The Sizewell C Project

6.3 Volume 2 Main Development Site

Chapter 14 Terrestrial Ecology and Ornithology

Appendix 14C4 Fen Meadow Compensation Study

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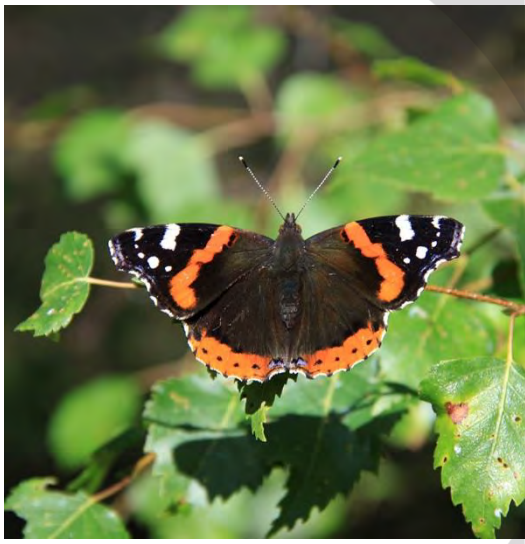
EDF Energy

Sizewell C

Fen Meadow Compensation Study – Report of Visits to Target Sites 2019



Wood Environment & Infrastructure Solutions UK Limited – June 2019

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1. Introduction

1.1 Background

The proposed development platform for Sizewell C will extend a short distance into the eastern margins of Sizewell Marshes Site of Special Scientific Interest. The toe of the batter of the proposed platform will define the extent of permanent land-take but, additional to that, ditch re-alignment is required which will take a limited amount of further land.

Based on National Vegetation Classification (NVC) survey data the main affected habitats are M22 *Juncus subnodulosus – Cirsium palustre* fen meadow, S26 *Phragmites australis - Urtica dioica* tall-herb fen, S4 *Phragmites australis* reedbed and some W5 *Alnus glutinosa – Carex paniculata* wet woodland.

Losses of the habitats listed with the exception of fen meadow and wet woodland[1]are being addressed through the Aldhurst Farm Habitat Creation Scheme. Feedback from Natural England in 2014/2015 during consultations on the design of the Aldhurst Farm site was that:

- Aldhurst Farm should provide satisfactory compensation, both in terms of quality and quantity, for loss of reedbed and lowland ditch habitats;
- Creation of reedbed is likely to provide satisfactory compensation for impact on invertebrate assemblage, subject to further investigation of the invertebrate fauna associated with the affected wet woodland;
- Rare vascular plant assemblage is mainly associated with lowland ditch habitat and fen meadow; reedbed is of limited interest in this respect; and
- Aldhurst Farm is unlikely to be suitable for the creation of fen meadow/rush pasture as there would be very limited compatible/contiguous habitat.

The focus of this study is therefore on the provision of compensatory fen meadow habitat, particularly M22 *Juncus subnodulosus – Cirsium palustre* fen meadow.

The extent of permanent fen meadow loss to platform development and ditch realignment is still to be precisely defined but is likely to be less than 0.5ha.

1.2 Scope of the Study

This study aim is to identify potential sites for provision of fen meadow habitat that is sustainable in the long term to compensate for any unavoidable loss of fen meadow habitat. Key characteristics for the potential sites were considered to be:

- **Site size**: The site has to be of sufficient size to provide adequate compensation for any unavoidable land-take taking account of requirements for conservation management and the need to be sustainable (e.g. resilient to potential effects of climate change such as sea level rise) in the long-term. It is currently envisaged that 2-3 ha would be a minimum requirement but would depend on the precise landtake figure and the approach taken to biodiversity offsetting;

[1] Excluding the potential for 'wet woodland' to establish at Aldhurst Farm over the long term, in the absence of active reed-bed management.

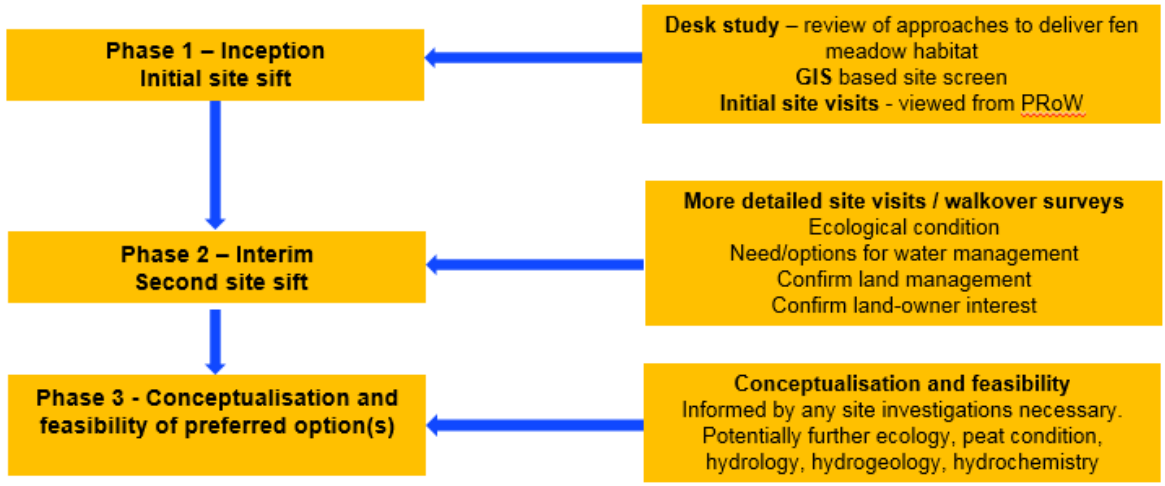
- **Site status**: Undesignated, not currently under conservation management, existing habitats should not be classified as existing fen meadow and should offer significant potential for enhancement;
- **Environmental setting**: appropriate hydrology; hydrogeology; hydrochemistry & substrate;
- **Connectivity:** Need to be close to existing areas of fen meadow/rush pasture or grazing marsh habitat under appropriate conservation management; and
- **Accessibility:** Must be readily accessible for any initial capital works and ongoing conservation management.

