

Natural England Commissioned Report NECR141

# New Forest SSSI Ecohydrological Survey Overview

Annex W: Denny Bog and Penny Moor

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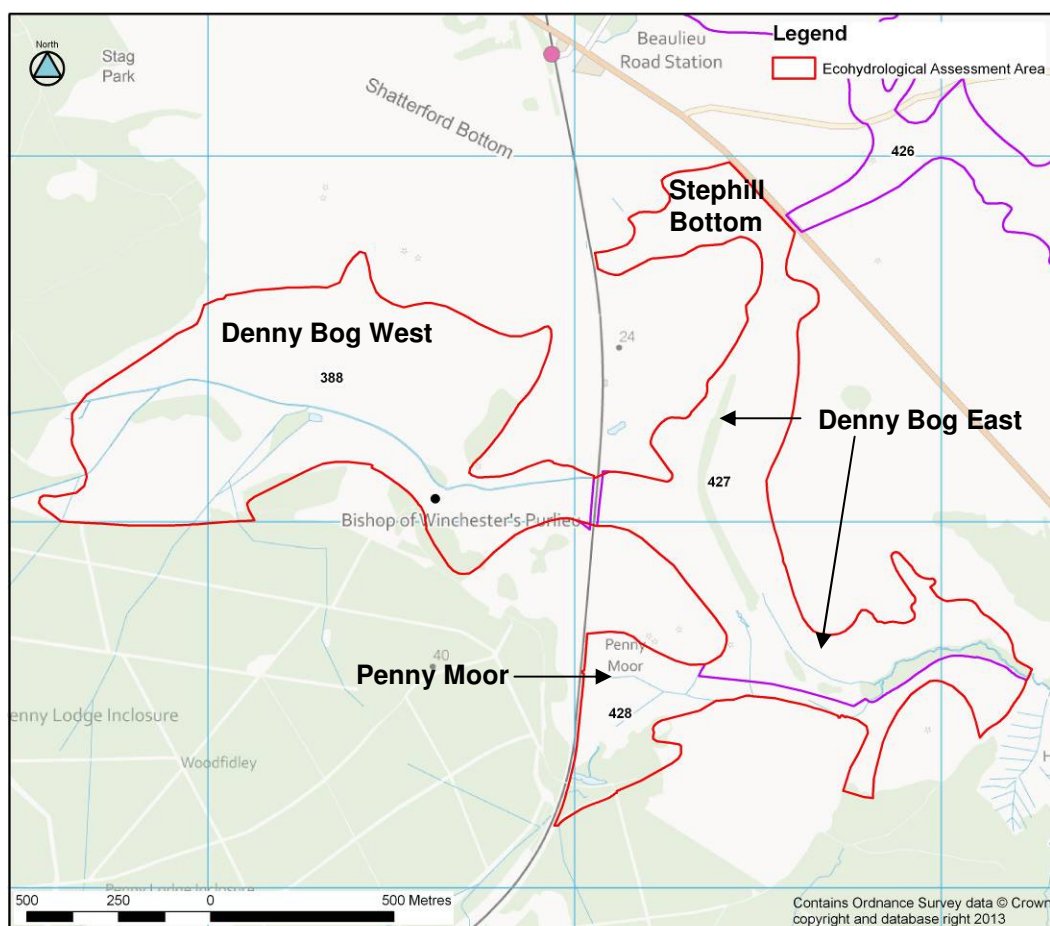
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# 1 Denny Bog and Penny Moor

## 1.1 Introduction

This Ecohydrological Assessment Area (EcoHAA) covers 137.6 ha and is contained within SSSI Units 388, 427 and 428 with its centre at National Grid Reference (NGR) 434914 105074 (see Figure 1-1). In Figure 1-1, individual unit boundaries are shown in purple where they do not coincide with the EcoHAA boundary, which is shown in red. Note that Unit 426 in the northeast is not part of the EcoHAA.

**Figure 1-1: Location Map**



The site includes Denny Bog (divided into western and eastern parts by a railway line and associated embankment), Penny Moor and Stephill Bottom. Denny Bog includes valley mires and areas of marsh or marshy grassland. Penny Moor contains marsh or marshy grassland. Stephill Bottom contains a valley mire.

The wetlands are generally seepage-dominated, being fed by groundwater seepage from Quaternary river terrace sand/gravel deposits and also from the underlying Tertiary sands (Becton Sand and Chama Sand Formations). Denny Bog and Penny Moor have been subject to extensive drainage and are dissected by a network of open ditches. Drainage and grazing have locally led to the replacement of valley mire by "lawn" (marshy grassland). The surface water drainage network in the eastern part of Denny Bog has undergone headward erosion, and this has been addressed by restoration measures. Footpath erosion is an issue locally. The valley mire in Stephill Bottom has not been subjected to artificial drainage.

**Table 1-1: Ecohydrological Assessment Area Summary Table**

<b>Eco-hydrological Assessment Area</b>		<b>X</b>
Name		Denny Bog
Relative Geomorphology Assessment		
Size (ha)		137.6
SSSI Units		428, 427 and 388
Valley Side Wetland	Present	Y
	Wetland Type	Seepage Dominated
	Main Source of water	Denny Bog: seepage from the base of Quaternary river terrace sand/gravel deposits and also from the underlying Becton Sand Formation.  Stephill Bottom: seepage from the base of Quaternary river terrace sand/gravel deposits and also from the underlying Becton Sand and Chama Sand Formations.
	Indicative NVC communities	W4b, M25a, M21a, M16
	Wetland Types	Mire, Wet Grassland, Wet Heath, Wet Woodland
	Drainage Damage	N
	Scrub/Tree Encroachment Damage	Y - localised Scots Pine encroachment (Minor)
	Poaching and Grazing Pressures Damage	Y (Minor)
Valley Basin Wetland	Present	Y
	Wetland Type	Seepage Dominated
	Main Source of water	Denny Bog and Penny Moor: mainly seepage from the Becton Sand Formation (via permeable alluvium).  Stephill Bottom: seepage from Quaternary sand/gravel deposits and also from the underlying bedrock (Becton Sand and Chama Sand Formations).
	Indicative NVC communities	W4b, M25a, M21a, M16, M24, M29
	Wetland Types	Mire, Wet Grassland, Wet Heath, Wet Woodland
	Drainage	Y - drains in valley bottoms (Major); Headward erosion of watercourse in Denny Bog East (Moderate?) could not be observed during the site visit because of high water levels. It is understood that restoration works have been undertaken.
	Scrub/Tree Encroachment Damage	Y - localised Scots Pine encroachment (Minor)
Poaching and Grazing Pressures	Y - grazing pressures and associated drainage, particularly in Denny Bog West and around the railway, have produced large wet lawn areas (Moderate).	
Additional Comments		Bishop's Dyke surrounds the site. This embankment is typically some 1.5 m high and has a ditch on either side. The embankment acts as a partial barrier to surface runoff (there are gaps in the embankment), with water ponding on the uphill side. Drains entering the southern edge of Denny Bog West pass over the Headon Formation and are likely to bring in base-rich water. Footpath erosion is an issue locally (Minor).

It should be noted that although this is a standalone report, it is strongly reliant upon the background information provided in section 3 of the JBA (2013) Ecohydrology Survey Overview report, which provides general geology, ecology, hydrogeology, wetland mechanisms and restoration information for the New Forest wetlands surveyed. At the end of the report is a series of maps which support the assessment and indicate the spatial distribution of the features described.

## 1.2 Topography and Wetland Distribution

Denny Bog and Penny Moor lie within a valley system that drains eastwards and south-eastwards to Shepton Water. The valley system is divided into two parts by a railway line and associated railway embankment. There are a range of wetland types, including valley side mire, valley bottom mire and marsh (or marshy grassland). Stephill Bottom, on the northern edge of the area, is a north-eastward draining valley mire.

Denny Bog and Penny Moor are surrounded by a historical earthwork/embankment known as Bishop's Dyke. It is generally about 1.5 m high, with a small ditch on either side. Where the material making up the embankment is exposed it is seen to consist of brown soil (locally peaty) and orange/brown fine sand, both containing scattered flint gravel. There are gaps in the embankment that allow surface runoff through into the bog, although water does pond up-slope of the embankment in places. In general, the embankment is not likely to represent much of a barrier to water movement, partly because of the gaps and partly because of the relatively permeable nature of the embankment material.

Artificial drainage ditches are common within, and adjacent to, Denny Bog and Penny Moor. In the part of Denny Bog to the west of the railway line, drainage and grazing have produced extensive "lawn" areas. Stephill Bottom does not contain artificial drainage.

It is understood that headward erosion has taken place in the watercourses draining Denny Bog East<sup>1</sup>. The affected area is located some 500 m east of the railway line, close to the point where the footpath shown in Figure 1-5 crosses the bog (435488 104758)<sup>1</sup>. High water levels meant that the erosion could not be observed at the time of the site visit. However, it is understood that some restoration work has previously been undertaken here using heather bales<sup>1</sup>.

