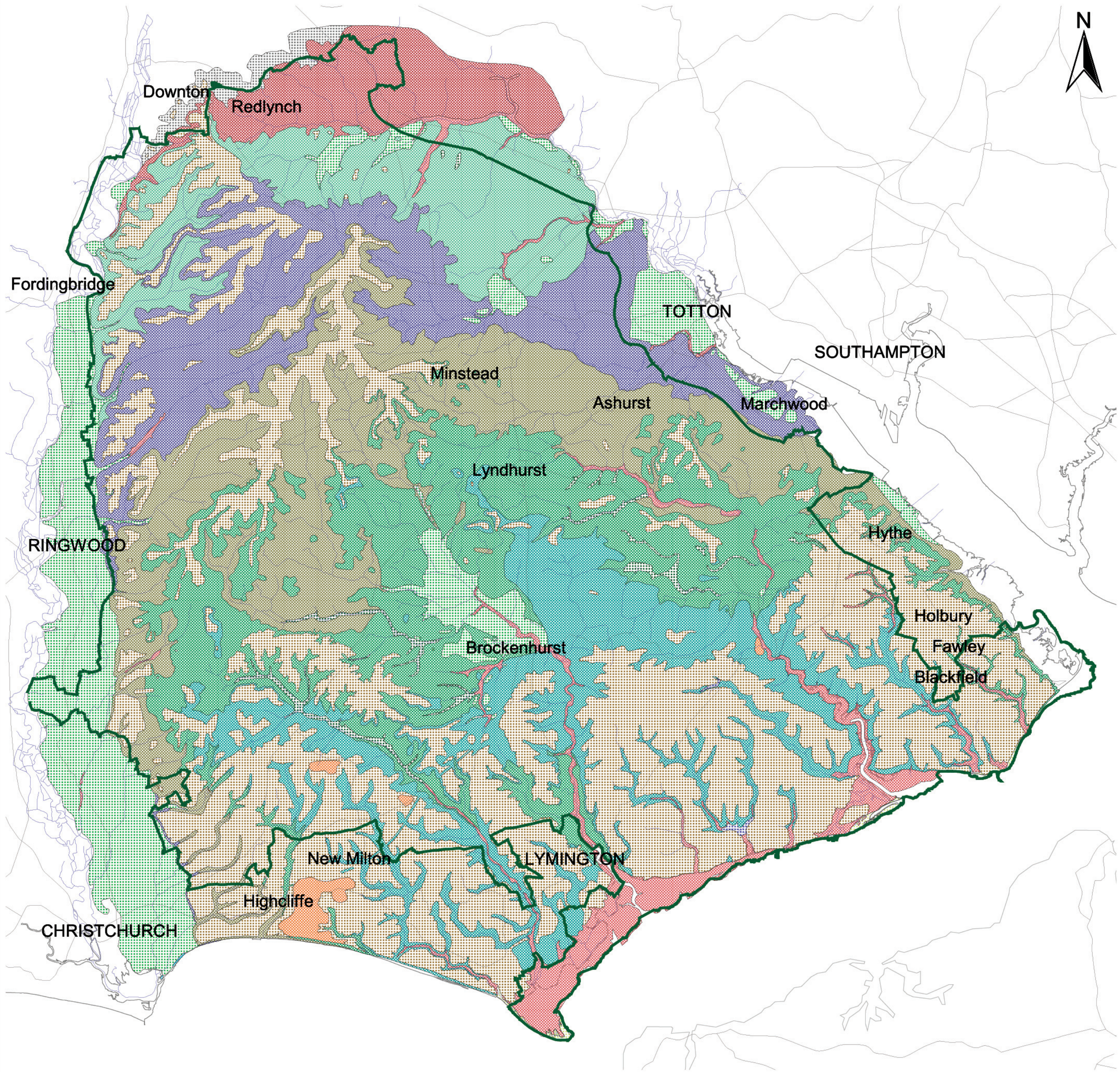

Figure 4

Geology

New Forest Life
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Legend

Description
- Alluvium
- Bagshot Beds
- Barton Clay
- Barton Sands
- Blown Sand
- Bracklesham Beds
- Brickearth
- Headon Beds
- London Clay
- Peat
- Plateau Gravel
- Pond
- Reading Beds
- Shingle
- Valley Gravel

New Forest National Park

Produced by: Date: 07 February 2006

Scale: 1:130,000 Source: G:\Data\Life 3\FinalReportMapping

Table 3-4: Geological Characteristics

Period	Epoch*	Drift & Solid Geology	Key Characteristics	Avon Water	Lymington	Beaulieu	Bartley	Cadnam	Hampshire Avon Tributaries
Quaternary	Recent 25,000 year BP	Shingle	Found along coastal fringes of Lymington catchment including Hurst		✓				
		Alluvium	Found lining modern day river floodplains and valleys	✓	✓	✓	✓	✓	✓
		Peat		✓	✓	✓			
	Pleistocene 1 million years BP	Valley Gravel	Flinty in character with a complex mix of gravel, sand and clay.		✓		✓	✓	✓
		Brickearth	Unstratified mixture of fine-grained quartz sand or flint. Laid down as flood deposits along younger river terraces and may have a partially aeolian (windblown) origin	✓					
		Plateau Gravel	Composed almost exclusively of flint with some pebbles of sarsen (silicified sandstone) laid down on old river terraces	✓	✓	✓	✓	✓	✓
Tertiary	Oliogene 40 million year BP	Headon Beds	Healdon formations deposited in freshwater lagoon comprising shelly clays, silts and sands Lyndhurst member deposited in brackish or marine conditions and comprises more sandy sediments. Upper Headon formation is shelly sand.	✓	✓	✓			
	Eocene 60 million years	Barton Sands	Sands of marine origin	✓	✓	✓	✓		✓
		Barton Clay	Clay deposit laid down in deep water. Marks start of Barton group		✓	✓	✓	✓	
		Bracklesham Beds	Fossil rich deposits laid down in warm, marine and freshwater conditions.				✓	✓	✓
		Bagshot Beds	Sandy beds of coarse, porous material					✓	✓