Ideally, the chosen site will not require significant engineering/construction activities.

1.3 Project Outline and Work to Date

The project comprises 3 phases and associated tasks as detailed in Figure 1.1.

Figure 1.1 Project Outline



The results of Phase 1 of the study, which covered a search of the whole of Suffolk, were reported in Wood (2018)[2]. Five sites were identified for further investigation, whilst 17 sites were put on hold subject to further assessment of initial 5 sites. A further 47 potential sites were considered least likely to be suitable and are very unlikely to be investigated further in future project phases. It was concluded in Wood (2018) that each of the 5 sites identified for further investigation would be of sufficient area to provide fen meadow habitat capable of compensating for unavoidable losses at Sizewell, although the work required to restore fen meadow to each would likely be different, and each would support different quantities/qualities of fen meadow.

Wood (2018) indicated that the next steps (Phase 2) should comprise:

- Undertaking a brief consultation exercise with stakeholders (specifically Natural England, Suffolk Wildlife Trust and Suffolk County Council). Although these stakeholders were consulted during the previous project phase and were asked about potential sites in the wider area, the identification of some further potential target sites now may prompt additional local knowledge in respect of, for example, any local initiatives that may be underway in the vicinity

[2] Wood (2018). Sizewell C. Fen Meadow Compensation Study – Approach and Initial Site Screen Report 2018. EDF Energy

of these areas that it would be important to be aware of before any approaches are made to landowners.

- Informal consultation with landowners by EDF indicating the scope of the study and requesting access for a one day visit.
- A one day site visit to each potential site comprising:
  - A walkabout survey to identify areas where (1) the peat is currently influenced by groundwater or near-surface seepage; and (2) fen meadow species are present within or close to the site margins;
  - A reconnaissance hand augering survey to identify general peat quality (substrate condition), sub-surface geological materials, presence of water table and areas of upwelling groundwater; and
  - Consideration of broad options for water management and potential for changes to land management.
- Report on the findings of these visits, update the assessment of site suitability and provide an assessment of what could be possible in respect of establishing fen meadow habitat, including initial high level conceptualisation.

1.4 Stakeholder Consultation

A stakeholder update meeting was held by telephone on 9 April 2019. The results of the updated site screening exercise were presented and discussions minuted. No feedback was provided in respect of local initiatives or potential additional sites. However a useful discussion regarding terminology to be used in the study and site selection resulted in agreement that sites sought could include those considered to be 'former fen meadows', but should not be 'degraded fen meadows' i.e. areas that would still be considered to support fen meadow habitat, but in a degraded state.

1.5 Sites to be taken forward and objectives of the visits

The five sites identified for further investigation (Wood (2018)) were:

- Site No. 10 – Aldecar Lane;
- Site No. 11 – Watering Lane;
- Site No. 28 – Blyth Road;
- Site No. 33 – Stratford St Andrew; and
- Site No. 54 – Pakenham Fen.

The locations of these sites are illustrated in Figures 1.2-1.5.

EDF agents sought permission from the landowners to access these sites for the purpose of informing this study. At the time of reporting access had been agreed, and 1 day visits undertaken, to Sites 10, 11, 28 and two areas of Site 54.

Objectives of the visits to each site were as follows:

- **Vegetation.** To assess the presence and location of soil surface attributes (notably micro-topography, ground softness and the presence of peat) and groundwater-tolerant/dependent plant species (higher plants and bryophytes).

- **Ditch network.** To record the nature and extent of the ditch network present, including existing structures (if any) and consider the potential for water level management.
- **Substrates.** To undertake shallow coring transects at each site to locate and characterise substrates within the surface rooting zone.
- **Target determination of the investigations.** To identify areas within each site that have the potential to develop into fen meadow habitat through reasonable interventions.

1.6 This Report

This report presents the results of assessment visits made to sites (or site compartments) that owners had agreed EDF access to for the study. The report is structured as follows:

- Section 2 presents the objectives of, and methods undertaken during the site studies, on the accessible sites;
- Section 3 presents the study results for each of the sites visited; and
- Section 4 presents conclusions and next steps.

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260000

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Mitford House

Sternfield

Sandy La

Mea

A12

A1094

Manor Farm House

Site No.10

Site No.11

Monks Valley House

Racewalk Covert

alk Barn Farm

Snape Watering

A1094

Hulv

Ch

Cor

Key

Potential fen meadow compensation sites

Scale at A3: 1:7,000

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Figure 1.2
Site No. 10 and 11 - Location Map

May 2019

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WORTH
Chediston Street
B1123
Roman Way
Holton Road
Site
No.28
Red House Farm
River
Blyth
Bramfield Road
B1117
Black
House
Mells
Gatehouse
A144
Wenhaston
Grange

Key

Potential fen meadow compensation sites

Scale at A3: 1:7,000

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Report of Visits to Target Sites 2019

