 m O.D., grow by the East Dart at the waterfall [613821] above Broad Marsh. On the metamorphic aureole the larger crags, such as Sharp’s Tor [729899] near Castle Drogo, have fewer trees because the rock’s jointing or cleavage is close and the screes are unstable, although on some bare screes occasional trees have managed to establish and root to depth. Elsewhere a thin litter of vegetation and humus overlies the scree.

In a few conifer stands trees have been put in among the clitter as extensions of the planting on adjacent less rocky land. Examples are at North and South Park in the North Teign’s gorge above Gidleigh Park [677879], abutting Moretonhampstead and Moor Gate soils, and at Hemstone Rocks [646835], Fernworthy surrounded by Hexworthy / Rough Tor soils, both locations’ difficult terrain compounded by steep slopes. Harvesting on such ground may have its difficulties.

An unintended consequence of conifer plantations on former moorland has been the germination and growth of self-sown Sitka spruce trees around the Fernworthy and Soussons plantations. These are particularly abundant within about a kilometre north and northeast of Soussons. Remarkably there are such Sitka trees on the moor up to 3.5 km northwest of the Fernworthy plantations, on Hepste and Hexworthy / Rough Tor map units.

In places healthy, mature trees can be found apparently perched on boulders and rocks, yet rooting into soil whose upper surface starts a metre or more below the base of the trunk. It is interesting to speculate how such plants survived the initial years of establishment, although once that has been done soil in the voids between the rocks clearly meet the tree's needs. In some of the damper woodland sites low in valleys, tree seedlings, particularly those of Sitka spruce, can be found growing on mossy cushions on boulders, rocks and fallen trees, although their long term survival seems unlikely.

**Plate 69. Oak growing from rock face next to the East Dart, head of Broad Marsh.**
At 501 m O.D. this may be the highest native tree on Dartmoor.

4.3.2 ECOLOGY:

For convenience this description of ecological attributes of the district's soils considers first their general relationships with plant communities, followed by information on subsurface biology, invertebrates, microbes and fungi. The former are based on the literature, for example Baldock and Walters [2008] and Mercer [2009], plus the designations of Sites of Special Scientific Interest and Special Areas of Conservation [Natural England, 2015], supplemented by the author's field observations. The text regarding invertebrates, microbes and fungi is contributed by Dr Matthew Shepherd of Natural England.

As a generality most biological activity takes place in the top few centimetres of soil, where roots proliferate and litter is plentiful.

There are overriding considerations of a] location either on moorland or on the enclosed lowland in-bye; b] soil wetness class, with ranges from rarely wet to perennially waterlogged; c] acidity, or more properly soil reaction, which ranges from strongly acid [pH in water <4.5] to neutral [pH 6.6 - 7.5]. Whereas the dry, freely draining soils allow deep rooting by a range of plants and are exploited to depth by animals in size from nematodes and springtails to foxes and badgers, much of the permanently wet ground's ecology is near to and above the soil surface. Their ability to root to depth into waterlogged soil explains the success of *Molinia caerulea* and cotton grass *Eriophorum* spp. on much of the moorland. Acidity varies depending on parent material, vegetation and on the history of human land use, whether prolonged coppicing or farmers' application of lime and fertilisers, while reflecting soil horizons and pedogenic processes as well. There is a response to soil reaction in most semi-natural vegetation and, as Griffiths *et al.* [2011] demonstrate, by soil bacteria.

**The moorland**

This encompasses a number of vegetation communities from the blanket bog of the high plateau, through wet and dry heaths and *Molinia* moor to bent-fescue grassland on the lower, relatively dry margins. While general relationships between soils and the vegetation are evident there are variations, some reflecting management history, such as swaling and grazing pressure, peat and vag cutting, as well as erosion. Over most of the moorland's vegetation communities two species appear consistently, *Calluna vulgaris* or ling and *Molinia caerulea,* their frequency of occurrence ranging from widespread dominance to an almost solely token presence.

Vancouver's description [1808, p 282-4] of the moorland flora, as Mercer [2009] notes, does not go amiss today. His broad division between the "most elevated part…one continuous chain of morass" and "the depasturable parts" is recognisable and, with elaborations, has been mirrored in later attempts to map the moor's vegetation. Stapledon *et al.* [1940], in a national scale exercise classifying the grasslands of England and Wales, mapped the high moorland as "*Molinia* moor", separating it from the fringing "Heather moor", with smaller separations around Grimspound [701809] of "Heather 'fell'". The more detailed 1 inch scale vegetation survey by Ward *et al.* [1972] showed "Blanket bog" and ribbons of "Valley mire" on the high moor, with the lower land mostly falling into "Heath", with lesser polygons of "Bilberry moor" and "Grassland". The National Park's Vision for 2030 [2005] maintained, again with more detail below the blanket bog, Vancouver's broad divisions. The ADAS [1998] mapping of land cover, however, depicted a mosaic of "Heather moorland" and "Grass moorland" across almost the whole moorland landscape.

The high, flat or nearly flat land in the pristine phase of the Winter Hill fibrous peat map unit is dominated by blanket bog vegetation, with several *Sphagnum* species widespread. Also evident are common and hare's-tail cottongrass *Eriophorum angustifolium* and *vaginatum,* deergrass *Trichophorum caespitosum*, cross-leaved heath *Erica tetralix*, ling, sundew *Drosera* spp*.,* bog asphodel *Narthecium ossifraga* and *Molinia*. Changes in hydrology, terrain and shelter occur in the severely eroded phase of the Winter Hill soils, introducing mixtures of wet heath and *Molinia* grassland, with some areas of bare peat, both as eroded surfaces and redeposited material.

These changes from the blanket bog proper, extend onto the slightly lower moorland, often on ground with a steeper slope, on the Hepste map unit. Much of this peat is thinner than upslope and humified. Over large parts it has been eroded or cut for fuel, the distinction between the two not always readily made in the field. Residual areas of un-degraded peat occur from place to place. Whereas the latter remain wet perennially, the ground around erosion channels and baulks between peat cuttings, while still wet for much of the year, is noticeably drier. The vegetation on this land reflects these differences and other pressures such as grazing and burning histories, producing mosaics of wet heath and *Molinia* dominated grassland. Wetter areas in the floors of peat cuttings and in blocks of unconsumed, original peat surface carry *Sphagnum* and cotton grass and other hydrophilous plants. Drier gully edges and cutting rims are often picked out by ling and *Molinia,* these patterns incorporating the rectangular or linear pattern of peat workings into that of the vegetation mosaics.

Much of the moor's basin peat, mapped as the Crowdy unit, supports mixtures of wet grassland and heath similar to that over the Hepste soils. But it does include low-lying wet valley mires with patches of treacherous quaking ground, open pools and water flowing both in channels and diffusely over the surface. The valley bottom mires have their own characteristic flora with *Sphagnum* species, sedges *Carex* spp., bogbean *Menyanthes trifoliata* and soft and sharp-flowered rushes *Juncus effusus* and *acutiflorus*. In some sites the vegetation has aspects of the blanket bog with cotton grass commonly present. Substantial parts of the basin peat have been cut for fuel, repeating the linear vegetation patterns already noted among Hepste soils.

Cotton grass thrives on the blanket bog and on much of the basin peat, aerenchyma in its roots enable it to root deeply into waterlogged soils. *Molinia'*s roots can similarly penetrate to depth. Deeper in the peat there are methanogenic archaea. Although they make up a very small proportion of the total soil they figure strongly in peat processes. Besides the methanogenic archaea there will be surface methanotrophs, feeding on the methane produced by their anaerobic counterparts.

At the surface of the *Sphagnum* bogs creatures living in, on and among the *Sphagnum* leaves, include a wide range of Protozoa, rotifers, tardigrades and possibly even gastrotrichs. There are a few semi-aquatic mites which specialise in bogs, including oribatids of the genus *Limnozetes* and the families Malaconothridae and Trimalaconothridae, while the more freely draining parts will support jointed mites of the Brachychthoniidae. Springtails tend to be scarce in these habitats, but there are blanket bog specialists such as *Tetracanthella wahlgreni*, which may be present, along with other poduromorph springtails. Earthworms are thought to be absent, but small enchytraeids, which tolerate lower pH than their larger cousins, may be numerous.

**Plate 70. Broad Down.**

Most of this view is underlain by peat soils of the Winter Hill map unit, with Crowdy soils in the basin floor. Parts of the scene have suffered peat cutting and erosion. Over most of the year the *Molinia* grassland has this washed-out, beige appearance, which belies the plant's common name of purple moor grass. There is a badger foraging in the centre middle ground.

The mixture of wet heathland with ling and cross-leaved heath and *Molinia* dominated grassland passes downslope onto the mineral soils of the Princetown and Hexworthy / Rough Tor map units. At lower altitudes there are some incursions of western gorse *Ulex gallii*. Both map units have acidic soils that remain wet for much of the year and are subject to Dartmoor's severe climate. On the Hexworthy / Rough Tor soils conditions become drier as altitude declines further east, dry heathland with bell heather *Erica cinerea*, bilberry *Vaccinium* *myrtillis* and western gorse, developing. The heathlands, partly on these soils, on and near south Chagford Common [675825], the biggest block of heather moor on Dartmoor, are important for their ecological, landscape and amenity value. Again surface wetness precludes most biological activity in the subsoil, although the relatively dry subsoils in several patches of Hexworthy / Rough Tor soils among the peat of the high moor contain setts and earths of badgers and foxes.

**Plate 71. A badger sett on the high moorland.**

They find suitable burrowing in the relatively dry subsoils of Hexworthy / Rough Tor soils, just downslope of the blanket peat. Some setts are worryingly close to the most southerly nesting ground of the dunlin. Being deciduous, the raffia-like leaves of *Molinia* detach, and are clearly valued by the badgers as bedding material.

The exploitation of the soil for fuel on these soils took the form of vag cutting, the paring of the organic or humose topsoil, rather than the deeper working affecting the peat soils to the west. Although the practice largely ceased more than half a century ago, the surface scars left are quite apparent as shown by the relatively stunted growth of plants growing directly on mineral subsoil.

Approaching the moorland's eastern boundary, as around Birch [687814] and Hookney [699813] Tors, the dry heathland passes onto the freely draining ground of Moor Gate soils. In places mosaics develop of heath with grassland containing *Molinia*, mat-grass *Nardus stricta*, sheep's fescue *Festuca ovina*, common and bristle bents *Agrostis tenuis* and *curtisii*, as well as bracken *Pteridium aquilinum*.

Gorse dominates parts of the East Dart valley just north of Postbridge [648789]. On these dry, lower margins of the moor sporadic hawthorn and rowan trees grow, while the area north and east of Soussons plantation contains a number of self-sown Sitka spruce trees.

In the drier heaths and grasses there will be a wider range of creatures than on the peat soils. In the low pH soils Acidobacteria will predominate, largely due to the small numbers of other groups. More fungi will appear, with numerous heathland specialist species. More mycorrhizal fungi will also be present, including the *Rhizoscyphus* species which are mutualistic partners of ericaceous plants by supplying nutrients to the plant in return for photosynthetic carbon. Moorland grasses and herbs will be supported by a range of Glomeromycota which perform a similar role. Acid grasslands also support a wide range of fungi, including the hallucinogenic *Psilocybe semilanceata*, ascomycete ‘fairy clubs’ and dung roundheads, which proliferate where grazing animals have excreted. A wider range of springtails and mites will occur in these soils, including some of the common and widely distributed species, such as the large, curly-antennaeed *Pogonognathelllus longicornis.* Some earthworms will also be present in the grassier areas, including the ubiquitous surface dweller *Lumbricus rubellus* and the acid-loving *Dendrodrilus rubidus*. Nematodes can be expected to be almost ubiquitous, only avoiding the deep blanket bog peat. Moor Gate soil profiles often show evidence of animal activity in the subsoil.

The various workings for tin ore across the moorland provide a range of ground conditions. The linear mounds and furrows of the tin-streamed ground give dry, often rocky, sites with heathers or bracken alongside pools and waterlogged ground with *Sphagnum* and in places stunted willows. In many tin streamed basins these ridges and troughs are each only a few metres wide, producing striated, corduroy-like vegetation patterns. A few of the mounds are still bare of plant cover. In places the streaming has penetrate into the Crowdy map unit and is marked by narrow ridges of dry vegetation among the valley mire. Elsewhere the streamworks have radically changed the near surface hydrology, with an area of Crowdy peat west of Rippator [643880] effectively drained and having bracken established across it, after the nearby Gallaven Brook’s [639882] valley was deepened.

The openworks, notably around the Warren House [674810] and Headland Warren [693811] include deep gerts and spoil mounds. Their size, often several metres from top to bottom, very steep or precipitous sides, undulating floors and occasional rocky outcrops create a variety of niches not found on the open moorland. Some of the deeper gerts shelter trees. Much of the vegetation is heath, although grassy stretches floor some gerts. The spoil banks of the Vitifer mine, shown as totally bare in photograph 13 in Greeves [2015] taken in the 1860s, now have a vigorous cover of dry heathland.

Waterlogged, boggy worked ground flanks the sides of the Red Water Brook [683804] near Golden Dagger mine.

**Plate 72. Lower moorland at Hookney Down in high summer.**

The slopes on this moorland have the freely draining Moor Gate soil map unit, with Crowdy peat soils in the basin floor. Under the right light conditions or snow cover, cultivation marks show on this land.

Although not extensive, the granite tors and clitter, shown on the soil map as Rock Dominant, add to the moorland landscape. Most bare rocks have lichens growing on them. The rocks have joints and voids of a range of widths in and between them. Depending on exposure, the narrower ones can shelter bryophytes, grasses or shrubs of bilberry and heathers, with stunted oaks growing in crags at the eastern end of Sandy Hole Pass [621815] and the highest of these, as noted above, growing by the East Dart at 613821 above Broad Marsh. Is this a triumph for seed dispersal or a relict of formerly more widespread oak woodland? Interstices among the clitter are commonly wider and where the jumble of boulders is not too dense the vegetation there is like that of the surrounding moor.

The plantations at Fernworthy and Soussons Down are ecological anachronisms set in the moorland. At ground level the young plantations, and blocks of older trees when unthinned and unbrashed, form dark and sterile environments. The mature and immature conifers, plus a few broad leaved stands, as well as clear felled and open ground, can provide habitats contrasting with the moor. These offer, as Baldock and Walters [2008] note, various niches for specialised species that would otherwise not occur in the area, including some invertebrates and bird species, for example the crossbill, which feeds on conifer seeds, as well as certain ground nesting birds and raptors, plus cover for red and roe deer, rabbits and some foxes and badgers.

**Plate 73. Tin streamed ground at Watern Combe.**

The subparallel ridges and troughs, and the abrupt valley-side scarps are typical of such workings. Their 'corduroy' pattern adds diversity to the terrain and to the vegetation. Much of the basin floor in the middle ground has been worked, although basin peat of the Crowdy soil map unit remains in places. The steeper slopes in the background have Hexworthy / Rough Tor soils. Hangingstone Hill, on the skyline, is capped by blanket peat in the Winter Hill soil map unit and, in part, by ground stripped of peat by medieval charcoal burners.

### The in-bye

Although grassland agriculture dominates this area, there is some ecological diversity, partly provided by differing soil properties, or reflecting land management practices and land cover. Most of the soils are freely draining but there is significant wetness in some. Nearly all are naturally acid to a degree, although some are more so with distinctive surface horizons in consequence of vegetation and land use history.

The most extensive group of acid and freely draining soils encompasses the Moretonhampstead, Bridford, Furlong, Denbigh and Tavy / Ty-Gwyn map units. Apart from a few small hillside flushes, surface water is absent. Much of this land has been farmed since it was enclosed many centuries ago, traditional mixed farming giving place to livestock enterprises over the last 50 years. Dry pastures, grazed or cut for silage, are the rule on the agricultural land, most only having a small range of plant species. However, a number of fields on these freely draining soils have greater floral diversity, thanks to isolation or agricultural ‘neglect’, and the consequent lower soil nutrient content. There are substantial areas of dry, acid, bent-fescue grassland, deciduous woodlands and coniferous plantations. Some of the semi-natural grasslands, such as Mardon [772879] and Meldon [697866] Downs are commons, Whiddon Park [723894] is a Tudor deer park with mature oaks, beech and ash trees, while there are many small, fields gradually falling out of agricultural use and a few remaining hay meadows.

**Plate 74. Headwater valley in the in-bye, between Barramoor and Lettaford Cross.**
Ground-water gley soils of the Laployd map unit and Crowdy peat soils underlie the rough grazing / rhôs pasture of the valley floor. Freely draining Moretonhampstead and Moor Gate soils cloak the slopes and ridges. The foreground is too steep for agriculture, unlike the land across the valley.

Bracken, brambles and gorse quickly encroach on pastures and open downland if not checked by grazing or swaling, followed by gradual establishment of secondary woodland. Parts of Hayne Down [740800], Manaton were undergoing this at the time of survey. Indeed, that much of the oak dominated woodland that occupies steep ground on these map units has gone through this process is demonstrated by the presence of old hedgebanks in the woods. Other oak woods have been coppiced, while some, such as parts of Rushford Woods [703896], are ancient woodlands. Many of these woods are carpeted with bluebells in the spring. At their western, windward ends, and at their margins on the upslope shoulders of sharply cut valleys, the exposed trees are commonly stunted and wind trimmed.

Biological activity is evident throughout these soil profiles, roots penetrate to depth and evidence of burrowing animals, both as surface disturbance and as infilled burrows, [krotovina] is never far away. In late winter and early spring mole hills abound on these soils.

**Plates 75. The valley shown in Plate 74 in high summer.**

Bracken has replaced spring's bluebells, the gorse and *Molinia* have coloured up in the valley floor, while grazing and silage cutting of some of the grass fields in the background have bleached their colours.

The grasslands in this area support a range of Glomeromycota fungi which are partners of the grasses and herbs, as well as the encroaching scrub, but also found in some grasslands, are waxcap fungi, which display their species diversity by a wide range of different coloured fruiting bodies. However, the higher pH and nutrient status of the soils will encourage a wider range of soil bacteria, with Proteobacteria becoming more abundant, and tending to eclipse the Acidobacteria.

There are some established plantations of deciduous trees, for example beeches on Clifford Hill [773894]. Conifer plantations, several established on former farm land in the last century, are more extensive. Where un-thinned their heavy shade and acidic litter preclude any green ground flora. Nevertheless wood ants seem to thrive in and around the plantations. Woodlands on the Tavy / Ty-Gwyn floodplain soils include wild daffodils in the field layer, attracting tourists to the more accessible sites.

Soils in the Moor Gate, Drogo, Willingstone and the Old Woodland phases of Bridford and Moretonhampstead map units are freely draining and very acid.

There is no surface water. While the Moor Gate soils include a sizeable proportion of land relatively recently enclosed for farming, most of this group is in woodland or plantations, downland or moorland. Much of the land is of great amenity value, including designated Sites of Special Scientific Interest in the valleys of the Rivers Teign and Bovey, primarily listed for their ecological status.

**Plate 76: A few species rich hay meadows remain on the freely draining soils of the in-bye.** Photo D. V. Hogan.

Agricultural intensification has not taken place, preserving species-rich meadows, containing plants such as Birdsfoot Trefoil *Lotus corniculatus*, Cat's Ear *Hypochoeris spp,* Eyebright *Euphrasia nemorosa*, Pignut *Conopodium majus*, Red Clover *Trifolium pratense,* Yellow Rattle *Rhinanthus minor*, various orchids and many softer, less competitive grasses, including Sweet Vernal *Anthoxanthum odoratum* and Yorkshire Fog *Holcus lanatus.*

Moor Gate soils occur on the lower parts of the open moorland as well as across the in-bye. On the moor there is a mixture of dry heathland of ling, bell and cross-leaved heathers, bilberry and western gorse with dry acid grassland with sheep's fescue, mat-grass, common and bristle bents and *Molinia.* Similar arrays occupy sites on the in-bye, where they can undergo gorse and scrub incursion, as between Castle Drogo [723901] and the River Teign and on Trendlebere Down [770801]. There are substantial areas of oak woodland, particularly on steep and very steep slopes, much of it old coppice with heathy vegetation making up the field layer. The ling, bilberry, etc. in the field layer serves as a reminder of the acidity of these soils, which has come about after many rotations of coppicing, in the long term a rapacious form of woodland management. During the 20th century substantial areas of former oak coppice were planted with conifers.

Moderate soil biological activity is evident to depth, both by roots and burrowing animals. The litter layers in the broad leaved woods contain numerous and diverse organisms, including large predatory mites of the Parasitidae and Veigaiidae, which will feed on many springtails of different kinds. These will also be preyed on by pseudoscorpions and centipedes, including long blind eu-edaphic geophilomorphs. Millipedes are also important decomposers here, with both flat-backed and snake millipedes common in the litter, along with innumerable beetles, many in the Staphylinidae. Coniferous litter is often not very diverse in fauna, but there will be oribatid mites such as Poroliodes and Damaeidae that feed on the fungi that are the main decomposers here, and Protura [eyeless, antenna-less, proto-insects] are found in conifer litter.

**Plate 77. Moribund oak woodland on very steep ground, in the Teign Gorge.**

Centuries of coppicing, involving repeated removal of timber and bark, has impoverished and acidified the soils, as the heather and bilberry ground layer testify.

Across the in-bye the Rock Dominant map unit of tors, clitter, crags and screes is more often than not shrouded by trees, often in oak woods. Such land has been left as unusable by farmers, much of it is inaccessible to animals and so many saplings that have germinated survive unbrowsed. Although the rocks dominate, there are substantial interstices in clitter and most tors in which soil material has accumulated. In the tors' narrower fissures organic-rich seams may accumulate.

In wider openings soils similar to the surrounding less rocky ground can be present. Most of the Rock Dominant map unit is in freely draining terrain. However a few clitters do extend to areas affected by high groundwater, as at 702895 [Rushford Wood]. Above Horsham Steps at 759817, and at 785874 northeast of Doccombe, clitter occludes the watercourses at times of normal flow.

Extensive spreads of completely bare rock are the exception, particularly on the granite, many exposed rocks being partly covered by lichens and bryophytes. Trees not only establish in the crevices in the tors and clitter, many thrive, their roots often reaching deep into openings in the rocks. Clearly they find sustenance that way, but it is less clear how, as seedlings, they survived until their roots reached into the fissures.

**Plate 78. Oak trees colonising granite clitter on Lustleigh Cleave.**

Here much of the land was open grassland until late in the 20th century, before grazing and swaling ceased.

On parts of Lustleigh Cleave [771813] mature oak woodland has long grown among the clitter and tors, protected there from grazing animals and contrasting with the younger trees that have sprung up on less rocky ground since grazing and swaling ceased. In the shelter of denser woodlands, particularly deeper in valleys and on steep, north facing slopes, boulders support cushions of mosses and leaf litter. Here and there tree seedlings grow on these cushions. Unlike the often relatively smooth aspect of granite surfaces, rock faces on the aureole slates are angular and uneven, jointing and cleavage being closer spaced but less open. Consequently fewer trees have established on places such as Sharp's Tor [729899] near Castle Drogo. Small plants, grasses, forbs and shrubs, including gorse, do however cling on in fractures in any more sheltered recesses in these crags. Below the slate crags are unstable screes of large, angular, blocky stones. Parts of the screes are unvegetated, elsewhere a thin litter covers them and at a few places trees have established themselves.

It is worth noting that Victorian photographs published by Greeves [2015] show several views of parts of the in-bye that are now densely covered by trees, as being less heavily wooded 150 years ago. Examples in the Teign Gorge are between his photographs 15 to 27, that of Hunt's Tor [722898] from Whiddon Park being particularly striking. His photo 56 shows part of Lustleigh Cleave with similarly reduced tree cover, as is the slope north of Manaton Green [749813] on photo 62 and the southeast facing hillside immediately northwest of Chagford Bridge [694879], visible in photo 38.

**Plate 79. Cushions of mosses on granite boulders in the shelter of steep woodland at South Park, Gidleigh.**

The groundwater affected soils of the Laployd and Sulham / Eversley map units, along with sporadic pockets of Crowdy peat soils, provide a sharp contrast in ecological conditions across the in-bye, in which dry soils otherwise predominate. They form a series of often narrow, ribbon-like strips along valley side footslopes and floodplains, strikingly picked out in blue on the soil map. The ground is waterlogged for much of the year, with watercourses, pools and boggy areas, plus occasional ditches, which are mostly choked by sediment. It is likely that pipe drainage, long since degraded, has been installed at some time in places.

**Plate 80. Species-rich rhôs pasture on Laployd and Crowdy soils.**
A mixture of sward heights, favoured for butterfly conservation, is best achieved when grazed by ponies, which are more selective in their foraging than are sheep or cattle. Freely draining Moretonhampstead soils cloak the valley-side slopes.

Wetness, by limiting the land's agricultural flexibility, means that there are numerous pockets of wet heathland, species-rich rhôs pasture, *Molinia* grassland and wet woodland such as willow carr, alongside rushy agricultural pastures. These wet pastures have a reputation for harbouring the livestock parasite liver fluke *[Fasciola hepatica]* and its host, the dwarf pond snail *[Lymnea truncatula]*. The devil's-bit scabious *[Succisa pratensis]* grows here. Being the food plant of larvae of the marsh fritillary butterfly *[Euphydryas aurinia]* and the narrow bordered bee hawk moth *[Hemaris tityus]*, it gives such pastures value for invertebrate conservation. The attraction of such land to wading birds is illustrated by common reference to it as 'snipe moors'. The agricultural land on these map units reveals the former extent and the potential for reconstruction of species-rich, wet grasslands. Pollen in the thicker peat, particularly further away from the moorland, has the potential to disclose the in-bye's vegetation and land use patterns in the past.

In these wet Laployd, Sulham / Eversley and Crowdy soils root penetration and other biological activity in the soil are restricted by the anaerobic environment that waterlogging brings. However specialist creatures can survive. Enchytraeids will probably do well, and also the earthworm *Eiseniella tetraedra* or possibly even the rare *Helodrilus oculatus* in these waterlogged areas. Fungi will dominate in the woodlands, even outstripping the bacteria, especially in coniferous woodlands. Many will be basidiomycetes and ascomycetes that form ectomycorrhizae with the forest trees, while the living trees themselves will carry numerous endophytic fungi capable of decomposing dead wood.

While tin workings on the open moor are readily evident in the landscape, across the in-bye they are commonly concealed by woodland. Without serious restoration their agricultural value is negligible, so that nature has been left to take its course in all but a few places. As on the moor, stream working threw up mounds and ridges of spoil, separated by variably wet hollows, furrows and pools. A few linear openwork chasms [beams or gerts] are also present. Ground conditions vary within the workings, giving dry woodland on the ridges and mounds, but willow carr in wet hollows and in a few larger strips, for example along the valley bottom 500 m west of Mardon Down and around Peck Pits [764832], Lustleigh. The deep, steep sided gert below Neadon Cleave [758818] is cloaked with oak woodland, continuous with that on the rest of the National Nature Reserve.

A restricted group of soils comprising the Halfway House / Drewston, Tedburn and Halstow map units have subsoils with slow permeability, which induces some profile wetness. The Halfway House / Drewston soils overlie decomposed granite, the Tedburn and Halstow soils occur in the lower, drier shale country in the northeast. Although surface horizons can be slightly acidic, depending on agricultural history, pH tends to rise down the subsoil, sometimes approaching neutral values. Much of this land is in damp, locally rushy pastures, often in ditched fields which are likely to have had artificial drainage in the past.