**Figure 1-2: View of Shepton Water at Pigbush Passage (Ford), the point of outflow from Denny Bog East (NGR 436239 104570, view looking north-eastwards; flow from left to right)**



<sup>1</sup> Allen, R. (2005) Soil and Water in the New Forest and the Valley Mires. [online] Available at <http://www.soilandwater.co.uk/index.php?id=33&click=0> [accessed 20th December 2012]

**Figure 1-3: Bishop's Dyke, a historical embankment surrounding Denny Bog and Penny Moor - view from near the eastern end of the site, looking westwards (NGR 436036 104725)**



**Figure 1-4: Cross-section through Bishop's Dyke embankment (NGR 434857 105322)**



**Figure 1-5: Footpath erosion on the lower slopes of Furzy Brow at the eastern edge of the EcoHAA (NGR 435584 104799, looking south-west towards the valley mire of Denny Bog East)**





**Figure 1-6: General view of the valley mire in Denny Bog East (NGR 435515 104773, looking northwest)**



**Figure 1-7: Marshy grassland - "lawn" - on Penny Moor (NGR 435289 104528, looking west)**



Figure 1-8: Valley mire in Stephill Bottom (NGR 435138 105681, looking east-northeast)



### 1.3 Ecology

The ecological aspect of this ecohydrological assessment is discussed in two parts: the area to the east of the railway (Denny Bog East and Stephill Bottom) and the area to the west (Denny Bog West).

#### *Denny Bog East, Penny Moor and Stephill Bottom*

The southern end of this area, including Denny Bog East and Penny Moor, has a watercourse running along the valley bottom. For the most part this is lined with Grey Willow *Salix cinerea*, Downy Birch *Betula pubescens*, Alder *Alnus glutinosa* and Oak *Quercus robur*. Adjacent to these areas are valley mire areas, with Deergass *Trichosporum germanicum*, White Beak-sedge *Rhynchospora alba*, Bog Myrtle *Myrica gale* and Purple Moor-grass *Molinia caerulea* (M21a). Patches of Bog Pondweed *Potamogeton polygonifolius* are present in small pools on the ground surface, with *Sphagnum* hummocks. Surrounding these central valley mires, Purple Moor-grass is by far the dominant species giving rise to a M25a community. Beyond this wet heath habitat is more prevalent, with Cross-leaved Heath *Erica tetralix*, Purple Moor-grass and some Heather *Calluna vulgaris*.

As discussed above, there is an embankment, named Bishop's Dyke on OS maps, set back 50 – 100m from the channel within this eastern side of the unit. The species on the bank are much more typical of dry heath conditions, including Heather and Bracken *Pteridium aquilinum* dominating (H2 habitats).

During the survey, a significant amount of water was pooled around the two footbridges located in the centre of the unit. The visit followed a period of heavy rain, and the pooling was potentially caused by the crossing points themselves, which may have acted as an impediment to water movement. A small stand of Common Sedge *Carex nigra* dominated swamp, which merges into the Purple Moor-grass dominated valley mire habitat, is present in this area. Around the south-westerly footbridge, the vegetation is heavily grazed and a closely-cropped wet grassland 'lawn' is present. A number of drains have been cut through this area.

Due to the high water levels during the survey, large pools of standing water were present in this area, and some channels could be seen flowing across the marshy grassland. Some slightly higher banks are also present in places indicating that the channels may have been deepened in the past.

At Stephill Bottom, valley mire habitat, in good condition, is present in the valley bottom, with significant thickets of Grey Willow dominated scrub, and some stands of Bog Myrtle. Very wet Deergrass and White Beak-sedge dominated mire (M21a) is also present in significant patches along with an area of dystrophic standing water, which had ponded adjacent to the road.

### *Denny Bog West*

To the west of the railway line, the unit had been significantly affected by drainage, with a large central drain and several other connecting side drains in the south and west of the unit. This had resulted in the creation of large, heavily grazed wet lawns over significant areas. Large areas of Grey Willow dominated scrub and woodland are also present in the unit, particularly along the main drain in the valley bottom.

To the north of the main drain, significant areas of valley mire habitat are present, both Purple Moor-grass dominated M25a habitat, which is relatively species poor, and a more species-rich M21a habitat with Deergrass, White Beak-sedge and a number of other species present.

Water had also ponded around the footbridge and boardwalk crossing at the western side of the unit, potentially exacerbated by the crossing point itself. Species including Bog Pondweed, Floating Sweet-grass *Glyceria fluitans*, Yellow Water-lily *Nuphar lutea* and some Soft Rush *Juncus effusus* tussocks were recorded during the survey. Due to the heavy rain preceding the survey, water levels were particularly high and surface water present over a wide area, particularly downstream of the footbridge, hindering access to some areas.

## 1.4 Geology and Hydrogeology

Table 1-2 shows the geology in the area.

**Table 1-2: Geology and Hydrogeology**

Age	Group	Formation - member	Description	Thickness	Hydro-geological Role	Water Resources
Quaternary		Alluvium	Sand and clayey sand with flint pebbles	Up to 10 m	Aquifer / Aquitard	Yields from alluvium and terrace gravels are often obtained from the adjacent rivers.
		River terrace deposits	CLAY, SILT, SAND and GRAVEL.		Aquifer / Aquitard - Spring lines may be present at the base of high level river terraces.	
Tertiary (Eocene)	Solent Group	Headon Formation and Headon Hill Formation	Greenish grey shelly CLAY with laminated SAND, SILT and CLAY.	Up to 49 m	Aquifer / Aquitard	Sandy strata may provide yields sufficient for domestic or small agricultural use.
	Barton Group	Becton Sand Formation	Yellow/buff fine- to very fine-grained well sorted SAND.	6 – 70 m	Aquifer - The most permeable and reliable aquifer within the Barton Group.	Yields up to 600 m <sup>3</sup> /d in the south; in the north they rarely exceed 200 m <sup>3</sup> /d.
	Barton Group	Chama Sand Formation	Greenish grey fine- to very fine-grained and rather clayey/silty SAND; slightly glauconitic. Also sandy CLAY.	6 – 15 m	Aquifer	May yield small supplies

A borehole at Woodfidley Passage in Denny Bog West (NGR 434620 105060) (available at <http://www.bgs.ac.uk/GeolIndex/>) describes the superficial deposits as "green grey sludgy clayey sand" and interprets them as alluvium and wash. Shallow hand augering undertaken in an area of mapped alluvium in the eastern part of Denny Bog (NGR 435442 104736) encountered the following succession with increasing depth:

0 - 0.1 m	Brown organic-rich sandy soil
0.1 - 0.2 m	Dark brown clayey sand with scattered pebbles/granules of flint
0.2 - 0.25 m	Brown fine-grained sand.

## 1.5 Water Supply Mechanisms

The wetlands on site are seepage-dominated, although flushes may be developed on slopes beneath stratigraphic boundaries with a strong permeability contrast, particularly the boundary between river terrace sands/gravels (higher permeability) and underlying Tertiary sands (lower permeability) (see Figure 1-9 and Figure 1-10).

In Stephill Bottom, the valley mire is fed by groundwater seepage from the base of river terrace sand/gravel deposits and also from the underlying bedrock (Becton Sand and Chama Sand Formations). On Denny Bog and Penny Moor, valley bottom wetlands are fed by diffuse groundwater seepage from the Becton Sand Formation via permeable alluvial deposits (sand and clayey sand). Valley side wetlands are fed by groundwater seepage from the base of river terrace sand/gravel deposits and also by diffuse seepage from the underlying Becton Sand Formation.