Figure 1.3
Site No. 28 - Location Map

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Benhall Street

Site
No.33

rove Farm

Manor Farm

Mill Lane

Stratford
St Andrew

Farnham

Key

Potential fen meadow compensation sites

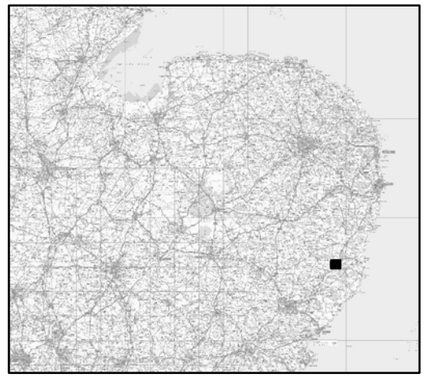

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Figure 1.4
Site No. 33 - Location Map

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592000
593000
594000
269000
268000
N
Thieves Lane
Broadway
Grimstone
The Black Bou
North
Old Hall Farm
Site
No.54
South
Fen Road
Pakenham Fen
Upper Town
Pakenham
Bull

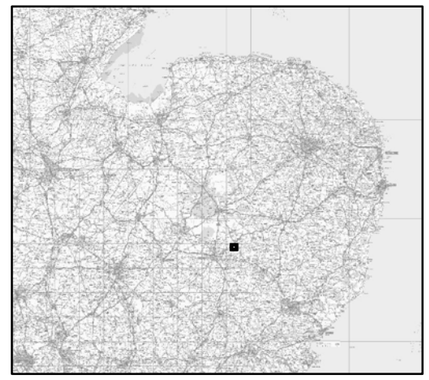
Key

Potential fen meadow compensation sites

Study Area

South

North



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Sizewell C
Fen Meadow Compensation Study -
Report of Visits to Target Sites 2019

Figure 1.5
Site No. 54 - Location Map

May 2019

wood.

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2. Methods

Sites 10, 11 and 28 were visited on 9 and 10 April 2019, with two accessible areas of Site 54 visited on 30 April and 1 May 2019. Two key survey types were undertaken on each site visited:

- Walkabout survey; and
- Shallow soil core survey.

2.1 Walkabout survey

A walkabout survey traversed the sites to assess each landscape element present within and on the margin of each site. All open ditches were incorporated into this survey, particularly those framing the margins of the site (groundwater influence) or those traversing it (carrying surface water).

Particular attention was paid to:

Soil surface features:

- Micro-topographic lows such as inundated or soft ground, particularly where peat forms the ground surface.
- Exposed sub-surface substrates, including all ditch sides.

Ditch network

- Flow direction.
- Dimensions (depth, width, water depth, freeboard). In respect of water depth and freeboard it is important to note that the surveys were undertaken following a period of low rainfall and therefore conditions recorded are probably representative of low rainfall rather than typical, conditions.
- Existing water management and control structures.
- Potential for water level management.

Indicator plant species:

- Grassland species, used either to exclude parts of the site as potential fen meadow habitat, or to indicate that re-wetting and groundwater flushing would be required.
- Rank vegetation indicating sources of eutrophication (internal – e.g. peat degradation; external – e.g. surface drain runoff or watercourse flooding).
- Swamp and inundation species, used to indicate that at least seasonal water detention is currently achieved.
- Fen meadow and fen species.

Ditch flora:

- For consideration of the likely influence of groundwater (rather than rainwater or surface drainage).

The primary source for determining the relationship of recorded species to groundwater-dependency was Londo (1988)[3]. Wirdum (1991)[4] and the National Vegetation Classification (NVC) were also consulted. Londo's classification for 'phreatophytes (groundwater-dependent plant species) is given in Table 2.1. All recorded higher plants are listed in Appendix A with Londo's (1988) phreatophyte category.

Table 2.1 Phreatophyte categories (Londo 1988)

Category	Definition
H	Hydrophytes, species with vegetative parts submerged or floating on the water
W	Obligate phreatophyte. Species requiring a water table at the soil surface (in years with a normal water table) or higher during part of the year or permanently for good development and completion of their life-cycle, e.g. germination.
F	Obligate phreatophyte. Species growing only within the sphere of influence of the water table, which is generally below the soil surface.
V	Non-obligate phreatophyte. Species growing mainly or almost exclusively within the sphere of influence of the water table, which is generally below the soil surface.
K	Non-obligate phreatophyte – 'Lime aphreatophytes'. Species growing mainly or almost exclusively within the influence of the water table (which is generally below the soil surface) but occurring above this sphere of influence on soils rich in lime.
P	Non-obligate phreatophyte – 'Local phreatophytes'. Species that grow above the sphere of influence of the water table in much of their area of distribution but depend on this sphere of influence in certain areas or places.
A	Aphreatophytes. Species that are not bound to the sphere of influence of the water table. However, many of these species can be found, often abundantly, within the sphere of influence of the groundwater.

2.2 Shallow soil core survey

Shallow soil core surveys were undertaken as transects across the site in locations suggested by the walkabout survey in order to assess near-surface substrate features:

- Sediments present within 1 metre of the ground surface (where augering possible): sediment types (thickness; relative permeability); evidence of waterlogging.
- Presence of water table within 1 metre of ground surface.
- Peat condition where present (see Table 2.2).

All cores are presented as a log of soil cores and summarised as part of a zone of similar cores within each site account.

[3] Londo G. (1988) Nederlandse freatofyten (Dutch phreatophytes). Pudoc, Wageningen.
[4] Wirdum van G. (1991) Vegetation and Hydrology of Floating Rich-fens. Thesis, Amsterdam.