### 4.3.3 ENVIRONMENT

**Soil hydrology**

As was demonstrated by Boorman *et al.* [1995], soils have an important role in explaining hydrology at both the site level and the catchment scale, different soils and their substrates having characteristic responses to seasonal and annual precipitation. Among this district’s soils this includes vertical unsaturated flow through the soil into the substrate, in some saturated lateral flow and runoff predominates, others have groundwater close to the surface, while over a small area seasonal effects play a part.

**Plate 81. Across the Laployd soil map unit there are occasional mounds where peat has developed on small 'spring eyes'.**

Many of these are marked by tussocks of *Carex* spp [tussock sedges]. The auger handle is about 2 m above the ground.

**Plate 82. Krotovinas.**

Left of centre and slightly to the right of the coin are small pockets of well sorted grit particles infilling small chambers in earthworm burrows. The fragments are around 2-5 mm in size. Plate 82 shows the left hand example in more detail. Such pockets are encountered from time to time in freely draining, stony soils. Darwin [1881] suggests these grit fragments, sometimes along with seeds, have been brought down by the worms so that they can hibernate away from direct contact with the soil, yet with scope for air circulation, their respiration being solely through their skin. While in the Southwest worms are more commonly observed coiled in aestivation under dry conditions, rather than in hibernation, this is usually within subsoil burrows lacking the gritty infillings illustrated here.

The freely draining, [wetness class I] soils dispose of excess water by vertical unsaturated flow. Under the land covers dominating in this district surface runoff is unlikely, only happening under extreme conditions, either exceptional weather or very bad soil management. Beneath the Moretonhampstead, Furlong and Moor Gate soils on the granite the flow will reach groundwater at depths more than 2 m, moving via joints and fissures rather than through consolidated rock. Altered, granite saprolite bodies may interfere with water movement, as noted in Section 1.2.8.

**Plate 83. The left hand part of Plate 82 in detail.**

On a wider scale Tables 3.4 and 4.16 in Boorman *et al.* [1995] show the effectiveness of these soils and rock types by the very high base flow index and very small national standard percentage runoff values. While most of the soils [Bridford, Denbigh, Drogo and Willingstone] over the Carboniferous rocks are similarly freely draining, there is mostly no significant aquifer at depth, rather impermeable, hard slatey rock, often overlain by a metre or more of shattered regolith or head. Very localised zones of faulting account for sporadic springs and flushes across the slate and shale outcrop. Generally the broken rock of the head provides a direct and effective pathway for water movement below the soil on the metamorphic aureole. Here surface seepage along footslope concavities is mostly minimal and often absent, the lack of substantial tracts of groundwater gley soils there, contrasting with the swaths of Laployd soils on the granite.

Nationally derived values show a predominance of base flow contributions from these soils, although the standard percentage runoff values are substantially more than for the model represented locally by the freely draining soils over granite. On the limited areas of freely draining alluvium in the Tavy / Ty-Gwyn map unit the groundwater is within 2 m depth. These floodplain soils suffer frequent flooding, albeit of short duration, mostly in the winter.

**Table 16. Soil hydrology.**

| ***Soil series*** | **Wetness class [Roman numerals]** | **HOST model after Boorman *et al.*[1995]** | **HOST class** | **BFI [Nationally] from Boorman *et al.*[1995] table 3.4** | **SPR% [Nationally] from Boorman *et al.*[1995] table 4.16** | **HOST low flow group** |
|---|---|---|---|---|---|---|
| **Moretonhampstead** | I | A | 4 | .790 | 2.0 | 4 |
| **Moor Gate** | I | | 4 | .790 | 2.0 | 4 |
| **Furlong** | I | | 4 | .790 | 2.0 | 4 |
| | | | | | | |
| **Denbigh** | I | H | 17 | .613 | 29.2 | 7 |
| **Bridford** | I | | 17 | .613 | 29.2 | 7 |
| **Drogo** | I | | 17 | .613 | 29.2 | 7 |
| **Willingstone** | I | | 17 | .613 | 29.2 | 7 |
| | | | | | | |
| **Tavy / Ty-Gwyn** | I & III | E | 8 | .533 | 44.3 | 6 |
| | | | | | | |
| **Halfway House / Drewston** | III<br>IV | I,J or F | 21 or 18<br>24 or 9 | .330<br>.311 | 47.2<br>39.7 | 7<br>7 |
| | | | | | | |
| **Halstow** | III | I or J | 21 | .330 | 47.2 | 7 |
| **Tedburn** | IV | | 24 | .311 | 39.7 | 7 |
| | | | | | | |
| **Hexworthy / RoughTor** | ? | D | 15 | .387 | 48.4 | 9 |
| **Princetown** | V | | 15 | .387 | 48.4 | 9 |
| **Hepste** | V | | 28 | .522 | 60.0 | 10 |
| | | | | | | |
| **Laployd** | V | G | 12 | .092 | 60.0 | 10 |
| **Crowdy** | VI | | 12 | .092 | 60.0 | 10 |
| **Sulham / Eversley** | V | | 12<br>10 | .387<br>.437 | 60.0<br>25.3 | 10<br>6 |
| | | | | | | |
| **Winter Hill** | VI | | 28 or 29<br>28 = eroded | .522 or .232 | 60.0 | 10 |

Soils in the Halfway House / Drewston map unit, along with the tiny areas of the Tedburn and Halstow soils, have impermeable and gleyed layers in their subsoils and are seasonally waterlogged. Water movement has seasonal patterns, with saturated lateral flow for much of the year, with some likelihood of surface runoff at wetter times. However, after a period of summer drying, shrinkage in the subsoils allows some vertical unsaturated flow or saturated bypass flow into the substrate. This ceases late in the year once the soil has rewetted and swelling has closed the fissures, causing saturated lateral flow to resume. These soils make contributions to both stream flow by way of base flow and runoff, the balance between these pathways varying with the time of year and soil moisture conditions.

Although the soil hydrology of Hexworthy and Rough Tor profiles is complicated overall [see Section 3.6.4], for present considerations they have affinities with the Princetown and Hepste map units. All are soils saturated for much of the year, have raw peaty tops over aquiferous, fissured granite or groundwater in it, and are where saturated lateral flow and some surface runoff are coupled with a proportion of vertical water movement to depth. Nationally derived ratings of base flow indices and standard percentage runoff confirm that these soils contribute to both pathways.

Among the soils discussed so far in this section, vertical flow, primarily to groundwater in the granite, has been a major hydrological pathway. That is the origin of the shallow groundwater characterising the Laployd, Sulham / Eversley and Crowdy map units. These are peaty topped soils [Eversley series excepted] that are severely or permanently waterlogged, in which saturated lateral flow in the soil and runoff over it account for water movement. On the wet floodplain land, mapped as Sulham / Eversley soils, flooding is a frequent occurrence, particularly from autumn to spring and can persist for much longer than on the drier land of the Tavy / Ty-Gwyn map unit.

On the permanently waterlogged soils of the pristine blanket bog phase of the Winter Hill map unit water movement is by shallow saturated lateral flow in the peat and by surface runoff. On the severely eroded phase, while these routes probably predominate, around gullies flow is likely to take place through a greater depth of the peat. Also in the gullied ground, water movement is more obviously channelled, contrasting with the diffuse pattern across the pristine phase. While national figures suggest that eroded peat makes a substantial contribution to base flow indices, pristine peat's part in that is smaller. On most land overlying the granite there are marked springlines around lower valley sides, in the in-bye picked out by the junction of the freely draining soils and the groundwater affected ground, notably the Laployd map unit. Similarly in basins with Crowdy soils among the Hexworthy / Rough Tor and Hepste map units on the moorland. Although similar physiographic basins form in parts of the blanket bog of the Winter Hill map unit, there is no change in ground conditions commensurate with the springlines at lower altitude. It appears either the blanket peat is not 'leaking' water to the granite in the first place, or is diffusing the groundwater as it emerges from the rock.

Flood risk is an aspect of the hydrological responses of land causing concern for property, crops, livestock, transport, and on occasions, life. It is conditioned by both the natural circumstances of the land and by its use and abuse. Inundation occurs frequently and persists for some duration on the floodplain soils of the Sulham / Eversley map unit, particularly in the winter half year. The Tavy / Ty-Gwyn soils over alluvium suffer flooding too, but for shorter duration and less frequently. Tin streamed tracts along watercourses, particularly on the moorland, are also affected.

Contributions to flooding from soils above the floodplains are most likely from those listed in the lower half of Table 16. These have high wetness class numbers and small base flow indices, with surface runoff described as being likely in their HOST response models in Boorman *et al.* [1995]. The freely draining soils, by contrast, are inherently unlikely to generate surface runoff unless mismanaged. Such land is however attractive to arable cropping and winter stocking, tempting malpractices that encourage compaction, runoff and soil erosion, which can substantially degrade surface hydrology. However in this district, dominated by grassland, moorland and woodland, that possibility is less than in arable farming areas.

**Groundwater vulnerability**

Soils, in influencing the movement of water in the environment, affect the transfer of any pollutants carried in it. Palmer *et al.* [1995] established a systematic scheme for evaluating soils for the protection of groundwater. Local rocks, both the granite and the Carboniferous were treated as variably permeable, minor aquifers. Three levels of leaching potential, *high, intermediate* and *low*, were recognised.

In this district Moretonhampstead, Furlong, Bridford, Tavy / Ty-Gwyn and Eversley soils fall in the high potential category. The Moretonhampstead and Bridford soils, as coarse textured or moderately shallow soils can readily transmit non-adsorbed pollutants and liquids, but have sufficient clay or organic matter to attenuate some adsorbed pollutants. The Tavy / Ty-Gwyn soils of the floodplains are deep and permeable with coarse textures which have low attenuation capability and rapidly transmit a wide range of pollutants. Soils of intermediate potential are the Denbigh, Moor Gate, Drogo, Willingstone, Halfway House, Sulham and Halstow series. Apart from Denbigh and Halfway House soils this group is defined as soils which can possibly transmit a wide range of pollutants. Denbigh and Halfway House soils have moderate attenuation potential for diffuse pollutants, although the possibility is that some non-adsorbed, diffuse-source pollutants and liquid discharges could pass through the soil. Other soils in the district are unlikely to be penetrated by pollutants because water in them flows laterally, or because with high clay or organic matter content they adsorb pollutants.

**Soil carbon storage**

Soils contain organic carbon, primarily derived from plant remains. In peat soils, in this district notably in the Winter Hill map unit, thicknesses of organic matter well over 1 m thick can accumulate. In most mineral soils the largest concentrations are in the surface horizons and upper subsoils. Amounts depend on the processes of soil formation, with wetness and acidity helping the conservation of organic matter and hence carbon, while the relative thicknesses, stoniness and density of horizons affect overall quantities. Generally freely draining and neutral or less acid soils are biologically more active and less able to retain organic matter. Unconsolidated or weakly consolidated material retaining rock structures [C horizons] or hard rock [R horizons], containing little or no organic carbon, usually occur within 1 m depth in mineral soils. Soil organic carbon percentage in soil horizons is stated in most of the analyses in Sections 3.N.2 throughout Chapter 3, 1 $m^3$ masses in Sections 3.N.4.

Estimates of the quantity of organic carbon per soil profile in Table 17 are based on the profiles in Chapter 3 and their organic carbon percentages by mass, weighted for horizon thickness and for any dilution of the soil by stones and rock, along with variations in soil density. Where appropriate, profile organic carbon calculations for similar soils in adjoining areas are included, as indicated in column 4 of Table 17. These draw on profile descriptions from Clayden [1971], Harrod *et al.* [1976], Staines [1976], Hogan [1977 and 1978], Harrod [1981] and Hogan and Harrod [1982]. For soil horizons where organic carbon was not determined, estimation has been via loss on ignition percentages, using the formula LOI % minus 10% of clay content, divided by 1.72. For two profiles, the Tavy series in Section 3.13.2 and the Drewston series in Section 3.7.2, no loss on ignition analyses were made. For the purposes of these overall weighting estimates for similar horizons in related soils, such as the Ty-Gwyn and Halfway House profiles, were used.

Additional weightings are included in Table 18 to account for subsidiary soils listed in Sections 3.N.3 of Chapter 3. For all but the thicker peat soils values are limited to 1 m depth. The profile descriptions in Sections 3.N.2 provide assessments of the abundance of stones, mostly following Hodgson [1997], a few using the system of Soil Survey Staff [1960]. Both methods use descriptive classes defined by ranges of stone percentage, median values being used in calculation for the present purposes. Bulk density of the soil also influences the calculation of the quantity of soil organic carbon.

There are broad relationships between bulk density and soil horizons, organic matter content, soil texture and structural development. While measurements of bulk density are available for some of the representative profiles listed in Chapter 3, for most they are not. However, there are published [Harrod 1981, Hogan and Harrod 1982, Findlay *et al*. 1984] and unpublished [Hogan 1978] measurements of bulk density for 54 soil horizons in related soils from surrounding districts that provide supplementary information. Within the study district there is a substantial range from very low bulk density [<0.2 g $cm^{-3}$] in the fibrous peat of the Winter Hill series to high [1.3–1.8 g $cm^{-3}$] in coarsely structured prismatic subsoils as in the Tedburn, Halstow and Drewston series.

**Table 17. Soil organic carbon estimated content by soil series or phases.**

To 1 m in mineral soils, to mineral substrate in peat soils > 1 m thick.

| Soil | Mean S.O.C. kg $m^{-2}$ to 1 m depth in mineral soils; to mineral substrate in peat soils > 1 m deep | Mean S.O.C. tonnes ha to 1 m depth in mineral soils; to mineral substrate in peat soils > 1 m deep | Number of sampled profiles | Range re column 2 |
|---|---|---|---|---|
| **Winter Hill pristine phase**** | 331.87 | 3318.7** | 1 | |
| **Winter Hill Map Unit overall mean thickness**** | 257.27 | 2572.7** | 1 | |
| **Winter Hill slightly eroded phase**** | 240.06 | 2400.6** | 1 | |
| **Winter Hill severely eroded phase**** | 145.37 | 1453.7** | 1 | |
| **Hepste series** | 118.70 | 1187.0 | 1 | |
| **Hepste Map Unit mean thickness** | 112.12 | 1121.2 | 1 | |
| **Crowdy Map Unit mean thickness**** | 115.4 | 1154.0** | 1 | |
| **Crowdy series 1 m** | 113.67 | 1136.7 | 1 | |
| **Winter Hill series 1 m** | 95.64 | 956.4 | 1 | |
| **Princetown series** | 57.65 | 576.5 | 1 | |
| **Laployd series** | 43.5 | 435.0 | 2 | 28.06 – 58.93 |
| **Willingstone series** | 42.29 | 422.9 | 3* | 33.09 – 50.48 |
| **Hexworthy / Rough Tor series** | 40.10 | 401.0 | 7* | 27.64 – 68.86 |
| **Sulham / Eversley series** | 38.6 | 386.0 | 2 | 38.17 – 39.17 |
| **Moor Gate series** | 29.8 | 298.0 | 6* | 16.98 – 41.8 |
| **Drogo series** | 26.43 | 264.3 | 3* | 17.51 – 36.89 |
| **Moretonhampstead Old Woodland phase** | 24.88 | 248.8 | 1 | |
| **Bridford Old Woodland phase** | 18.47 | 184.7 | 3* | 13.47 – 25.44 |
| **Denbigh series** | 15.46 | 154.6 | 11* | 8.51 – 21.51 |
| **Furlong series** | 15.64 | 156.4 | 2 | 13.37 – 17.9 |
| **Halfway House / Drewston series** | 14.5 | 145.0 | 2 | 14.5 – 15.79 |
| **Moretonhampstead series** | 14.09 | 140.9 | 6* | 7.99 – 26.13 |
| **Bridford series** | 13.84 | 138.4 | 4 | 8.79 – 8.76 |
| **Tedburn series** | 13.64 | 136.4 | 8* | 8.89 – 23.07 |
| **Tavy / Ty-Gwyn series** | 12.01 | 120.1 | 2 | 9.57 – 14.4 |
| **Halstow series** | 10.77 | 107.7 | 7* | 9.83 – 13.06 |

Asterisk indicates that profiles in addition to those shown in this Record have been used. Double asterisk indicates peat profiles where organic horizons are > 1m depth.

**Table 18. Total soil organic carbon by soil map unit within SX68/78.**

| Soil map unit | Area ha in SX68/78 | S.O.C. tonnes $ha^{-1}$ | Total S.O.C. tonnes in SX68/78 |
|---|---|---|---|
| **Winter Hill** | 1169 | 2241.1 | 2,619,846 |
| **Hepste** | 589 | 1105 | 650,845 |
| **Crowdy** | 1072 | 1057.1 | 1,133,211 |
| **Princetown** | 688 | 530.8 | 365,190 |
| **Laployd** | 1308 | 437 | 571,596 |
| **Hexworthy / Rough Tor** | 3142 | 429.8 | 1,350,432 |
| **Sulham / Eversley** | 265 | 393 | 104,145 |
| **Willingstone** | 6 | 355.9 | 2,135 |
| **Drogo** | 170 | 254.6 | 43,282 |
| **Moor Gate** | 2656 | 247.7 | 657,891 |
| **Bridford Old Woodland phase** | 371 | 184.1 | 68,301 |
| **Halfway House / Drewston** | 366 | 167.3 | 61,232 |
| **Moretonhampstead** | 5246 | 228.6 | 1,199,236 |
| **Bridford** | 369 | 150.9 | 55,682 |
| **Moretonhampstead / Furlong** | 1270 | 147.4 | 187,198 |
| **Moretonhampstead Old Woodland phase** | 78 | 145.8 | 11,372 |
| **Tedburn** | 12 | 136 | 1,632 |
| **Drogo with Crags** | 25 | 129.2 | 3,230 |
| **Tavy /Ty-Gwyn** | 161 | 121.7 | 19,594 |
| **Halstow** | 8 | 120.6 | 965 |
| **Denbigh** | 96 | 120 | 11,520 |
| **Bridford with Crags** | 26 | 97.4 | 2,532 |
| **Total** | 19093 | | 9,121,068 |

Ranking in Table 17 demonstrates the range in carbon content among the leading soil series and phases of the district's map units. In the peats of the Winter Hill, Hepste and Crowdy map units estimated carbon content is around 100–120 kg $m^{-2}$ in 1 metre profiles, contrasting with contents of 10–60 kg $m^{-2}$ in mineral soils. Among the peat soils amounts vary with the degree of humification and density; humified peat has greater bulk density than fibrous peat [averages being about 0.29 against 0.18]. This table also shows amounts calculated for thicknesses of peat greater than 1 m, representing average thicknesses of peat in the three map units, plus the three conditions of erosion on parts of the Winter Hill map unit. On the uneroded peat average estimated carbon content is 330 kg $m^{-2}$ for fibrous peat with a mean thickness of 3.47 m.

The more or less freely draining brown earths and brown podzolic soils, along with the wetter Halfway House / Drewston, Tedburn and Halstow soils, contain small amounts of organic carbon, typically estimated for 1 m profiles at less than 20 kg $m^{-3}$. This is attributable in the brown earths and brown podzolics to high biological activity consequent on favourable natural drainage and their tendency to be relatively shallow and stony. They are also favoured for agriculture. For the three map units with slowly permeable subsoils, marked seasonal changes in moisture conditions may be contributory. The Old Woodland phases of both the Bridford and Moretonhampstead soils have more organic carbon than their normal phase equivalents, thanks to its accumulation in undisturbed and acidic L, F and H surface horizons. As would be anticipated, in the humic brown podzolic soils in the Moor Gate and Drogo series, there are slightly larger amounts of organic carbon as a result of more acidic, yet still freely draining environments.

Among the district's other soils, with moderate or larger amounts of organic carbon, increased content reflects soil wetness. The very restricted Willingstone series is the exception to this. The Sulham / Eversley soils, occupying wet floodplain sites in permanent pasture or semi-natural vegetation, have both humus-rich topsoils of varying thickness, and, as often occurs from place to place among alluvial soils, buried Ah horizons. The Hexworthy / Rough Tor and Princetown series are surface wet due to restricted subsoil permeability, compounded by the hydrological effects of the acidic peaty surface horizons encouraged by that surface waterlogging. Comparable estimated amounts of organic carbon [around 40 kg $m^{-3}$] are in the groundwater affected Laployd soils, which flank many lower valley sides, particularly across the in-bye.

In Table 18 the values of soil organic carbon for leading and subsidiary soils [as described in Sections 3.N.3 of Chapter 3] are weighted for each of the map units, whose areal extents are multiplied up to provide soil organic carbon values for the survey area as a whole. In summary they indicate about 8.73 megatonnes [Mt], of which about half, 4.40 Mt, are in the peat soils. Much of the remainder [about 2.69 Mt] is in mineral soils on the moorland, or across the in-bye in ground-water gley soils in the valley floors or in downland soils, with brown topped mineral soils, notably in the Moretonhampstead map units, accounting for most of the other 1.64 Mt.

The weightings applied in Table 18, which allow for subsidiary soils in the map units, explain the apparent discrepancies between the Table's third column and that of Table 17. Generally variations are only a few percent, often the effect of a shallower or less humose or peaty subsidiary soil being partly offset by one with a greater amount of organic material. For example the Hexworthy / Rough Tor map unit [Section 3.6] has variable thicknesses of peaty or humose topsoils, as well as the map unit including subsidiary soils with both larger average S.O.C. contents, notably the Princetown series, and with less S.O.C., the Moor Gate series. The most striking differences are understandably in the Bridford and Drogo *with crags* phases, where substantial areas of outcrops dilute the soil volume. The S.O.C. of the Denbigh map unit is also diminished by about a third, in this case by inclusions of shallow Powys series and more stony Bridford profiles.

**Plate 84. The Mariners' Way recreational trail near Teigncombe.**

Poor ground conditions on Laployd soils during most of the year necessitate a causeway, both to allow access and to protect the vegetation and soil.

Table 18's values can be extrapolated across the Dartmoor National Park as a whole via the National 1:250,000-scale Soil Map. This shows a total of 39.4 Mt, with 18.3 Mt in the peat soils, 13.8 Mt in peaty or humose topped mineral soils on the moorlands, on downland in the in-bye and in valley floors, with the remaining 6.3 Mt being in non-humose mineral soils, largely found on enclosed, farmed land. Over its nearly 1,000 $km^2$ extent, the Dartmoor National Park contains about 50 $km^2$ of soils not represented on SX 68/78. Most extensive among these are the typical brown earths over basic igneous rocks around Tavistock, with carbon contents to 1 m depth typically around 15 $kg\ m^{-2}$. Less extensive, but containing more carbon [between 40-60 $kg\ m^{-2}$], are stagnopdzols and stagnohumic gleys over Palaeozoic mudstones and slates on a few $km^2$ around Blackdown [510820]. Smaller areas on other parent materials include land in the Bovey Basin and over Devonian Limestone.

### 4.3.4 AMENITY AND CULTURE

Tourism is an important component of the economy on and around Dartmoor. For farmers it offers a chance to supplement earnings from agriculture through accommodation, by providing pony riding or sites for camping and caravan or occasional short term events. When the land is used for recreational purposes soil conditions can present both challenges and opportunities. George and Jarvis [1979] listed criteria for assessing land suitability for sites for picnics, caravan parking, camping and for footpaths. Those criteria included soil and site features including profile wetness class, texture and stoniness of the surface soil, slope, rockiness, wind exposure and flood hazard. Their definitions of exposure to wind mean that the well suited category is limited to sheltered valleys.

On Moretonhampstead, Furlong, Moor Gate, Denbigh, Bridford and Drogo soils, away from steep slopes and from very rocky or bouldery ground the land is moderately well suited for siting camping, caravan parks and brief, occasional events. In well sheltered locations these soils can be regarded as having well suited sites. The valley floor locations of Tavy / Ty-Gwyn soils offer similar shelter, but have the drawback of the risk of flooding. The Halstow, Tedburn and Halfway House / Drewston soils are poorly suited on account of their seasonal wetness. The remaining soils of the district are unsuited for these activities because of their location in sites of landscape and ecological value [a constraint that also affects parts of the freely draining land] and their intense wetness.

Ranking for footpath development follows, with a few exceptions, a similar pattern. The freely draining soils are moderately well suited on the George and Jarvis scheme, with shelter warranting upgrading in favoured situations. Where the land is steeply sloping or very bouldery the rating is down-graded. Inclusion of Halfway House / Drewston soils is justified among the well suited group. Wetness in Hexworthy / Rough Tor, Princetown, Laployd, Halstow, Tedburn and Sulham / Eversley soils makes them poorly suited for footpaths, in some places needing causeway construction and maintenance. In any event on designated access land such structures might be inappropriate. The three peat soil map units, which, with the exception of several small polygons of Crowdy map unit, fall on open moorland, are unsuited to footpaths. Causeways will be needed on any footpaths crossing Laployd and Crowdy soils in the in-bye.

An important benefit of the moorland and of some land in the in-bye is unfettered access for walking and rambling, ranging from short, casual sallies by families from the road side to the annual Ten Tors event and military survival exercises extending over days. Strict ranking of land to cover these is neither possible nor appropriate. However the soil map and this Record, provide insights in to the nature of the terrain, its wetness, ruggedness and likely difficulties it will present. For example, on the peat soils parts of the severely eroded phase of the Winter Hill map unit and the Crowdy map unit are difficult to negotiate, in places dangerous, as are some of the tin workings mapped as disturbed ground.

Soils in the landscape widely reflect the land’s physiographic texture and hydrology. In turn soil patterns exert a number of cultural influences. These include relationships between soil distribution and the patterns of fields, woods, moorland and their boundaries. In places they affect the pattern of roads and footpaths, while there are some influences on vernacular terminology and place names. Wider views of soils and landscape are explored in Chapter 7.

Soil changes followed by boundary hedgebanks around fields, woods and downland are a widespread expression of how soil conditions express themselves in details of the cultural landscape, occurring most commonly where they pick out contrasts in soil wetness and acidity. Examples between the ground-water gley soils of the Laployd map unit and the freely draining Moretonhampstead and Moor Gate map units are striking, as in Figures 8 and 9 near Langaford, North Bovey [703844]. Most often such boundaries define the outline landscape elements, ridges or valleys, with broadly uniform soils. It is worth reflecting that the soil differences were recognised by the original enclosers when these boundaries were initially set out. That they were as stark and real then as they are now has a bearing on our understanding of the evolution of the cultural landscape and landscape archaeology.

The wet versus dry contrast between Laployd and Moretonhampstead map units is strongly reflected in the distribution of the *rough ground* and *medieval enclosures* categories, mapped across much of the in-bye by the Devon Historic Landscape Characterisation project [Turner, 2007, and Devon County Council, 2016]. Other aspects of the soil map may be relevant in the context of landscape history. The patterns of Moor Gate soils within the enclosed land, for example, some of which are clearly mirrored on the HLC map, some not so, point to unwritten messages of the landscape's evolution.

Along much of the cornditch, separating the moorland and the enclosed in-bye, the change of soil is as abrupt as the few metres width of that boundary structure. Does that sharp change reflect an existing natural feature picked out when the land was enclosed, or has it developed as a consequence of different systems of land management?

Long established lanes and roads, whose alignment was decided centuries before tarmac and engineering brought year-round firmness, seek out the drier ground, often following ridge crests. Elsewhere, if that is not feasible, the wet footslopes with Laployd soils are skirted, as along the B3344 between Beetor Cross [713843] and Heatree Cross [729809]. If wetter soils have to be crossed, the normally very narrow lanes develop wide verges. Over much of the district, the line of many lanes trend north northwest to south southeast or roughly east northeast to west southwest, broadly following the physiographic texture described in Chapter 1. Numerous field boundaries on the in-bye mirror these grains, directions first followed by many Bronze Age reaves on the moorland.