Figure 1-9: Conceptual Model Diagram: Stephill Bottom

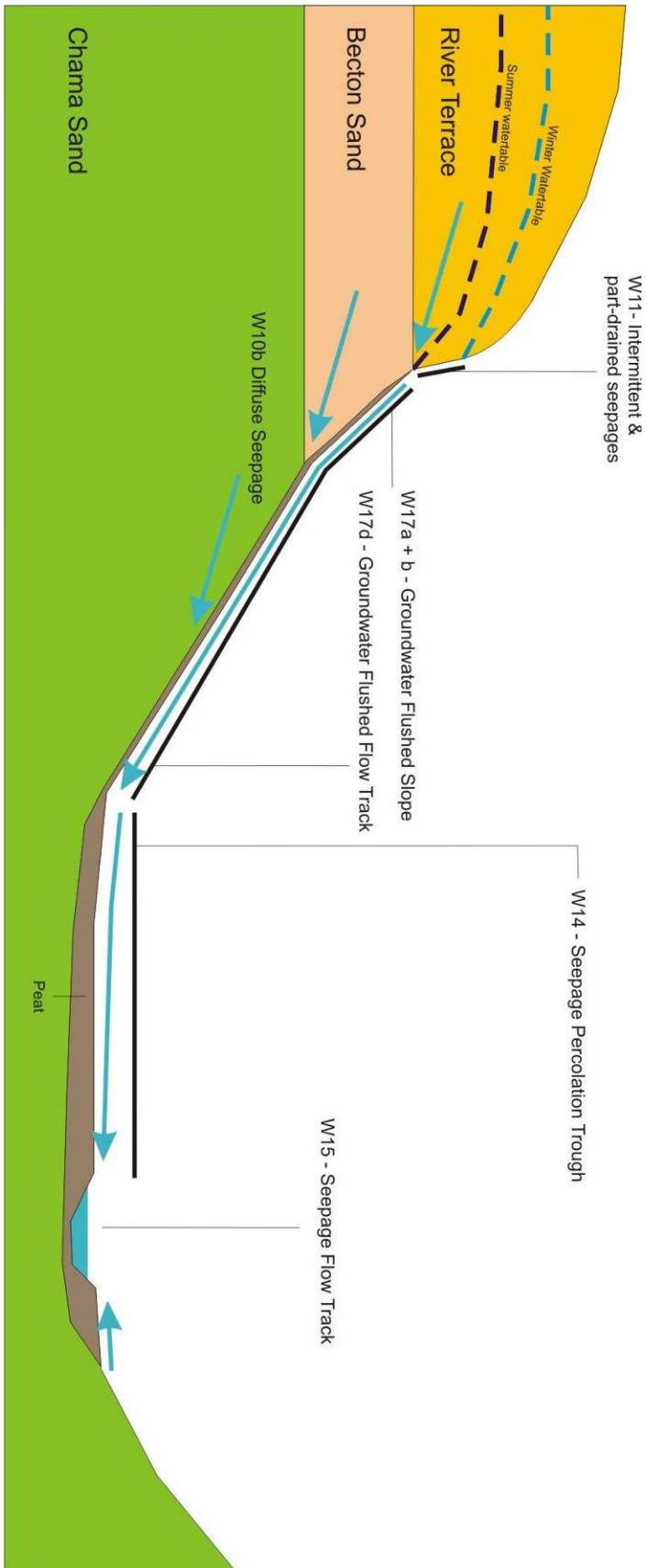
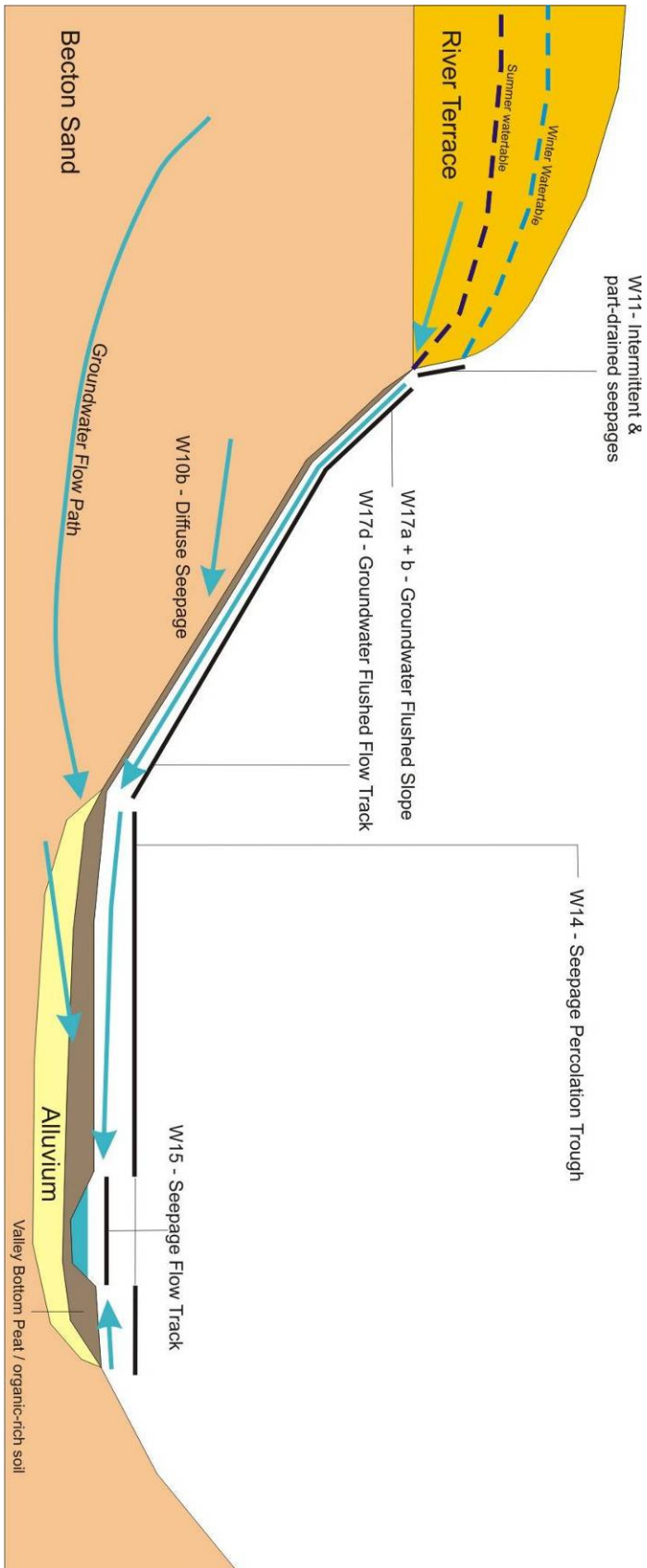


Figure 1-10: Conceptual Model Diagram: Denny Bog and Penny Moor



### 1.5.1 WETMECS identified

WETMECs are ecohydrological classifications of how water can be supplied to a wetland to create distinguishable habitats. WETMECS were developed in partnership between the Wetland Research Group at the University of Sheffield, the Environment Agency, English Nature (now Natural England) and Countryside Council for Wales (now Natural Resources Wales). For each Ecohydrological Assessment Area WETMECS have been identified.

The WETMECS identified include:

Valley side wetlands - W10b, W17a+b and W17d with small areas of W11 above.

Valley bottom wetlands - W10b, W11, W14 and W15.

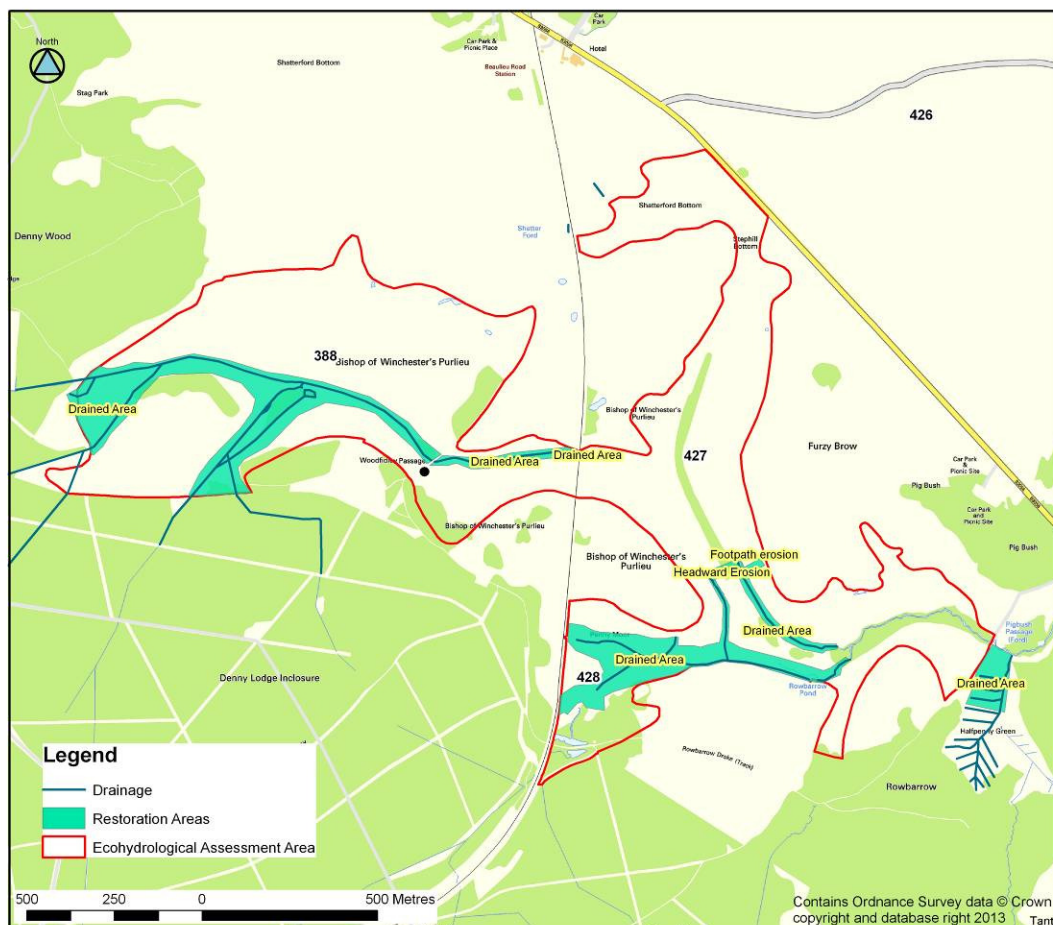
## 1.6 Damage and Restoration

### 1.6.1 Damage

There are a number of areas of significant damage within Denny Bog and Penny Moor (see Figure 1-11). Most relate to drainage. In the western part of Denny Bog there are extensive "lawn" areas developed where valley mire has been destroyed by drainage and grazing. In Denny Bog East the upstream end of the surface water drainage system has undergone headward erosion. Just beyond the south-eastern boundary of Denny Bog East is an area of herringbone drainage that may be affecting water levels within the unit: this has been highlighted on the Restoration Areas Map. Footpath erosion is an issue locally.