Table 3-5:Sites of Geological or Physiographic Interest

River Basin	Site of Special Geological or Physiographic Interest	Key Features of Interest
Hampshire Avon Tributaries	Studley Wood SU 227 158	Prolific Tertiary locality exposing the only complete exposure of the silty Huntingbridge Formation of the Bracklesham Group, remarkable for its molluscan fauna and the number of species limited to the formation. Numerous corals, scaphoda, bivalves and gastropods make it an outstanding Eocene locality of great interest in studies of Tertiary stratigraphy and palaeontology.
Hampshire Avon Tributaries	Cranes Moor SU 247 069	A large mire complex set in a shallow basin containing significant peat accumulations dating back to Devensian late glacial times. A key reference site for palynological and palaeoecological studies in southern England. Also unusual for the apparently rapid accumulations of peat in the Boreal Period and is thus important for the study of early immigration and expansion of flora in post-glacial times.
Hampshire Avon Tributaries	Wood Green Gravel Pit SU 172 170	The pit exposes gravel, deposited by the River Avon, rich in palaeolithic artefacts. Palaeolithic assemblages provide major evidence for the subdivision of the terrace sequence in the Solent Basin, where they are particularly important owing to a dearth of palaeontolgical sites. The site also has significant potential to elucidate the complex history of the River Avon gravels and the evolution of The Solent River.
Cadnam	Shepherd's Gutter SU 263 153	Locality renowned for its rich Tertiary marine faunas, known to geologists since the mid 19th C. Shows a section through the Selsey Formation of the Bracklesham Group, of Middle Eocene age, and includes several mollusc-rich horizons and one kind of Nummulites correlatable with the Isle of Wight and Bracklesham sections. A key locality for showing correlations between classic Eocene localities of the Hampshire Basin, and for its prolific molluscan faunas.
Lymington	Park Hill Inclosure SU 316 059	Only exposure in England outside the Isle of Wight to show upper middle Headon Beds. The occurrence of Cerithidea ventricosa and other mollusca in the Headon clays allows correlation with the type of sections of the Isle of Wight. The fauna of well-preserved shells and fish remains makes this one of the richest Tertiary faunal localities on the mainland. Also an important site for its palaeontology and for correlations within the Tertiary Hampshire Basin.
Lymington	Mark Ash Wood SU 247 069	A valley mire complex of considerable importance for palynological and palaeoecological studies. Peat growth at the site dates from the early part of the Devensian late-glacial to the sub-Atlantic Period. Also contains older post-glacial peats in the New Forest and is exceptional for high accumulation rates during late-glacial times. Macrofossil and pollen analyses have yielded some of early British post-glacial records of bryophytes. Site also important for tracing early post-glacial immigration and expansion of flora in post-glacial times.
Lymington	Highland Water SU 272 073 SU 239 123	Unique area demonstrating a combination of low management and low human impact on fluvial processes. The hydrological and fluvial characteristics of Highland Water are typical of those that formerly occurred in much of southern England. The site provides valuable opportunity to study both the role and influence of vegetation in hydrological and fluvial processes as well as the effect of debris dams.

3.3.2 Geomorphology

The New Forest can be viewed as a plateau dipping gently from north to south. The steeper western escarpment is flanked by the broad Avon Valley while the lower valley of the River Test and Southampton Water provide a boundary to the to east. The gently sloping southern flank is bounded by the Solent. The smaller tributaries and streams draining the Forest have eroded down through the plateau to create gently sloping valleys between flat-topped hills giving rise to an undulating topography **(Figure 5)**. The highest point in the Forest is around 125m OD to the north of the Forest along the watershed between basin of the Cadnam and Hampshire Avon Tributaries.

The main Forest watershed runs approximately north to south and separates the Hampshire Avon tributaries from the other five main river basins. The Blackwater and Cadnam Rivers drain east into the lower end of the River Test and Southampton Water respectively. The Lymington, Avon Water and Beaulieu all drain in a southeasterly direction to the Solent.

The Hampshire Avon tributaries have cut deeply incised U-shaped valleys, which are separated by long, narrow, gravel-capped ridges. Their short, steep profiles have evolved in response to recurrent down cutting by the River Avon whose course has remained reasonably stable through recent geological history.

In contrast, the drainage networks east of the main watershed seem to have evolved in response to a retreating river or shoreline. The Cadnam, Bartley and Lymington rivers all have their sources close to the watershed in the north east of the forest around the 90m OD. The Beaulieu rivers rises at a lower level (46m OD) toward the middle of the Forest at Lyndhurst while the Avon Water rises to the south of Burley (50m OD).