Table 2.2 Terms used to describe peat condition

Term	Definition
Earthy peat	Found above the hemic peat, and usually forming the ground surface of the peat body, earthy peat is the very dark brown to black-coloured form of peat exposed to the atmosphere. Called 'earthy' peat to signify the ripening, or maturing, of the peat near the ground surface, the material is dust-like when dry. As the dust cannot return to the gel-like consistency when wet, it typically ponds rainwater after a shower. Moisture held in the peat topsoils therefore becomes increasingly different from the groundwater. In fen peats, this is reflected in the vegetation that develops. For example, Hard rush *Juncus inflexus* tends to colonise drains side influenced by calcareous groundwater while soft rush *J. effusus* colonises the normal ground surface, reflecting the influence of the more acidic rainwater.
Hemic peat	This type of peat has been partially decomposed so that much of the softer plant remains are no longer more than 'fossil' traces left in a watery mid-brown paste that also suspends fragments of wood and other harder plant remains. In this survey, hemic peat was initially recognised by its colour. Secondary forms of recognition are by squeezing a sample (confirming a watery paste) and by locating plant fragments.
Woody inclusions	In many cases, the hemic peat was largely derived from the remains of fen woodlands. Where wood fragments occurred within hemic peat in a core, this was recorded.
Fibric peat	This type of peat is typically composed of visible fragments of fen mosses, plants and pieces of wood suspended in a straw-coloured liquid. Rarely encountered in the survey and only at depth. Its presence indicates part of the peat body that has remained virtually anaerobic since its formation.
Sapric peat	Sapric is a generic term to describe well-decomposed peats where fibrous plant remains are no longer evident. The peat surveys identified bodies of sapric peat, which is very dark grey in colour, beneath hemic peat. The locations of sapric peat in this situation are probably correlated with the drawdown zones of fluctuating waterbodies. These include drains linked to rivers and to rivers themselves.

3. Site Results

The results of the studies undertaken on each of the sites visited are presented below.

3.1 Site No. 10 Aldecar Lane, Benhall

General description

The Aldecar Lane site shown in Figure 1.2 includes a section of the River Fromus valley south of Saxmundham, close to Site No. 11. The River Fromus drains the margin of the East Anglian clay plateau and makes a gentle descent over crag sands exposed on the valley sides to Snape, where it joins the River Alde. Upstream of the site is the Marsh Farm Caravan Site and associated valley excavations, which are water-filled. On the western side of the site, the network of floodplain drains is joined by a short tributary draining from the west of the A12 road; the drain on the southern boundary also appears to link the sewage treatment works to the main river.

The site lies on the margin of Benhall Parish, which broadly follows the modern course of the main river channel, though a new channel line has removed the former meander pattern through this section. A network of drains on the site appears to convey waters from the valley margin towards the main river.

The most extensive habitat present on the Aldecar Lane site is species-poor pasture, dominated by Perennial Ryegrass or Creeping Bent on the floodplain. The ground surface in the eastern and northern parts of this site are markedly drier than the western side near the valley margin. Groundwater influence in this area is indicated by both the ditch flora and the small group of species that mark out areas of the floodplain surface where groundwater upwelling is suspected. These include Hard Rush, a jointed rush and the widespread occurrence of Marsh Horsetail growing with Creeping Bent. Over the remaining floodplain, where the influence of rainwater is prevalent, these species are absent or very uncommon. Secondary habitats consist of the aquatic and swamp communities associated with bodies of open water that are confined to the main river channel and ditch system.

Ditch Network

A summary of observations made in relation to the ditch network are given in Table 3.1.

Table 3.1 Ditch network observation summary

ID	Description	Width (m)	Freeboard (m)	Water depth (m)	Flow	Notes
W1	Central field drain	2-3	1	Shallow	Standing water. No apparent flow	The ditch drains to the north and then curves west to meet the western boundary ditch.
W2	Ditch along western border	3	0.5	Shallow	Low flow to south	Sewage treatment works located to the west approx. 1m above water in ditch.
W3	Ditch connecting to northern drains	2	1	Boggy	No apparent flow	Ditch is nearly dry
W4	Connecting drain	2.5	1	0.3-0.5	No apparent flow	Culvert is approx. 0.5m diameter pipe. No apparent flow

ID	Description	Width (m)	Freeboard (m)	Water depth (m)	Flow	Notes
W5	West to east drain	2.5	1-1.5	0.4	Flow from west to east	Flow was not obvious at the time of the visit.
W6	River Fromus	2.5	1.5-2	0.4	Flow from north to south	Steep bank on west side, much gentler bank on east side.
W7	Drainage Ditch flowing west to east at southern end of site	2	1-1.5	0.2	Flow from west to east	Water was clearly flowing from west to east during the visit, converging with the River Fromus.

Note: Dimensions are approximate. The ID field references label on Figure 3.1.

Water is distributed around the site via a series of interconnected drainage ditches. Two of the ditches drain to the River Fromus (W5 and W7). There are no existing water level control structures in any of these drains. Site No.10 has some potential for water level management which would be focused around the southernmost drainage ditch (W7), where flowing water was observed during the visit. There is the potential to introduce a water level control structure (drop board sluice or similar) along this ditch or along the western ditch (W2) to increase water levels in this area. There is also the potential to transfer raised water from this ditch (via a wind pump or similar) to the central field drain (W1). This could be coupled with a water level control structure at the northern end of the central drain to further encourage water levels to rise in this area.