Localised encroachment of Scot's Pine *Pinus sylvestris* was observed in some places.

Figure 1-11: Restoration Areas Map





## 1.6.2 Restoration

It is understood that some restoration work has already been undertaken on Denny Bog, with heather bales being used to combat headward erosion in the eastern part of the bog<sup>2</sup>. It is recommended that the situation be monitored to determine the success of the restoration. If erosion continues then further preventative measures will be required. These could include the use of staked heather bales (where flows are not too energetic), the installation of wooden weirs and/or the infilling or re-profiling of the channel. The engineering design of suitable measures would need to be based on a detailed study beyond the scope of this report.

**Table 1-3: Restoration Area Summary Table**

Restoration Area	Damage Type	Restoration Proposals	Improvement	Constraints and Issues
Denny Bog: western and eastern parts	Drainage	Drain blocking	Raising water levels to encourage re-establishment of mire habitat and extension of existing mire areas and potentially wet heath areas.	Potential impacts on drainage of land higher up the catchment (possible impairment of drainage if water levels are raised).  The herringbone drainage in the east is outside the EcoHAA, but still within the New Forest SSSI.  "Lawn" areas represent degraded mire and yet may be of ecological value in their own right locally. However, in this Unit they were not of an especially high quality.
Denny Bog: centre of eastern part	Headward erosion	Monitor the situation and assess the success (or otherwise) of existing restoration measures. If necessary, take further preventative measures (see main text).	Habitat protection: preventing further erosion of the valley mire.	The design of suitable erosion control measures will require a more detailed study beyond the scope of this report.  Heather bales may be washed away by high energy flows, and weirs may be bypassed.
Footpaths	Erosion	Monitor erosion and, if necessary, re-surface the problem section(s).  Also assess if footbridges/ boardwalks are resulting in the localised ponding of water, potentially impacting on mire communities. Possibly increase size of culvert pipes and/or raise bridges/boardwalks.	Protection of valley side habitats from erosion.	
Localised areas throughout unit	Scrub encroachment (Scot's Pine)	Monitoring, and removal if scrub encroachment becomes extensive	Removal of Scot's Pine which have potential to invade mire and wet heath habitats, leading to further drying.	

<sup>2</sup> Allen, R. (2005) Soil and Water in the New Forest and the Valley Mires. [online] Available at <http://www.soilandwater.co.uk/index.php?id=33&click=0> [accessed 20th December 2012]

## 1.7 Monitoring requirements

### 1.7.1 Water Monitoring

It is understood that groundwater levels on Denny Bog were monitored in 14 dipwells between February 1999 to November 2000<sup>3</sup>. The monitoring data were not available for review as part of this project, and the locations of the dipwells are not known.

Continued monitoring of groundwater levels (in shallow boreholes) and surface water levels (in stilling wells installed in ditches and streams) would be useful on this site, especially within the valley bottom wetlands affected by drainage. It would help inform the details of any further restoration work and would also help to determine whether the existing restoration plan was working.

The existing monitoring network should be reviewed, and additional monitoring added, if necessary. Monitoring could be undertaken using automatic water level recorders, limiting the need for visits by Natural England staff or contractors. Automatic water level recorders could potentially be installed within the existing dipwells on the site.

### 1.7.2 Vegetation

Scot's Pine seedlings were beginning to encroach into wet heath areas in patches throughout the Unit; this should be monitored with fixed point photography and transect studies to ensure that this species does not continue to spread. Similar monitoring should be implemented in relation to localised areas of footpath erosion.

Where drainage restoration works are implemented, fixed point quadrat surveying should be implemented to assess the changes in vegetation communities present.

**Table 1-4: Monitoring Requirements**

Eco-hydrological Assessment Area	SSSI Units	Site Names	Requirements for monitoring: ecology	Requirements for monitoring: hydrology (number of installations estimated)
X	388, 427 and 428	Denny Bog West, Denny Bog East and Penny Moor	Fixed point camera and transect survey (specifically focussing on extent of pine scrub encroachment, areas where footpaths are impeding flows and footpath erosion/poaching) Fixed point quadrat survey	The following new installations are recommended, although existing dipwells could also be used for groundwater monitoring on Denny Bog.  5 boreholes and 5 stilling wells (10 installations in total) Plus associated monitoring and data processing

## 2 Maps

**Map 1: Location**

**Map 2: Aerial Photography**

**Map 3: Topography, Hydrology and Wetland Distribution**

**Map 4: Phase One Habitat**

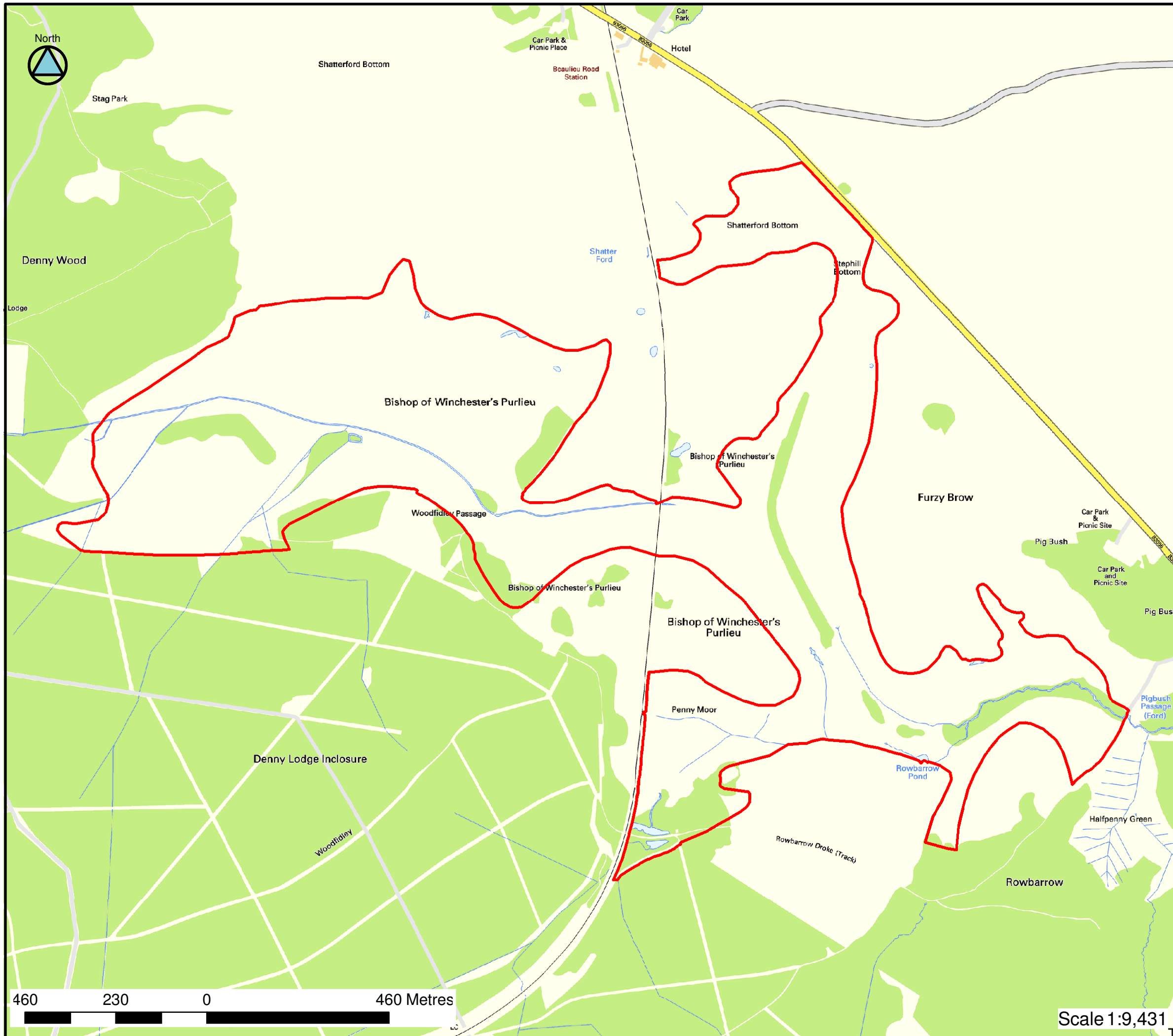
**Map 5: Drift Geology**

**Map 6: Bedrock Geology**

**Map 7: Eco-Hydrology Map**

**Map 8: Restoration Plan**

<sup>3</sup> Allen, R. (2005) Soil and Water in the New Forest and the Valley Mires. [online] Available at <http://www.soilandwater.co.uk/index.php?id=33&click=0> [accessed 20th December 2012]