3.3.3 Soils

The soils of the New Forest have been mapped by the Soil Survey of England and Wales at 1:250,000 scale and are described in Bulletin No. 15 Soils and their use in South-East England. Ten different soil associations can be found across the river basins as summarised in Table 3-6. More detailed soil surveys have been carried out for the Inclosures (Pyatt 1964) as shown in **Figure 6.**

The majority of soils are seasonally waterlogged as indicated by the soil wetness class. However, drainage in many parts of the Forest has improved the drainage characteristics. The humose, waterlogged surfaces of the many soils are highly susceptible to poaching and structural damage during the winter months.

Table 3-6:Soil Characteristics

Soil Association	Characteristics	Soil Wetness Class	Avon Water	Lymington River	Beaulieu River	Bartley Water	Cadnam River	Hampshire Avon Tributaries
Wickam 3 (711g) (42m OD)	Typical stagnogley soil. Fine loamy or fine silty drift over clayey passing to slowly permeable clay or mudstone. During heavy winter rain excess water is disposed of by lateral flow. In New Forest soils often have thin humose surface horizons and poach easily Waterlogged for long periods during winter but moderately droughty during summer	III or IV	✓	✓	✓	✓	✓	✓
Bolderwood (643c) (On ridges above 43m OD)	Very acid Stagnogley-podzols. Occur where river terrace drift and Plateau Gravel cover Tertiary clays, loams and sands. Coarse loamy, flinty, horizons over clayey stoneless drift. Subsoil pans and other slowly permeable layers impede vertical water movement causing seasonal waterlogging. Excess winter rain is absorbed slowly and ponds on surface but there is little run-off. Surfaces are wet and muddy in winter and humose or peaty topsoils are slippery and vulnerable to erosion.	III or IV	✓	✓	✓			✓
Holidays Hill (643a) 25m OD	Stagnogley-podzols with permeable sandy surface horizons passing to loamy and slowly permeable layers below. Wet at the surface for long periods in winter with thin humose or peaty surface horizons developing under heathland. At risk of poaching & compaction in winter.	IV		✓	✓		✓	✓
Shirrell Heath 1 (631c) 95m OD	Very acid, sandy-humo-ferric podzols. Permeable and well drained and droughty in summer	I						✓
Southampton (634) 47m OD	Palao-argillic podzol with very stoney, very acid, sandy soils	-						✓
Bursledon (572j) 40m OD	Stagnogleyic argillic brown earths with fine loamy horizons passing to clay and sand. Seasonally waterlogged	III or IV		✓				✓
Hurst (841b) 20mOD	Typical argillic gley soils with coarse loamy horizons over non-calcareous gravelly deposits, developed in river terrace gravels. Waterlogged by ground water for much of the winter with short periods of winter flooding. Can be droughty in summer.	III or IV		✓	✓		✓	✓
Shabbington (841d)	Argillic gleys developed in loamy drift which vary in stoniness and commonly rest on bedded sandy or gravelly material at depth. Found in river terrace drift. Tend to be affected by high water levels and are seasonally waterlogged.	III or IV	✓					
Isleham 1 (861a) (121m OD)	Typical humic-sandy gley soils developed in permeable, sandy, sometimes stoney drift found in valley bottoms and depressions. Perennially waterlogged and support much boggy vegetation.	V						✓
Efford (571s)	Argillic brown earths with well drained brown fine loamy soils associated with river or marine terraces where drift overlies non-calcareous gravel.	I	✓	✓	✓			✓

(Source: Jarvis et al 1984)