Terrestrial flora present

The site is composed of a single landscape unit – the modern floodplain. At the surface, a further sub-division can be made between the southwest and northeast sides. The northern and eastern sides are drier and support stands centred on the *Lolium perenne-Poa trivialis* leys of the *Lolio-Plantaginion* grassland (MG7b) (Figure 3.1). This is likely the result of the deep channels of the Fromus river and the northern ditch of the site.

To the south and west – and extending into the centre of the site – are radiating zones of inundation vegetation. The wettest lies in the southwest corner and is composed of a simple matrix of creeping bent and creeping buttercup (OV28 *Agrostio-Ranunculetum repentis* community). This is surrounded by a similar stand with soft rush (the *Polygonum hydropiper-Rorippa sylvestris* sub-community OV28a). Radiating out from this stand into progressively less inundated ground, much of the rest of this area is somewhat transitional to the *Lolio-Plantaginion*, with the replacement of soft rush by hard rush indicating a shift to more base-rich conditions.

Along the boundary drain on the western side, areas that are inundated for a shorter part of the growing season are still composed largely of creeping bent and creeping buttercup, but also support water mint, terrestrial lesser water parsnip, a slender-leaved jointed rush and also the mosses *Calliergonella cuspidata* and *Drepanocladus aduncus* on the margins of shallow hollows. The jointed rush patches were largely composed of slim, round slightly curved leaves in groups of 3-7, with cross-partitions and no evidence for a longitudinal partition; laterally compressed stems were uncommon and only found in the hollows. At this early stage in the growing season, and from the evidence available, it is assumed that the latter is jointed rush but that the former is more likely to be the hybrid with sharp-flowered rush, *Juncus* x *surrejanus*, which appears to be common in slightly flushed valley margin locations in Suffolk.

Although the vegetation in this southwest part of this site exhibits some of the characters of impeded flow at the surface, it also supports a suite of species found in fen meadows. Of these, the jointed rush may be most indicative of actual or recent groundwater influence in part of this site.

Aquatic (Ditch) flora present

There are two elements to the ditch flora. The most extensive are those sections of ditch that comprise, or are fed from, the site boundary ditch. This channel is fed, at least in part, by drains running across the edge of the floodplain from the base of the valley slopes. Part of the system is fed by a stream with a catchment extending from the western side of the A12 road. In these ditches, branched bur-reed is particularly frequent, typically growing with lesser water parsnip and various-leaved water-starwort. With water mint and marsh marigold, this group of groundwater-dependent species form the bulk of the ditch vegetation.

The second element of the ditch flora is found along this section of the main channel and along the northern ditch of the site, which is connected to it (locations 3 and 4). Here, cloudy grey water and algal growth indicate the presence of a different (eutrophic) water environment. Common reed is most frequent here and grows exclusively along the lower banks. Although some various-leaved water-starwort and branched bur-reed are also present in low numbers, these channels are relatively impoverished. The survey field notes are given in Appendix B.

Soil conditions

The site was sampled by four cores (Figure 3.2), which also indicates the location of two zones suggested by the coring results. A summary of the soil survey is provided as a log of soil cores in Table 3.2; site notes are given in Appendix B.

All four cores proved a sequence of silt loam over silty clay of peat within a depth of 125 cm. The upper surface of the silty clay is quite level across the site, only varying between 21-28 cm b.g.l.

Zone B is further away from the main channel and closer to the alderwood recorded from the western side of the site. Both cores were located in shallow standing water and intense mottling was found almost at the ground surface. The vegetation indicates that water tends to sit at the surface into the first part of the growing season. Core 1 showed a strong groundwater response when the core reached peat at 72 cm b.g.l., with the water table rising to 10 cm b.g.l. No indication of groundwater was proved in core 2 as the core filled with standing water, however, it is assumed that a similar response to core 1 would be observed if the coring were repeated when the ground surface was dry. The groundwater is forced beneath the impermeable silty clay under sufficient pressure to allow a substantial rise through the core. It is noted that there had been little rainfall in the months preceding the survey.

Zone B was sampled by two cores which show a thinning of the silty clay in the vicinity of core 3 in the north of the site and a thickening to the south and east. In comparison with Zone A, core 3 and 4 sample drier topsoils where significant mottling is not encountered within the root zone. Notwithstanding, the water tables in both cores are more elevated than that recorded in Zone A.

Table 3..2 Aldecar Lane, Benhall – Log of soil cores

Core / Soil type	**1**	**2**	**3**	**4**
		cm b.g.l		
Silt loam	0	0	0	0
Silty clay	28	25	28	21

Core / Soil type	1	2	3	4
Peat	72	92	49	110
End of core	125	125	125	125
Mottling	2	2	41	44
Standing water	2	5		
Water table - initial	72	?	60	54
Water table - final	10	?	60	54

Assessment of potential for fen meadow restoration

The Aldecar Lane has some potential for re-creating fen meadow vegetation using the inflow of waters from the valley margin. While the northern and eastern sides would not appear to be suitable (as they are currently drier) the shallow depth of the silty clay sediment may provide the opportunity to retain groundwater-sourced ditch waters within or near the root zone of the western and central soils.

The primary locus for fen-meadow development is the area of inundation vegetation closest to the valley margin (Figure 3.3), which comprises an approximate area of **1.5ha**. There is good potential for water management to provide the necessary water to support habitat in this area. A further area (indicated by the dotted line on Figure 3.3, approx. **0.7ha**) is identified around its eastern margin on the damp transition to dry – and somewhat elevated – *Lolio-Plantaginion* grassland. This fringing part of the floodplain is likely to require more substantial intervention to permit the development of fen meadow vegetation.