**LEGEND**

 Ecohydrological Assessment Area

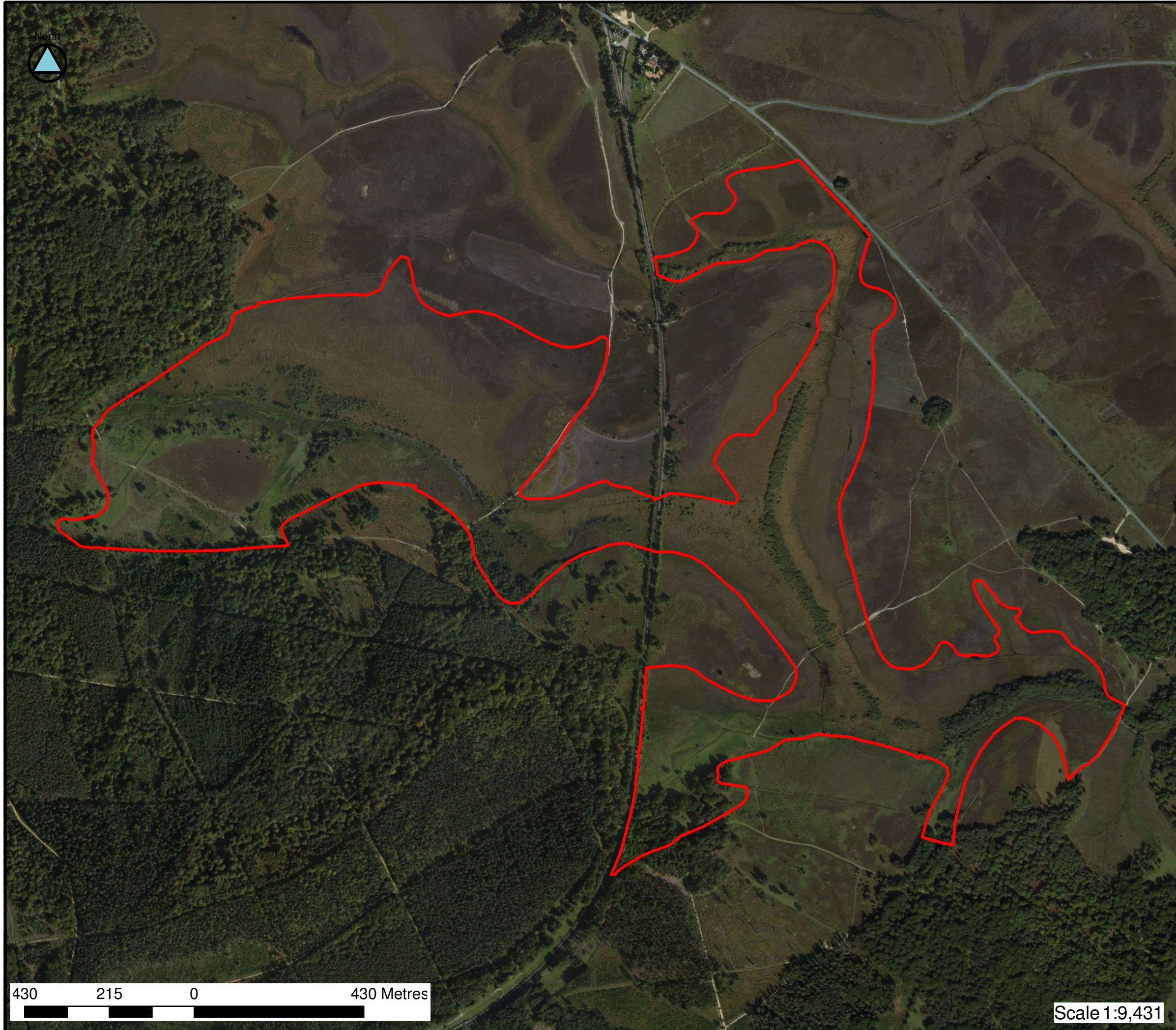
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**MAP 1**

Site Location

Scale 1:9,431



**LEGEND**

 Ecohydrological Assessment Area

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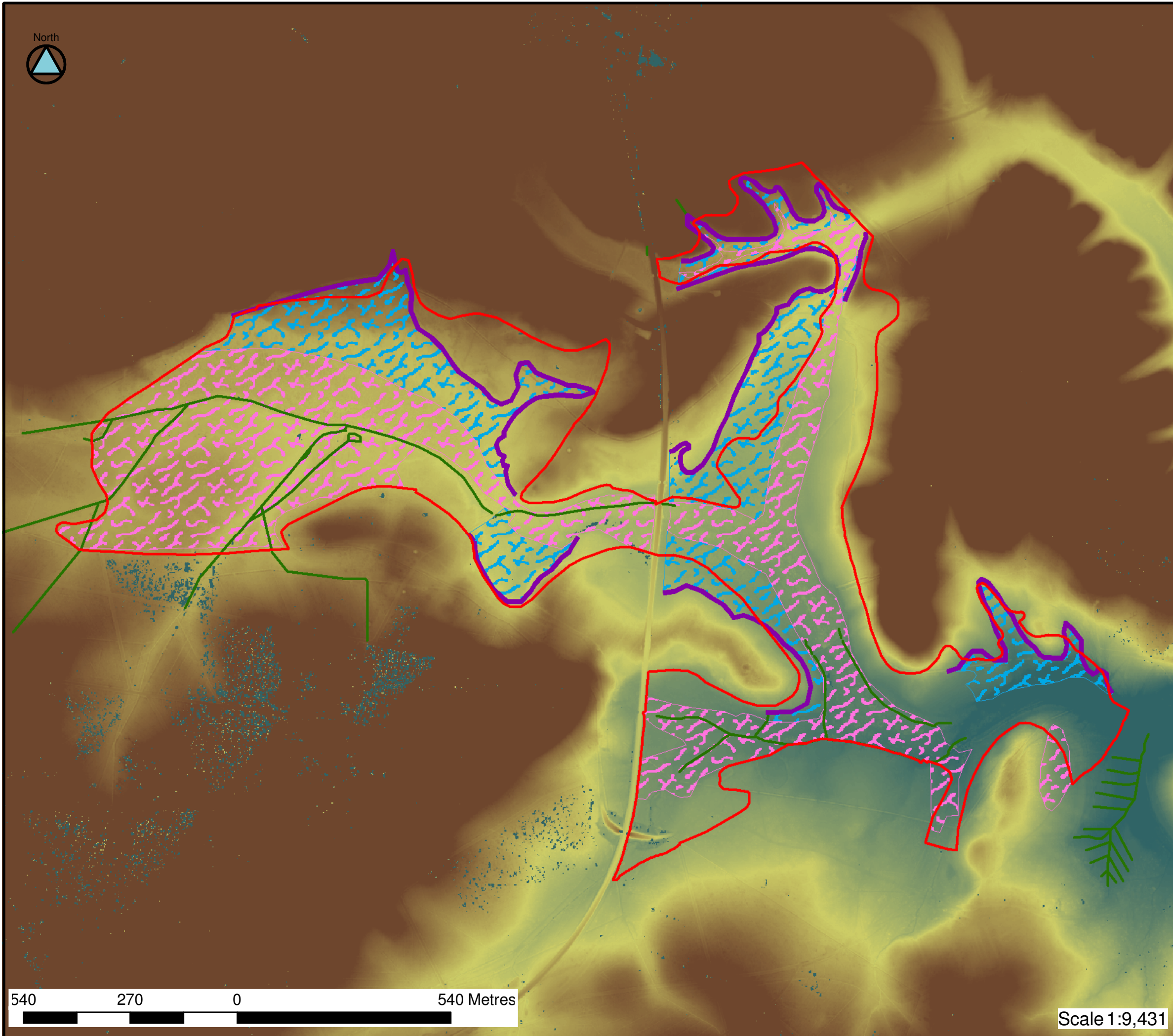


430 215 0 430 Metres

Scale 1:9,431

MAP 2

Aerial Photography

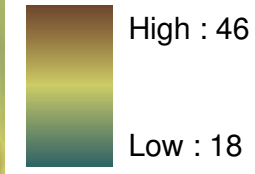


**LEGEND**

- Ecohydrological Assessment Area
- Seepage face
- Drainage
- Valley Bottom Wetland
- Valley Side Wetland

**LIDAR**

**mAOD**



© Forest Research based on Cambridge University Technical Services and New Forest NPA data.