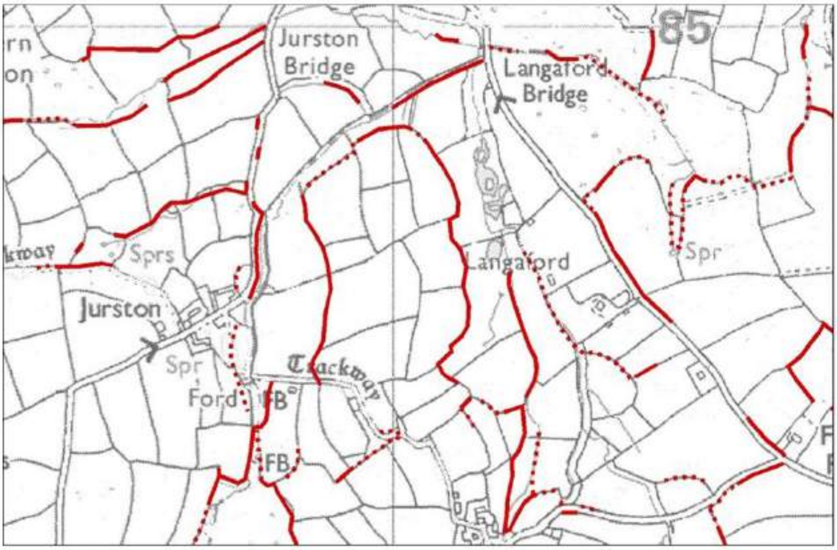



**Figure 8. Coincidence of boundaries of soils and fields around Langaford & Jurston.**
The red lines indicate where soil and field boundaries overlap, the dotted lines represent close, but not complete, concurrence.

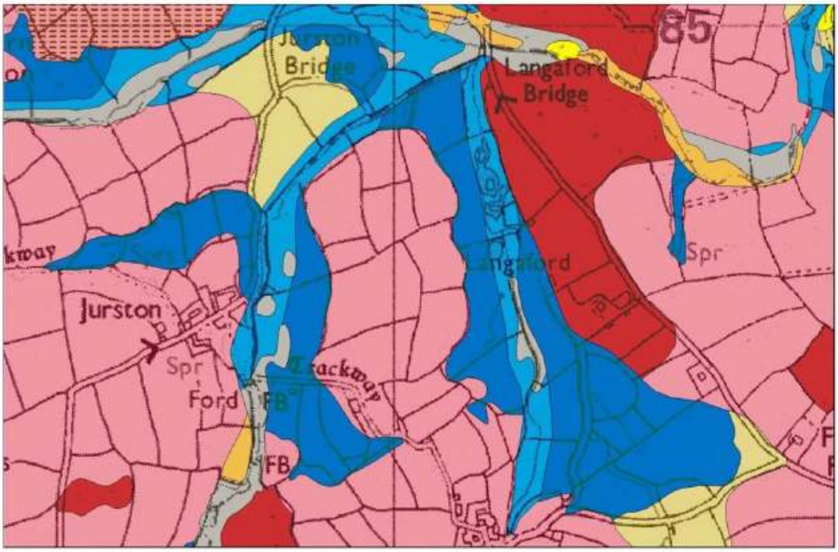



**Figure 9. Soil patterns around Langaford and Jurston.**
The colour coding for the map units is: pink = Moretonhampstead, stippled pink = Moretonhampstead / Furlong, red = Moor Gate, light blue = Sulham / Eversley, dark blue = Laployd, orange = Tavy / Ty-Gwyn, beige = Halfway House / Drewston, grey = disturbed ground, yellow = Rock Dominant. The base map is © Ordnance Survey 2015, licence number 100024842 via Dartmoor National Park Authority.

Until well into the last century footpaths were integral parts of the rural way of life, used day in day out as part of everyday activities. Figure 10 illustrates paths across Lustleigh and Water [763814] Cleaves, as far as practical avoiding the wet, marshy ground of the Laployd soils and sticking to the freely draining ground.

Although nowadays rarely heard, a Devonian term for brightly coloured subsoil ‘foxmould’ is still occasionally applied to the subsoils of Moretonhampstead, Moor Gate and Bridford soils. The word was used by Vancouver [1808] in describing local ‘granite gravel’ soils. Similar use in east Devon has been adopted by geologists for part of the Cretaceous Upper Greensand formation. Decomposed granite is now widely spoken of on Dartmoor using the Cornish term ‘growan’, an example of a geomorphologically adopted term re-emerging in everyday language. An alternative for it when used locally as an aggregate or fill is ‘Chagford Gold’. The terms ‘shillot’ and ‘woodstone’, the one meaning the shale and the other the blocky, angular, thermally altered mudstones of the Carboniferous rocks of the metamorphic aureole, are both widely applied by farmers to Denbigh and Bridford soils respectively. They sometimes use the expression ‘iron and mire’ with regard to the shale Dunland country. While it is clear that mire indicates the Tedburn soils in their winter state, there is ambiguity whether iron refers to the clay’s intractable hardness once dried out, or the shallow, ‘bony’ patches on Denbigh soil where shillot rises to within plough depth.

Place names and field names are often at the least suggestive of allusions to the soil and land. The Chagford area has both ‘Sandy Park’ [712896] and ‘Venton’ [695910]. Many fields relatively recently reclaimed from old common or residual moorland carry the name ‘Down’. ‘Gratnar’ occurs widely, with 14 instances recorded on the tithe map of 1839 in North Bovey parish alone, indicating a rocky or bouldery field; it also names a farm there at 720835. ‘Cleave’ applies widely to very steep, often rocky ground and names such as ‘Clay Pit’ are given to fields here and there. The stem ‘Furze’ or ‘Furzy’ appears in many field names, with ‘Fursdon’ a farm at 752842. From figures given by Marshall [1796] and Vancouver [1808] for rental values of such gorse clad ground, their value as sources of fuel would have been appreciated over the centuries.

For many years now agro-environmental payments to farmers under Single Farm Payments, stewardship schemes and currently under the Basic Payments Scheme, have depended on good soil management being practiced. Guidance has included the Code of Good Agricultural Practice [MAFF 1985], while at present standards are those of Good Agricultural and Environmental Condition, [Defra 2013, 2015a and b]. Compliance with these requires appreciation of soil properties, including soil management to limit erosion, maintenance of soil organic matter, establishment of buffer strips along watercourses and groundwater protection. In the past there was a requirement for farmers to make a 'Soil Protection Review' each year, while, for example, the Code of Good Agricultural Practice specifically precluded slurry spreading on waterlogged soils.

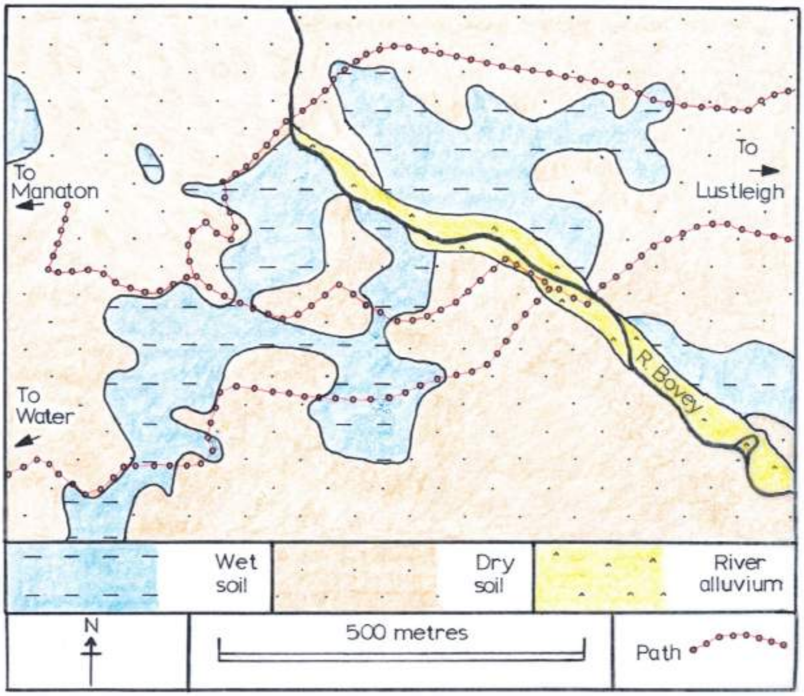



**Figure 10. Footpaths following dry soils between Lustleigh and Manaton.**

## 4.3.5 SOIL ENGINEERING

The availability of modern machinery means that soils can be excavated, moved, stockpiled or reused as fill on an unprecedented scale. Local examples include levelling ground by cut and fill for agricultural buildings and yards and for amenity or sports grounds, bulldozing for access roads and rides in hillside plantations and construction of ornamental pools and lakes, as well as several forms of urban development and even in the recent building of the cob house in Plate 85. There are contrasts in the behaviour of different soils in such works, primarily reflecting their hydrological properties and their textures.

The freely draining soils in the Moretonhampstead, Furlong, Moor Gate, Denbigh, Bridford, Drogo, Tavy / Ty-Gwyn and Willingstone map units form stable slopes in shallow cuts or trenches, they are suitable for use as fill and can be handled and stored under all but the wettest conditions. Boulder free subsoil material from the freely draining granite soils has widespread use locally as low grade fill, dressing material for footpaths, etc. Such use of growan or 'Chagford gold' is more appropriate aesthetically in granite country than that of flints, Devonian limestone, or Carboniferous mudstones and cherts from conventional commercial sources.

**Plate 85. A recently constructed cob house.**

While the mineral subsoil in the Hexworthy / Rough Tor map unit is stable in shallow trenches and cuts, the organic topsoils make these soils less suitable for fill and made up ground, entailing care when moving and stockpiling. Halfway House / Drewston soils are less stable than the freely draining soils and require some care over timeliness of handling and storage. Stability in excavations of the clayey Halstow series is similarly modest, while the high clay content, seasonal wetness and moisture retention make it poorly suited for use as fill and call for care in handling. The related Tedburn soils display similar restrictions in yet more acute forms and are poorly suited to movement and storage. These two map units are the only local soils where their shrink-swell properties might induce subsidence in load bearing structures. Stability of the mineral subsoil in cuts and trenches in Princetown soils is moderate due to profile wetness. The peaty topsoils and profile wetness make it poor material for fill and any handling and storage demand great care with timeliness to avoid damage to soil structure. On Laployd soils high groundwater and organic surface layers make for very limited stability when they are cut, trenched or used for fill, while timing of handling and storage is critical.

Location on the moorland for the Winter Hill map unit and most of the Hepste and Crowdy soils precludes any engineering use of them there. Stability among them is minimal, they are unsuited to use as fill and should not be moved or handled mechanically. They have negligible load bearing capacity.

**Plate 86. An incongruous juxtaposition of ashlars [the large, rectangular stone blocks] and brownish cob [puddled earth].**
Unlike in much of Devon, cob, traditionally the 'poor man's building material', is relatively unusual on Dartmoor. Ashlars, by contrast, are mostly found in higher status buildings; note the 'randoms' in the rest of the walls.

Comments above in Section 4.3.3 on soil hydrology and groundwater vulnerability have bearing on the performance of soakaways and percolation tests in the soils. While in principal the freely draining soils might be expected to function well in these respects, sporadic reduction in depth to rock, both on the Moretonhampstead, Furlong and Moor Gate map units over granite and the Bridford, Denbigh and Drogo soils on the Carboniferous, is likely to skew results. In places a decrease in percolation may be brought about through less permeable saprolite within the granite substrate, hinted at by the frequently occurring very small springs and wet spots noted in Section 3.3.3 around Moretonhampstead. The distinctive hydrology of the Halfway House / Drewston, Halstow and Tedburn soils will give different percolation properties depending on the season. In most summers subsoil cracking, following drying and shrinkage, will allow an inflated impression of hydraulic conductivity. For much of the year, however, when the soils are wet and swollen, vertical water movement will be negligible.

Soil hydrology and pH affect the rate of corrosion of buried metal, which is of concern for buried infrastructure and of archaeological interest. Jarvis and

Hedges' models [1994] directed particularly at iron pipes, assessed corrosivity on a scale of 1 [non-aggressive] to 5 [very highly aggressive]. Evaluation for each soil map unit in the district using their methodology is given in Sections 3.N.4 of Chapter 3. In summary the Moretonhampstead, Furlong, Moor Gate, Denbigh, Bridford, Drogo, Willingstone and Tavy soils are classed as non-aggressive because they are freely draining and rarely wet. The occasionally wet Halfway House, Ty-Gwyn and Halstow series rate as slightly aggressive, with the wetter Drewston, Laployd, Hexworthy / Rough Tor, Eversley and Tedburn soils in class 3 [moderately aggressive]. Class 4 of highly aggressive soils includes Princetown, Laployd and Sulham series, which are usually wet. Perennial wetness and low pH place the three peat soil map units in the very highly aggressive class 5.

No comparable scheme is available for the aggressiveness of soils to timber structures. However, it is widely commented locally that the life of fencing posts is much shorter on the wet Laployd map unit than on the freely draining Moretonhampstead soils. These observations have come to the fore in recent years with modern, environmentally-benign, timber treatments being less effective than the tanalisation formerly used. The effects of such contrasting ground conditions may also be relevant to other timber infrastructure, notably poles used in power and telephone lines.

Over much of the Southwest soil, in the form of cob, has been, for centuries, a favoured building material. On Dartmoor, with a plentiful supply of stone, it is relatively rare, despite its excellent insulating properties. However there are some examples of its past use, as in Plate 86, but most frequently it served to level up the tops of stone walls close to eave level. The modern example, shown in Plate 85, constructed using readily available machinery, has zero haulage miles for the main building material, and is cool in summer and cosy in winter.

The nature of a locality's soils and geology strongly influence the design, installation and functioning of ground-source heat pump systems. The ground's thermal properties and the presence of any groundwater, along with ease of excavation and drilling, are key concerns. Geological considerations are set out by Banks [2009] and Busby *et al.* [2009]. With depths of installations at 1.5 m or greater, information from soil studies is most relevant to systems using horizontal pipework at shallow depths. In addition, soil mapping's indication of near-surface hydrology is uniquely detailed, and can show, in more detail than standard geological maps, areas where groundwater approaches the surface, sites where deeper, vertical arrays or "open", borehole systems may be favoured.

Characterisation of ground conditions at depths of around 1.5 to 2 m. straddles the boundary between soil and geological expertise, involving layers comprising diverse assemblages of mineral material and organic matter, along with variations of aggregation and consolidation. Direct measurement of soil properties from such depths is not regularly forthcoming, other than for analyses of horizons designated BC and C in Chapter 3's profile descriptions, although there are other exceptions, such as Nozviger [2005]. However, an appreciation of the make-up and variation of the soils' substrates at such depths is developed during soil surveys. From the geological perspective DECC [2008] and Busby *et al.* [2009] provide some data on thermal properties of superficial deposits, albeit in generalised terms, while many installations, neither in such deposits nor soil, rather will fall within the zone of weathered, but *in situ,* rock. There uncertainties over physical and chemical changes, such as fracturing and comminution, as well as locally the kaolinisation of the granite, abound.

The potential rate for transfer of heat from the ground to heat-exchanger pipes, its *thermal diffusivity,* is determined by the ground's *specific heat capacity*, its porosity / density and its *thermal conductivity.* Lithology, porosity / density and the degree of water saturation are the main influences on thermal conductivity, increased porosity reducing it, saturation increasing it. In materials of high hydraulic conductivity and where groundwater reaches a horizontal loop array, the potential for heat transfer is substantially enhanced.

Applying these principals to subsoils and substrates of the settled in-bye of this survey district provides some conclusions.

On freely draining sites on both the granite outcrop and the Carboniferous rocks, notably on Moretonhampstead, Moor Gate, Bridford, Drogo and Denbigh map units, there is considerable short-range variation in ground conditions at the level of shallow, horizontal installations. On the granite lateral passage from loose growan to solid granite, via stony head, in places with fragipans, can take place over a few metres. Decomposed, *in situ* granite can also be encountered. Some of the heads, particularly on the metamorphic aureole are very open and coarsely porous, in places scree-like with large interstitial voids. As on the granite, such materials may be cheek by jowl with little weathered rock almost up to the surface. Such variations will reduce specific heat, thermal conductivity and diffusivity, through the high porosity of some growan, and particularly head on the metamorphic aureole, where the pores seldom if ever contain water. The ease of trenching will also be affected, with some ground diggable with a JCB, some requiring drilling and even blasting.

Sites in the Laployd and Sulham / Eversley map units having high hydraulic conductivity and, being affected by groundwater, have augmented potential for heat transfer, with the possibility of the water being the main thermal resource. Similar conditions may affect the upslope end of parcels of the Tedburn map unit, the 1.5+ m layers beneath Tavy / Ty-Gwyn soils and the lower margins of the freely draining Moretonhampstead and Moor Gate map units abutting Laployd soils. In the latter case the unsaturated zone may be sufficiently shallow to make the groundwater reachable by trenching or boring.

Subsoils with small porosity and small hydraulic conductivity underly much of the Tedburn, Halstow and Halfway House / Drewston map units. These soils become waterlogged in the autumn and remain so through the winter into spring. This saturation is likely to have some thermal benefit, and occurs over the half of the year when heat will be required.

# Chapter 5 Peat Thickness

Peat thickness was measured by augering or steel rods along the 46 linear traverses listed with their grid references in Table 19. They were chosen to cover the main peat soil landscape elements on the Winter Hill, Hepste and Crowdy soil map units in the western part of the survey area in SX68. Most of the Winter Hill observations are in the parts little affected by peat cutting. Over 1,800 measurements were made, in most instances observations at notional 25 m paced intervals [checked by GPS every 4th observation]. Exception to the 25 m spacing were in a] all of traverse 1, and the eastern part of traverse 46, where measurements were on each slope facet; b] on traverse 17 and between 370 m and 520 m on number 46, where spacings were 50 m.

**Table 19. National Grid references of peat thickness traverses in SX68.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Fr 3440 4380<br>to 2810 4420 | 13 | Fr 195 987*<br>to 201 090<br>to 145 041<br>to 102 132 | 25 | Fr 3896 6381<br>to 4043 6962 | 37 | Fr 1304 9130<br>to 1459 9609 |
| 2 | Fr 3336 4202<br>to 2593 5175 | 14 | Fr 272 347<br>to 244 417<br>to 260 438<br>to 294 367 | 26 | Fr 3538 6707<br>to 3898 6622 | 38 | Fr 0602 8978<br>to 0228 9306 |
| 3 | Fr 2792 5369<br>to 3684 4845 | 15 | Fr 202 381<br>to 097 325 | 27 | Fr 4491 7730<br>to 4861 7471 | 39 | Fr 0234 9340<br>to 0430 9319 |
| 4 | Fr 3249 3046<br>to 2354 2179 | 16 | Fr 168 317<br>to 060 298 | 28 | Fr 4105 9871<br>to 3617 9983 | 40 | Fr 0851 2034<br>to 9812 2517* |
| 5 | Fr 2902 2427<br>to 2176 287<br>to 1892 2882 | 17 | Fr 057 326<br>to 084 336 | 29 | Fr 6394 9966<br>to 3549 9342 | 41 | Fr 0532 1780<br>to 0290 270 |
| 6 | Fr 2155 2477<br>to 1473 2030 | 18 | Fr 109 468<br>to 034 465<br>to 030 394<br>to 061 393 | 30 | Fr 3556 9532<br>to 3844 0003 | 42 | Fr 0387 5819<br>to 0072 4662 |
| 7 | Fr 1304 2767<br>to 2030 2826 | 19 | Fr 186 422<br>to 067 390 | 31 | Fr 0320 6834<br>to 0820 5524 | 43 | Fr 9998 5566*<br>to 0594 5103 |
| 8 | Fr 5395 7604<br>to 4828 7997 | 20 | Fr 230 717<br>to 231 584 | 32 | Fr 0353 5822<br>to 1590 5799 $ | 44 | Fr 0875 1001<br>to 0037 1267 |
| 9 | Fr 4903 8563<br>to 4944 9450 | 21 | Fr 2290 5372<br>to 2319 5755 | 33 | Fr 1850 5500<br>$ to 2594 5270 | 45 | Fr 0021 1109<br>to 9994 1574* |
| 10 | Fr 5398 6789<br>to 5387 6722<br>to 5672 6531 | 22 | Fr 135 174<br>to 981 179 * | 34 | Fr 1844 6531<br>to 1931 7818 | 46 | Fr 2217 2162<br>to 2560 2090<br>$$ to 3170 2220 |
| 11 | Fr 342 865<br>to 335 912<br>to 303 332<br>to 297 804 | 23 | Fr 160 480<br>to 109 471<br>to 109 378 | 35 | Fr 1595 7402<br>to 1013 7462 | | |
| 12 | Fr 234 777<br>to 328 733 | 24 | Fr 160 550<br>$ to 9998<br>5566* | 36 | Fr 0845 9899<br>to 0880 9143 | | |

Fr=From start of traverse. Those marked $ are corners of Fyfe's GPR Hangingstone Hill block; from $$ and 250 m E is his Winney's Down block; locations marked * are just outside SX68.

Summary results are in Tables 20, 21 and 22. A small number of observations, where traverses crossed cut away peat, narrow sub-alluvial strips on river head-waters, tin workings and mineral soils at traverse ends, are not tabulated. Traverses 24, 32 and 33 terminate at the corners of an area of Hangingstone Hill [617861] where Fyfe *et al.* [2010] measured peat thickness using ground penetrating radar.

**Table 20. Summary of peat thicknesses [cm] by map units.**

| Parameter | All Peat map units | Winter Hill | Hepste | Crowdy |
|---|---|---|---|---|
| **Arithmetic mean** | 168 | 269 | 70 | 102 |
| **Median** | 125 | 260 | 60 | 90 |
| **Standard deviation** | 133 | 132 | 44 | 62 |
| **Maximum** | 740 | 740 | 276 | 405 |
| **Minimum** | 0 | 10 | 0 | 0 |
| **Range** | 740 | 730 | 276 | 405 |
| **Interquartile range** | 180 | 145 | 36 | 70 |
| **Upper quartile** | 245 | 325 | 80 | 130 |
| **Lower quartile** | 65 | 180 | 44 | 60 |
| **%>80 cm** | 69 | 96 | 29 | 61 |
| **Number of observations** | 1738 | 773 | 440 | 526 |

Table 20 shows peat thicknesses in the various peat soil map units as measured on the 46 traverses. Taken at the broadest level, of all peat soil map units, mean and median amounts are 168 and 125 cm within a range of 0-740 cm.

**Table 21. Summary of peat thickness [cm] in Winter Hill phases.**

| Parameter | All of Winter Hill units | Pristine | Slightly eroded | Severely eroded |
|---|---|---|---|---|
| **Arithmetic mean** | 269 | 347 | 251 | 152 |
| **Median** | 260 | 320 | 250 | 135 |
| **Standard deviation** | 132 | 147 | 86 | 82 |
| **Maximum** | 740 | 740 | 520 | 360 |
| **Minimum** | 10 | 45 | 10 | 20 |
| **Range** | 730 | 695 | 510 | 340 |
| **Interquartile range** | 145 | 180 | 120 | 112.5 |
| **Upper quartile** | 325 | 425 | 305 | 203 |
| **Lower quartile** | 180 | 245 | 185 | 90 |
| **%>80 cm** | 96 | 99.7 | 95 | 82 |
| **Number of observations** | 797 | 292 | 341 | 140 |

Seen in more detail, there are clear differences among the various soil map units, the peat being thickest in the Winter Hill soils with a median of 260 cm, and least on the Hepste map unit where the median thickness is 60 cm.

Degradation in the Hepste map unit by cutting and erosion has played a part in reduction of peat thickness by direct removal, compounded by the associated hydrological changes that have caused humification and shrinkage. Median and mean values are less than 80 cm, the thickness criterion [see Section 2.2.2] separating ‘peat soils’ from ‘peat over lithoskeletal material’, with only the Hepste map unit’s upper quartile exceeding that cut off.

While large parts of the basin peat of the Crowdy map unit have been cut for fuel, the impact of erosion is negligible, over 60% of observations exceeding the 80 cm criterion. The location of the Crowdy soils mapped in basins and flushes further accounts for the greater thickness of peat compared with the Hepste soils on higher ground, with a maximum of 405 cm and upper quartile of 130 cm against Hepste’s 276 cm and 80 cm. Spring action may have supplemented peat growth in places, while flatter sites and low lying location also discouraged peat cutters.

**Table 22. Summary of peat thickness [cm] in Winter Hill slightly eroded and severely eroded phases.**

| Parameter | Not eroded in slightly eroded phase | Eroded in slightly eroded phase | Not eroded in severely eroded phase | Eroded in severely eroded phase |
|---|---|---|---|---|
| **Arithmetic mean** | 263 | 211 | 227 | 118 |
| **Median** | 268 | 220 | 218 | 110 |
| **Standard deviation** | 85 | 75 | 69 | 61 |
| **Maximum** | 520 | 380 | 360 | 295 |
| **Minimum** | 65 | 10 | 105 | 20 |
| **Range** | 555 | 370 | 255 | 275 |
| **Interquartile range** | 125 | 105 | 128 | 80 |
| **Upper quartile** | 320 | 260 | 293 | 155 |
| **Lower quartile** | 195 | 155 | 165 | 75 |
| **%>80 cm** | 99 | 96 | 100 | 75 |
| **Number of observations** | 260 | 80 | 44 | 96 |

Among the Winter Hill soils, results [Table 21] are broken down among the three phases shown on the terrain map. In all the range is from 10 cm to 740 cm, the thinnest records coming from within the eroded phases of the map unit, the thickest on the high plateau at 570 m O.D. on flat, pristine ground between Cranmere Pool [603858] and Black Hill [604846]. In all aspects, apart from minimum depth, the peat in the pristine phase of Winter Hill is thicker than in those portions unaffected by erosion within the mapped eroded phases; in these cases there is a median thickness of 320 cm in the pristine phase, against 250 cm and 135 cm in the slightly and severely eroded phases, respectively.

Table 22 shows that the peat is thicker in most respects in the uneroded parts of the slightly eroded phase [median of 268 cm] than in those of the severely eroded phase [median of 218 cm], while similarly on the eroded parts of the slightly eroded phase there is more peat, with median thickness of 220 cm, than on eroded ground in the severely eroded phase where the median amount is 110 cm. The discrepancy between the total of observations in all of the Winter Hill map unit [column 2 in Table 21] and the sum of the three phases [columns 3, 4 and 5] comes about from additional measurements in parts of the soil map unit on cut-over ground.

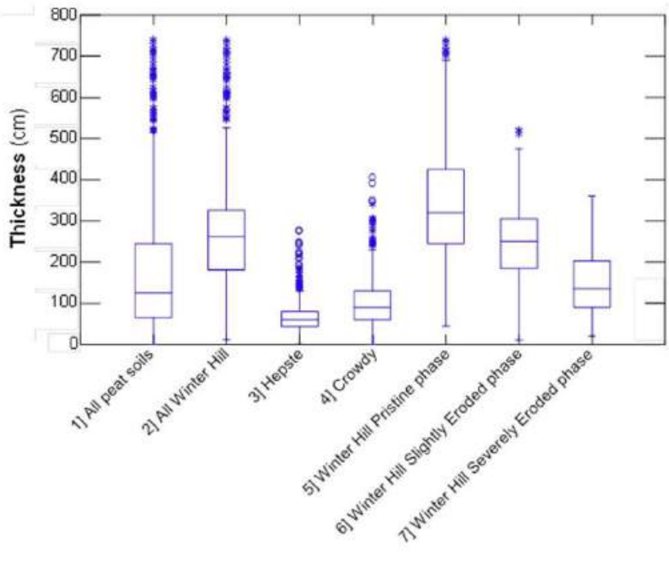



**Figure 11. Thickness of peat on peat soil map units and phases.**

The horizontal lines within the boxes represent median values, the boxes mark the central tendency [66%] of each site's values and the lines and circles represent the outliers.