Although there are few suitable terrestrial species on the site, those that are present appear to extend over sizeable areas. The nearby fen meadow present on Manor Farm Meadows County Wildlife Site (CWS)[5] may also provide a suitable source of propagules.

In conclusion, it is considered that there is good potential for fen meadow habitat to be deliverable on this site, subject to the results of further studies and detailed conceptualisation.

3.2 Site No. 11 Watering Lane, Benhall

General description

The Watering Lane site (Figure 1.2) includes a section of the River Fromus valley south of Saxmundham, close to Site No. 10. The River Fromus drains the margin of the East Anglian clay plateau and makes a gentle descent over crag sands exposed on the valley sides to Snape, where it joins the River Alde. Upstream of the site, the network of floodplain drains is joined by a short tributary draining from the west of the A12 road; one drain also appears to link the sewage treatment works to the main river.

The site lies on the margin of Benhall parish, which largely follows the modern course of the main river channel. This retains much of its regular meander pattern with the exception of one short cut-off channel. A non-flowing secondary channel runs roughly parallel to the main channel, with which it is connected at two points in the centre of the site and along its southern boundary with the A1094 road to Snape. This second channel is itself connected to valley margin drains, most noticeably a catch drain that divides the site from a section of wet valley margin in the northern part of the site.

[5] CWS Number: Suffolk Coast No.12 Manor Farm Meadows, Benhall.

The most extensive habitat present on the Watering Lane site is species-poor floodplain pasture on the valley floor. A block of dry, sandy grassland forms the valley toeslope in the southern half of the western side of the site, abutting the secondary channel. The open water habitat is largely confined to the main river channel and marginal catch drain, though it was evident that most, if not all, of the channels are periodically wet.

Ditch Network

A summary of observation made in relation to the ditch network are given in Table 3.3.

Table 3.3 Ditch network observation summary

ID	Description	Width (m)	Freeboard (m)	Water depth (m)	Flow	Notes
W1	Drainage ditch along western boundary (north)	1-3	1	0.5	No apparent flow	The ditch runs along the western boundary of the site. It is connected to a moat, adjacent the site to the west.
W2	Drainage ditch along western boundary (central)	2	1	0.5	No apparent flow	Connected to the River Fromus by a west-east ditch, but currently blocked by a large trunk so no flow. It appears that this drain may have originally continued southwards.
W3	Shallow scrape from west to east	3	0.3	n/a	Dry	The scrape is relatively shallow. It runs from the western boundary ditch (W1) to the River Fromus but is currently dry.
W4	River Fromus (central)	3	1.5	0.4	Flow from north to south	
W5	Culvert	0.9			No apparent flow	Vehicle crossing. No flow through culvert at time of visit. Connects with dry secondary river channel to south.
W6	Secondary river channel	5-6	0.5	n/a	No flow	Secondary channel runs roughly parallel to the River Fromus. Potentially periodically wet.
W7	River Fromus (south)	3	1.5	0.4	Flow from north to south	

Note: Dimensions are approximate. The ID field references label on Figure 3.4.

Water is distributed around the site via a series of interconnected drainage ditches. There are no existing water level control structures in any of these drains, although a large tree trunk is currently blocking the drain at W2. The western boundary ditch in the northern half of the site would be the most obvious area for potential water level management. There is a freeboard of around 1m in this area which may allow introduction of a water level management structure to increase ditch levels to allow irrigation of the northern part of the site. However, consideration would need to be given to the impact on adjacent land including the sewage treatment works, the property at the end of Aldecar Lane and the adjoining moat, and Manor Farm Meadows CWS. At the time of the visit there was a lack of water along the secondary channel in the southern half of the site, thus limiting the potential for water level management in this southern area.

Terrestrial flora present

The site is composed of two landscape units – the sandy upland margin and the modern floodplain.

Dry sandy grasslands descend to the floodplain within the southern half of the site (Figure 3.4). There is typically a distinct break of slope above the course of the secondary channel, though the transition from drier grassland to moist floodplain vegetation varies from abrupt to rather diffuse along two sections at the northern and southern ends. To the north, this is marked by a shallow spur drain. Although dry at the time of survey, and containing no groundwater-influenced plant species, this is assumed to have once drained near-surface seepage water into the secondary channel. At the southern end of this landscape unit, the diffuse vegetation boundary is also likely to have been the focus of near-surface flows, as has been demonstrated by soil core 1.

These marginal grasslands have a ruderal appearance and support frequent Ragwort. Although too fertile to support acid grassland, they are nonetheless likely to be prone to summer-droughting, and to be maintained in an immature condition with a proportion of bare ground. The grasslands do not support species influenced by groundwater, though there is the potential to do so in the two areas identified.

This landscape unit retreats outside the site to the north and is replaced by floodplain. The site boundary follows the main ditch draining this part of the floodplain, which abuts the fen meadow on Manor Farm Meadows CWS.

The modern floodplain forms the larger of the two landscape units within the Watering Lane site. To the south and on the entire main channel frontage, the sward is a fairly uniform group of stands centred on the *Lolium perenne-Poa trivialis* leys of the *Lolio-Plantaginion* grassland (MG7b). Three variants are noted.