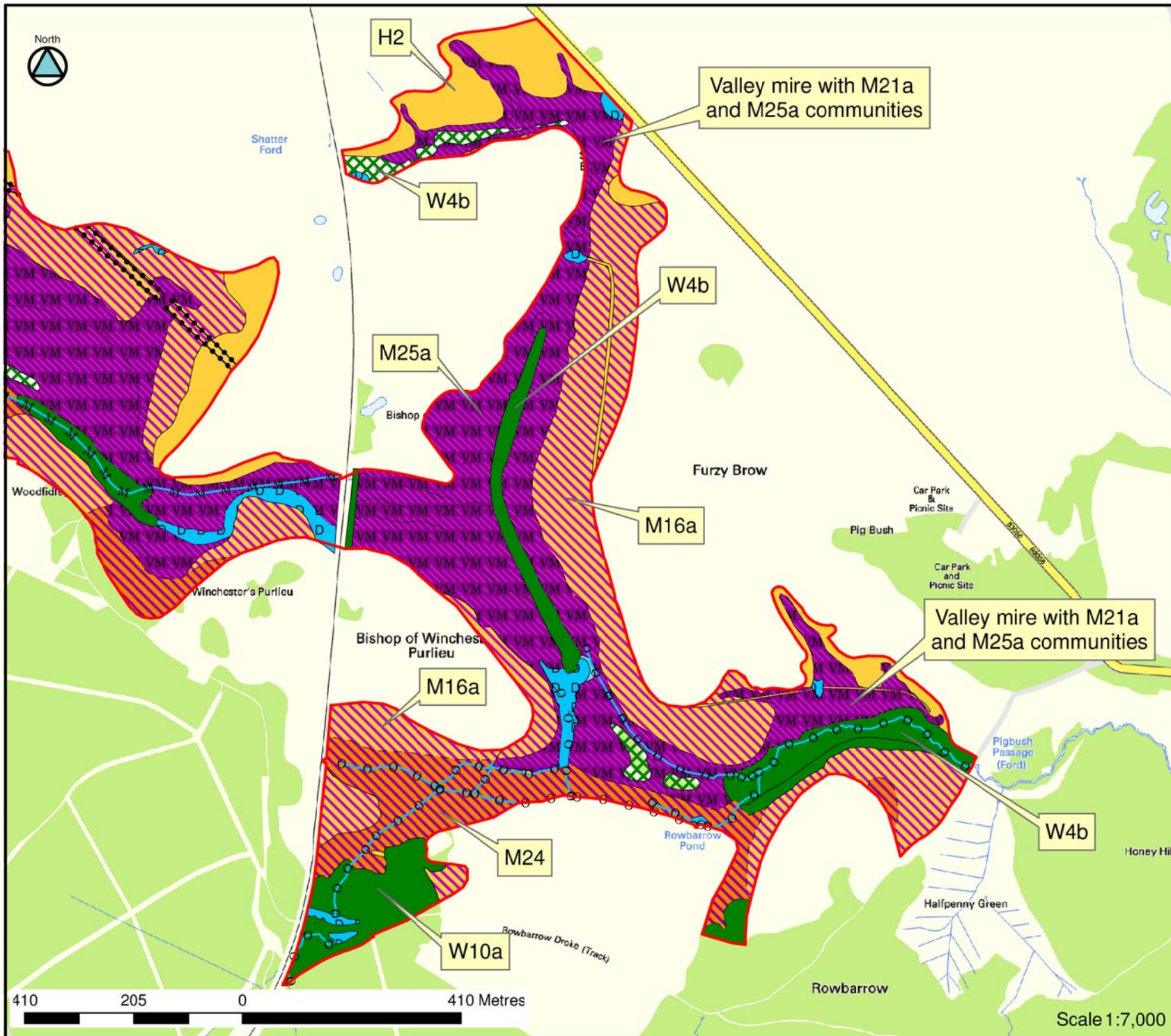


**MAP 3**

Topography, Hydrology and Wetland Distribution



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**LEGEND**

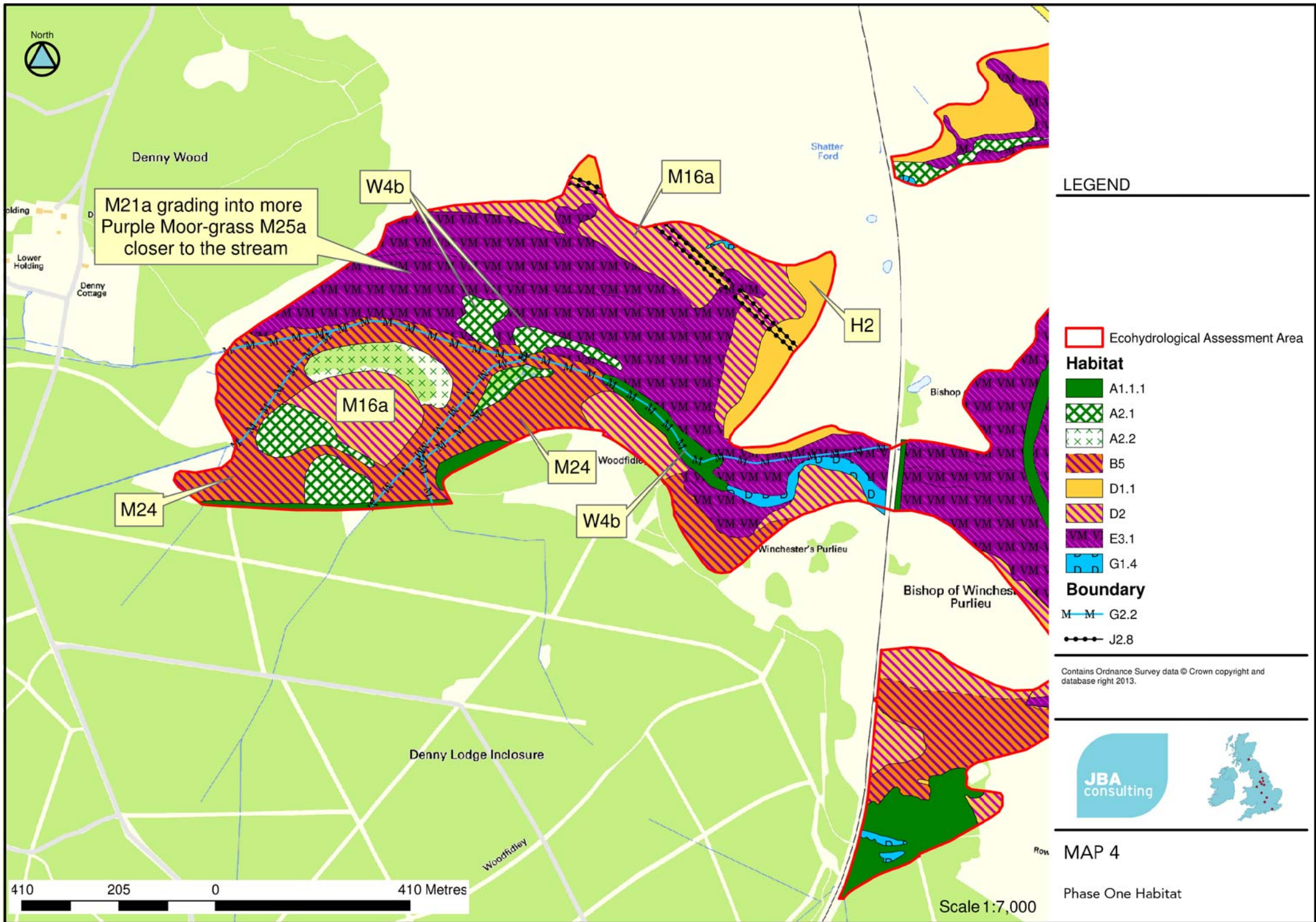
- Ecohydrological Assessment Area
- Habitat**
- A1.1.1
- A2.1
- B5
- D1.1
- D2
- E3.1
- F1
- G1.4
- Boundary**
- M-M G2.2
- G2.3
- J2.8

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**MAP 4**  
Phase One Habitat

Scale 1:7,000



M21a grading into more Purple Moor-grass M25a closer to the stream

**LEGEND**

- Ecohydrological Assessment Area
- Habitat**
- A1.1.1
- A2.1
- A2.2
- B5
- D1.1
- D2
- E3.1
- G1.4
- Boundary**
- M-M G2.2
- J2.8