In the Winter Hill map unit, the traverses confirm the greater areal extent of erosion in the severely eroded phase, [noted in Section 3.28] where 96 out of 140 [68%] of the measurements fell on eroded ground, compared with 24% [80 out of 341] on the slightly eroded phase.

Taking these proportions affected by erosion and weighting them against differences in median thickness of peat between eroded and un-eroded parts of the two phases from Table 22, some estimate of erosion can be derived. Losses on the slightly eroded phase's eroded parts are indicated at 4,800 $m^3$ ha; -for the phase as a whole- 1,152 $m^3$ ha. Amounts removed from the severely eroded phase come out at 10,800 $m^3$ ha in the eroded areas and 7,344 $m^3$ ha for all the phase. By extrapolating these figures across the mapped phases on SX68, their total erosional losses can be estimated. From the slightly eroded phase of 390 ha extent, losses are 449,280 $m^3$, with an apparent loss of 1,615,680 $m^3$ from the severely eroded phase's 232 ha.

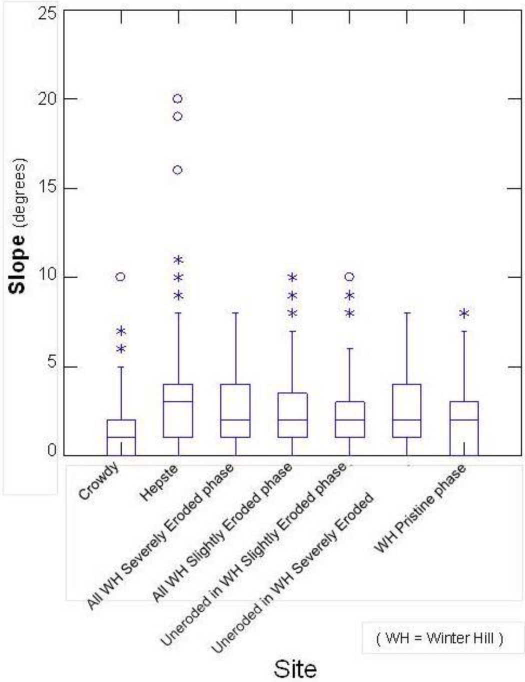



**Figure 12. Slopes on the peat soil map units.**

The horizontal lines within the boxes represent median values, the boxes mark the central tendency [66%] of each site's values and the lines and circles represent the outliers.

**Slopes of peat soil units:** Given a suitable climate [high rainfall and negligible summer moisture deficit] and hydrological conditions [ground perennially saturated by groundwater or soil permeability or slopes insufficient to dispose of the received precipitation], peat will tend to form, plant residues remaining partly or wholly undecomposed when waterlogged and anaerobic. Acidity can achieve a similar result; often in this district the two processes work together.

On Dartmoor, most valley floors and associated footslopes are affected by springs and high groundwater tables encouraging the growth of basin peat, the Crowdy soil map unit [Section 3.12]. Over most of the high moorland, severe climate and level or gentle slopes give rise to the blanket hill peat of the Winter Hill [Section 3.10] and Hepste [Section 3.11] map units, less than 2% of the ground with peat soils being on slopes steeper than 7$^{O}$. On the small areas steeper than about 10$^{O}$ the peat attenuates to less than 40 cm thickness and mineral soils develop, while below about 500 m O.D. the blanket peat thins into mineral soils on gentler slopes as the climate becomes less harsh.

During the measurement of peat thickness along the 46 traverses, the angle of the overall slope of each site was measured. A summary of those slopes is in Table 23, for each soil map unit, with further break-down in Table 24 within the Winter Hill unit for its three peat soil erosion phases described in Section 3.28. The flattest ground is that within the basin sites of the Crowdy map unit, with the steepest in the Hepste map unit and the eroded ground within the slightly eroded phase of the Winter Hill soils. The pristine Winter Hill phase tends to be on the level or gentle slopes that offer erosion the least opportunity to initiate. There is a similar but slightly less marked character to the uneroded ground within the slightly eroded phase of Winter Hill soils, differing from the eroded part of that phase. This contrasts with the severely eroded phase where differences of slopes between the eroded sites and those without erosion are negligible, both being intermediate within the slope range found in the slightly eroded phase.

**Table 23. Slope angles in degrees on peat soil map units.**

| Parameter | **Winter Hill** | **Hepste** | **Crowdy** |
|---|---|---|---|
| **Count** | 271 | 438 | 525 |
| **Range** | 0-10 | 0-20 | 0-10 |
| **Mean** | 2.21 | 3.01 | 1.57 |
| **Median** | 2 | 3 | 1 |
| **Upper quartile** | 3 | 4 | 2 |
| **Lower quartile** | 1 | 1 | 0 |
| **% 1$^{o}$ or less** | 36 | 30 | 60 |
| **% 3$^{o}$ or less** | 74 | 60 | 90 |
| **% > 5$^{o}$** | 13 | 11 | 2 |
| **% > 7$^{o}$** | 2 | 2.5 | <1 |

**Table 24. Slope angles in degrees on phases of the Winter Hill map unit.**

| Parameter | **Pristine phase** | ***Uneroded ground* in the slightly eroded phase** | ***Eroded ground* in the slightly eroded phase** | ***Uneroded ground* in the severely eroded phase** | ***Eroded ground* in the severely eroded phase** |
|---|---|---|---|---|---|
| **Count** | 291 | 261 | 80 | 44 | 96 |
| **Range** | 0-8 | 0-10 | 0-10 | 0-8 | 0-8 |
| **Mean** | 1.89 | 2.33 | 3.00 | 2.59 | 2.58 |
| **Median** | 2 | 2 | 3 | 2 | 2 |
| **Upper quartile** | 3 | 3 | 4 | 4 | 4 |
| **Lower quartile** | 0 | 1 | 2 | 1 | 1 |
| **% 1$^{o}$ or less** | 44 | 37 | 18 | 37 | 33 |
| **% 3$^{o}$ or less** | 85 | 79 | 66 | 60 | 69 |
| **% > 5$^{o}$** | 5 | 4 | 8 | 7 | 8 |
| **% > 7$^{o}$** | <1 | 2 | 1 | 5 | 5 |

# Chapter 6 Analyses

Major horizons of some representative profiles were sampled during the survey and analysed by the methods described by Avery and Bascomb [1982]. Where appropriate reference is made to profiles already described by Clayden [1964 and 1971], Staines [1976], Hogan [1977 and 1978] and Harrod [1981]. Analyses derived from earlier surveys are fuller and more diverse than those sampled and described during the present survey. Results for individual profiles, with comment where appropriate, are tabled in Sections 3.N.2 of the map unit descriptions in Chapter 3. Some general comments are made below.

Soil reaction was measured on almost all samples, particle-size distribution on almost all mineral horizons sampled and some organic surface horizons. Organic carbon was determined in most surface and peat soil horizons and some subsoils. Loss on ignition, total nitrogen and rubbed fibre were determined in all peat soils. Pyrophosphate-extractable iron, aluminium and carbon, and dithionite-extractable iron were determined in nine profiles. Water retention properties of five soils were evaluated and thin sections made of some B horizons to support morphological and chemical evidence for classification. Most results are expressed as percentages by mass of oven dried soil finer than 2 mm, although water retention properties are expressed by volume.

## 6.1 PARTICLE-SIZE ANALYSIS

Particle-size analyses support field estimates and indicate proportions of different soil fractions, allowing comparisons between horizons and soils. This can show lithological discontinuities in profiles, pedological accumulation of clay and the influence of weathering and other soil forming processes on different parent materials. In general, with experience, most soils can be allocated in the field with acceptable accuracy to a particular particle-size class [Hodgson *et al.* 1976] by hand texturing.

## 6.2 SOIL REACTION [pH]

The pH values quoted from previously published surveys, plus Hogan [1978], were determined both in a 1:2.5 suspension of soil in water and in 0.01 M calcium chloride solution by means of a glass electrode assembly. The latter gives smaller values and measures more truly the pH at soil particle and root surfaces, being less affected by seasonal fluctuations in the electrolyte concentration of the soil solution [Russell 1961]. pH was only measured in water on the mineral soils sampled in the current survey. For three peat soils, pH in calcium chloride solution was also measured in field moist samples.

For convenience, ranges of pH [in water] can be referred to the following scale:

*strongly acid <4.5*

*moderately acid 4.5 – 5.5*

*slightly acid 5.6 – 6.5*

*neutral 6.6 – 7.5*

*alkaline >7.5.*

Soil reaction is influenced by management, particularly in the topsoil. On agricultural land applied lime and fertilisers have their effects, in woodlands coppicing and natural processes in ancient woodlands acidify soils, litter from many conifers in plantations has a similar effect, as does that from many heathland plants.

## 6.3 ORGANIC CARBON

For samples of mineral soil profiles analysed before 1984 this was determined by Tinsley's [1950] wet oxidation method. The results support differentiation of peaty and humose soils. For mineral soil profiles analysed in 2015 Walkley and Black's [1934] wet oxidation method was used. Those are the profiles in Chapter 3 under Sections 3.3.2, 3.4.2, 3.7.2, 3.13.2, 3.14.2, 3.20.2 and 3.22.2. In organic soils devoid of clay, the loss on ignition values for oven-dried [105$^{O}$C] soil can be equated with concentration of organic matter, whilst the loss on ignition value, minus 10% of the clay content for oven-dried [105$^{O}$C] mineral soils, divided by 1.72, indicates the concentration of organic carbon amounts.

## 6.4 CARBON AND NITROGEN

The carbon results are used to designate horizons as distinct, humose or peaty. By applying the equation *organic matter = organic carbon x 1.72* organic matter can be calculated, organic carbon approximating to 60 percent of organic matter. The ratio of carbon to nitrogen gives a measure of the humification of peats.

## 6.5 LOSS ON IGNITION

Ignition of a sample gives an indication of amounts of organic matter present. In most, but not all, mineral soils described in Chapter 3 from previously published surveys, organic carbon rather than loss on ignition was measured. Where only loss on ignition percentage is available, organic carbon content can be estimated through subtracting 10% of the clay content from the loss on ignition value and dividing the product by 1.72. The organic soils in Sections 3.10.2, 3.11.2 and 3.12.2 are devoid of clay, so that their ignition loss figure can be converted to organic carbon amounts using the formula in Section 6.3.

## 6.6 PYROPHOSPHATE EXTRACTION

Potassium pyrophosphate solution [0.1 M] mostly extracts organically bound iron and aluminium and some organic carbon from soils. The results are used to distinguish podzolic Bs horizons, in which the content of pyrophosphate-extractable iron and aluminium is more than 0.3%, and amounts to 5% or more of the clay content of the horizon. Brown earths usually fall short of these requirements and amounts extracted by pyrophosphate decrease with depth, whereas in podzolic soils most are extracted in the Bs and Bh horizons.

## 6.7 RESIDUAL DITHIONITE EXTRACTION

Sodium dithionite solution will extract both the poorly and the well crystallised [hydrous] iron oxides that remain after pyrophosphate extraction, that is the non-organically bound fraction [Bascomb 1968].

## 6.8 WATER RETENTION

Fifteen horizons from five profiles were sampled for measurement of water retention properties. The results provide an indication of pore-size distribution in the soil as a function of organic carbon content, soil density and particle-size distribution. In addition to the methods described by Avery and Bascomb [1982], Hall *et al.* [1977] describe such analyses and discuss interpretation of results. Properties determined on samples from this survey include bulk density, total pore space, available water, air and retained water capacities. Results quoted in Chapter 3 are on total soil by volume.

*Bulk density:* This is the apparent density of the soil in the field and, together with particle size distribution and organic carbon content, it influences plant available water, retained water capacity and air capacity [Reeve *et al.* 1973]. Bulk density also influences soil strength, penetration by roots, percolation rates and permeability to air and water. In agriculture it is relatively easily modified by cultivation and subsoiling. Change in bulk density involves a change in mass of soil per unit volume; for this reason soil water and porosity properties are expressed in terms of volume rather than mass. It is reported in $g\ cm^{-3}$ or $t\ m^{-3}$.

*Packing density:* This is a modification, following Renger [1970], of fine earth bulk density to account for unavailable water held in very fine pores associated with clay particles. It is more readily estimated in the field than bulk density and has the same units: $g\ cm^{-3}$ or $t\ m^{-3}$.

$$\text{Packing density} = \text{bulk density} + 0.009\ [\%\ \text{clay content}]\ \text{g cm}^{-3}.$$

*Air capacity / porosity:* The volume of air in a sample at 0.05 bar suction as a percentage of the sample volume indicates approximately the proportion of pores greater than 60 µm diameter, and is a measure of permeability, porosity and aeration at field capacity. Slightly or very slightly porous horizons with high packing density are relatively impervious and impede the downward percolation of water. Such impedance causes severe waterlogging as the surplus water must disperse by slow lateral movement and percolation through underlying, more permeable horizons. In high rainfall regimes the relationship between measured porosity and permeability may differ, with moderately, or more, porous horizons becoming effectively impermeable.

*Retained water capacity:* This describes the volume of water in a sample at 0.05 bar suction as a percentage of the sample volume. It is an indication of the amount of water held against gravity, approximating to water content at field capacity. In soils lacking a high water-table or drainage impedance, field capacity is likely to be achieved about 2 days after waterlogging. In less pervious soils a considerably longer period is involved. Retained water capacity is a guide to relative susceptibility to poaching and compaction on working or trafficking the land.

*Available water capacity:* Defined as the volume of water retained between 0.05 and 15 bar suctions, expressed as a percentage of the sample volume. The range from 0.05 bar, approximating to field capacity, to 15 bar, theoretically the permanent wilting point of temperate plants, indicates water volume available to plants and relative drought risk in soils. Because of the contribution made by organic matter, available water values tend to be largest in surface horizons.

## 6.9 BICARBONATE EXTRACTABLE [OLSEN] PHOSPHORUS

Determinations were by the method of Olsen *et al.* [1954]. The results indicate amounts of plant-available phosphorus. Statistics from the National Soil Inventory and the National Soil Archive compiled by Fraser [2000] on topsoil and subsoil Olsen P amounts provide a context for assessing the origin of the Furlong series described in Section 3.3.

## 6.10 MICROMORPHOLOGY

Five profiles used for the British Society of Soil Science annual conference at Exeter in 1978 [Hogan 1978] had thin sections of selected horizons described by P. Bullock and C.P. Murphy. These notes used the terminology of Brewer [1964].

# Chapter 7 Aspects of Dartmoor's Landscape

Dartmoor as a National Park attracts hundreds of thousands of visitors annually, accommodation and services for them ensuring the livelihoods of many local people. They come because the landscape appeals deeply to them, capturing their imaginations, from the incurable romantic to the more pragmatic ecologist. It is Dartmoor's wildness, visual character and aesthetics, heritage in all its forms, history, even the weather that has inspired artists, writers and poets and bring the steady streams of people along the B3212 from early spring to late autumn. What attracts them is often spiritual and nebulous and includes aspects such as literature and the arts, rustic vernacular buildings, archaeology, natural history or the scenery, parts of the latter two being covered elsewhere in this Record. However, much of the area's charm is the blending of those themes into the overall ambience of the landscape.

Dartmoor's assets are recognised institutionally, beyond it being a National Park. There are Sites of Special Scientific Interest, National Nature Reserves and land owned by the National Trust, the Woodland Trust and the Dartmoor National Park. Further to the specific protection these designations confer, the concept of 'natural capital' has emerged in Government policies in recent years, acknowledging what most lovers of landscapes have known all along.

Many people's ideas of Dartmoor have roots in Conan Doyle's novel [1902] "The Hound of the Baskervilles" and its various mass media offshoots. The forbidding images of the moor and the Grimpen Mire compound the alarm that the very thought of the hound triggers. Hemery [1983] says Heatree House [727807], Manaton was the inspiration for Baskerville Hall. Though there are legends of wish-hounds, witches and pixies, any disquiet is countered by postcards and calendars portraying grazing ponies and clapper bridges, usually on a sunny day. The folk song, "Widecombe Fair", adds to the mixed atmosphere of a bucolic idyll offset by rattling bones, skirling and groans. Tom Pearce's grey mare must have trudged across this study area from its home at Spreyton [700967], by way of Chagford [with the witch Old Mol and Civil War ghost], Watching Place [713842] [legendary as a gallows site and highwaymen's haunt] and Jay's Grave [732799] [of a tragic eighteenth century suicide, with fresh flowers mysteriously appearing every day], in its 20 km journey along Long Lane to Widecombe [718768]. That's if the mare and her seven passengers ever made it that far. Sabine Baring-Gould famously recorded much of the folklore of Dartmoor [Graebe, 2008].

Dartmoor has stirred numerous other writers. A few examples involving this survey district must suffice. Eden Philpotts, an eminent local author, poet, playwright and painter, friend of Conan Doyle, Jerome K. Jerome and Arnold Bennett. Bennett wrote the 18 novel "Dartmoor Cycle" between 1898 and 1923, setting the first “The Children of the Mist” at Rushford Mill [706884], the second “Sons of the Morning” at Gidleigh [710843] and a further one “The Secret Woman” on Taw Marsh [620900]. John Galsworthy owned a second home at Manaton from 1908-23 and based “The Apple Tree” on Kitty Jay’s story. R.D. Blackmore is reputed to have used the fatal shooting in 1641 of Mary Whyddon at her wedding in Chagford church as a model for the attempt on Lorna Doone’s life. Evelyn Waugh’s “Brideshead Revisited” was largely written at Easton [719887], Chagford, while Agatha Christie named her fictional Dartmoor house in the “Sittaford Mystery” after the local tor. The Dartmoor poet N.T. Carrington’s “The Sailor’s Fate” commemorates a traveller lost on the Mariners’ Way. Ted Hughes, the poet laureate, lived just off the moor and loved the Taw Head-Dart Head area, which inspired his poem “The River”.

There is a formidable book list on Dartmoor’s history, natural history and scenery, including the New Naturalist series by Harvey and St Leger Gordon [1963], with an impressive revision by Mercer [2009]. A stalwart among Dartmoor writers, Crossing’s topographic guide [1912] has stood time’s tests. The last 50 years have seen burgeoning enthusiasm for accounts of local history and topography, both in prose and in verse. Examples include “Heathercombe the history of a Dartmoor valley” [Pike 1993], Haytor-Hames [1981] “A history of Chagford” and “Blissful, restless Dartmoor“, [Pearse 2011]. Part of that is an ageing generation’s realisation that so much from the past’s heritage risks going unrecorded, and part the liberalisation of publishing, including its desktop variants. The internet, whether through the Project Gutenberg eBooks or informal blogs, adds new dimensions to the literature. Conservation organisations devoted to Dartmoor include the Dartmoor Society, the Dartmoor Preservation Association, the Dartmoor Trust and the Dartmoor Tin Research Group.

Many painters have been enthused by this countryside. Notable among them would be the Widgerys, father [W.] and son [F.J.]. The elder painted both moorland and lowland scenes, Cranmere Pool [603858], Ponies on Dartmoor, Gidleigh Park [677879] and Fingle Bridge [743899] in this survey district. His son’s reputation stands on impressionistic moorland scenes, the subtlety of the vegetation’s colours and the blue-grey distance of local settings including Steeperton Tor [618888], Gidleigh Moors [650875] and Wallabrook Clapper [653871]. Away from the moorland the artists seem to be lured by water features such as Fingle Bridge and Holy Street Mill [689878]. Even W.R. Sickert produced an impressionist’s view of Rushford Mill, while one might have expected the in-bye’s jumbled landscape to have offered attractive subjects for the Camden Town movement. Developing tourism in Victorian times encouraged local artists, William Snell Morrish for example, thus providing livelihoods for a number, as it still does, with the internet today making the viewing of art, past and present, available to all.

Photography, now as never before, presents the creative eye with opportunities. The area's attractions were recognised by pioneers, various archives, for example Greeves [2015], having early photographs. Comparisons with those hint at landscape changes, Hunt's Tor [722898] near Castle Drogo, among others, in the 1860s was in open ground, but long since then has become hidden by trees. Local historical works, such as Baldwin *et al.*'s Book of Manaton [1999], include century-old photos of lost farming practices such as denshering.

Music's place is high in contemporary culture. An annual festival, "Chagstock", organised from Chagford, is held just north of the survey area. Seth Lakeman, a nationally popular singer and song writer, acknowledges the inspiration he has drawn from Dartmoor, including one song featuring the tale of Kitty Jay. Similarly the landscape has stimulated the contemporary instrumental and orchestral music of Nigel Shaw, based near Postbridge, a few hundred metres south of the area covered by this soil survey. Baring Gould's collections included many folk songs from Chagford. The annual Two Moors Festival of classical music includes performances in churches in and around northeast Dartmoor, as well as more widely across Devon to Exmoor.

The contrast between moorland and the lower, enclosed in-bye, with its scattered woodland, is at the heart of the scenery. The moorland is the original Dartmoor. The in-bye, called by some the in-country, the Granite Gravel District of Vancouver [1808], has gradually become part of a wider Dartmoor, notably following the National Park's establishment. The contrast in landscapes remains stark, one part quintessentially rural and English, the other wild, unlike most of England's countryside. Both have charm aplenty. The rolling moorland, changing with the weather and the seasons, is not the untouched wilderness it might appear, but full of the marks of thousands of years of man's works. The in-bye is dominated by small, irregular fields, with woods and downs scattered among them. Just as the landscapes contrast sharply, their contact is abrupt, with the change marked by a single asymmetric bank, the stock-proof cornditch.

Almost all of the area is underlain by granite, whose properties impart the overall character of the terrain. Aeons of erosion have sculpted valleys and rounded hills, usually with a preferred orientation, many ridges and valleys favouring a northwest to southeast alignment, the 'grain' of the country. The valleys are blessed by networks of rushing, normally gin-clear, streams, only the Bovey and the Teign wide enough within the district to deserve the name river. In places the valley floors form broad basins separated by narrow, steep sided gorges where the rivers and streams have cut across the physiographic grain. The most marked of these are along the Teign, which, in its eastbound course, ignores the geologically determined relief patterns. On the highest ground in the west thick peat blankets the hills. In small parts of the northeast and southeast, the granite gives place to the Carboniferous rocks which surround it.

The break between moorland and the in-bye at the cornditch is usually at about 350-400 m O.D. The moorland, which makes up about 45% of this mapped district, rises westwards, in a broad series of steps to around 600 m O.D. on Hangingstone [617861] and Cut [598827] Hills, the thick peat forming above about 500 m. With the exceptions of a few hills, Meldon [696861], Easdon [730820], Butterdon [750884], Mardon [772879] and Hayne [740800] Downs, the enclosed in-bye lies below 300 m, standing as low as 50 m O.D. where the Bovey leaves the district's southeastern corner. The tops of these downs form conspicuous patches of moorland within the in-bye, while many of its steeper slopes are clothed by woodlands.

**The Moorland** The look and the feel of the moorland stem from the natural land forms including the terrain, in places flat, others steep and bluff, the vegetation's colours changing each season, the tors and rocks. All these are blended with the human footprint of prehistory's hut circles and monuments, the clapper bridges, historic tin and peat workings and stone walls of more recent newtake enclosures, along with the ponies, sheep and cattle grazing the moor. On top of this the Dartmoor weather ensures that any scene soon changes.

*The living moorland.* Many would think first of the purple and yellow of the moor in flower. However, from June into the autumn much of it is green as the *Molinia* shoots burst out and on the drier, often steeper, soils the bracken grows up. Largely remote from the roads and car parks, summer sees the white cotton grass on both the high blanket peat and the valley mires, along with the yellow bog asphodel and the delicate carnivorous sundew. Come autumn the colours change, the dead *Molinia* leaves turning to beige raffia and blowing into drifts in the gales, while the bracken goes reddish brown until the next summer. The interest goes beyond the vegetation's appearance, the different elements' ecology add scientific relevance, much of it discussed by Mercer [2009]. Soils matter in this, with the vegetation and the invertebrate communities differing with the degree of wetness. Larger animals, from rabbits to badgers, favour the freer draining ground for their burrows and setts.

Trees grow on the moor in relatively sheltered spots, including tin workings, provided grazing permits. There's a scatter of hawthorn and rowan on the lower, drier soils. Willows dot some of the valley mires. There are self-sown Sitka spruces on the moorland near Soussons [680800] and Fernworthy [650830] plantations. Interestingly, three such Sitkas grow around the Wild Tor [620873] ridge, the highest at 549 m O.D., some years at least one of these spruce trees being used by nesting birds. Stunted oaks cling to crags along the East Dart, one tree at the east end of Sandy Hole Pass [621815], the other accompanied by a small rowan at the head of Broad Marsh [614821], at 501 m O.D., candidates for the highest deciduous trees on Dartmoor.

**Plate 87. Castle Rock, Hurston.**

There are a few prominent granite outcrops in valley floors, as is Castle Rock, which is large enough to warrant the name 'tor'. In front of it is a mixture of ground disturbed in the winning of tin ore and wet soils of the Laployd soil map unit. The slopes of the middle and background are mostly covered by Moretonhampstead soils.

**Plate 88. A natural basin on Hingston Rocks.**

Similar features form here and there on other granite outcrops and tors, the largest being on Kes Tor. In winter rain water fills the basins.

*The moorland's physical setting*. Were it not for the pony, the emblem of Dartmoor would be the tor. While the name marks imposing, rugged outcrops, such as Oke Tor [612900] and Kestor [666863], others like Flat Tor [609816] and Little Hound Tor [633899], are much smaller, seemingly undeserving of their title. Some crown hill tops, some stand out from the hill-side or the spur end and one, Castle Rock [684834], Hurston, rises from the valley floor. Below many tors are tumbled boulders or clitter, often more extensive than the tor itself. Some tors include curious formations, among them the delicately poised, rocking logan stones, the Thirlstone natural arch at Watern Tor [629868], rock basins as at Kestor, once called the Druids' Font, or the pillar of Bowerman's Nose [741805], a huntsman petrified by the witches after he disturbed their coven. In the North Teign near Teignever [653871] a near metre wide pothole scoured clean through a boulder, the Tolmen, confers good luck on anyone who clambers through it.

**Plate 89. The Thurlstone, part of Watern Tor.**

This unusual formation is recorded as one of the landmarks in the perambulation of the boundary of the Royal Forest of Dartmoor in July 1240.

Compared with some other sections of Dartmoor, the part covered in this survey has relatively few tors. It does, however, share the undulating terrain of rounded hills separated by basins. In places its rolling hills are punctuated by abrupt cleaves, as on either flank of Taw Plain [618898], which can morph into narrow gorges, as in Steeperton Gorge [616889], cut by the headwaters of the River Taw.

Moorland streams are normally narrow, clear and swift. They have tranquil reaches punctuated by steeper, bouldery cataracts, but are seldom too wide to cross. This changes with heavy rainfall, as they turn into teak-brown torrents stained by the runoff from the peaty soils. Then it can become difficult to see the main channel and minor dips become serious obstacles to movement. Some headwaters are discoloured by mineral-rich algal growth from tin workings or springs. Away from the streams are occasional pools, only Raybarrow Pool [638900] being of any size. Most, including Cranmere Pool [603858], but a few metres across, usually within valley mires, some of them spring 'eyes', or in tin or peat workings, are covered in bright green vegetation and fringed by quaking ground, while the blanket bog has scattered pools, many no more than puddles.