Where water sits at or near the surface into the spring, the sward is slow to start growing and low-growing daisy is able to develop and flower in full sunlight. This variant is common across the floodplain throughout this site. The second variant is the inverse with stronger grass-growth on slightly elevated areas, particularly along the boundary with the drier sandy grasslands and beside the main channel. Meadow foxtail joins perennial ryegrass and rough meadow-grass as a co-dominant in places. The third variant appears to be restricted to two parts of the site and is characterized by the appearance of groundwater-influenced species scattered amongst the dominant matrix of perennial ryegrass and rough meadow-grass. These are hard rush and marsh horsetail (both frequent but not more than scattered through the sward), with patches of a slender-leaved jointed rush (occasional) and rare water mint. The jointed rush patches were largely composed of slim, round slightly curved leaves in groups of 3-7, with cross-partitions and no evidence for a longitudinal partition. At this early stage in the growing season, and from the evidence available, it is assumed that this taxon is most likely to be the hybrid with sharp-flowered rush, *Juncus* x *surrejanus*, which appears to be common in slightly flushed valley margin locations in Suffolk. This third variant of the *Lolium-Poa* grassland also supports a greater cover of other species associated with this kind of grassland, including frequent common mouse-ear and white clover and occasional meadow buttercup and common sorrel. Cuckooflower is also present in very low numbers. This kind of vegetation occurs to the north of the site on the southern corner of the County Wildlife Site and is likely to represent the kind of grassland that may once have been present around the margin of a seepage zone. A second, less marked area is also present in the centre of the site and may be associated with the area containing the spur drain. Here, occasional hard rush and jointed rush were the main indicators present.

Aquatic (Ditch) flora present

Due to their inter-connectedness, there is little variation in the species composition of the combined network of the floodplain ditches and river channels. Sampling data is given in Appendix C. In shallow water and on the banks of all but the main channel, greater pond-sedge tends to be dominant. It is typically accompanied by emergent species that have the facility to grow submerged in groundwater-influenced waterbodies. Both water mint and lesser water parsnip are at least occasional in most types of watercourse on this site. They are occasionally accompanied by marsh horsetail in the shallower waters of the old and connecting channels.

In deeper water, various-leaved water-starwort is constant in all types of watercourse; it is notably prolific in the boundary ditch alongside a stand of sedge swamp that lies outside the site.

The main channel was the only waterbody where yellow water-lily, broad-leaved pondweed, water plantain and great yellow-cress were observed. Filamentous algae were also recorded here.

One further feature of note is the presence of a small colony of the invasive giant hogweed (c.10 plants) forming a patch of c.10 m^2 on the apex of a cut-off meander at NGR TM3819060093.

The abundance of greater pond-sedge confirms that the groundwater-influence indicated by the fringing herbs is naturally eutrophic. This is also suggested by the lush growth of the vegetation along the valleyside margin of the floodplain, where a block of fen-meadow and alderwood accompany the sedge stand.

Soil survey

The site was sampled by three transects, as shown in Figure 3.5, which also indicates the location of three zones suggested by the coring results. A summary of the soil survey is provided as a log of soil cores in Table 3.4; site notes are given in Appendix C.

Zone A consists of two small areas sampled along the margin between the sandy valley footslopes and the floodplain. Both cores have developed a peaty to humic topsoil.

Core 1 lies outside the historic floodplain with no evidence for sediment deposition. A comparatively shallow water table is indicative of near-surface groundwater flowing through sand. Core 6 has a thin (21 cm) band of silt loam over the subtending sands with no evidence of mottling. Within the body of sand, there is a shift from good oxygenation to poor at 35 cm, with manganiferous streaks present at a depth of 74 cm, which appears to be the water table level in this area.

Zone B is the riparian frontage of the floodplain. The variable intensities of mottling in the topsoil do not correspond well with the distribution of 'daisy lawns', but the three sample cores all proved thick beds of silty clay over the silt loam, with no subtending peat recorded. Core 4 did not prove clay until a depth of 85 cm, however, which may indicate substantial variations in the upper surface of the clay close to the main channel. Depth to the water table in the sampled areas compared well with those of Zone A, suggesting that the bed of clay is maintaining the local water table near the main channel.

Zone C supports relatively thin layers of silt loam and silty clay over a bed of peat in the west of the site, with the silty clay thickening eastwards between cores 7 and 8. There is also a change in the degree of topsoil waterlogging, with cores 5 and 7 exhibiting more impeded drainage than is the case in the area sampled by core 8. Core 5 – adjacent to core 6 – also recorded manganiferous streaks at the relatively shallow depth of 35 cm, in silt loam. Although the water table was not initially proved until a depth of 106 cm, it subsequently rose to near this level, 39 cm b.g.l. The water table was initially recorded in sands below the bed of peat; as the basal part of the peat was more degraded than the upper part this may indicate that the groundwater level is fluctuating through the lower part, though it may rise through the peat during periods of heavier rainfall.

Table 3.4 Watering Lane – Log of soil cores

	Zone A		Zone B			Zone C		
Core / Soil type	**1**	**6**	**2**	**3**	**4**	**5**	**6**	**7**
				cm b.g.l				
Peaty top	0	0		0	0	0	0	
Humic silt loam		6	0					
Silt loam		14	20	2	3	5	4	0

	Zone A		Zone B			Zone C		
Core / Soil type	**1**	**6**	**2**	**3**	**4**	**5**	**6**	**7**
Silty clay			38	33	85	28	31	21
Peat						45	41	94
Humic sands	4							
Sands	36	35				106		
End of core	91	125	125	125	125	125	125	125
Mottling	56	14	4	20	10	5	4	25
Manganiferous streaks		74				35		
Water table - initial	56	74	50	60	55	106	98	-
Water table - final	56	75	50	60	55	39	60	87

Assessment of potential for fen meadow restoration

The Watering Lane site has relatively limited potential for re-creating fen meadow vegetation using the inflow of waters from the valley margin. It is largely dependent upon the section of boundary ditch in the northern half of the site for a supply of groundwater. This may be used to irrigate the northern of the two areas of groundwater-influenced vegetation. However, the low level of the secondary channel may make it impossible to retain groundwater in the central part of the site, where the southern area is located.