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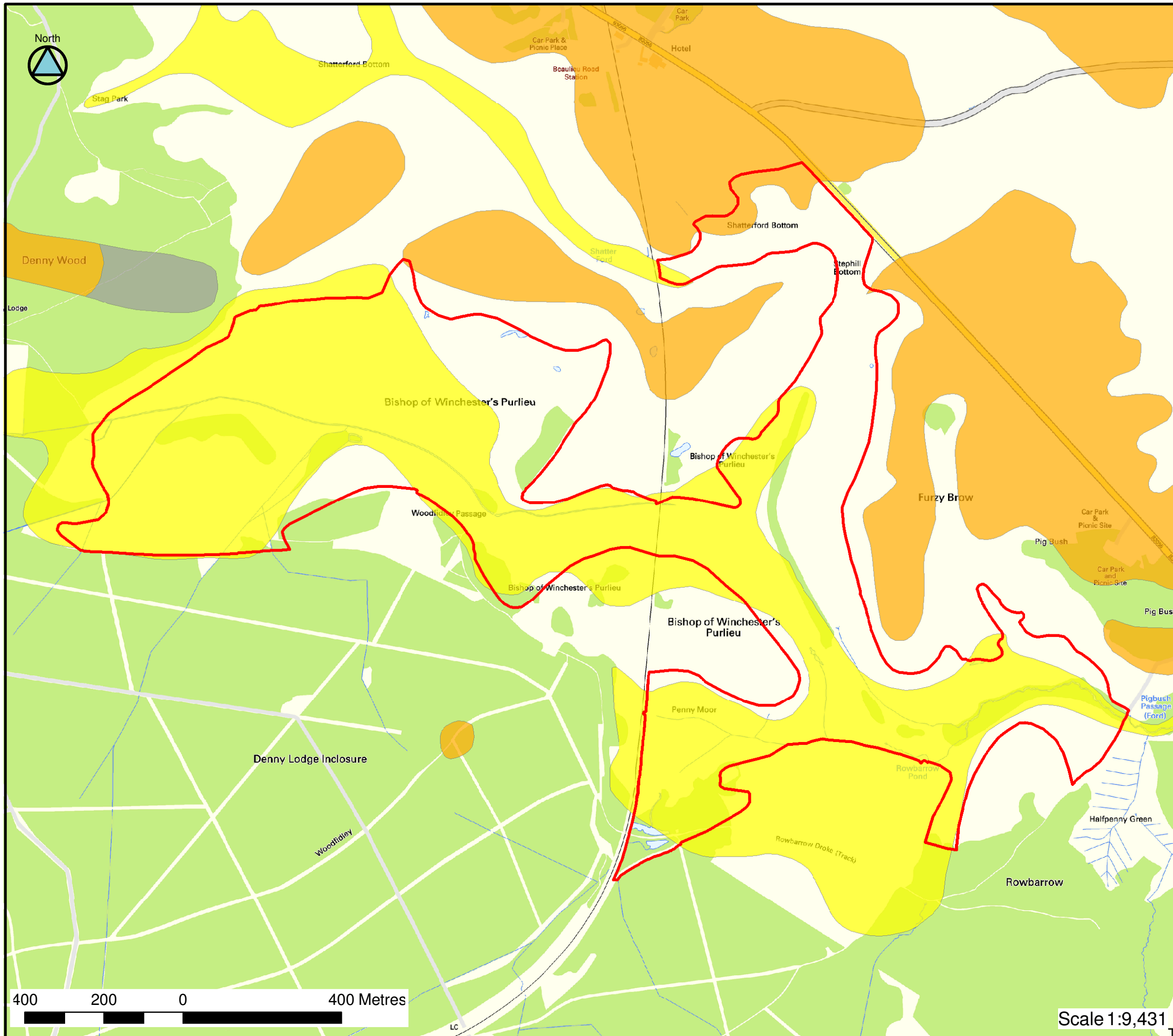


**MAP 4**

Phase One Habitat

Scale 1:7,000

410 205 0 410 Metres



**LEGEND**

- Ecohydrological Assessment Area
- No Drift
- Other Deposits
- Alluvium - Clay, Silt, Sand and Gravel
- Head - Clay, Silt, Sand and Gravel
- Head - Gravel, Sand, Silt and Clay
- Head - Silty Clay
- Head - Gravelly Sand
- Peat
- River Terrace Deposits - Clay and Silt
- River Terrace Deposits - Sand and Gravel
- River Terrace Deposits - Sand, Silt and Clay

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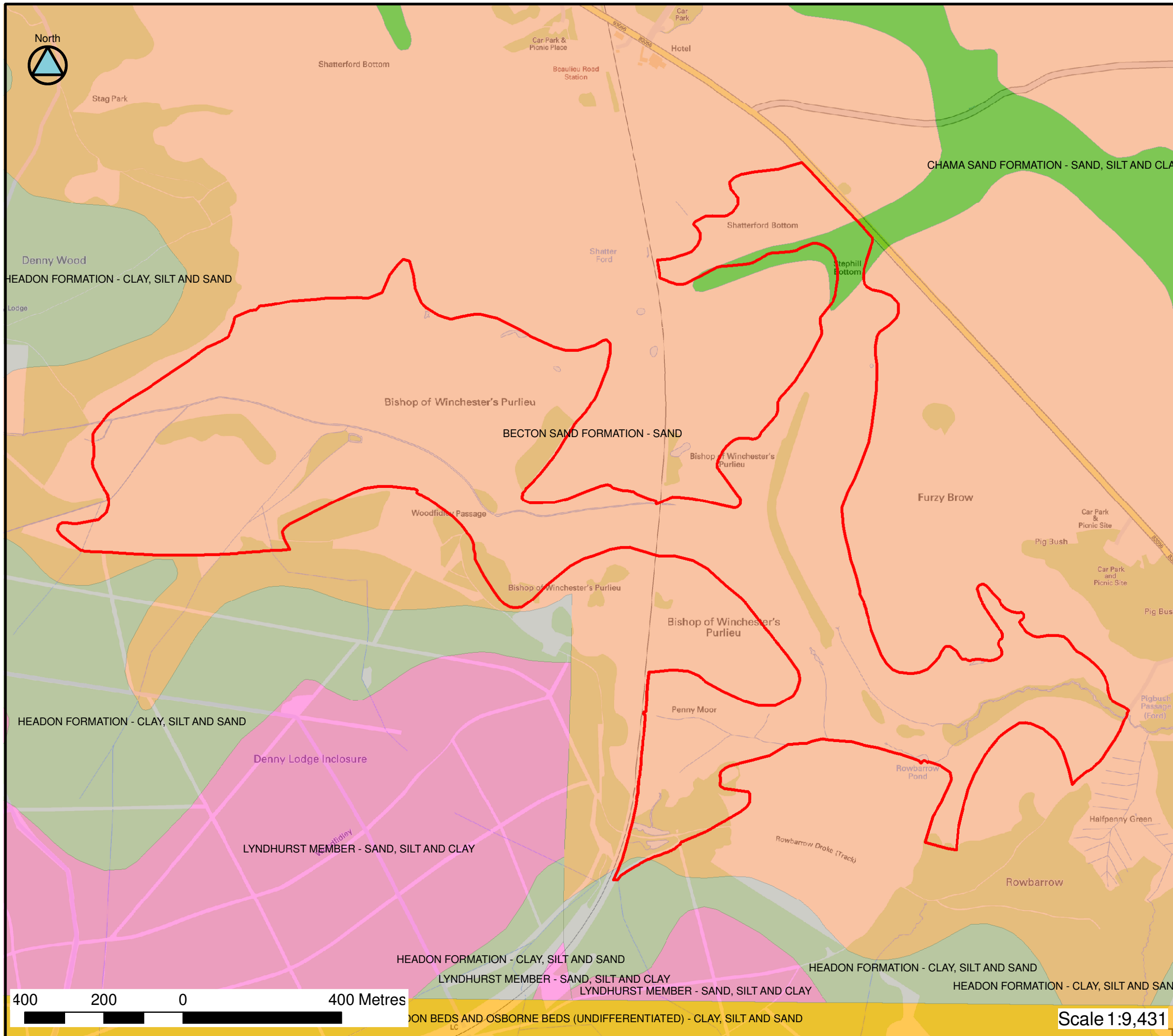


Scale 1:9,431

MAP 5

Drift Geology





- ### LEGEND
- Ecohydrological Assessment Area
  - Other Rock Types
  - Headon and Osbourne Beds  
- Clay, Silt and Sand
  - Headon Formation  
- Clay, Silt and Sand
  - Lyndhurst Member  
- Sand, Silt and Clay
  - Becton Sand Formation  
- Sand
  - Becton and Chama Sand Formation  
- Sand, Silt and Clay
  - Becton Bunny Member  
- Clay
  - Chama Sand Formation  
- Sand
  - Chama Sand Formation  
- Sand, Silt and Clay
  - Chama Sand Formation  
- Silty Clay
  - Barton Clay Formation  
- Clay
  - Barton Clay Formation  
- Sand
  - Selsey Sand Formation  
- Sand, Silt and Clay
  - Marsh Farm Formation  
- Clay, Silt and Sand
  - Poole Formation  
- Sand, Silt and Clay
  - London Clay Formation  
- Clay, Silt and Sand