**Plate 90. The distinctive granite pillar, Bowerman's Nose, Hayne Down, Manaton.**
Its legend is that a huntsman, who, disturbing a witches' coven, was petrified in punishment.

The weather has a role in our perception and the ambience of Dartmoor. Most visitors stay away on its bad days of cold, driving rain and zero visibility. At times it has weather of its own, days when the forecasters miss a trick. Cumulus clouds can become thunderheads over it, while the lowlands enjoy almost unbroken sunshine. Three times during this survey the author has retreated from the high moor in the face of unforecast lightning. Even in its better moods it can change from an idyllic balm to an intimidating gloom, whose arrival adversely changes the perceived scale and form of the landscape. Then you appreciate your map, GPS, and waterproofs. Remember, 1998's Ten Tors Event was abandoned halfway through due to heavy snow in mid-May. On a good day from higher vantages there are glimpses of the Channel, east Devon's Blackdowns, Exmoor, Bodmin Moor and the grey clay tips north of St Austell. At times the changing light brings glimpses of landscapes that vanish with the next cloud's shadow; a rock, one minute standing out like surrender's white flag, disappearing when the sun goes in.

**Plate 91. The Tolmen, a pothole 1 m in diameter, in the North Teign at Teign-e-ver.**

Its origin was through smaller stones, trapped in an initial depression in the river bed, perhaps one similar to that in Plate 88, then being swirled endlessly in the current, gradually scouring out this pothole. Tradition states that passing through it brings good luck.

*Seclusion and history of moorland landuse.* Solitude is one of the moor's offerings, alone with the sounds of the wind and the streams, the song of the larks and the occasional croaks of a pair of ravens. On a good day this can endure for hours, on others, even when out of earshot of farms and roads, planes and helicopters can interrupt. The col at the Grey Weathers [638831] seems to be a magnet for low-flying helicopters passing up and down the Teign and Dart. Rescue from intrusions by that mechanical world can come unexpectedly. While measuring peat depths in a mire, completely unrecognised, almost alien, mutterings were repeated every minute or so, each time from another direction, enough to stir one's belief in the legendary pixies. Later a scroll through the RSPB's CD of bird songs revealed that it was the drumming of snipe, a radically different sound to that bird's so familiar call in flight.

Dartmoor is renowned for its arrays of prehistoric stone structures, hut circles, reaves, stone rows, kists, cairns, menhirs and stone circles. A Bronze Age amber and gold pommel found on Hamel Down [705800] was destroyed in the Plymouth blitz. Recently similarly dated fabric, accompanied by tin and amber beads were excavated from a kist on Whitehorse Hill [617853], the oldest [early Bronze Age] find of tin in Britain. The Bronze Age hut circles are scattered across the moorland below the blanket bog, some grouped into 'villages' as at Grimspound [701809] and Kennon Hill [642891]. Many are on particularly bouldery ground, on the face of it curious if they housed farming communities. This is one of the conundrums that prehistory presents, all part of the moor's mystique and charm.

**Plate 92. The Bronze Age compound, Grimspound, holds a number of hut circles.**

While there are other such clusters of hut circles in 'settlements' on Dartmoor, others occur singly or grouped in small numbers. There are very few on the in-bye.

Particularly striking are the reaves, linear Bronze Age enclosure boundaries, which in places cross the cornditch into the in-bye, dictating the lines of the modern fields' hedges. Others, which are less obviously functional, include the almost north-south orientation of most stone rows between the North Teign and Challacombe Down [690807], the array of stone circles in the head of the North Teign catchment, including one newly 'discovered' near Sittaford Tor [633830]. The willingness of early antiquarians to ascribe so many structures to the druids, until geology showed otherwise [Druids nil: Science three] should carry a message for any archaeologist prepared to speculate on the purpose of monuments without the benefit of evidence. Whatever their origin, these still attract visitors, some being used in celebrations at May Day and Midsummer or for demonstrations of the dowser's craft.

**Plate 93. This part of Dartmoor has several stone circles, as at Scorhill.**

These are reckoned to be late Neolithic to early Bronze Age in origin. The skyline ridge is capped by Watern and Wild Tors.

The historic period added to the moor's character, it being exploited for resources, notably for tin and fuel, irremediably altering the land's character. Medieval documents imply that rights to extract both were already established customs by the time of the Conquest [Gerrard 1994]. Farming has also brought changes ever since the Crown's interest in Dartmoor as a hunting 'forest' declined. Clapper bridges made of slabs of granite are icons of Dartmoor for many tourists. The three on the moorland at Teign-e-ver [653871] and Teignhead [639844] are of uncertain origin but will have been maintained for tinners and grazers. The Victorian Frank Philpotts signposted with plaques 'peat passes' near Statts House [620824], the Northwest Passage [602824] flanking Cut Hill, and between Hangingstone and Whitehorse Hills at 618855. A monument to victims of an RAF crash stands on Hamel Down at 713807, while an engraved boulder at 609865 near Taw Head commemorates the poet laureate Ted Hughes.

Streamworks, excavations for placer tin, scar many valley floors and lower slopes. Typically they have linear ridges of spoil and hollows, stopping abruptly in valley-side bluffs. Stream working, the limit of medieval tin exploitation, declined with the Civil War. In its time it was a highly prized activity, the tinners a law unto themselves with their own parliament, although closely regulated by the Crown. Their imprisoning of a local M.P. became the basis of Parliamentary Privilege [Greeves, 1981]. Tin from northeast Dartmoor was assayed and taxed at the stannary in Chagford before sale. The scatter of ruins, shelters, stamp [crushing] mills, blowing houses [smelting furnaces], along with leats providing water power, are intriguing parts of the moor's character.

**Plate 94. The clapper bridge across the North Teign, near the derelict farms at Teignhead and Manga.**

Towards the end of the eighteenth century, stimulated by the technologies of the Industrial Revolution, tin working, including true mining, resumed, notably south and east of the Warren House Inn [674809], at the Birch Tor-Vitifer and Golden Dagger sites. The open works or gerts, chasms crossing the moor there hint at how the place must have been, with industrial turmoil instead of the tranquillity enjoyed now. The disturbed ground on the soil map indicates the scale of the tin workings. Some ancillary structures, notably the water supply leats, deserve mention. The Birch Tor-Vitifer leat guided water from the North Teign and the East Dart several kilometres to the mine. That these impressive relics were hewn by picks, shovels, wheel barrows and little else, deserves a thought while admiring them on a summer's day.

More extensive than the tin workings, but less obvious, are Dartmoor's peat workings, one more intriguing facet of this landscape. Peat on the high moor was cut for fuel for centuries, into living memory, by commoners for home fires, by the tinners and by carbonarii, medieval charcoal burners licensed by the Duchy of Cornwall. Families of commoners each spring cut peat in lines called ties, stacking it to dry before collection later in the year. The ties were mostly aligned with any slope, minimising flooding, flat sites being avoided. Peat around the tin workings was exploited similarly. On cut-over peat the ground surface is constantly up and down, sometimes by only a few cm, elsewhere by a metre or more. These changes mark the ties, with baulks of unconsumed peat between them picked out by drier vegetation with heather, contrasting with the *Sphagnum* in the ties.

**Plate 95. A vag.**

As well as cutting the blanket bog's peat for fuel, commoners also removed the thin peaty tops from the mineral soils lower on the moorland. Vag cutting continued well into the 20th century.

Of the peat cuttings, only the ground bared by the carbonarii is sufficiently uniform to map as disturbed ground. Hundreds of acres on the hill tops, between Statts House and Wild Tor [623877] have lost a metre or more of peat. South of Wild Tor low doughnut-shaped mounds contain charcoal, remnants of the carbonariis' meilers, their kilns. A few ruined huts occur on the cut-over ground, at Statts House on Winneys Down and north of Quintin's Man [621839]. On the lower moorland, downslope from the blanket peat, commoners pared off the thin peaty topsoil for fuel as vags. Shallow dips in the ground, picked out by stunted vegetation, still mark their sites.

Without farming, the moorland vegetation would be unrecognisable because of the effects of the timing and amount of grazing. Before the Bronze Age, man began clearing the Post-glacial forest for both hunting and farming. The hut circles and reaves are measures of Bronze Age farming, whether arable or pastoral, seasonal or year-round. That relatively intensive use of vulnerable soils coincided with climate change, hastening soil acidification and the expansion of heathy vegetation. Saxon and Norman times saw Devon as a royal forest, land for the King's hunting. Eventually this forest shrank to high Dartmoor and Exmoor, and the Duchy of Cornwall rented parts of the moorland to tenant farmers. The land south of the Warren House Inn formed part of the medieval Walna tenement, its field boundaries still evident on the ground. In-bye farms reclaimed some 'outfields' from the moor. From the 17th century further farms and newtakes were established. Boundary walls originating with them, as around the abandoned farms at Teignhead [635843] [founded in 1808], Manga [639849], and Fernworthy [650830], are prominent. No buildings remain at Manga and Teignhead is barely recognisable. Other than Headland Warren Farm [693811], Warren House Inn and the house at Stannon [650806], the one remaining intact structure worthy of note is the nearby Sheepfold at 645808.

**Plate 96. A site of vag cutting west of Thornworthy Tor.**

Its edge is picked out by the slight rise in the ground. Many places across the lower moorland on Hexworthy / Rough Tor and Princetown soils have had a few cm removed from their peaty or humose tops in this way. Even when the vegetation is rank, the small steps marking the vag cuttings are noticeable under foot.

Life as a medieval tinner, a carbonarii or as a moorland grazer was tough. Accounts gathered by Greeves [1986] from workers at Birch Tor-Vitifer give a feel for mining life. He quotes William Hosking [working there in the 1830s] "...the air was very bad…… It killed scores of miners" and the vicar of Widecombe writing: "Dartmoor has been fitly called the Botany Bay for miners". In the boom times work was round the clock, with accommodation described as wretched, 'hot bedding' being one consequence. People walked miles for employment at Birch Tor-Vitifer. Greeves tells of two miners from Sticklepath, 12 km to the north, who each week shared a pony for their journey. The one rode ahead to the halfway point, tethered the mount for his workmate to collect, completing the journey on foot. Others walked from Whitchurch 23 km away. One can only imagine the life of the tin streamers and peat cutters whenever Dartmoor's weather showed its bleak side.


**Plate 97. Shovel Down, at the southern end of Gidleigh Common.**

Image © 2016 Getmapping plc. North is towards the image's top. From left to right, the scale is about 700 m. The grey areas in the centre are former vag cuttings, including that in Plate 96. In images from other seasons the cuttings are not apparent. The diagonal line to their lower right is a track following the parish boundary. Less obvious towards the top of the image are the lines of Bronze Age reaves trending northeast to southwest, with others at right angles; a hut circle is prominent towards the top centre. The area towards the top left includes a field system and settlement. Just visible, running from there, towards the lower left, is the line of a leat, which carried water to a medieval tin works at Southill, three km to the northeast.

A long established use of the moorland was summer grazing for stock from the in-bye and lowlands. Such transhumance may have been at the heart of Bronze Age landuse. It was practiced for much of historic times, supported by the laws of *levancy and couchancy,* which controlled the stock numbers, and through that the vegetation. Twentieth century innovations, the arrival of hardy Scottish blackface sheep and Galloway cattle, allowed outwintering by farmers from the nearer in-bye, leading to serious overgrazing and soil damage, compounded by vehicles repeatedly taking out fodder to stock, which in turn congregated in anticipation of their feed's arrival. In the second half of that century public policy favoured high stocking rates, again detrimental to the vegetation. The relative resilience of the grass *Molinia* compared to ling and heathers, meant in places a hands and knees search before spotting specimens of the latter. Recently the pendulum has reversed, stock numbers have fallen and the concern of many is that gorse, in particular, is thriving. A further worry is whether the rising generation of farmers with moorland rights is numerous or willing enough to maintain traditional management ways. An example is the learing of sheep, where a flock is conditioned, if necessary by the shepherd's day and night attention, to stick to its own grazing ground.

*Public enjoyment of the moorland*. This takes many forms. For some an hour in the Warren House Inn or even a car park suffices, for others a brief foray with binoculars or camera, should the weather allow, then back to civilisation. Letter boxers, ornithologists, long distance walkers, including Ten Tors competitors and Duke of Edinburgh Award candidates, as well as military personnel, can be encountered in some of the remoter places. Cyclists, horse riders and farmers' quad bikes leave their tyre or hoof marks. Much of the moorland, including the blanket bog, is criss-crossed by tracks, some linking landmarks or skirting valley bogs or erosion, some flanking the military ranges. Away from these tracks are hazards, which include the worst of all boggy ground, the bright green quaking patches in the mires; then there are the soft, bare gully floors, plus the occasional unseen and potentially leg-breaking, narrow slot-gully. Watercourses, from normally dry channels to streams and rivers, can transform dangerously when rain falls on the already waterlogged peat.

The moor is large enough to absorb the wide range of interests it arouses without friction. However, in some circles, two uses, conifer afforestation and the military presence, do provoke discord.

The plantations at Fernworthy [650830] and Soussons Down [680800], visible on a single satellite image of the whole of the country, let alone from much of Dartmoor, are, in many eyes, blemishes on the landscape. While the timber has value, with the plantations providing local employment, and sheltered trees demonstrate how well conifers can grow there, the commercial and strategic circumstances that brought about their planting can seem passé now. Fernworthy's trees protect the reservoir from eroded sediment, although ill-timed soil disturbance during harvesting may trigger acidic runoff, threatening the fishery there. The conifers, both the mature trees and younger ones giving denser cover, the few broad leaved stands, as well as clear-felled and open ground in the plantations at Fernworthy and Soussons, supply wildlife habitats quite different to those of the open moorland. These provide opportunities for species that would otherwise not inhabit the moor, from invertebrates to large mammals, including red and roe deer. Among birds visiting and living in the plantations are various ground nesting species and raptors, along with the crossbill, which feeds on conifer seeds.

Military training has gone on here for much of the last 200 years. Although the ranges are smaller than in the past and no longer used for artillery, live firing continues, preventing public entry at times. In addition to this inconvenience there are hazards in military detritus and ordnance. Several areas, not all within the current ranges, are pocked by shell craters. Prominent hills, for example Steeperton Tor [618888] and Quintin's Man [621839], are crowned by observation posts and flag poles, scarcely easy on the eye. Military access is the main vehicular use on the high moor's tracks, some of which probably originated with the tinners and peat cutters. The range boundaries' red and white markers and warning notices again diminish the moor's solitude, as does the sound from time to time of helicopters and aircraft. Closure of the Loop Road to Okement Hill [605875] has deprived many of access to the remote high moor. The moving target line below East Mill Tor [603898], the widened peat pass south of Hangingstone Hill [618855] and some moorland trackways are military works. Many wooden poles, erected on Hamel Down around 708807 to obstruct enemy airborne landings in the Second World War, remain 75 years on.

**Plate 98. A shell crater on Broad Down.**

This lies some distance beyond the current military range boundary.

It must be acknowledged that both military installations and forestry plantations have been part of Dartmoor's story for a long time and that both the Ministry of Defence and the Forestry Commission take their obligations to it seriously. Archaeological features in the forestry are identified and protected, with the ground around them mown, while the MOD takes an active interest in the support of ecological and archaeological conservation on the ranges.

**The In-bye** East of the moorland, below the cornditch, is the in-bye's patchwork of small grass fields enclosed by earthen hedgebanks. Among the fields and the farms, villages and hamlets, are patches of moorland, downland and woodland, where slope, rockiness or wetness preclude farming. The hedgebanks, many of medieval origin, along with the woods and downs they abut, are often higgledy-piggledy and aligned in sympathy with the lie of the land and the soils, are well-integrated into the landscape. The people who enclosed the land had a sure feel for changes in its character. Such links between the land and field shapes contrasts with the chequer board pattern over much of England that was enclosed later following eighteenth and nineteenth century Parliamentary Acts. This harmony may belie the land's first function in providing pasture for sheep and cattle and, through that, farmers' livelihoods.

**Plate 99. Second World War defences on Hamel Down.**

Fear of invasion meant that poles were erected on possible aircraft landing sites. Remarkably many of the posts remain over 75 years later.

*Physiography of the in-bye.* Like the moorland most of the in-bye is underlain by granite. The rolling hills with their steep valleys, have a grain, as on the moorland, dictated by the rock's structures and fault lines. Most noticeably, the picturesque Wray and Forder Brooks' valleys, followed by the A382, are etched roughly northwest to southeast along one such fault zone, while the west to east alignment of the River Teign is a striking exception. Lest the impression forms that this is mere musing from a geological ivory tower, a minor earthquake affected the Sticklepath Fault in June 2011. For the author it was like a blow to the soles of the feet and the feeling, rather than the sound, of a distant gun's report.

Although farmed, the in-bye has its share of tors and clitter. Some are prominent and named like Heltor [799870] and Blackingstone [786855] Rocks. Others, although bigger and more rugged than many moorland 'imposters', are hidden in woods and so go nameless. Visitors at Castle Drogo [723901] who gaze across the valley admiring the oak-clad Whiddon Wood, never dream that at its top at 727894 stands a hidden, anonymous tor accompanied by an apron of clitter on the slope below. Beyond the granite outcrop, notably along the north side of the Teign Gorge below Drogo, the surrounding 'country rocks', baked hard when the granite magma was first emplaced, outcrop as crags and tors high on the hillside. These rocks splinter when weathered, unlike the bouldery granite, so that the slopes below are cloaked with screes. The farmers call these rocks 'woodstone', since they resemble split firewood.

**Plate 100. Logan stones are delicately balanced, rocking boulders.**

This example weighing several tonnes rests in the River Teign below Hunt's Tor, Castle Drogo. Old Ordnance Survey maps record several logan stones across this survey district.

Its rivers and streams are among the delights of the in-bye. Below the moorland the North Teign is broad enough to call a river. Its course from the cataract at Teign-e-ver [653871] and through the gorge above Gidleigh Park [677879] is impressive. Below that, although continually widening, its normal demeanour is gentler. From there to Castle Drogo there is a paternoster of basins with floodplains interrupted by small gorges. The Bovey widens into a river south of North Bovey village [740839], after it is well across the enclosed country. On entering Lustleigh Cleave at Foxworthy [757821] its character changes, where Donn [1765] noted on his map "This River has a Subterraneous Passage". For some distance above Horsham Steps [759817] granite clitter chokes the river, the water roaring out of view beneath, making it worth visiting at normal flows and a must at flood time. Downstream there are quieter reaches punctuated by steepening gradients and small cataracts. By the time it is joined by the Becka Brook near Hisley Bridge [780800] the Bovey is turning calmer, although not without containing a small house-sized boulder close to that confluence. A feature in Lustleigh Cleave is the Clam Bridge [767811], a simple pole footbridge with a hand rail. Sadly this has been fenced off and replaced by a health-and-safety compliant suburban structure, an irony in a National Park where teenagers are let loose in all weathers to find their way from tor to tor across bogs, mires and torrents. A couple of km due south of Horsham Steps on the Becka Brook are its Falls [762801], themselves a spectacle, and, thanks to the nearby ‘new’ road to Manaton [750812] and a visitors’ centre, a tourists’ honey pot.

There is more than scenic value and sound in the rivers and streams. Over the granite they carry little of the fine sediment that in clayey catchments threatens to suffocate fish eggs in their redds, making ideal spawning grounds for salmon and trout, and justifying their reputations as fisheries. There are fine cast iron signs, if you know where to look, still announcing the Great Western Railway’s [nationalised in 1948] rights to beats along the Teign and Barramoor Brook, that went with its Manor House Hotel [731844], nowadays the Bovey Castle.

Between Gidleigh Park and Steps Bridge [804883] there are at least eight weirs on the Teign, most formerly supplying mills. A few of the several hydroelectric installations along that river, some working, others now derelict, have been fed from the weirs. That at Yeo [678665] was reputedly the first domestic system of its kind in the country, with some of the metering still in place. The largest, on the Castle Drogo estate, may be reinstated by the National Trust. Leats, some still flowing, other silted and overgrown, are common features, most served traditional overshot mill wheels, such as the Holy Street Mill [689878], favoured by many artists. At Thornworthy [670849] a Victorian vertical axis turbine with swan-necked feed was supplied from a reservoir receiving water from leats on the newtake. Natural pools are absent from the in-bye. However, besides Fernworthy Reservoir [665843], there are numerous ponds and small amenity lakes in valley floors, while both Blackingstone [783858] and Fernworthy [671841] quarries are permanently flooded.

Here in the moor’s rain shadow the weather and climate are less bleak and the land lower. Rainfall is around half that on the high moor, and dank, misty days are less frequent. The main soils are free draining and, although shallow and rocky in places, acceptable prospects for the livestock farmer. There are some wet soils flooring many of the valleys, fed by springs from the granite.

**Plate 101. The River Bovey at Horsham Steps, emerging from its clitter-choked stretch.**

As Benjamin Donn's map of 1765 records: "This River has a Subterraneous Passage". The clitter affords an easy river crossing for a footpath between Manaton and Lustleigh, hence the name Horsham Steps.

*Landuse on the in-bye, past and present.* There was settlement of the in-bye by Neolithic people, which continued through the Bronze Age. However the evidence, mostly hut circles and reaves, is sparse relative to the moorland. This may indicates a preference at that time for the higher ground, or the evidence may have been compromised by more than a thousand years of settlement and farming. Three Iron Age hill forts overlook the Teign Gorge at Wooston Castle [765897], Prestonbury [747900] and Cranbrook Down [739890], the latter apparently never completed, and another on Lustleigh Cleave at 762824, Hunter's Tor. Few or no Roman or Romano-British remains were left. The earliest documentary reference to the area comes in the Anglo Saxon Chronicles' reference to a battle at Hingston Down [770859] in 858 AD, although the folk of east Cornwall will dispute this location with vigour. Saxon occupation followed, with the pattern of settlements and farms set in the next few centuries. The oval shaped Lustleigh [785813] churchyard indicates particular antiquity. A feature of feudal life was the manor, examples are Teigncombe [672871] and Wray, the latter less easily located. Canterbury Cathedral held an estate at Doccombe [776868], hence the wood named St Thomas' Cleave [789884].

**Plate 102. A spate at Horsham Steps.**

More recently plaques and monuments have been erected, both in prominent places and in seclusion. Some commemorate people, from those who changed the World, Sir Frank Whittle lived outside Chagford, to ordinary folk whose grand-children remember them with posies in the quiet, near to where they lived out their lives. Granite stones and boulders invite inscription. The Three Fishes Stones at Heathercombe [718810] carry doxology from the Lord's Prayer, there is abstract sculpting in Whiddon Deer Park [723894], while each year's May Queen is named on a boulder in Lustleigh's Town Orchard [783822].

As on the moorland, tin ore was extracted by both streamworks and openworks. Because the land was then unfit for farming much of it has reverted to woodland and is thus concealed from view. There are gerts of the same depth of many on the moor, although covering smaller areas, around Chagford in Rushford Wood [701897] and near Great Weeke [715875], also between Horsham Steps [759817] and Foxworthy Bridge [757820], east of Manaton. A kilometre north of Foxworthy Bridge streamworks along the River Bovey left unusually large mounds. Southeast of North Bovey village [740839] and near Dogmarsh Bridge [713893], Chagford, bulldozing has restored tin-streamed ground for farming.

The farmed landscape is dominated by grass and grazing livestock, with local breeds such as the White Faced Dartmoor sheep and South Devon cattle, still with a presence. However arable cropping has had a bigger role in the past. Dartmoor's largest ancient monument, Challacombe's lynchets [693800], testifies to medieval arable farming. Vancouver in 1808 described mixed farming. Many fields' lower hedges have soil built-up against them, tokens of former cultivation. Before mechanisation of potato growing in the 1960s the district had a reputation for the crop, many farms growing a few acres. The only potato market shown on Benjamin Donn's Devon map [1765] at Two Bridges [607747], part way to Plymouth and the Navy, perhaps shows that reputation's age.

In the post-war years many farms had small dairy herds but numbers shrank, so now there is only one in the district and that specialises in ice cream manufacture. Changing fortunes in farming mean that not all grassland is cropped thoroughly. On the freely draining soils some pasture is intensively managed, but less fertiliser and fewer stock, particularly on difficult and remote ground, allows nature back, with patches of broom, blackthorn, bracken, gorse, foxgloves, ragwort, violets and bluebells all brightening the scene. The next step in nature's reassertion is secondary woodland. On the wet soils, rushy grassland and rhôs pastures with rushes, heathy plants, scabious and *Molinia,* are only fit for light summer grazing. Besides its plants, the land provides distinctive niches for animals from springtails, earthworms and spiders to badgers and deer, from cinnabar moths and fritillary butterflies to wrens, snipe and buzzards.

Seen overall, the in-bye changes with the light, the season and the viewpoint. Even grass transforms from winter's washed-out green to almost emerald in springtime's flush to patchy brown, scorched in the summer drought. Harvesting the grass leaves the sward pale until rain brings the aftermath. Hedgerow plants, whether closely laid or overgrown and tree-lined, add their own colours; striking for parts of the year are the white flowers of the blackthorn and hawthorn. The woods, dappled grey through winter and into spring, always startle the eye with day-by-day changes in their hues as they break into leaf. In the autumn the dying foliage's colours make the shortening days more bearable. Only the conifers stay constant. On the downland the gorse adds colour almost year round, while the bracken, reddish brown for half the year quickly turns green come June. Even the rhôs grasslands start the year drab and beige, but colour up as the year develops.

As mentioned, most of fields in the district have earthen hedgebanks as their boundaries. Mainly medieval in origin, one to two metres high and as far across, they are the result of human toil on a scale worth contemplating. In many places the plants in the hedges indicate the kind of ground the bank stands on. Banks in some woods witness the reversion of former farm land, some relatively recently, as at Boveycombe [777804], Lustleigh. In very rocky places rough stone walls replace the banks. Elsewhere more substantial walls enclose fields, those at West Combe [683871], Chagford, reputedly built by French officers, prisoners during the Napoleonic wars, billeted in the town. Local wealth from tin led to the impressive walls built around the Tudor Whiddon Deer Park [723894].

**Plate 103. Trees growing on rocks at Linscott.**

Throughout the in-bye many tors, outcrops and boulders have mature trees growing on them. Once established they readily root in fissures deep into the granite. How they become established and survive their early years is more puzzling. In places rockiness may discourage browsing by sheep, deer and cattle.

The twentieth century brought its many changes. The countryside's near self-sufficiency ended as people became educated, better off and more mobile. Most markedly the numbers working in agriculture shrank, some traditional crafts declined, ordnance maps from the early years of the century showing smithies in every village and hamlet. On the other hand thatching has boomed, such roofing being a major maintenance cost on the area's multitude of 'chocolate box', grade 2 listed houses. Over the last few decades, studios and galleries producing art, jewellery, pottery, sculpture and other contemporary craftwork have sprung up around the district, servicing tourism and providing livelihoods.


**Plate 104.The area's rivers and streams have long attracted anglers.**

The Great Western Railway bought North Bovey Manor as a hotel in the 1930s, along with extensive fishing rights. British Railways retained the hotel into the 1970s. Signs such as this still survive. Local rumour has it that, had Hitler's 'Operation Sealion' gone ahead successfully in 1940, the Manor House would have become home for a senior member of the Nazi party.