* F0r description of Soil Wetnes Class refer to Appendix K

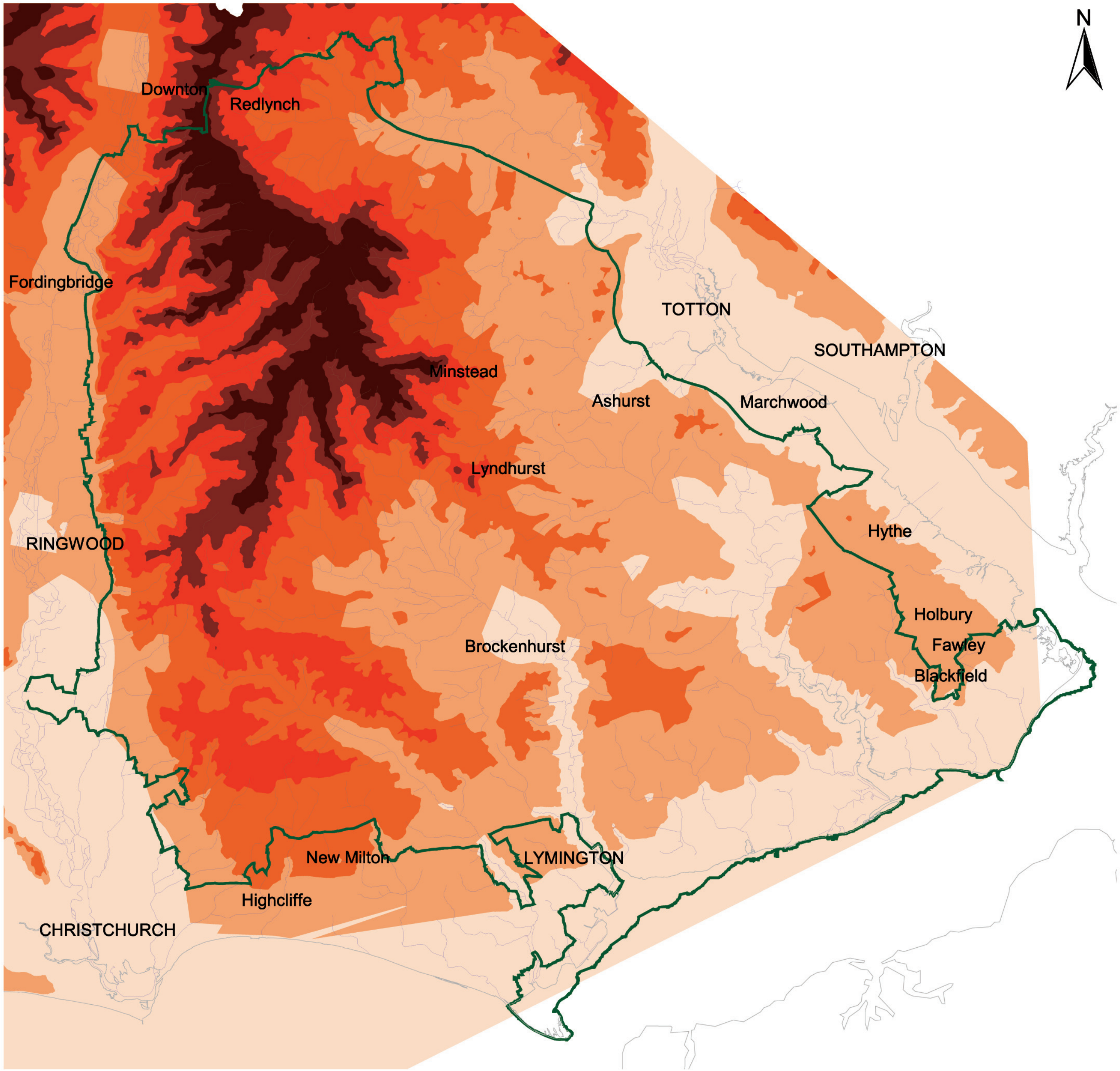

Figure 5

Topography and Relief

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Legend

Elevation (m)
Elevation Range
- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- 100 - 120

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Note: Elevation not determined outside New Forest River basins

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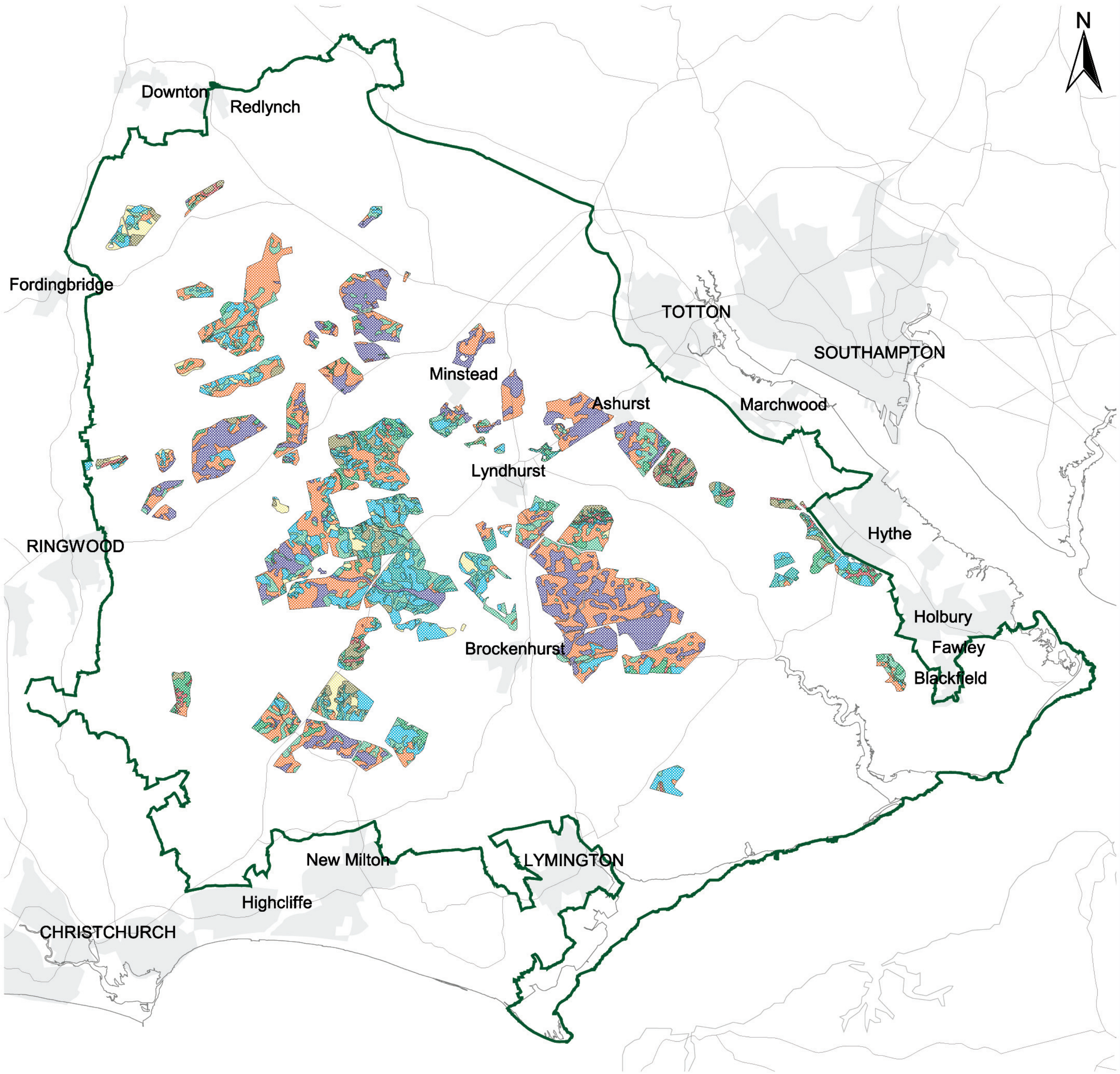
Figure 6