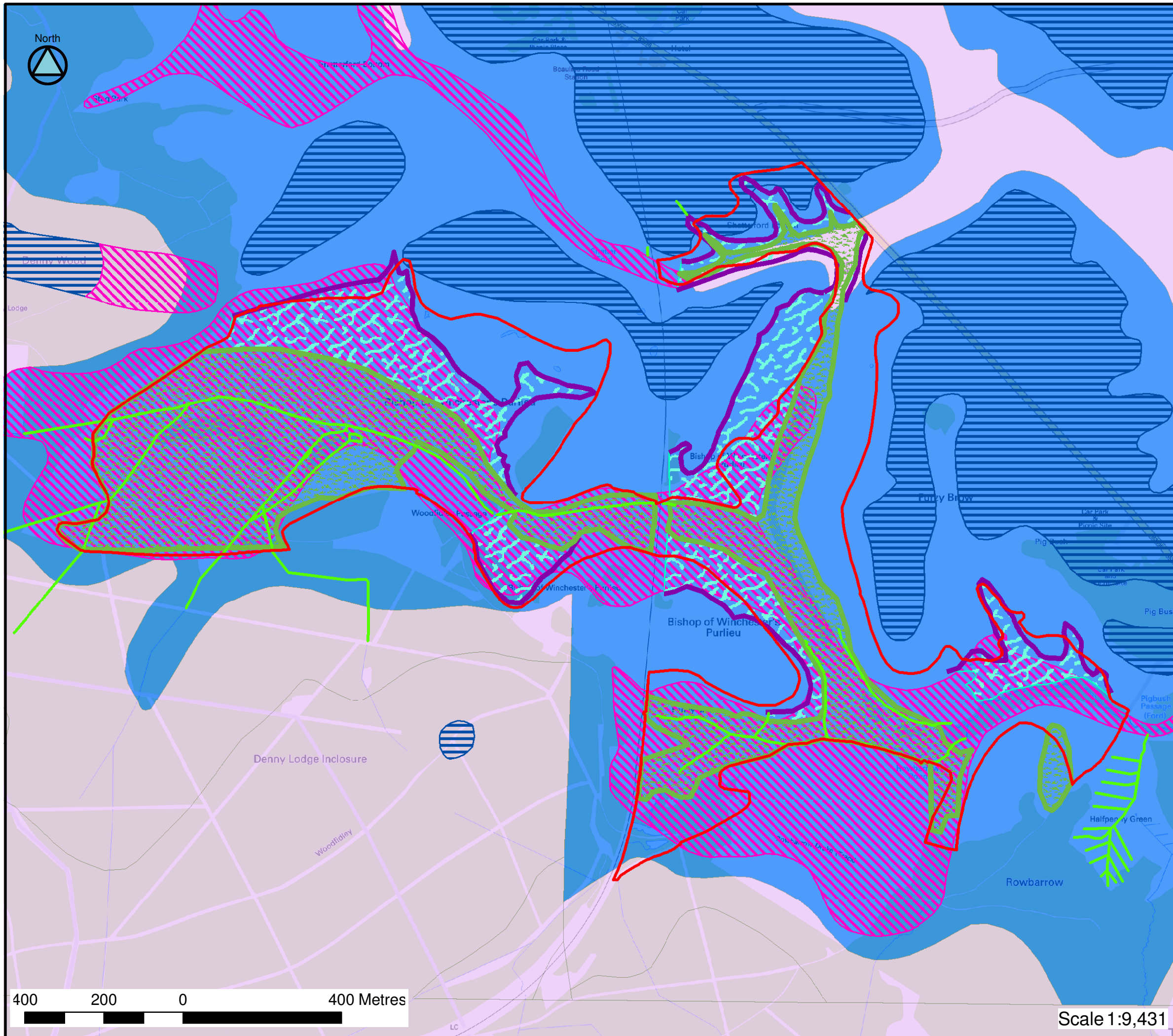
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**MAP 6**  
Bedrock Geology



Scale 1:9,431



**LEGEND**

- Ecohydrological Assessment Area
- Seepage face
- Drainage
- Valley Bottom Wetland
- Valley Side Wetland
- Drift Hydrogeology**
- Aquifer
- Aquifer/Aquitard
- Aquitard
- Bedrock Hydrogeology**
- Aquifer
- Aquifer/Aquitard
- Aquitard

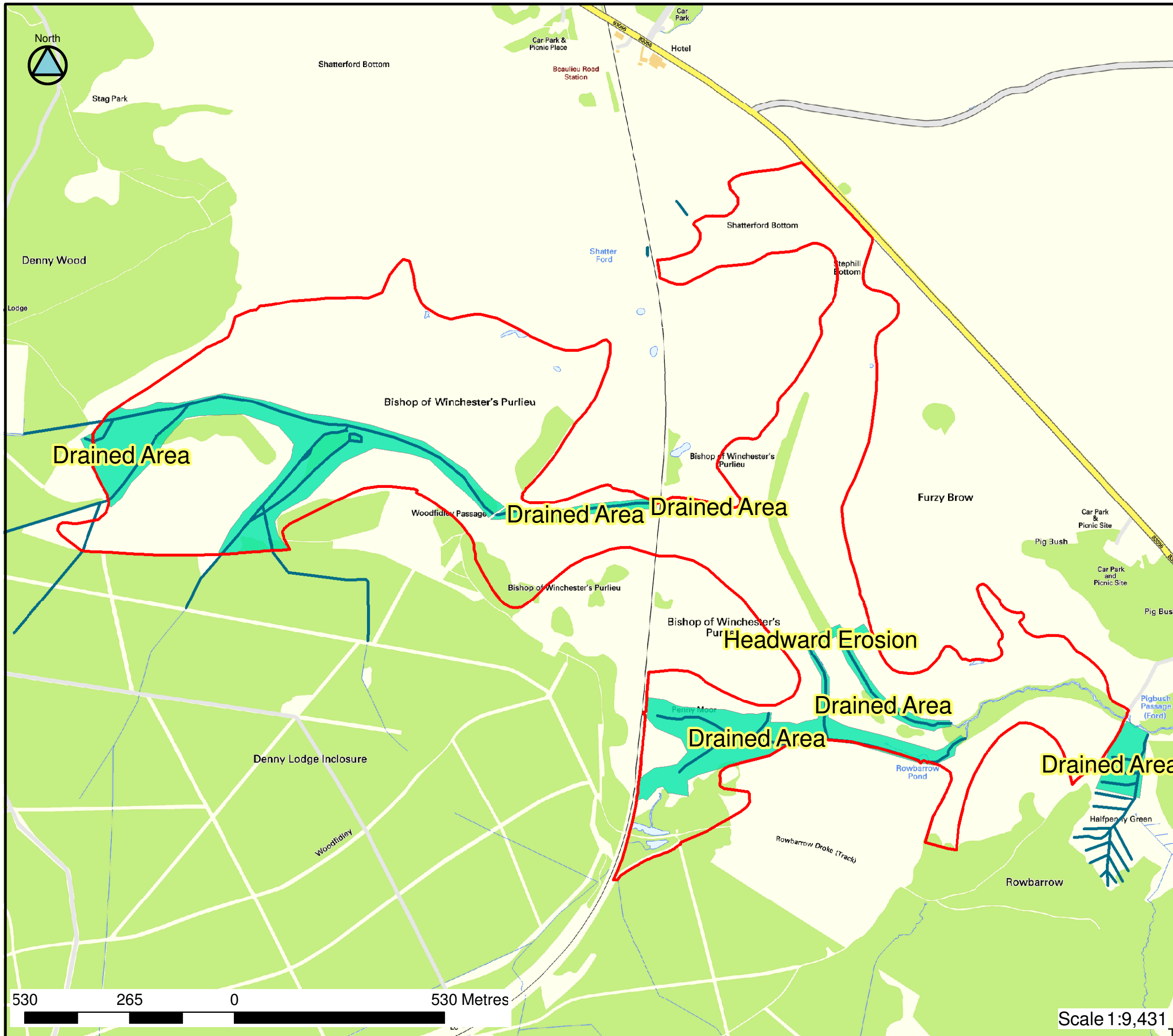
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**MAP 7**  
 Eco-hydrology



Scale 1:9,431



**LEGEND**

- Ecohydrological Assessment Area
- Drainage
- Restoration Areas

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**MAP 8**  
Restoration Plan

Scale 1:9,431