*Woodlands.* The raison d'être of much of the in-bye's woodland is that rocky and steep ground lacks any agricultural value. Long bands of it flank the Wray, Bovey and Teign valleys. In places the age-old oak woodland and coppice were replaced by conifers in response to the demands of two World Wars. Both the conifers and the pressures for home-grown timber now seem out of place. The Bovey valley oak woods form a National Nature Reserve, while the National and Woodland Trusts are re-establishing native woodland in those parts of the Teign Gorge planted with conifers. Woodland also occurs on the wet soils. If grazing ceases on the ecologically important rhôs pastures they revert to carr woodland, itself prized for its conservation value, with alder, birch and willow. Conifers were put in during the 1940s on freely draining fields around 780893 above Clifford Bridge by Dartington Woodlands and on wet and dry fields around Bowda [740831], North Bovey. Other plantations protect the catchments of Kennick [804844] and Trenchford [804827] reservoirs, while land at Heathercombe [718810] was planted to provide timber for the Bovey Basin's clay mines.

**Plate 105. The remains of buddles.**

These conical forms were part of structures used in processing metal ores.

Traditionally the woodlands, particularly oak coppices, were parts of the rural economy. Coppicing on 10-20 year rotations provided small timber, wood for charcoal and fires, and bark for the tanneries, charcoal hearths dotting many of the woods. However that, over the centuries, soured and degraded the soil, with the accumulation of up to 30 cm of acid, peat-like mor humus in many coppices, coupled with incipient podzolisation beneath, indicated by the heathy ground vegetation that has developed. Less directly, but equally telling, is correspondence in the Dartington Archive stating that young conifers only established after the removal of the acid humus, which then went for sale as horticultural peat. Given shelter from the wind, both broad leaved and conifer growth across the in-bye can be impressive in plantations and as ornamental trees. There has been an arboretum at Heathercombe since the late 19th century. In spring the wooded valleys along the Teign attract many visitors enjoying the wild daffodils.

**Plate 106. Many Dartmoor farms traditionally had ash houses.**

Ash from domestic hearths was collected for use as a fertiliser and neutralising agent on tillage ground.

*Downland.* The residual moorland and downland on higher and steeper sites, is often common grazing for adjoining farms. The vegetation and soils are very similar to the lower main moorland beyond the cornditch. Dark topped soils, often in large rectangular fields, suggests such downland was previously more extensive, enclosure coming later than the smaller, irregular fields elsewhere in the in-bye. The element ‘down’ in many of these fields’ names on the 1840’s tithe maps confirms this. In recent years social and agricultural changes meant abandonment of some common grazings. Swaling, the burning of dry or dead vegetation in late winter, traditionally encouraged fresh spring growth and, where still carried out, demands cooperation among the commoners controlling the fire. The last commoner to swale part of one common was charged [unsuccessfully] with arson, the reaction of non-agricultural, incomer [‘blown-in’ in local parlance] neighbours being to summon the fire brigade rather than join in time-honoured land management. A consequence of the reduced use of some commons and downs is the unchecked growth of tree seedlings. When the author first saw Lustleigh Cleave [770810] in 1965 it was open, almost savannah-like grassland with tors and clitter and only small groups of trees. Aerial photos from 1975 show the same. By the early 2000s young oak–birch woodland had developed, obscuring the rocks and the view over any distance. Nearby at Hayne Down [744808] the same process is under way on the lower slopes.

As with the rhôs pastures and neglected dry fields, the downland and woodlands offer habitats for insects, birds and other animals. They are inhabited by deer, roe and fallow deer in particular, the Teign Gorge having a number of albino animals. In winter migratory woodcock use this land for shelter. Even the twentieth century's often maligned conifers sited on previously farmed land can add interest with an abundance of large wood ant nests in some 'new' plantations.

**Plate 107. Some field gateways have slotted granite gateposts.**
Such posts predate hinged gates, when timber rails were fitted into the mortise slots, much as in Plate 108 below. The second post's mortises were shaped as inverted letters 'L', allowing easy removal of the rails.

*The built landscape.* This is country with narrow winding lanes, bordered by hedgebanks, linking the farms, hamlets and villages to the small towns. Originally meant for pack animals, not motor vehicles, they avoid tracts of wet soils, many following ridges. In crossing brows they are sunken, worn in by erosion over the centuries. Footpaths, once essential parts of life, similarly seek the dry ground, skirting round bogs. Some are fossilised as rights of way, now used for leisure rather than their original purposes. The Batworthy [661865] to Gidleigh [671884] church path still has its footbridge at 662869 over the North Teign, it appears on maps, but is not a public right of way. Other footpaths close to coppices are reckoned to be charcoal burners' paths. The long distance Mariners' Way footpath, reinvented in the late twentieth century, recalls the route of seamen signed off at Bideford heading to Dartmouth.

Most farm sites were established by the twelfth century, although the actual buildings are younger. Several traditional long houses survive, with granite walls under thatched roofs. Located on a slope and often south facing, originally the humans occupied the higher end and the cattle the lower, and without chimneys, the smoke filtering through the thatch. Once a chimney was built an upstairs could be added. Chimneys in the end or side walls suggest early construction. Some, as in a grade 1 listed example at Lettaford [702840], have walls built of large, rectangular ashlar blocks. Granite and thatch were used for centuries, including in much of Moreton and Chagford, contributing to the area's appeal. Of particular character are the Cross Street alms houses, Moreton and the Three Crowns, Chagford. The prosperity brought by tin built some grander houses, as at Whiddon Park [721892]. Cob, Devon's traditional building material, is rare here, partly because of granite's availability, partly due to the weak, sandy nature of the soil. A few old farm buildings might have a cob course levelling up the top of a wall. There is some substantial cob in a wall at Jurston [696844], cheek by jowl with impressive granite ashlars. Recently a whole house has been built with cob at 760885 near Pinmoor, Moreton, using soil excavated at the site.

**Plate 108. A reconstruction of the slotted rails that preceded hinged field gates.**

There are numerous minor structures of note in the district. Bee hive-shaped ash houses are common, relicts of the days when hearth ash was saved for use as manure. Some contain cave spiders. In the days before weather-proof bee hives, woven straw 'skeps' were placed in 'bee boles', small cavities in south facing walls. At two farms among the grade 2 listed features are well preserved dung pits. Butterwells, roofed, gated and walled-around wells and springs are also listed at a number of places, as are roadside granite crosses. Widespread, but less often noted, are slotted 'gate' posts, relicts of a time before hinged field gates.

While the last century saw a decline in the use of local building materials, 'progress' has had other effects. Wealth generated outside the locality has built houses and estates around it. Among the larger are what was called the Manor House, now known as Bovey Castle [731844], constructed for the Edwardian Viscount Hambledon [W.H. Smith], Castle Drogo, [723901] 'England's last castle', imposingly sited immediately north of the survey area, designed by Lutyens for Julius Drewe [Home and Colonial Stores] in the 1920s, Heatree House [727807], Manaton built in Victorian times by John Kitson, son of 'the maker of Torquay' and Outer Down [683865], Chagford built for the Jameson Whiskey family in 1911. Both Bovey Castle, with its golf course, and Drogo might be criticised for their intrusiveness in the landscape. It has been commented that the latter, grade 1 listing or no, is as appropriate to the Teign Gorge as the conifer plantings that usurped parts of its ancient oak woods, or the scrap yard at Lettaford [699843]. Many farms were renovated with granite walls, brick quoins and architraves and slate roofs, by the Hambledon Estate. The last century has seen less grand, but still substantial house building by people attracted by the district's beauty. Others have moved into what were formerly working farms. Fernworthy reservoir's dam [671843], built in the late 1930s, faced with stone quarried on the site, was the last major constructional use of granite, although Blackingstone's [783858] rock is being used in the current refurbishment of Castle Drogo.

The area's landscape, like all of Dartmoor, has numerous, almost, endlessly diverse appeals and many functions, which this chapter has attempted to summarise. The geology, physiography and soils are the fabric into which the many threads, past and present, are sewn, making up the tapestry of the landscape. Importantly, farming in its stewardship of so much of both the moor and the in-bye, faces social and agricultural challenges.

There are fewer working farms, fewer active commoners, some older farmers stepping back in frustration at change and at what has been called "ecological expertise with agricultural innocence" in public bodies, while fewer youngsters are staying in farming. At the same time the sale of many, what were small family farms, as bijou residences to non-farmers, who have brought wealth from 'up country', has had its effects. The houses and buildings, even gates, banks and walls, are often in a better state of repair than ever, but with the grass keep let to the few remaining farmers, one of whom has 14 separate landlords. The area's outstanding asset is the melding of all its alluring aspects.

The future will bring many challenges, probably the greatest, summarised by Mercer [2009], being maintaining the character of the moorland through grazing management. And that will depend, more than anything, on the active involvement of a sufficient number of farmers, their flocks and herds. Some will tell you, considering modern agricultural and social circumstances, that is a tall order.

# References

ADAS. [1998]. *Environmental monitoring in the Dartmoor ESA 1994-1997*. MAFF*,* London.

AVERY, B.W. [1958]. A sequence of beechwood soils on the Chiltern Hills, England. *J. Soil Sci.* **9,** 210-24.

AVERY, B.W. [1973]. Soil classification in the Soil Survey of England and Wales. *J. Soil Sci.* **24,** 324-38.

AVERY, B.W. [1980]. *Soil classification for England and Wales.* Soil Surv. Tech. Monog. No.14.

AVERY, B.W. and BASCOMB, C.L. [Ed.] [1982]. *Soil Survey Laboratory Methods.* Soil Surv. Tech. Monog. No.6.

BALDOCK, N. and WALTERS, J. [2008]. *The wildlife of Dartmoor.* Walters, Buckfastleigh.

BALDWIN, J., BUTLER, S., HARPER, B., HEWITT,J., HUGO, R., KAPFF, M., PERKINS, K., STEWART, C. and TAYLOR, A. [1999]. *The book of Manaton.* Halsgrove Press, Tiverton.

BALL, D.F. [1960]. *The soils and land use of the district around Rhyl and Denbigh.* Mem. Soil Surv. Gt Br.

BANKS, D. [2009]. An introduction to thermogeology and the exploitation of ground source heat. *Q.J. Eng. Geol.and Hydrogeol.* **42,** 283-93.

BASCOMB, C.L. [1968]. Distribution of pyrophosphate-extractable iron and organic carbon in soils of various groups. *J. Soil Sci.***19,** 251-68.

BENDELOW, V.C. and HARTNUP, R. [1980]. *Climatic classification of England and Wales.* Soil Surv. Tech. Monogr. No.15.

BIBBY, J. S. and MACKNEY, D. [1969] *Land Use Capability Classification*. Soil Surv. Tech. Monogr. No.1.

BIBBY, J.S., DOUGLAS, H.A., THOMASSON, A.J. and ROBERTSON, J.S. [1982]. *Land capability classification for agriculture.* Macaulay Institute for Soil Research, Aberdeen.

BIRSE, E.L. [1971]. *Assessment of climatic conditions in Scotland 3. The bioclimatic sub-regions.* Macaulay Institute: Soil Survey of Scotland.

BLUM, W.E.H. [1993]. Soil protection concept of the Council of Europe and integrated soil research. P37-47 in EIJSCACHERS, H.J.P. and HAMERS, T. *Soil and environment* **1** *Integrated soil and sediment research: a basis for proper protection*. Kluwer, Dordrecht.

BLYTH, F.G.H. [1962]. The structure of the northeastern tract of the Dartmoor granite. *Q.J. Geol. Soc*. **118,** 435-53.

BOORMAN, D.B., HOLLIS, J.M. and LILLY, A. [1995]. *Report No. 126 Hydrology of soil types: a hydrologically-based classification of the soils of the United Kingdom.* Institute of Hydrology, Wallingford.

BOOTH, T.C. [1977]. *Windthrow hazard classification.* Forestry Commission Research Information Note 22/77/SILN.

BRAMALL, A. [1912]. *Dartmoor*. Mem. Geol. Surv. U.K.

BREWER, R. [1964]. *Fabric and mineral analysis of soils.* Wiley, New York.

BRITISH GEOLOGICAL SURVEY [1969]. *Okehampton. England and Wales, Sheet 324. Solid and drift geology. 1:50,000.* Keyworth, Nottingham.

BRITISH GEOLOGICAL SURVEY [1976]. *Newton Abbot. England and Wales, Sheet 339. Solid and drift geology. 1:50,000.* Keyworth, Nottingham.

BRITISH GEOLOGICAL SURVEY [1995a]. *Dartmoor Forest. England and Wales, Sheet 338. Solid and drift geology. 1:50,000. Provisional Series.* Keyworth, Nottingham.

BRITISH GEOLOGICAL SURVEY [1995b]. *Exeter. England and Wales, Sheet 325. Solid and drift geology. 1:50,000.* Keyworth, Nottingham.

BUSBY, J., LEWIS, M., REEVES, H. and LAWLEY, R. [2009]. Initial geological considerations before installing ground source heat pump systems. *Q.J. Eng. Geol.and Hydrogeol.* **42**, 295-306.

CLAYDEN, B. [1964]. *Soils of the middle Teign valley district of Devon.* Bull. Soil Surv. Gt Br.

CLAYDEN, B. [1971]. *Soils of the Exeter district.* Mem. Soil Surv. Gt Br.

CLAYDEN, B and MANLEY, D.J.R. [1964]. The soils of the Dartmoor granite. In: *Dartmoor Essays.* Devon Assoc. Adv. Sci.

CLAYDEN, B. and EVANS, G.D. [1974]. *Soils in Dyfed I: Sheet SN41 [Llangendeirne].* Soil Surv. Rec No. 20.

CLAYDEN, B. and HOLLIS, J.M. [1984]. *Criteria for differentiating soil series.* Soil Surv. Tech. Monog. No.17.

COLPRESSE, S. [1667]. *A georgicall account of Devonshire and Cornwalle.* MS in Bodleian Library, Aubrey ii, 83.

CONAN-DOYLE, A.I. [1902]. *The Hound of the Baskervilles*.

COPE, D.W. [1986].*Soils in Gloucestershire IV: Sheet SO72 [Newent].* Soil Surv. Rec. No.93.

CROSSING, W. [1888]. *Amid Devonia's alps, or Wanderings and adventures on Dartmoor.* 127-8.

CROSSING, W. [1912]. *Guide to Dartmoor: a topographical description of the Forest and Commons*. [Reprinted as *Crossing's Guide*, latest 1990]. David and Charles, Newton Abbot.

DARTMOOR NATIONAL PARK AUTHORITY. [2005]. *A vision for moorland Dartmoor.* Bovey Tracey.

DARTMOOR NATIONAL PARK AUTHORITY. [2115]. http://www.dartmoor.gov.uk/learningabout/lab-printableresources/lab-factsheetshome/lab-climateweather. [Last accessed 4th July 2015].

DARWIN, C.R. [1881]. *The formation of vegetable mould, through the action of worms, with observations on their habits.* London.

DECC. [2008] *Microgeneration installation standard: MIS 3005.* 47 p. London.

DEFRA. [2013]. *Protecting our soil, water and air. PB13558.* 124 p. London.

DEFRA. [2015a]. *The guide to cross compliance in England 2015.* 84 p. London.

DEFRA. [2015b]. *Cross compliance in England: soil protection standards 2015.*16 p. London.

DEVON COUNTY COUNCIL [2016] http://gis.devon.gov.uk/basedata/viewer.asp?DCCService=hlc [Last accessed 2nd March 2016]

DIXON, S. [1830]. *A journal of ten days excursion on the western and northern borders of Dartmoor.* p 25-6.

DONN, B. [1765]. *A map of the county of Devon.* London.

DURRANCE, E.M. and LAMING, D.J.C. [1982]. *The Geology of Devon.* University of Exeter.

ELLENBERG, H. [1974]. Zeigerwerte der Gefässpflanzen Mitteleuropas. *Scripta geobotanica.* **9,** 197 p. Göttingen.

Environment Agency [2016] http://www.dartmoor.gov.uk/learningabout/labprintableresources/lab-factsheetshome/lab-climateweather [last accessed 14/10/2016]

EVANS, D.J.A., HARRISON, S., VIELI, A. and ANDERSON, E. [2012a]. The glaciation of Dartmoor: the southernmost independent Pleistocene ice cap in the British Isles. *Quaternary Science Review.* **45**, 31-53.

EVANS, D.J.A., HARRISON, S., VIELI, A. and ANDERSON, E. [2012b]. Dartmoor's overlooked glacial legacy. *Geology Today.* **28**, 224-9.

F.A.O. [1998]. *World reference base for soil resources.* Food and Agriculture Organisation of the United Nations, Rome.

FASHAM, M.J.R. [1971]. A gravity survey of the Bovey Tracey Basin, Devon. *Geological Magazine.* **108**, 119-30.

FERRACCIOLI, F., GERARD, F., ROBINSON, C., JORDAN, T., BISZCZUK, M., IRELAND, L., BEASLEY, M., VIDAMOUR, A., BARKER, A., ARNOLD, R., DINN, M., FOX, A. and HOWARD, A. [2014]. *LiDAR based Digital Terrain Model (DTM) data for South West England.* NERC Environmental Information Data Centre. http://doi.org/10.5285/e2a742df-3772-481a-97d6-0de5133f4812

FINDLAY, D.C., COLBORNE, G.J.N., COPE, D.C., HARROD, T.R., HOGAN, D.V. and STAINES, S.J. [1984]. *Soils and their use in South West England.* Bull. Soil Surv. Gt Br.

FOX, H.S.A. [1994]. Medieval Dartmoor as seen through its account rolls. In *The archaeology of Dartmoor. Perspectives from the 1990s.* Devon Archaol. Soc. Proc. **52**, 141-71.

FRASER, A.I. [2000]. *Towards a systematic framework for quantifying and extrapolating diffuse phosphorus transfer from agricultural land to the national scale.* Unpublished Ph.D. thesis, Cranfield University.

FYFE, R.M., WOODBRIDGE, J. and ROWE, J. (2010). *Archaeological and palaeoecological survey at Hangingstone Hill, Winney's Down and Broad Down, Dartmoor.* Unpublished report, University of Plymouth.

FYFE, R.M. and WOODBRIDGE, J. (2012). Differences in time and space in upland vegetation patterning: analysis of pollen data from Dartmoor, UK. *Landscape Ecology*. **27**, 745-760.

FYFE, R.M., COOMBE. R., DAVIES, H. and PARRY, L. (2014). The importance of sub-peat carbon storage as shown by data from Dartmoor, UK. *Soil Use and Management.* **30**, 23-31.

GEORGE, H. and JARVIS, M.J., [1979]. Land for camping and caravan sites, picnic sites and footpaths. In: *Soil survey applications* [ed M.G. Jarvis and D. Mackney]. Soil Surv. Tech. Monog. No.13, 166-83.

GERRARD, S. [1994]. The Dartmoor tin industry: an archaeological perspective. In *The archaeology of Dartmoor. Perspectives from the 1990s.* Devon Archaeol. Soc. Proc. **52**, 173-98.

GRAEBE, M. [2008]. Devon by Dog Cart and Bicycle: The Folk Song Collaboration of Sabine Baring-Gould and Cecil Sharp, 1904–17. *Folk Music Journal.* **9,** 292–348,

GREEN, C.P. and EDEN, M.J. [1973]. Slope deposits on the weathered Dartmoor granite, England. *Zeitschrift für Geomorphologie,* Supplementband. **18,** 26-37.

GREEVES, T.A.P. [1981]. *The Devon tin industry 1450-1750: An archaeological and historical survey.* Ph.D. thesis, University of Exeter.

GREEVES, T.A.P. [1986]. *Tin mines and miners of Dartmoor.* Halsgrove, Tiverton.

GREEVES, T.A.P. [2015]. *Dartmoor's earliest photographs. Landscape and place 1860-1880.* Twelvehead Press, Truro.

GREEVES, T.A.P. and NEWMAN, P. [2011]. *The Great Courts of Devon Tinners 1510 and 1710.*

GRIFFITHS, R.I., THOMSON, B.C., JAMES, P., BELL, T., BAILEY, M. and WHITELEY, A.S. [2011]. The bacterial biogeography of British soils. Environmental Microbiology. 13 (6), 1642–54.

HALL, A.D. [1913]. *A pilgrimage of British farming*, 1910-12. Murray, London.

HALL, D.G.M., REEVE, M.J., THOMASSON, A.J. and WRIGHT, V.F. [1977]. *Water retention, porosity and density of field soils*. Soil Surv. Tech Monogr. No 9.

HANCOCK, J.M. (1969). Transgression of the Cretaceous Sea in South-West England. *Proc. Ussher Soc.* **2**, 61-83.

HARRIS, H. [1968]. *The industrial Archaeology of Dartmoor.* David and Charles, Newton Abbot.

HARROD, T.R. [1978]. *Soils in Devon IV: Sheet SS30 [Holsworthy].* Soil Surv. Rec. No 47.

HARROD, T.R. [1979]. Soil suitability for grassland. In *Soil survey applications* [ed M.G. Jarvis and D. Mackney]. Soil Surv. Tech. Monog. No.13. 51-70.

HARROD, T.R. [1981]. *Soils in Devon V: Sheet SS61 [Chulmleigh].* Soil Surv. Rec. No 70.

HARROD, T.R., CATT, J.A. and WEIR, A.H. [1973]. Loess in Devon. *Proc. Ussher Soc.* **2**, 554-64.

HARROD, T.R., HOGAN, D.V. and STAINES, S.J. [1976]. *Soils in Devon II:Sheet SX65 [Ivybridge].* Soil Surv. Rec. No.39.

HARVEY, L.A. and ST. LEDGER-GORDON, D. [1962]. *Dartmoor.* The New Naturalist, Collins, London.

HAYTOR-HAMES, J. [1981]. *A history of Chagford*. Phillimore and Co.

HEMERY, E. [1983]. *High Dartmoor – land and people.* Robert Hale.

HODGSON, J.M. [Ed.] [1976]. *Soil survey field handbook.* Soil Surv. Tech. Monogr. No. 5.

HODGSON, J.M. [Ed.] [1997]. *Soil survey field handbook.* Soil Surv. Tech. Monogr. No. 5.

HODGSON, J.M., HOLLIS, J.M., JONES, R.J.A. and PALMER, R.C. [1976]. A comparison of field estimates and laboratory analyses of the silt and clay content of some west Midland soils. *J. Soil Sci,* **27,** 411-19.

HOGAN, D.V. [1977]. *Soils in Devon III: Sheet SX47 [Tavistock].* Soil Surv. Rec. No 44.

HOGAN, D.V. [Ed.] [1978]. *Autumn Meeting 18$^{th}$-21$^{st}$ September 1978. Programme and Guide to Excursions.* Brit. Soc. Soil Sci. Unpublished.

HOGAN, D.V. and HARROD, T.R. [1982]. *Soils in Devon VII:Sheet SS74 [Lynton].* Soil Surv. Rec. No.78.

HOLLIS, J.M. [1991]. *Proposal for the classification, description and mapping of soils in urban areas.* English Nature, Peterborough.

HOSKINS, W. G. [1943]. The reclamation of the waste in Devon, 1550-1800. *The Economic History Review*. **13**, No. 1-2, 80-92.

HOSKINS, W. G. [1954]. *Devon.* Collins, London.

JARVIS, M.G. and HEDGES, M.R. [1994]. Use of soil maps to predict the incidence of corrosion and the need for iron mains renewal. *J. Inst.Water and Env. Management.* **8**, [1] 68-75.

JARVIS, R.A. [1968]. *Soils of the Reading district.* Mem. Soil Surv. Gt Br.

JARVIS, R.J., BENDELOW, V.C., BRADLEY, R.I., CARROLL, D.M., FURNESS, R.R., KILGOUR, I.N.L. and KING, S.J. [1984]. *Soils and their use in Northern England.* Bull. Soil Surv. Gt. Br.

JENKINS, G.J., PERRY, M.C. and PRIOR, M.J.O. [2008]. *The climate of the United Kingdom and recent trends.* Hadley Centre, Meteorological Office, Exeter.

JONES, R.J.A and THOMASSON, A.J. [1985]. *An agroclimatic database for England and Wales.* Soil Surv. Tech. Monogr. No.16.

JUKES-BROWNE, A.K. [1904]. The valley of the River Teign. *Quart. Journ. Geol. Soc.* **60**, 319-34.

LINTON, D.L. [1955]. The problem of tors. *Geographical Journal.***121**, 480-7.

LOVELAND, P.J. (1981). Heavy Minerals in the Upper Albian/Lower Cenomanian. *Proc. Ussher Soc.* **5**, 91.

MacALISTER, D.A. [1908]. *Unpublished Geological Survey 1:63,360 field slip*, *Devon sheet CXIX [99] NW* . British Geological Survey Archive.

MAFF. [1988]. *Agricultural Land Classification. Revised guidelines and criteria for grading the quality of agricultural land.* MAFF, London.

MACKNEY, D., HODGSON, J.M., HOLLIS, J.M. and STAINES, S.J. [1984]. *Legend for the 1:250,000 Soil Map of England and Wales.* Soil Surv. England and Wales.

MARSHALL, W. [1796]. *The rural economy of the west of England.* Nicol, London.

McHUGH, M. [1989]. *Moisture regimes, redox / podzolic characteristics and profile morphology of stagnopodzols, stagnohumic gley soils and their reclaimed counterparts in Devon.* Unpublished Ph.D. thesis, University of Exeter, Department of Geography.

MERCER, I. [2009]. *Dartmoor. A Statement of Time.* The New Naturalist Library. Collins, London.

METEOROLOGICAL OFFICE. [1952]. *Monthly and annual totals of Rainfall 1950 for the United Kingdom.* Meteorological Office, Bracknell.

METEOROLOGICAL OFFICE. [1963]. *Monthly and annual totals of Rainfall 1959-1960 for the United Kingdom.* Meteorological Office, Bracknell.

METEOROLOGICAL OFFICE. [1977]. *Average Annual Rainfall (Millimetres); International Standard Period 1941-1970; Southern Britain*. Meteorological Office, Bracknell.

METEOROLOGICAL OFFICE. [1979]. *Monthly and annual totals of Rainfall 1970 for the United Kingdom.* Meteorological Office, Bracknell.

METEOROLOGICAL OFFICE. [1984]. *Monthly and annual totals of Rainfall 1980 for the United Kingdom.* Meteorological Office, Bracknell.

METEOROLOGICAL OFFICE. [1991]. *Monthly and annual totals of Rainfall 1990 for the United Kingdom.* Meteorological Office, Bracknell.

METEOROLOGICAL OFFICE. [2015] . http://www.metoffice.gov.uk/public/weather/climate/#?tab=climateMaps [Last accessed 4th July 2015]

NATURAL ENGLAND. [2015] https://designatedsites.naturalengland.org.uk/ [Last accessed 29th April 2015]

NEWMAN, P. [2010]. *Domestic and Industrial Peat Cutting on North-Western Dartmoor, Devon: an archaeological and historical investigation.* Report for Natural England, Newton Abbot.

NOZVIGER, D.L. [2005]. Soil temperature variations with time and depth. http://soilphysics.okstate.edu/software/SoilTemperature/document.pdf [Last accessed 13th August 2016]

OLSEN, S.R., COLE, C.V., WATANBE, F.S. and DEAN, L.A. [1954]. *Estimation of available phosphorus in soils by extraction with sodium bicarbonate.* Rep. No. Circular 939. United States Department of Agriculture, Washington D.C.