Soil Types within Inclosures



Legend

Soil type

- Freely-drained sand
- Sand or loam mottled throughout
- Sands or gravels freely drained throughout
- Sands or gravels impeded in B and C horizons
- Slightly imperfectly drained sandy loam
- Straight clay
- Two storied soil (clay overlain by up to 20in. of gravel sand or loam).
- Very poorly drained light textured soils
- Very poorly drained light textured soils with fibrous peat
- Very poorly drained soils with alluvial topsoil

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Scale: 1:130,000	Source: G:\Data\Life 3\FinalReportMapping

3.3.4 Geological, Geomorphological & Soil Issues

a) Susceptibility of the soil to damage

In certain areas of the Forest, the waterlogged nature of some of the soils makes them susceptible to structural damage (compaction and erosion) when working with machinery. It is often not feasible to work with heavy machinery on soils during the late autumn, winter and early spring months (unless the ground is likely to be frozen for an appropriate length of time) which significantly limits the time period available to carry out certain restoration works. Even in summer, heavy rainfall events have resulted in machinery standing idle to prevent undue damage to the soil structure which can add to the final project costs.

These limitations require careful planning of the timing of the works and an appreciation that periods of poor weather can result in increased project costs.

Further Reading

Institute of Geological Sciences. Lymington Sheet 330 1:50 000 Series
Bournemouth Sheet 329
Ringwood Sheet 314

Jarvis M.G., Allen R.H., Fordham S.J., Hazelden J., Moffat A.J. & Sturdy R.G. (1984). **Soils and their Use in South East England**, Harpenden 1984

Melville R.V. & Freshney E.C. (1982) **British Regional Geology – The Hampshire Basin and adjoining areas**. Institute of Geological Sciences

Soil Survey of England & Wales, Soils of England and Wales - Sheet 6 South East England Scale 1:250,000

3.4 HYDROLOGY & DRAINAGE

3.4.1 Introduction

The six main river basins are drained by a complex network of rivers, streams and drains as shown in Figure 7 and Table 3-7. Although many have different local names, for the purposes of this Plan they are referred to by the names cited on the New Forest 1:25,000 Ordnance Survey map.

A significant amount of data exists for the Lymington Catchment as this has been studied for many years by Southampton University and has been subject to specialist studies for the Life 3 Project . However, the majority of watercourses within the New Forest are not classified as Main River and data is limited for many of the streams. The locations of Monitoring and Gauging Stations are also shown in Figure 7.

Since the 1870's, well over half the total length of main streams and first order tributaries have been modified to some extent by drainage schemes to improve areas for forestry or grazing. For example, 78% of surveyed channel in the Black Water and 44% along the Highland Water have been modified in the past. Even so, the rivers and stream still represent an excellent example of a relatively undisturbed lowland river system.

3.4.2 The River Basins

Lymington River Basin

The Lymington River Basin is the largest basin (127km2) in the New Forest and comprises a dense network of steams and tributaries draining a highly wooded catchment. The highest tributaries (Highland Water & Bratley Water) rise at 100- 110m OD around Ocknell Inclosure just to the north of the A31. Highland Water is joined by Bagshot Gutter at SU263 084 before continuing south east via Millyford Bridge and the A35 (SU 276066) to join the main River Lymington at Bolderford Bridge (SU291041)

Bratley Water rises at 98m OD from spring lines around the valley occupied by Slufters Inclosure, to the north of the A31. It flows south through North Oakley Inclosure where it becomes the Blackensford Brook (SU237066) and on through Anderwood Inclosure to meet the Black Water just upstream from Dog Kennel Bridge (SU 241052).

The small network of tributaries feeding the Warwickslade Cutting rise around 75-55mOD in the area of Mark Ash Wood, Wooson's Hill Inclosure and Holidays Hill Inclosure to the north of Bolderwood Arboretum Ornamental Drive. The Warwickslade Cutting joins Highland Water at SU282051.

The Black Water rises around 68m OD to the outside edge of South Oakley Inclosure and flows south-east via Dog Kennel Bridge and Dames Slough Inclosure to pass under the A35 at Blackwater Bridge (SU244047) and Rhinefield Ornamental Drive before flowing through a long, straightened reach known as Fletchers Water. Fletchers Water joins Highland Water at SU 287044