PALMER, J. and NEILSON, R.A. [1962]. The origin of granite tors on Dartmoor, Devonshire. *Proc. Yorks. Geol. Soc.* **33,** 315-40.

PALMER, R.C., HOLMAN, I.P., ROBINS, N.S. and LEWIS, M.A. [1995]. *Guide to groundwater vulnerability mapping in England and Wales.* National Rivers Authority R and D Note 578/1/ST.

PARRY, L.E. [2011]. *The Sustainable Carbon Management of Moorlands: spatial distribution and accumulation of carbon on Dartmoor, southwest England.* Unpublished Ph.D. thesis, University of Exeter.

PEARSE, C. [2011]. *Blissful, restless Dartmoor*. Barramoor Books, Newton Abbot.

PEEL, S., MATKIN, E.A. and HUCKLE, C.A. [1988a]. Herbage growth and utilized output from grassland on dairy farms in southwest England: case studies of five farms, 1982 and 1983. Herbage growth. *Grass and Forage Science*. **43**, 61-69.

PEEL, S., MATKIN, E.A. and HUCKLE, C.A. [1988b]. Herbage growth and utilized output from grassland on dairy farms in southwest England: case studies of five farms, 1982 and 1983. Herbage utilization. *Grass and Forage Science*. **43**, 71-78.

PIKE, C.D. [1993]. *Heathercombe the history of a Dartmoor valley.* Westcountry Books, Tiverton.

PYATT, D.G. [1982]. *Soil classification.* Forestry Commission Research Information Note 68/82/SSN.

PYATT, D.G., HARRISON, D. and FORD, A.S.[1969]. Guide to site types in forests of north and mid-Wales. *Forest Rec.* London. No.69.

REEVE, M.J., SMITH, P.D. and THOMASSON, A.J. [1973]. The effects of density on water retention properties of field soils. *J. Soil Sci.* **24,** 355-67.

RENGER, M. [1970]. Über den Einflus der Dränung auf das Gefüge und die Wasserdurchlässigkeit bindiger Böden. *Mitteilungen Deutschen Bodenkundlich Gesellschaft.* **11**, 23-8.

RÖMKENS, M.J.M., BAUMHARDT, R.L., PARLANGE, J.Y., WHISLER, F.D., PARLANGE, M.B. and PRASAD, S.N. [1985]. Effects of rainfall characteristics on seal hydraulic conductance. In *Assessments of soil surface sealing and crusting.* [Eds. F. Callebaut, D. Gabriels and M. De Boot], pp.228-35, Ghent, Belgium.

ROWAN, A.A. [1977]. *Terrain classification.* Forest Rec., No. 114. London.

RUDEFORTH, C.C., HARTNUP, R., LEA, J.W., THOMPSON, T.R.E. and WRIGHT, P.S. [1984]. *Soils and their use in Wales.* Bull. Soil Surv. Gt Br.

RUSSELL, E.W. [1961]. *Soil conditions and plant growth.* Longmans, London.

SELWOOD, E.B., EDWARDS, R.A., SIMPSON, S., CHESHER, J.A., HAMBLIN, R.J.O., HENSON, M.R., RIDDOLLS, B.W. and WATERS, R.A. [1982]. *Geology of the country around Newton Abbot.* Mem. Geol. Surv. Gt. Br.

SHORTER, A.H., RAVENHILL, W.L.D. and GREGORY, K.J. [1969]. *Regions of the British Isles. Southwest England.* Nelson, London.

SIMMONS, I.G. [1964]. An ecological history of Dartmoor. In *Dartmoor Essays.* The Devonshire Assn., Exeter.

SMITH, L.P. [1976]. *The agricultural climate of England and Wales. Areal averages 1941-70.* Tech. Bull. Minist. Agric. Fish Fd. Lond. No. 35.

SOIL SURVEY STAFF [1960]. *Field Handbook.* Soil Surv. Gt Br.

SOIL SURVEY STAFF [1975]. *Soil taxonomy: a basic system of soil classification for making and interpreting soil surveys.* Agriculture Handbook No. 436, Soil Conservation Service, United States Department of Agriculture, Washington D.C.

STAINES, S.J. [1976]. *Soils in Cornwall I: Sheet SX18 [Camelford].* Soil Surv. Rec. No.34.

STAINES, S.J. [1979]. *Soils in Cornwall II: Sheet SW53 [Hayle].* Soil Surv. Rec. No.57.

STAMP, L.D. [1941]. *The land of Britain. The report of the land utilization survey of Britain. Part 92. Devonshire.* Geographical Publications, London.

STANES, R.G.F. [1964]. 'A georgicall account of Devon and Cornwalle' 1667 by Samuel Colpresse. *Trans. Devonshire Ass. Adv. Sci.* **96,** 269-302.

STANES, R.G.F., JEWELL, A. and BASS, R. [2008]. *The husbandry of Devon and Cornwall.* Exeter.

STAPLEDON, R.G., DAVIES, W., WILLIAMS, T.E., HUGHES, G.P. and DAVIES, A.G. [1940]. *Vegetation. Grasslands of England and Wales. Map 1:625,000.* Welsh Plant Breeding Station.

TE PUNGA, M.E. [1957]. Periglaciation in southern England. *Koninklijk Nederlandsch Aardrijkskundig Genootschap.* **74,** 401-12.

THOMASSON, A.J. [1979]. Assessment of soil droughtiness. In *Soil survey applications.* Ed. M.G. Jarvis and D. Mackney. Soil Surv. Tech. Monogr. No.13, 43-50.

THOMASSON, A.J. [1982]. Soil and climatic aspects of workability and trafficability. *Proc. 9th Conference of the International Soil Tillage Research Organisation, Osijek, Yugoslavia.* 551-7.

THORNDYCROFT, V.R., PIRRIE, D. and BROWN, A.D. [2004]. Alluvial records of medieval and prehistoric tin mining on Dartmoor, Southwest England. In: *Geoarchaeology: An international Journal.* **19,** 219-36**.**

THORNTON, P .S. (1987). *The density and distribution of badgers in South West England*. Unpublished Ph.D. Thesis, University of Exeter.

TINSLEY, J. [1950]. The determination of organic carbon in soils by dichromate mixtures. *Trans. 4th int. Congr.Soil Sci.* **1,** 161-4.

TROLL, C. [1965]. Seasonal climates of the Earth. In*: World maps of climatology* [Eds. F. Rodenwaldt and H.J. Jusatz].

TURNER, S. [2007]. *Ancient country: the historic character of rural Devon.* Devon Archaeol. Soc. Exeter.

USSHER, W.A.E. [1896] *Unpublished Geological Survey 1:63,360 field slip*, *Devon sheet C [100] NE* . British Geological Survey Archive.

VANCOUVER, C. [1808]. *General view of the agriculture of the county of Devon.* Board of Agriculture, London.

VINCENT, A. [1974]. *Sedimentary environments of the Bovey Basin.* M.Phil. Thesis University of Surrey.

VON POST, L. [1924]. Das genetische System der organogenen Bildungen Schwedens. *Memoires sur la nomenclature et la classification des sols.* International Soil Science Congress Helsingfors, Pedology IV Commission, 22, 287-304.

WALKLEY, A. and BLACK, I.A. [1934]. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Sci.* **34,** 29-38.

WARD, S.D., JONES, A.D. and MANTON, M. [1972]. *Vegetation of Dartmoor.* Field Studies Council.

WATERS, R.S. [1957]. Differential weathering and erosion in Oldlands. *Geog .J.* **123,** 503-13.

WATERS, R.S. [1961]. Involutions and ice wedges in Devon. *Nature.* **189**, 389-90.

WATERS, R.S. [1964]. The Pleistocene legacy to the geomorphology of Dartmoor. In *Dartmoor Essays*, 73-96. Devonshire Assn., Exeter.

WATERS, R.S. [1965]. The geomorphological significance of Pleistocene frost action in South West England. In *Essays in Geography for Austin Miller,* 39-57. Reading University.

WATERS, R.S. [1971]. The significance of Quaternary events for the landforms of South West England. In *Exeter Essays in Geography,* 23-31. University of Exeter.

WILLIG, D. and HÄUSLER, H. [2012]. Aspects of German military geology and groundwater development in World War II. In Rose, E.P.F. and Mather, J.D. [eds] [2012]. *Military aspects of hydrogeology*. Geol. Soc., London, Special publications **362.** 187-202.

WOOLNER, D. [1965]. *Peat charcoal.* Devon Cornwall notes and queries. **30**, 118-20.

YOUNGER, P.L. [2012]. Crouching enemy hidden ally: the decisive role of groundwater discharge in two major British battles, Flodden 1513 and Prestonpans 1745. In Rose, E.P.F. and Mather, J.D. [eds] [2012]. *Military aspects of hydrogeology*. Geol. Soc., London, Special publications **362.** 19-36.

# Appendix   Climatic details

As noted in Chapter 1 [Section 1.5], this Appendix contains details of spatial and temporal variations in meteorological conditions, elaborating those described in that chapter. They include both basic values from Meteorological Office web sites and Smith [1976], as well as interpreted assessments, such as for soil moisture conditions and growing season length, as by Smith, Findlay *et al.* [1984] and Jones and Thomasson [1985]. This survey district falls within the Agroclimatic Area 43 North of Smith [1976].

*Days with rainfall*

Meteorological Office [2015] contains maps showing the average number of rain days [with more than 1 mm] across the region during 1971-2000. In this survey district the fewest [130-150 days] occurred in the lowest sites, in the extreme northeast, and in the Forder and Wray valleys. By contrast the high moorland experienced 170-200 days, the moorland fringes 160-170, with most of Mercer's [2009] Middle and Far East having 150-160 days. Both Exmouth, 20 km east on the coast, and Rothamsted in Hertfordshire experienced around 120 rain days in the average year.

*Sunshine*

Details of local annual average sunshine duration [1971-2000] within the survey area can be found in Meteorological Office [2015]. There 1,600-1,650 hours per year [4.45 hours per day] are shown in the far southeast around Knowle and Drakeford Bridge. Most of the rest of O.S. 10 km grid square SX78 averaged 1,500 -1,600 hours each year [4.25 hours per day] with the eastern half of SX68 at 1,450-1,500 hours [4.04 hours a day], amounts falling to 1,300-1,450 hours per year [3.77 hours per day] on the higher moorland. Smith [1976] gives 3.86 hours as a daily average for Area 43 North.

*Temperature*

In Meteorological Office [2015] mapping of annual average temperature for the decades 1971-2000 in the southwest shows the warmest part of the survey area to be just south of Lustleigh, where averages are 10-10.5$^{O}$C. This contrasts with the high ground, including the ridges from Mardon to Blackingstone Rock, averaging 7-9$^{O}$C, while much of the Forder and Wray Brooks vale falls between the two extremes at 9-10$^{O}$C. The range in annual average temperature of around 2.3$^{O}$C from the higher to the lower ground is slightly greater than the 1.9$^{O}$C difference between Princetown and Yarner Wood shown in Table 3a in Section 1.5.4, or 1.6$^{O}$C, if an allowance of 0.3$^{O}$C is made for temperature changes over the differing periods in the table. January mean temperatures are from 5.5$^{O}$C in the extreme southeast around the confluence of the Wray Brook and the River Bovey, to 2-4$^{O}$C on the high moorland. In July the low ground around Lustleigh is the warmest, averaging 16.5-18$^{O}$C, contrasting with 12-14.5$^{O}$C on the moorland above about 350 m O.D., most of the in-bye falling between these two. The monthly figures indicate mean temperature differences between the highest and lowest sites of around 2.5$^{O}$C in winter and 4$^{O}$C in July, somewhat greater than in Table 3 for Princetown and Yarner Wood.

In the Agroclimatic Area 43 North of Smith [1976] at 236 m O.D. an annual average temperature through 1941-70 of 9.1$^{O}$C is recorded, with a mean for January of 3.6$^{O}$C and 14.8$^{O}$C during July and August. Using Jenkins *et al.*'s [2008] Table 2.3 for comparison of Smith's 1941-71 values with the more recent local temperatures in Table 3, suggests the annual average temperatures at 236 m O.D. in Area 43 of around 10.3$^{O}$C, with a January mean of 4.4$^{O}$C and 15.2$^{O}$C in July. Variations of temperature from site to site are primarily affected by altitude, Smith's Table 1 shows a decline of about 0.6$^{O}$C per 100 m.

Meteorological Office [2015] indicates mean annual days with air frosts being fewest [30-40 days] south of Lustleigh and in the extreme northeast, and most frequent on the moorland at 50-80 days. In comparison, Exmouth on the coast is mapped in the range 0-20 days, while Rothamsted is 40-50 days. The web site shows mean values of 0-4 days with lying snow around Lustleigh, 10-14 days on the moorland fringes and the ridges between Mardon Down and Blackingstone Rock,14-28 days across most of the moorland and 4-10 days for the remainder of the district. Duration of snow cover at Exmouth appears similar to that around Lustleigh, while at Rothamsted it is 8-10 days.

Maps in Meteorological Office [2015] show annual mean values [1981-2010] for soil temperature at 30 cm, growing season length, [defined by Smith [1976] as the length of time the 30 cm soil temperature is above 6$^{O}$C] and growing degree days [the number of day degrees in excess of 5.5$^{O}$C]. In the district's extreme southeast average annual 30 cm soil temperature is shown to be above 10$^{O}$C, but declining to 8-9$^{O}$C on the high moorland, with the range 9-10$^{O}$C fringing the moorland and running along the high ground around Mardon Down and Blackingstone Rock. Exmouth's values are above 11$^{O}$C, with those at Rothamsted between 10 and 11$^{O}$C. For the decades 1941-70 in Agroclimatic Area 43 North at 236 m O.D. Smith [1976] gives 30 cm soil temperatures averaging for the year at 9.96$^{O}$C, with a spread from 4.7$^{O}$C in February to 15.5$^{O}$C in July. Place to place variation is a reflection of altitude, with an annual decline of 0.61$^{O}$C per 100 m rise, as well as being influenced by slope and aspect, soil type and soil moisture regime.

The length of the growing season was mapped by Findlay *et al.* [1984], following Smith [1976]. Small areas in the northeast and southeast of the survey area average over 275 days, declining to about 225 days along a northwest to southeast trending line passing through Chagford and Manaton, with the highest western summits being below 175 days. For the 1941-70 period Smith put the growing season at the average height of Area 43 North as 257 days, from 25$^{th}$ March to 7$^{th}$ December. Altitude, slope and aspect contribute to variations about these dates. Smith's Table 16 indicates that reduction of the growing season with altitude, put at 30-35 days per 100 m, is around double that for eastern, midland and northern England. The Meteorological Office's mapping of growing season length shows much of the survey area averaging over 310 days, although the high moorland is separated, being between 240-70 days. The Exmouth area is recorded having more than 310 days, around Rothamsted 290 days are shown.

On Meteorological Office [2015] growing degree days are mapped having minimum values on the high moorland between 1000 and 1250, with maxima around 1500-1750 in lower situations. At Exmouth around 1750 degree days are the average, with Rothamsted's mean being between 1500 and 1750. The map of Bendelow and Hartnup [1980] for accumulated temperature above 5.6$^{O}$C shows the 1925 degree day isotherm close to the district's southeastern corner. Their 1650 isotherm runs roughly northwest-southeast from Throwleigh to Manaton, while the high moorland, including the Hamel Down ridge, is placed between 1100 and 1375 degree days. Jones and Thomasson [1985] use accumulated temperature of degree days above 0$^{O}$C between January and June as a robust guide to the thermal energy available to plants. Their map shows a local maximum of just over 1450 degree days in this district's northeastern corner, amounts declining gradually southwestwards to below 1250 on the high moorland. By way of comparison levels on the coast at Exmouth are better than 1550 degree days, at Rothamsted in Hertfordshire they are around 1400, while the high moorland's values are matched around the uplands of Wales and Northern England.

*Wind and Exposure*

The district's location on the peninsula and elevation mean, compared with most of lowland England, it is exposed to wind, particularly the prevailing westerlies. The moorland above 500 m O.D. is shown [Meteorological Office, 2015] to have average annual wind speeds of 15-20 knots. Only on Land's End are comparable speeds met in the rest of the southwest peninsula. More widely they are confined to the highest land in Wales, the Pennines, and the Lake District. This contrasts with the 6-8 knots in the lower, more sheltered parts, notably the Wray valley near Lustleigh and the vale between Chagford and Castle Drogo, plus, of course, several abrupt, secluded valleys. The exposure categories used by Bendelow and Hartnup [1980] depict very exposed land, with average wind speeds over 12.9 knots over the moorland above 500 m O.D., the land in the Forder- Wray vale along with the Teign valley near Chagford and the district's far northeast as moderately exposed [speeds less than 9.4 knots] and the remainder with intermediate average winds.

Shelter and exposure are important for forestry, Pyatt *et al.* [1969] providing a means [Topex] of assessing them. Obtained by measuring the elevation of the skyline at eight compass points and summing the angles, the Topex result is applied to one of five classes, ranging from severely exposed [sum of angles 0-10$^{O}$] to very sheltered [100$^{O}$+]. Most hill top sites here fall in the severely exposed class, where perennial vegetation, whether trees in the in-bye, or forestry and gorse bushes on the moor, can display considerable wind pruning. Ground configuration below interfluvial crests and hill tops results in some variation in Topex rating. Moderately and very sheltered sites are mainly confined to lower valley sides and bottoms. Within the in-bye, the more exposed sites are marked by the asymmetry of solitary trees and stunting along the edges of woods and plantations facing the prevailing winds. While sites in eastern England, such as Rothamsted, may have Topex values in the exposed or severely exposed categories, such asymmetry is rare, thanks to the lower wind speeds there.

*Relative humidity*

Temperature and wind speed regimes across the survey area are discussed above and in Section 1.5. Meteorological Office [2015] maps average percentage relative humidity. Unlike other meteorological properties altitude and relief have little influence on this. Annual averages are shown falling between 82-84%, January's 86-88%, while in July the southwest of the district is slightly more humid with mean values of 80-82%, against 78-80% in the northeast. At Exmouth the annual average is around 82%, at Rothamsted 80-82%.

*Soil moisture*

In Chapter 1, Section 1.5.6, the significance of soil moisture conditions to both soil development and the economic and environmental behaviour of soil is described in some detail. Here the spatial and temporal variations in the soil moisture state in and around SX68/78 are elaborated.

As well as the mapping of accumulated temperatures noted above, Jones and Thomasson [1985] have mapped mean maximum potential soil moisture deficit for the period 1961-75 and median duration of field capacity during 1941-70. As integrations of meteorological parameters, the distributions of both soil moisture deficit and field capacity duration broadly reflect the patterns of temperature and precipitation already described. In the extreme northeast and southeast, the driest parts of the district, their map of soil moisture deficit indicates maximum mean values of 100 mm, declining to about 75 mm along a line through Chagford and Manaton, and falling below 50 mm west of the Rivers East Dart and East Okement. Average maximum potential cumulative soil moisture deficit mapped by Bendelow and Hartnup [1980] shows the highest moorland around Cut and Hangingstone Hills to be without a deficit. By contrast the far northeast of the survey area exceeds 100 mm. Their 80 mm isopleth runs northwest to southeast through Chagford and North Bovey, that for 60 mm roughly along the moorland bounding cornditch and the 40 mm line from Headland Warren through Fernworthy Reservoir and on to Oke Tor.

For the Exeter district Hogg, in Clayden [1971] [Table 7], used rainfall amounts subtracted from potential transpiration to compare accumulated soil moisture deficits between Laployd [801849] at 317 m O.D., just east of this survey, and Exmouth on the coast. By Hogg's calculations a maximum deficit at Laployd [801849] of 43 mm occurred in July, compared with 138 mm in August at Exmouth, where the July deficit was almost three times that at Laployd. Not only were the local site's deficits smaller, they initiated later [June rather than April] and ended earlier [September instead of November].

Applying Hogg's approach, plus Smith's assessment of variations from mean conditions, to sites in the survey area, suggests that with Area 43 North's average rainfall of 1449 mm, only the lower ground in the eastern in-bye is affected by serious soil moisture deficits more frequently than one year in four. As for the moorland, represented by White Ridge, soil moisture deficits come out as the one year in 10 exception.

Using the same methodology at Cut Hill [594 m O.D., annual average rainfall 2478 mm], representing the highest, wettest land with thick blanket peat, no calculated soil moisture deficit develops even in the driest year in a decade. Potential transpiration in the average year there amounts to 379 mm, with excess rainfall of 2101 mm.

There are *caveats* to this approach, which uses average monthly potential transpiration values, originally calculated to assess irrigation needs, and average monthly rainfall, with correction factors for variations from place to place and year to year. However it makes use of limited information and does demonstrate variations between sites and years.

More detailed, but largely similar values to those at Laployd [801849], are given in Fig 1.2b of Harrod *et al.* [1976] for a site on the southern edge of Dartmoor at Moorhaven, Wrangaton [666575] at 200 m O.D, averaging 1520 mm rain a year. There no median soil moisture deficit occurred until early May and only peaked at 38 mm in late June. In most years the deficit was made up by August. Year to year variations about averages are indicated by the Moorhaven figures. Only in the drier quartile of years did the accumulated soil moisture deficit there exceed 50 mm, and then only by small amounts and only in June and July. In wet quartile years single figure deficits were the rule, with late May and Early June alone being without the possibility of returns to field capacity. By mid-October the probability of field capacity having re-established was nearly 100%.

**Table 25. Smith's [1976] average potential transpiration [mm] applied to average annual rainfall [mm] for Area 43 N and to White Ridge.**

| Location & Parameters | Annual potential transpiration mm | Maximum accumulated soil moisture deficit mm | Start of SMD | End of SMD | Annual excess rainfall mm |
|---|---|---|---|---|---|
| **Area 43N** average height 236 m O.D. rainfall 1449 mm | | | | | |
| **Average year** | 467 | 9 | Jun | Jly | 982 |
| **Dry quartile** | 508 | 30 | Jun | Aug | 912 |
| **Wet quartile** | 335 | 0 | | | 1050 |
| **Dry year in 10** | 791 | 124 *[84] | Apr | Oct *[Sep] | 646 |
| **Wet year in 10** | 211 | 0 | | | 1238 |
| **Laployd after Hogg, 317 m O.D., rainfall 1218 mm** | | | | | |
| **Average year** | 457 | 43 | Jun | Aug | 761 |
| **White Ridge** 482 m O.D. **rainfall** 2062 mm | | | | | |
| **Average year** | 402 | 0 | | | 1661 |
| **Dry quartile** | 471 | 0 | | | 1592 |
| **Wet quartile** | 333 | 0 | | | 1730 |
| **Dry year in 10** | 738 | 31 | Jun | Aug | 1329 |
| **Wet year in10** | 272 | 0 | | | 1792 |

**Bracketed figure represents recalculated value following MAFF [1967], with transpiration values halved once the calculated soil moisture deficit exceeds 50 mm.*

Jones and Thomasson's [1985] map of median duration of field capacity [1941-70] again reflects the broad east to west increase in climatic severity. Only the land northeast of the Teign below Clifford Bridge experiences a value below 225 days. Most of the district has more than 250 days, the moorland in excess of 300 days. For the centre of O.S. 10 km sheet SX78 the median duration was 255 days, rising to 325 days in the wet year in 4. At the centre of SX68 the median length of the state was 338 days, the condition persisting year around in the wet quartile of years. The median date for the ending of field capacity at the centre of SX78 was 17th May, at SX68's centre 10th June. The return to field capacity at these 2 sites had median dates of 4th September and 7th July respectively. Table 26 summarises variations about these median values.

Comparison of values for SX68 and 78 with those for in lowland England place them in a wider context. Mean maximum soil moisture deficit for the Rothamsted area on Jones and Thomasson's map is around 175 mm, whereas locally it is between <5 mm and 100 mm. Median duration of field capacity there is shown as around 130 days, contrasting with 250->300 for most of this survey area.

**Table 26. End and return dates of field capacity [FC].**

| | Wet quartile date end FC | Median date end FC | Dry quartile date end FC | | Wet quartile date return to FC | Median date return to FC | Dry quartile date return to FC |
|---|---|---|---|---|---|---|---|
| **SX68** | 19/7 | 10/6 | 18/5 | | 17/6 | 7/7 | 27/7 |
| **SX78** | 28/6 | 17/5 | 27/4 | | 7/8 | 4/9 | 26/9 |

*Bioclimatic classification*

Tables 27 and 28 below set out the class limits and local distribution of Bendelow and Hartnup's [1980] bioclimatic classification. Exmouth on the coast is mapped as E4P by Bendelow and Hartnup, Rothamsted as D4M.

A further level mapped by Bendelow and Hartnup, *oceanicity,* [Birse 1971] quantifies the relative climatic influence of large tracts of open sea. At the scale of Troll's [1965] classification of the World's seasonal climates all of Devon falls in the *hyperoceanic* subsector of mild winters, cool summers and long, less intense growing seasons. It contrasts with the country's least oceanic, *meioceanic* subsector, between Peterborough and London, including Rothamsted.

**Table 27. Thermal and moisture classes, and exposure categories for bioclimatic classification.**

| | | ***MOISTURE REGIME →*** | ***Moderately wet*** | ***Slightly wet*** | ***Moderately moist*** | ***Slightly moist*** |
|---|---|---|---|---|---|---|
| | | ***Symbol*** *[+ moisture deficit [mm] ]* | ***1*** *[<40]* | ***2*** *[40-60]* | ***3*** *[60-100]* | ***4*** *[100 -180]* |
| **THERMAL REGION ↓** | Symbol [ + day$^{O}$ >5.6$^{O}$C] | | | | | |
| **Moderately cold** | **A** [<825] | | | | | |
| **Slightly cold** | **B** [825 - 1375] | | V & P | V | | |
| **Moderately cool** | **C** [1375 – 1650] | | P | P | P | |
| **Slightly cool** | **D** [1650 – 1925] | | | | M & P | M |
| **Moderately warm** | **E** [>1925] | | | | M | |

N.B. **Exposure categories** scale in average windspeed [m/s]: V= very exposed [>6.6], P= exposed [4.8 – 6.6], M= unexposed [< 4.8].

**Table 28. Local distribution of bioclimatic classes.**

| **MOISTURE REGIME ➔** / **THERMAL REGION ➔** | ***1*** | ***2*** | ***3*** | ***4*** |
|---|---|---|---|---|
| **B** | **V** High moor above 500 m | **V** Slightly lower moor, Hameldown and Hookney Tors, Oke Tor to Kennon Hill | | |
| **B** | **P** Hurston & White Ridges,to between Stonetor and Hew Down | | | |
| **C** | **P** Around Fernworthy Resrvoir | **P** Lower moorland and in-bye SW of B3344 and line NW-SE through Waye Down and Meldon Hill | **P [i]** Mercer's Far East, E of Parford – Slade Cross scarp **[ii]** Strip running SE from Chagford, E of C2P & SW of River Bovey,& N & S Hartons, Lustleigh | |
| **D** | | | **M** Forder –Wray vale, plus low ground in Bovey valley between Batworthy and Foxworthy | **M** District's NE corner, NE of River Teign below Clifford Bridge |
| **D** | | | **P** NW-SE ridge around Meacombe, through Bughead Cross to Sanduck, plus Teign Gorge between Castle Drogo and Clifford Bridge | |
| **E** | | | **M** Low ground around Lustleigh | |

**Location grid references:** Batworthy 716852, Bughead Cross 735854, Castle Drogo 724902, Clifford Bridge 781897, Foxworthy 758821, Hameldown Tor 703806, Hew Down 635860, Hookney Tor 698813, Harton 767825, Hurston Ridge 670820, Kennon Hill 642895, Meacombe 727867, Meldon Hill 698861, Oke Tor 612900, Parford 714898, Sanduck 768836, Slade Cross 799813, Stonetor 648855, Waye Down 689892, White Ridge 650822

## Glossary

*Acidobacteria:* A group of bacteria, some of which are acid-loving; abundant in soils.