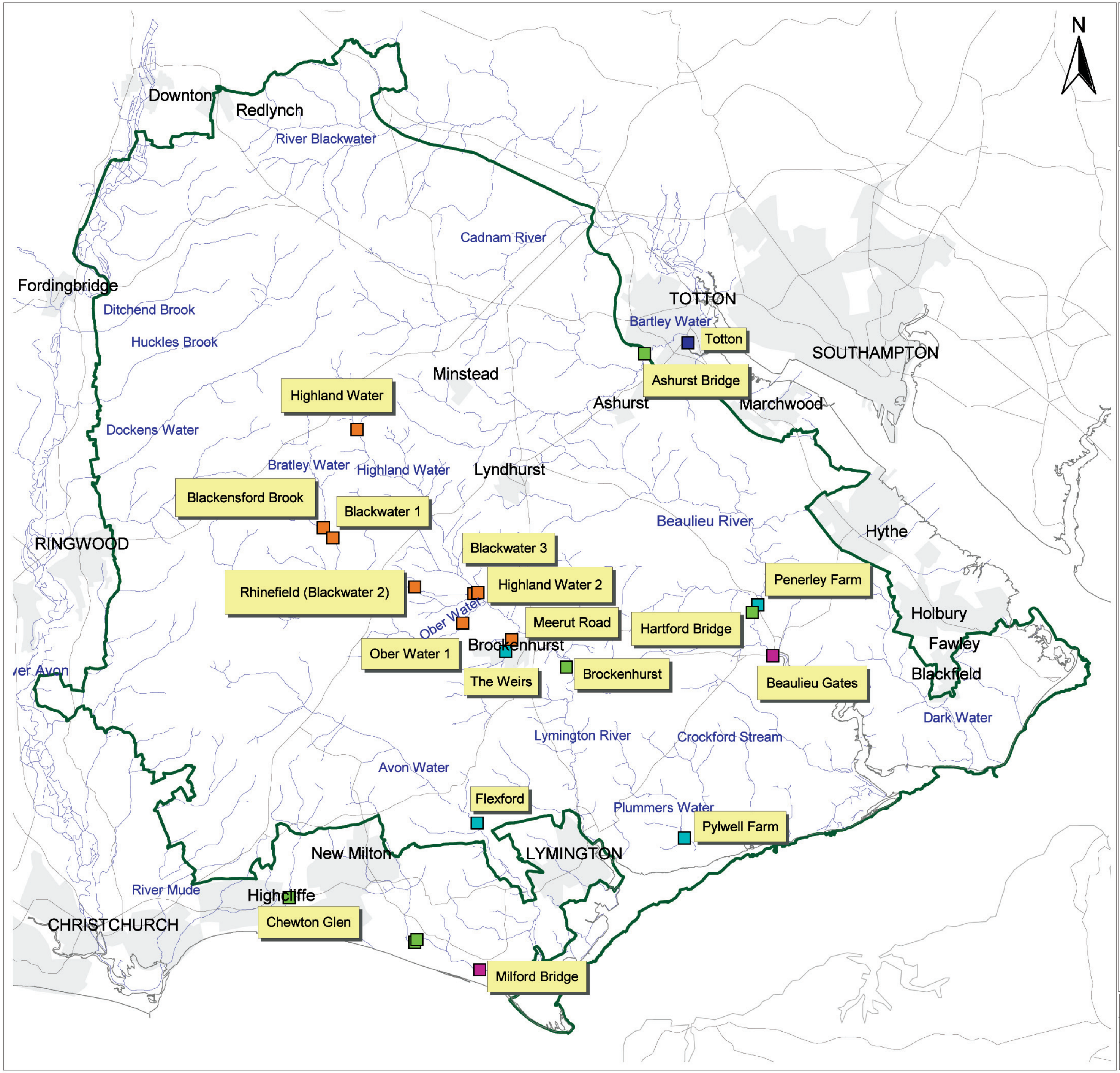

Figure 7
Watercourses and Gauging Stations

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Legend

Monitoring stations
- Flow
- Gauging
- Level
- Level and gauging
- Tidal

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Mill Lawn Brook rises at 90m OD from Ridley Bottom just to the south of the A31. It is fed by additional tributaries rising from Harvest Slade Bottom before flowing through Burley and then eastward via Markway Bridge (SU 250039) and Puttles Bridge (SU278 028) where it becomes known as Ober Water. The Silver Stream draining Redhill Bog also enters Ober Water at Puttles Bridge. The Ober Water continues to flow eastwards to the north of Brockenhurst where it joins the Lymington River at Bolderford Bridge (SU 291 041). The Weir Stream rises from White Moor at SU275019 and flows eastwards through Brockenhurst before entering the Lymington River at SU 304031.

From Bolderford Bridge the Lymington River is classified as main river . It continues to meander southwards through woods and agricultural land before passing to the east side of Lymington where it enters the sea. The normal tidal limit extends to Walhampton (SZ329963). Tidal flaps control the flow at its outfall.

Beaulieu River

The Beaulieu River has its source at Pikeshill on the north side of Lyndhurst rising at 55m OD. It flows south-eastwards draining predominately open heath and woodland except where it flows through the agricultural land holdings of Decoy Pond Farm and Ipley Manor. The river leaves the perambulation at North Gate (SU384047) from where it meanders southwards through fields and woodland before reaching its tidal limits at Beaulieu (SU 387 024) where tidal flaps control the flow. It then follows a long tidal estuary for approximately 8km to reach the sea.

Shepton Water rises at 14mOD at Penny Moor and flows eastwards via Shepton Bridge to join the main river at North Lane (SU 384044). Worts Gutter rises at 41m OD at the edge of Stockley Inclosure and flows eastward where it becomes the much straightened Penerley Water. The Shepton Water and Penerley Water converge at SU 375046.

A number of shorter un-named tributaries also join the Beaulieu throughout its length.

Bartley Water

Bartley Water is one of the smallest river basins. It is fed by two main tributaries – The Mill Steam and Fleet Water. The Millstream rises at 99m OD in Ringwood Ford Bottom and drains south-eastwards via Leominstead Pond before turning north east to converge with Bartley Water at SU305105. Fleet Water rises near Stoney Cross at around 109M OD and flows south-eastwards through wooded and agricultural areas before passing through Mill Pond and converging with the Mill Steam at SU 298102.

Outside the New Forest perambulation the Bartley Water is joined by a series of un-named tributaries which drain a large part of its catchment south of the M27. This part of the catchment is semi - rural interspersed with fields and settlements. The Bartley Water passes through the National Park Boundary to flow through Totton and enter the sea at the upper end of Southampton Waterr.

2 Main river classification mean that the Environment Agency has permissive powers to maintain the drainage capacity of the channel and may also carry out works to limit the risk of flood from the river subject to technical, environmental and economic feasibility and to the availability of funding.

Cadnam

The Cadnam is another small river basin draining the north-eastern corner of the Forest. The Cadnam River rises to the north-east of Minstead around 55m OD and drains north and north eastwards via a dammed lake at Paultons Park and Ower Bridge (SU 326167) to join the River Blackwater at SU 338171.

Avon Water

The Avon Water basin is a small basin draining the south-west edge of the Forest. It rises within the southern confines of Burley and flows eastwards where it drains Holmsley Bog. The river continues its journey following the edge of Wootton Coppice Inclosure and Broadley Inclosure where it appears to have been significantly straightened before passing the perambulation boundary at SZ 266984. From this point it flows through farmland via Sway Lakes and passes to the western side of Lymington before entering the Solent at Keyhaven. Tidal Flaps control its outfall to the sea.

Hampshire Avon Tributaries

The Hampshire Avon tributaries draining the Forest comprise a south-eastern sub-basin of the main Hampshire Avon. The tributaries comprise a series of small streams draining the western side of the Forest.

The most northerly stream is un-named but drains Deadman Bottom, Millerford Bottom and Hale Purlieu.

Black Gutter rises around 108m OD. Where the stream bends southwards at Stone Quarry Bottom it becomes the Ditchend Brook. It enters the River Avon at SU 148134.

The Latchmoor Brook rises at 115m OD at Picket Corner and flows south westwards through Islands Thorns Inclosure, Amberwood Inclosure and Alderhill Inclosure before entering the Open Forest. Around Ogdens the stream is known as the Huckles Brook where it flows through farmland before entering the River Avon at SU149106

The Dockens Water rises around Fritham at 115m OD and flows south westwards through the Open Forest passing close to the northern edge of Holly Hatch Inclosure, Broomy Inclosure and Linwood. After passing through the National Park Boundary it flows between gravel pits and Blashford Lakes Nature Reserve before joining the River Avon at SU 144064. Hampshire Wildlife Trust has carried out some restoration work on the Dockens Water where it flows through Blashford Lakes Nature Reserve.

Linford Brook rises at 94m OD and flows through Milkham Inclosure, Roe Inclosure, Greenford Bottom and Linford Bottom. After the perambulation boundary it passes through farmland and between gravel pits to the north of Ringwood before entering the River Avon at SU147058.

Smaller un-named tributaries drain Foulford Bottom and Cranesmoor to the south of the A31.

Table 3-7: Principal Watercourses & Tributaries

Principal Watercourse	Length (km)	Named Tributaries	Guaging/Monitoring Stations
Avon Water	18.5		✓ (Flexford)
Lymington River	15.0	Bagshot Gutter	
		Warwickslade Cutting	
		Longbrook	
		Highland Water	✓ (Highland Water 1 & 2, Brockenhurst
		Bratley Water	
		Blackensford Brook	✓ (Blackensford Brook, Blackwater 1)
		Blackwater	✓ (Blackwater 2)
		Fletchers Water	✓ (Blackwater 3)
		Silver Stream	
		Mill Lawn Brook	
		Ober Water	✓ (Ober Water 1)
		Etherise Gutter	
		Passford Water	
Beaulieu River	26.0	Worts Gutter	Hartford Bridge (ultrasonic)
		Shepton Water	Beaulieu Gates
		Penerley Water	Penerley Farm
Bartley Water	12	Millstream	Ashurst Bridge
		Fleet Water	Totton (Tidal)
Cadham River	-		
Hampshire Avon		Millersford Bottom	
		Black Gutter	
		Ditchend Brook	
		Latchmoor Brook	
		Huckles Brook	
		Dockens Water	✓ (Dockens Water)
		Linford Brook	

3.4.3 Channel & Floodplain geomorphology

Channel and floodplain form is a result of the processes of erosion, deposition and sediment transport over time. The processes are naturally constrained by the geology and topography of the catchment and the way in which the river responds to changes in climate and hydrology.

The natural form of many New Forest streams is a sinuous meandering channel of variable width and depth that is laterally, relatively stable and contains pools, riffles and debris dams (except in flood). However, a number of streams throughout the Forest catchments have been modified by straightening, deepening and removal of debris dams.

The gradient of most of the streams is relatively low ranging from 1% - 0.6%. The majority of channels are less than 5m wide with shallow flows. Channels wider than 7m and more than 1m deep are limited to the lowest reaches of the Lymington & Beaulieu rivers. The streams with the steepest gradients are generally the Hampshire Avon tributaries which drain down from the highest areas of the Forest. Debris dams (discussed further in section 3.4.7) can have a significant influence on channel width resulting in a greater variation in widths than might be found on a non-forested stream.