*Active layer:* The upper levels of *regolith* under *periglacia*l conditions, which, while overlying the *permafros*t, thawed each summer, tending to become a waterlogged slurry, subject to flow and contortion.

*Adret:* French term indicating the sunny, south facing side of a valley.

*ADAS:* Agricultural Development and Advisory Service. Formerly the advisory arm of *MAFF*, now an independent body. Until 1971 it was known as NAAS [National Agricultural Advisory Service].

*Aerenchyma:* Spongy tissue with air channels present in the roots of some plants, enabling rooting into waterlogged soils.

*Agistment:* The fee charged by the Duchy of Cornwall allowing stock to graze on the Forest of Dartmoor.

*Alluvium:* Unconsolidated material deposited by stream action on river floodplains.

*Altiplanation terraces:* Stepped hill side features produced by intense frost action.

*Andalusite:* A mineral typically found in low-grade thermally metamorphosed rocks.

*Aquifer:* A water bearing rock.

*Archaea*: Single-celled microorganisms.

*Architrave:* The brick or stone work around doors and windows.

*Arthropods:* Invertebrate animals with external skeletons, segmented bodies and jointed appendages. They include the insects and arachnids [spiders and ticks].

*Ascomycete:* A form of fungus commonly known as the sac fungi.

*Ashlar:* Dressed, usually rectangular, masonry block.

*Assart:* The allowance by the Duchy of Cornwall of the establishment of farming tenements within the Forest of Dartmoor.

*Base flow index [or BFI]*: Long term average proportion of stream flow occurring as flow unsupplemented by runoff.

*Basidiomycetes:* A group of fungi, with the *ascomycetes,* making up the ‘higher fungi’.

*Biomass:* The total mass [weight] of living organisms in a unit area.

*Biotite:* A form of the plate-like mineral *mica*, usually black or dark brown, an important constituent of the Dartmoor granite.

*Bioturbation:* The disturbance of soil by biological agencies.

*Brachychthoniidae:* A family of *oribatid* mites.

*Breccia:* A sedimentary rock made up of coarse, angular fragments.

*Bulling:* The servicing of cows by bulls.

*Calabrian*: Early *Pleistocene*, around 2 million years ago.

*Carbonarii:* Commercial licensees of the Duchy of Cornwall who burned peat for charcoal in medieval times.

*Carboniferous:* The geological term for the period from about 345 to 280 million years ago.

*Cassiterite:* Tin ore, tin oxide, tinstone.

*Catena:* A sequence of soils in which changes occur in response to altering climatic, physiographic or hydrological conditions.

*Cave:* The Devonian term for a clamp, the traditional means of storing root crops in the field. The heaped roots were covered with a layer of straw or bracken, in turn covered with earth, as protection against the weather and frosts. Caves, triangular in cross-section and about 1.5m high, could be many metres long.

*Chalcedony:* An ultra-fine grained form of *quartz.*

*Chert:* A fine grained form of *quartz* found as bands in sedimentary rocks.

*Chroma:* In soil colour description, following Munsell charts, the indication of departure from a neutral of the same *hue* and lightness *[value].*

*Clam bridge:* A bridge crudely fashioned from a tree trunk or trunks. Crossing [1912] notes others on Dartmoor, as at Peter Tavey and Shaugh Prior.

*Clapper:* A bridge made of slabs of granite.

*Cleave:* A Devonian term for a steep hillside.

*Clitter:* A jumble of granite boulders, often, but not always, downslope from tors.

*Cob:* Compacted, puddled earth, widely used as a building material elsewhere in Devon, but rarer in this area.

*Collembola:* The scientific name for *springtails.*

*Conglomerate:* A sedimentary rock made up of coarse, rounded fragments.

*Coppice:* Woodland traditionally cut on rotations of 10-20 years, producing multiple stems from each stool or root. Oak coppice provided fuel for charcoal burning, bark for *tannin* and small timbers for various uses. Split hazel stems are still used for thatching spars.

*Corestone:* A rounded or subrounded block of granite.

*Cornditch:* The boundary *hedgebank* between open moor and the enclosed in-bye. Its asymmetry is intended to allow stock, and originally the king's deer, to move from the enclosures, but not in reverse.

*Cretaceous:* The geological period from 136 to 64 million years ago.

*Cryoturbation:* Mixing and disturbance of *regolith* by frost action under *periglacia*l conditions.

*Cupola:* A small, dome-shaped extension from the edge of a *pluton*.

*Damaeidae:* A form of *arthropod*.

*Deep weathering:* The weathering alteration, such as *kaolinisation,* to some depth of rocks during prolonged tropical or subtropical episodes in the past.

*Denshering:* The paring and burning of the turf on fields or reclaimed moor or *downland,* to provide nutrients, plus a reduction in acidity ahead of cropping. The term is a contraction of 'Devonshiring'.

*Devensian:* The final glacial stage of the Pleistocene.

*Distinct horizon:* A topsoil insufficiently dark and with too little organic matter to qualify as *humose.*

*Dolerite:* A medium grained, basic igneous rock.

*Downland:* Acid grassland with bracken and gorse, in places heathy, within the in-bye, some of it never enclosed and providing common grazing; usually with dark topped soils. Although this definition contrasts with the wide national usage, indicating species-rich grassland over Chalk, the term is so strongly engrained in the vernacular of southwest England that its retention is justified.

*Doxology:* Words in Christian liturgy.

*Dredge corn:* A mix of oats and barley.

*Dunland*: The local term for the land underlain by Carboniferous shales.

*Easting:* Ordnance Survey National Grid line running south to north marking the distance east of the Grid's origin.

*Ecosystem:* A complete ecological community or unit.

*Ectomycorrhizae*: Symbiotic relationships between fungi and the roots of plants.

*Eluvial:* This term has 2 contexts. A] Pedological; indicating downward translocation of material in a soil. B] In mining; tin streamworks extending from the alluvium into the adjacent hill side.

*Enchytraeids:* Small, semi-terrestrial or aquatic worms.

*Endophyte*: A bacterium or fungus living within a plant for at least part of its life cycle without causing apparent disease.

*Eocene:* An epoch from the early *Tertiary* period, lasting from about 54 to 38 million years ago.

*Ericaceous plants:* The heather family, to include ling and bilberry as well as the heathers.

*Eu-edaphic:* Preferring soils with plentiful organic or mineral nutrients.

*Eustatic*: A world-wide change in sea level.

*Fault:* A fracture in rock where there is detectable movement. In a *wrench fault* movement is predominantly horizontal. In a *dextral wrench fault* the apparent movement is to the right.

*Feldspars:* Important light grey minerals, components of granite, where both *orthoclase* and *plagioclase* feldspars are found.

*Ferruginous:* Containing concentrations of iron.

*Field capacity:* This has two versions. A] Pedological: the moisture state of a soil after gravitational drainage has ceased, following saturation, drainage time varying with soil porosity. B] Meteorological: when rainfall and *potential transpiration* are in balance, using a standard soil model.

*Fine earth*: Particles less than 2 mm in diameter.

*Fluvial:* Relating to rivers and streams.

*Foggage:* The use of farm woodland for sheltering and feeding out-wintered cattle.

*Föhn:* Fair weather effects associated with descending air in the lee of high ground.

*Forest of Dartmoor:* The part of the moorland in the Duchy of Cornwall estate.

*Fragipans:* Dense, indurated subsoils with fine platy structure.

*Gangue:* Minerals unwanted by the miner.

*Gastrotrichs:* A group of microscopic, worm-like animals, often aquatic, sometimes referred to as hairybacks.

*Geophilomorphs:* Commonly known as soil centipedes.

*Gerts:* Gullies and chasms dug out in exploiting tin ore in the granite. Also known as *openworks*.

*Gleying:* Expressed as mottled soil colours, associated with waterlogging. Caused by the mobilisation and redistribution or removal of compounds, particularly of iron.

*Glomeromycota:* A form of fungus.

*Groundwater:* Water occupying pores or fissures in rocks, in places extending into soils.

*Growan:* Cornish term for granite-derived *head.*

*Haematite:* An iron mineral, formerly mined as 'shiny ore' near Kelly, Lustleigh.

*Head:* Unconsolidated mixture of stones, boulders and fine earth, commonly occurring over *in situ* bedrock.

*Hedgebank:* The traditional form of field boundary in the Southwest, comprising a mound of earth and rocks 1 -2 metres high, of similar width at the base, surmounted by a hedge.

*Holocene:* The Post-glacial, the last 10 thousand or so years.

*Hornfels:* A hard, medium or fine grained rock, lacking cleavage, produced by thermal metamorphism.

*Hue:* In soil colour description, following Munsell charts, the indication of relation to red, yellow, green and blue.

*Humification:* The condition where plant remains have decayed to the point where plant structures are not recognisable.

*Humose:* Mineral soil horizons, dark in colour, with significant organic matter, but insufficient of it to be called an organic or peaty horizon.

*Hydromorphic soils:* Soils with profiles characterised by *gleying,* indicative of waterlogging for significant periods of the year.

*Hydrophilous plants:* Plants favouring very wet conditions.

*Hydrothermal activity*: The action of hot water during igneous activity, bringing about changes to rocks.

*In-bye:* Land outside the moor proper, largely farms and fields, but with woods and *downland* scattered across it. *In-country* is an alternative form.

*Interfluve:* High ground between two streams or rivers.

*Isohyet:* Mapped line of equal rainfall.

*Isotherm:* Mapped line of equal temperature.

*Joint:* A fracture or fissure in a rock, across which there is no sign of movement.

*Kaolinisation:* The alteration of *feldspars* to *kaolin* by *hydrothermal* processes*, pneumatolysis* or *deep weathering*.

*Kaolin:* The product of alteration of *feldspars*; also known as china clay.

*Kist:* Stone coffins of Bronze Age origin.

*Krotovina:* An animal burrow in the soil infilled by distinctive soil, usually from the topsoil.

*Lazy beds:* A method of cultivation, particularly of potatoes, described by Vancouver [1808], of beds separated by trenches or furrows.

*Leaching:* The translocation of dissolved chemicals down the soil profile in percolating water.

*Learing:* An age-old practice of moorland stockmen of accustoming animals to a particular area, to which they then tend to return. The equivalent of ‘up-country’ hefting.

*Leats:* Man-made watercourses supplying tin workings and mills, often conducting the water considerable distances.

*Letterboxers:* Dartmoor has many letterboxes with visitors’ books and rubber stamps, visited by enthusiasts who record their visits. Cranmere Pool has a well-known example.

*Levancy and couchancy:* Medieval moorland laws forbidding grazers to have more stock on the moor than they could maintain on their home farms.

*Levee:* A strip close to the river, slightly higher than the rest of the floodplain.

*Lithoskeletal:* With bedrock or very stony rubble within 80 cm. See Section 2.2.2.

*Lode-back mines:* Shallow tin workings marked by paternoster-like lines of funnel shaped pits and spoil heaps.

*Loess*: Stoneless, silt-sized deposits transported by the wind.

*Lynchets:* Terrace-like benches, the product of prolonged cultivations along the contour.

*MAFF:* Ministry of Agriculture, Fisheries and Food.

*Magma:* The original molten state of the granite while deep in the earth’s crust.

*Malaconothridae:* A family of *oribatid* mites.

*Megacrysts:* Unusually large crystals.

*Meilers:* The kilns used in charcoal burning by the *carbonarii*.

*Menhir:* Standing long-stone of prehistoric age.

*Metamorphic:* Rocks altered by heat or pressure. Locally this applies to the metamorphic aureole fringing the Dartmoor granite, where rocks were baked as the hot granite was emplaced.

*Methanogenic:* Capable of producing methane; usually applied to microbes in anaerobic environments.

*Methanotrophs:* Microbes able to metabolize methane as their source of carbon and energy.

*Mica:* A plate-like group of minerals. One black form, *biotite*, is a major constituent of the Dartmoor granite.

*Mor:* Acid, peat-like humus.

*Moraine:* Material deposited by glacial action.

*Mudstone:* A hardened sedimentary clay, lacking the bedding planes of *shale* or the cleavage of *slate.* Locally known as *'woodstone'.*

*Mycorrhizal fungi:* Fungi that form a symbiotic association with the roots of vascular plants.

*Nematodes*: Also known as round worms, they are slender worms. The smallest nematodes are microscopic, while free-living species can reach as much as 5 cm long.

*Northing:* Ordnance Survey National Grid line running west to east marking the distance north of the Grid's origin.

*Oceanicity:* A measure of the relative climatic influence of large tracts of open sea.

*Ochreous:* Brightly coloured; in terms of Munsell charts, *chromas* of 6 or higher in *hues* of 10YR or redder.

*Oligocene:* The middle epoch of the geological *Tertiary period*, around 36 to 26 million years ago, when this area enjoyed a subtropical climate.

*Oligotrophic:* Peat with pH below 4.

*Openworks:* Gullies and chasms excavated in the search for tin. Also called *gerts.*

*Oribatids:* Small, eyeless, oval, non-parasitic mites, living at the soil surface.

*Orogeny:* Mountain building episodes with geological faulting and earth movements. Locally the Alpine [mid-*Tertiary*] and Variscan [*Carboniferous*] episodes have affected the rocks.

*Orthoclase:* A *feldspar* found in granite, particularly as prominent *megacrysts* up to 15 cm across.

*Pannage:* Pigs feeding on fallen acorns in woodland.

*Parasitidae:* A family of relatively large, predatory mites, which prey on micro-*arthropods* and *nematodes.*

*Parent material:* The substrate, deposit or rock in which the soil has formed.

*Pedology:* The study of soils.

*Periglaciation*: During the *Pleistocene*, when *permafrost* spread deep into the ground, summer thawing produced a shallow *active layer* at the surface; frost action was an important process too.

*Permafrost:* Ground that is permanently frozen, often to hundreds of metres depth.

*Permian:* The time period from 280 to 225 million years ago.

*Phase:* A subdivision of a soil map unit identifying particular profile or site properties, such as old woodland topsoil horizons or steep slopes.

*Phenocryst:* Relative large crystal set in a finer grained groundmass.

*Placer:* Deposits of minerals [tin in the local case] in river alluvium.

*Plagioclase:* A feldspar, found in granite as part of the groundmass.

*Pleistocene:* The period of the Ice Ages and interglacials, from around 2 million years to about 10 thousand before present.

*Pluton:* A large scale mass of igneous rock.

*Pneumatolysis*: Changes to rocks brought about by hot gases during igneous activity.

*Poaching:* The treading, deformation and compaction of moist and wet soil by grazing livestock.

*Poduromorphs:* One of the three main groups of *springtails.*

*Podzolisation:* Soil formation resulting from very acid conditions with an ashen subsurface horizon depleted of iron over lower, brightly coloured horizons of iron accumulation.

*Poroliodes:* A form of *oribatid* mite.

*Potential transpiration* or *potential evapotranspiration:* Growing plants remove water from the soil. Meteorological factors of temperature, humidity and wind speed condition the rate of its removal.

*Proteobacteria:* A major group of bacteria, including some free-living forms capable of nitrogen fixation, as well as a variety of pathogens.

*Protozoa*: Single-celled organisms with animal-like behaviour.

*Protura:* Very small (<2 mm long), soil-dwelling animals, sometimes termed coneheads.

*Pseudomorph:* One mineral in the crystal form of another. Locally *feldspars* have been pseudomorphed by *kaolin* in granite *saprolite*.

*Pseudoscorpions:* Small animals with flat, pear-shaped bodies and pincers, 2 to 8 millimetres in length, preying on larvae, ants, mites, and small flies.

*Quartz:* Pure silica, a normally colourless mineral, a major component of granite.

*Quartzite:* A sedimentary rock made up of *quartz* grains.

*Quoin:* External corner stone of a building.

*Rain shadow:* An area with relatively light rainfall consequent upon being in the lee of high ground.

*Reaves:* Bronze Age enclosure boundaries on parts of the lower moorland.

*Redd:* The depression in river-bed gravel made by salmon and trout in which they lay their eggs and then conceal them by sweeping gravel back over with their tails.

*Reduction:* The chemical removal of oxygen from a substance.

*Re-entrant:* An inward pointing break in the line of a hill side, a shallow valley.

*Regolith:* Rock waste.

*Reniform:* Kidney shaped.

*Rhizomes:* Modified subterranean stems of plants.

*Rhizoscyphus:* A *mycorrhizal* fungus.

*Rhôs pasture:* Wet, semi-natural grassland of great conservation value, peculiar to the Southwest and Wales.

*River terrace:* Flattish areas adjoining, but higher than, a floodplain, marking former valley floor levels.

*Rotifers:* Microscopic and near-microscopic creatures, common in freshwater environments, often called wheel animals.

*Salmonids:* Fish of the family *Salmonidiae;* locally salmon, trout and grayling.

*Saprolite:* Granite softened *in situ* by chemical decay of geological origin or by weathering.

*Saxicolous:* Plants living on and among rocks.

*Schattenseite:* German for the shaded, north-facing side of a valley.

*Screes:* Steep accumulations of coarse, angular *regolith,* usually on lower slopes below crags or rocky areas. Also called *talus.*

*Sesquioxides:* Oxides of iron and aluminium.

*Shale:* Sedimentary rock, originally clay, with marked parallel bedding planes. Locally known as '*shillot*'.

*Shillot:* The vernacular term in the Southwest for *shale* or *slate*.

*Shode:* Tin-bearing *head*, usually in a lower valley side slope.

*Slate:* A *mudstone* or *shale* that has suffered *metamorphic* alteration, imparting *slaty cleavage*. Locally known as 'shillot'.

*Slaty cleavage:* Flat, closely spaced planes of breakage in rocks, brought about by intense deformation.

*Slickensides:* Grooves or polished parts of rock or soil surfaces brought about by movement, as on *fault* lines.

*Soil moisture deficit:* The moisture state of the soil once *evapotranspirational* losses of moisture exceed rainfall receipts.

*Soil profile:* The soil as exposed in a section down from the surface, to about 1-1.5 m depth.

*Soil series:* Approximating to the layman's concept of 'soil type', this is the fourth level of the hierarchical soil classification. Soil series often broadly coincide with natural occurrences of soil types in the landscape.

*Solifluction:* The *periglacial* process where temporarily thawed, water-charged *regolith* is transported downslope over still frozen *permafrost*.

*Sonnenseite:* German for the south facing, sunny side of a valley.

*Specific heat capacity:* The quantity of heat required to raise the temperature of a unit of mass of a substance by one degree.

*Springtails [Collembola]:* Segmented animals normally less than 6 mm long, living on and in the soil.

*Stagnogley:* A soil characterised by surface wetness due to impermeable horizons.

*Standard percentage runoff:* The percentage of rainfall causing short-term increase in stream flow.

*Stannary:* A place [Chagford was one of the four on Dartmoor] where tin ingots were assayed and taxed before sale.

*Staphylinidae:* Rove beetles, common in terrestrial ecosystems.

*Streamworks:* Ground dug over across valley bottoms, primarily in medieval times, in the search for tin-bearing gravel.

*Subaerial:* Processes taking place on the Earth's surface while exposed to the atmosphere.

*Substrate:* The soil's parent material.

*Swaling:* Burning of dead vegetation to encourage fresh spring growth for grazing; a traditional moorland management practice.

*Talus:* Steep accumulations of coarse, angular *regolith*, usually on lower slopes below crags or rocky areas. Also called *scree.*

*Tannin:* A substance extracted from oak bark used in converting animal hides into leather.

*Tardigrades:* Water-dwelling, eight-legged, segmented micro-animals. Also known as water bears or moss piglets.

*Tertiary:* The geological period from about 64 million years ago until 2 million years ago.

*Texture:* The particle-size distribution of the *fine earth* fraction [less than 2 mm].

*Thalweg*: The long profile of a valley or watercourse.

*Thermal conductivity:* The capacity of a material to transmit heat.

*Thermal diffusivity:* The rate of temperature change produced in a unit volume by the quantity of heat flowing through the volume in a unit time under a unit temperature gradient.

*Tie:* Commoners' peat working for fuel, often worked in 'journeys' of 40 yards length.

*Tithe maps:* Detailed maps of each parish from about 1840, including field names, acreage, use, ownership and tenancy.

*Tourmaline:* A hard black mineral, associated with *pneumatolysis*, found in the Dartmoor granite and its *metamorphic* aureole.

*Trafficability:* The ease or otherwise with which soil and land sustain vehicular movements without rutting and soil structural damage, or delay.

*Transhumance:* The seasonal movement of livestock between two regions with different climates and vegetation. In this locality the movement of animals from the in-bye to the moorland to utilise summer grazing there.

*Trimalaconothridae:* A family of *oribatid* mites.

*Tundra:* Unglaciated ground and vegetation conditions associated with extreme cold and *permafrost*.

*Tupping:* The annual servicing of ewes by rams, also termed tups.

*Turbidite:* A sediment deposited by a turbidity current, a flow of a slurry of sediment and water down a subaquatic gradient.

*Turf-tie:* Commoners' peat working for fuel, often worked in 'journeys' of 40 yards length.

*Tye:* The working area in tinners streamworks.

*Ubac:* French term indicating the shaded, north facing side of a valley.

*Unripened:* Without indications of soil structural development.

*Vag:* Peaty or *humose* top of mineral moorland soil stripped and dried for use as fuel.

*Value:* In soil colour description, following Munsell charts, the indication of lightness within the same *hue* and *chroma*.

*Veigaiidae:* Free-living and predatory mites found in soil and decaying organic matter.

*Watertable:* The upper surface of groundwater.

*Woodstone:* The vernacular term around Dartmoor for hard, blocky *mudstone,* particularly on the *metamorphic* aureole.

*Xenoliths*: Inclusions within the granite of fragments the surrounding country rocks.

# Index

**Other publications dealing with soils in Devon and Cornwall:**

*Soils of the middle Teign valley district of Devon* by B. Clayden.

*Soils of the Exeter district* by B. Clayden.

*Soils in Devon I: Sheet ST10 [Honiton]* by T.R. Harrod.

*Soils in Devon II: Sheet SX65 [Ivybridge]* by T.R. Harrod, D.V. Hogan and S.J. Staines.

*Soils in Devon III: Sheet SX47 [Tavistock]* by D.V. Hogan.

*Soils in Devon IV: Sheet SS30 [Holsworthy]* by T.R. Harrod.

*Soils in Devon V: Sheet SS61 [Chulmleigh]* by T.R. Harrod.

*Soils in Devon VI: Sheet SS63 [Brayford]* by D.V. Hogan.

*Soils in Devon VII: Sheet SS74 [Lynton]* by D.V. Hogan and T.R. Harrod.

*Soils in Devon VIII: Sheet ST01 [Culm Valley]* by D.V. Hogan.

*Soils in Cornwall I: Sheet SX18 [Camelford]* by S.J. Staines.

*Soils in Cornwall II: Sheet SW53 [Hayle]* by S.J. Staines.

*Soils in Cornwall III: Sheet SW61, 71 and parts of SW62, 72, 81 and 82 [The Lizard]* by S.J. Staines.

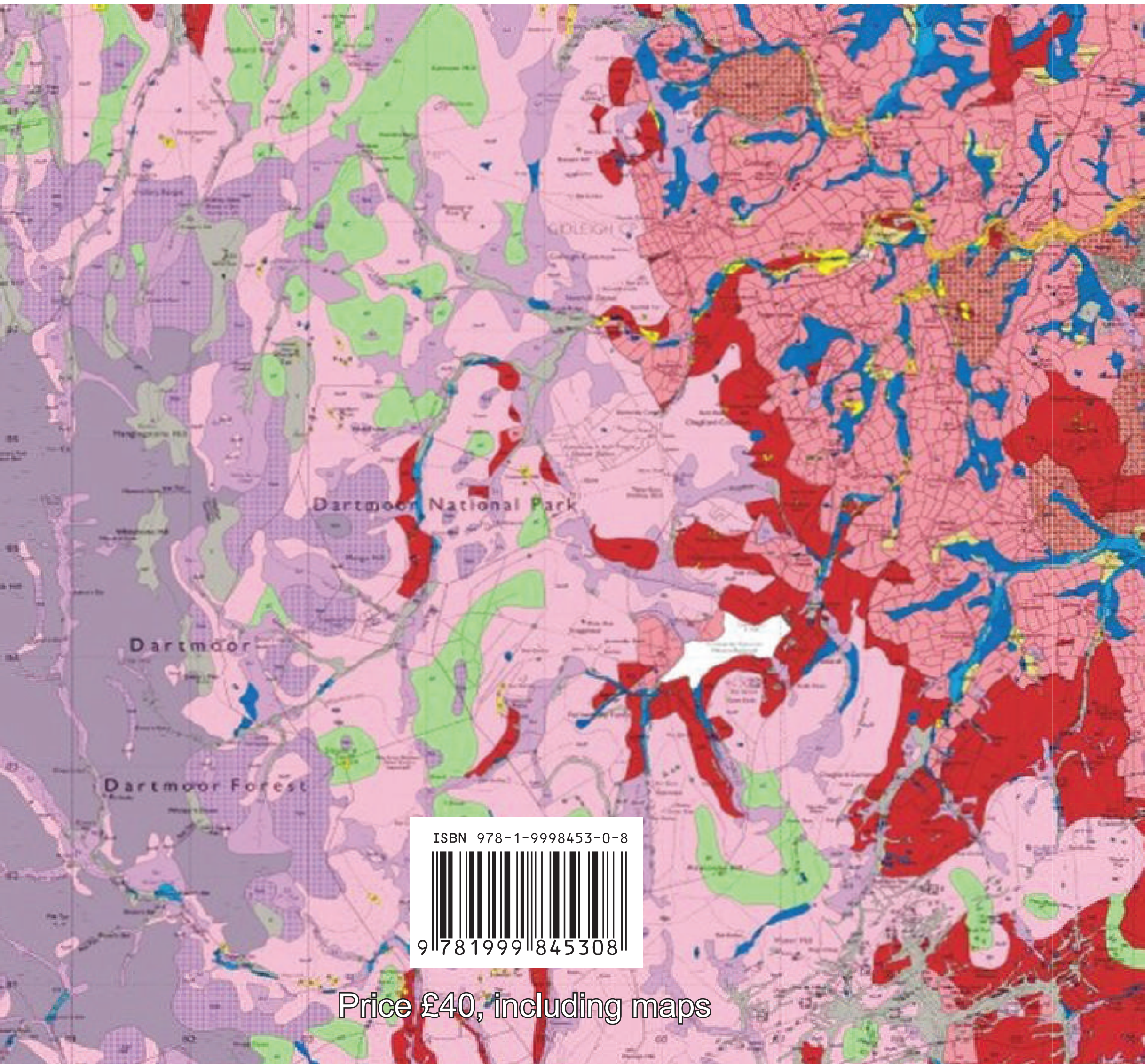
*Soils and their use in South West England* by D.C. Findlay, G.J.N. Colborne, D.W. Cope, T.R. Harrod, D.V. Hogan and S.J. Staines.

*Soils of England and Wales: Sheet 5, South West England;* map at 1:250,000 by G.J.N. Colborne, D.W. Cope, T.R. Harrod, D.V. Hogan and S.J. Staines.

These publications are available from Cranfield University

www.landis.org.uk/publications/

http://Landis.org.uk/publications/




ISBN 978-1-9998453-0-8

Price £40, including maps