Distinct areas of floodplain border the natural channels of the Forest streams and display a typical range of floodplain features such as

- ephemeral channels - (sinuous , linear scour features around 50cm wide and 5-50cm deep)
- pools and hollows
- wake deposits - material deposited behind obstacles such as trees, tussocks and woody debris
- abandoned channels – old river channels left one part of the floodplain when the river moved laterally elsewhere
- woody debris, trees & vegetation
- shallow man made drainage channel lawns

Even where the channels have been over deepened and flooding is less frequent remnant features can often be discerned.

3.4.4 Flow

The New Forest streams are fed by a combination of mires, bogs and surface water run off and through flow. Many of the streams typically have a mean daily flow rate of less than 0.5 m3s-1 during dry weather (Langford, 1996) and flows can be considerable lower during periods of summer drought. Flows measured at the gauging stations on the Dockens Water and the Lymington River are shown in Table 3-8 which give values for two contrasting streams. Further flow data for the Hampshire Avon Tributaries is given in Appendix D. The rivers and streams are characterised by their flashy nature and can rise rapidly in response to heavy or prolonged rainfall as shown in the hydrographs for the Lymington River and Dockens Water (Figure 8 & 9). Flood peaks tend to pass through quickly and during out of bank events the total magnitude of the flow cannot always be recorded.

During the summer months those streams fed by well developed seepage steps or mires continue to flow although at a much reduced level with only a few centimetres depth of water. However a number of streams, particularly the Hampshire Avon Tributaries are seasonally dry or reduced to a series of small pools separated by dry gravel bars or small trickles under the surface gravel (Plate I). Often only the deeper pools scoured out behind debris dams or on the inside of meanders contain any water.

Figure 8
Sample Hydrograph of Gauged Daily Flows of Lymington River at Brockenhurst

Max. and min. daily mean flows from 1960 to 2003 excluding those for the featured year (2003; mean flow: 1.09 m^3s^{-1})

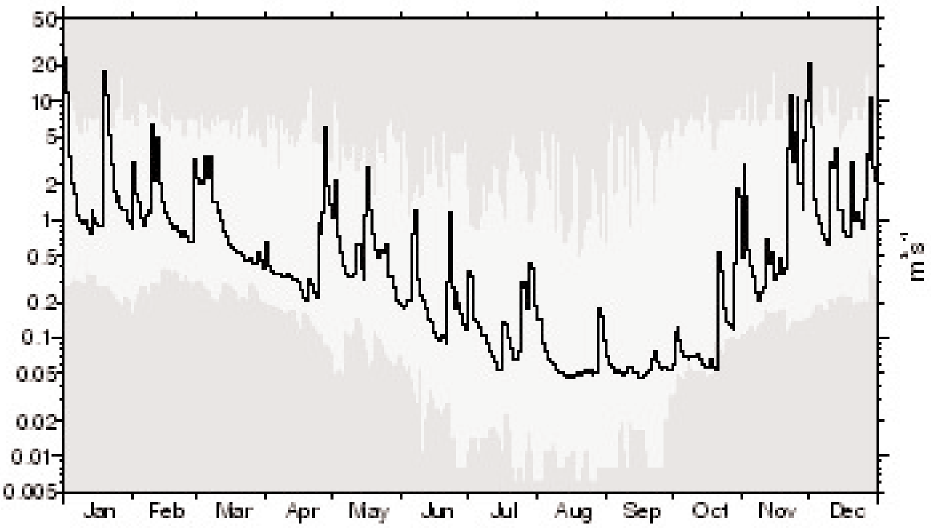
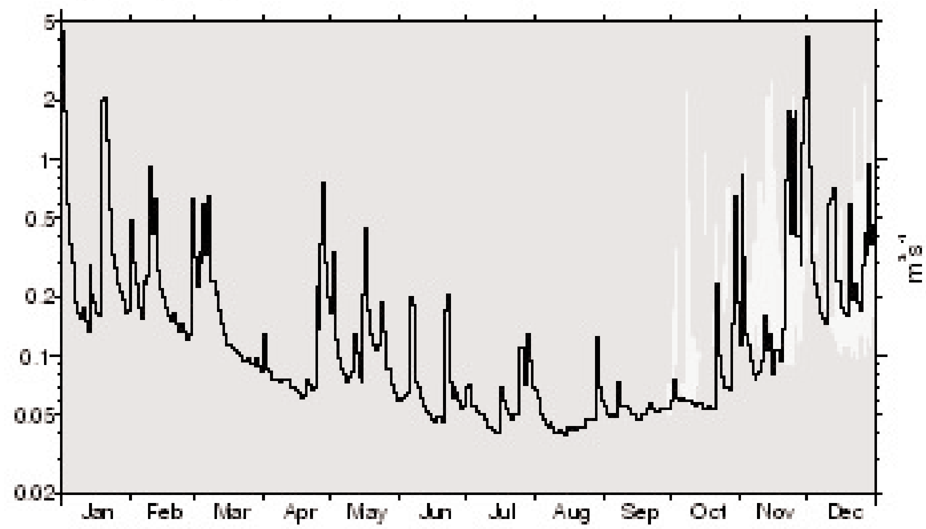


Figure 9
Sample Hydrograph of Gauged Daily Flows – Dockens Water at Moyles Court

Max. and min. daily mean flows from 2001 to 2003 excluding those for the featured year (2003; mean flow: 0.22 m^3s^{-1})



Source: Centre of Ecology & Hydrology