The primary locus for fen-meadow development is restricted to land adjacent to the western ditch in the north of the site (Figure 3.6), which comprises an approximate area of **0.5ha**, although part of this already supports fen meadow species and so enhancement of this area would not count towards the compensation target. Two larger potential blocks are also identified (indicated by the dotted lines on Figure 3.6, with additional areas of approximately **0.5ha** (north) and **0.7ha** (south)) centred on the two areas showing groundwater influence. In both instances, ditch water would need to be elevated onto the floodplain but detained above the layer of silty clay. However this is likely to be practically difficult to achieve and control on this site.

Based primarily on the existing nature of the site, identification of only a limited extent of area for developing fen meadow habitat and the difficulties in managing water appropriately to deliver the habitat without risk to other nearby receptors, it is suggested that this site is less preferable.

3.3 Site No. 28 Blyth Road, Halesworth

General description

The Blyth Road site (Figure 1.3) is a section of floodplain by the River Blyth on the south side of Halesworth, immediately east of the Bramfield Bridge where the A144 crosses the river valley. The Blyth drains the thinning margin of the East Anglian clay plateau to the west, where sands and gravels and crag sands have been exposed on the valley sides. Upstream of the river, land use is agricultural; the site itself lies between the river and a modern industrial estate and is immediately upstream of a sewage treatment works.

The site boundaries are defined by the river on the southern side and by the recently constructed Blyth Road on the upland margin. As seen elsewhere on this river section, the floodplain is dissected by drainage ditches leading from the base of the upland onto the channel corridor. All ditches run from a catch dyke running from beside the A144 along the upland toeslope to the eastern corner of the site. Here, although the dyke extends further along the floodplain margin, it is connected to a substantial ditch that crosses the floodplain to join the only cut-off meander within the site. The modern course of the Blyth is otherwise long-established, though a low bund extends across the site's frontage.

The most extensive habitat on the Blyth Road site is species-poor grassland, which grades towards rush pasture in its wetter areas. These are located away from the river on slightly lower-lying land at the foot of the valley slope, either side of the catch dyke. The ditch network supports a marginal flora with little open water, though it would appear most of the network is perennially wet.

Ditch Network

A summary of observation made in relation to the ditch network are given in Table 3.5.

Table 3.5 Ditch network observation summary

ID	Description	Width (m)	Freeboard (m)	Water depth (m)	Flow	Notes
W1	Catch dyke (SW)	2.5	0.5-1	0.4	No apparent flow	Runs SW-NE across the whole site. 1m freeboard on northern side, 0.5m on southern side. Catches groundwater from the north. It is not clear if this ditch receives run-off water from the industrial estate to the north.
W2	Catch dyke (NE)	2.5	0.5-1	0.4	No apparent flow	u/s of sewage treatment works. Dyke joins drain on NE boundary of site (W3).
W3	NE boundary drain	3	0.5-1	0.5	No apparent flow	Ditch drains towards the River Blyth, although no flow visible during the visit. Ditch appears to be permanently wet with an approx. 20cm variation in level.
W4	Cut-off meander	1.5-2	0.5	Boggy	No apparent flow	This feature appears to be an old meander that has been cut off from the River Blyth. The old channel is boggy with some standing water. Its possible that water may back-up here from the River.
W5	River Blyth (East)	3-4	2-2.5	0.6	Flow from SW to NE	The River Blyth runs from SW to NE and forms the southern boundary of the site. Two drains discharge to the River Blyth (W3 and W6).
W6	Connecting drain and culvert	2.5	1	0.2	No apparent flow	This drain connects the Catch Dyke to the River Blyth. The is a concrete retaining wall at the northern end, presumably with a culvert although this could not be seen during the visit. At the southern end the is another concrete retaining wall with a culvert (~0.7m diameter) that leads to the River Blyth. The was no flow and no discharge at the time of the visit.
W7-W9	Drainage ditches	2-2.5	0.6	0.1-0.3	No apparent flow	These drainage ditches extend SE from the catch dyke. There was no flow in these ditches at the time of the visit although shallow water was

ID	Description	Width (m)	Freeboard (m)	Water depth (m)	Flow	Notes
						present in each of the ditches. It is not clear if these are draining to, or from, the catch dyke.
W10	SW boundary ditch	1	0.3	Dry		This is a shallow ditch along the boundary of the site. This is a surface drain and does not appear to intercept groundwater.

Note: Dimensions are approximate. The ID field references label on Figure 3.7.

Groundwater is captured by the catch dyke near to the north-western boundary of the site. A series of drains run across the floodplain from the catch dyke towards the River Blyth. Two of the drains discharge to the River Blyth (W3 and W6). There are no existing water level control structures in the drains on site, although there is a culvert discharge to the River Blyth at W6. There is potential to install water level control structures along the catch dyke to encourage water to back-up, thus raising water levels within the catch dyke and the perpendicular drainage ditches. To prevent loss of water to the River Blyth via the culvert, a water level control structure may also be required within the ditch at W6. Raising water levels in these ditches will create the opportunity to distribute water onto the land.

Terrestrial flora present

The site is composed of three landscape units (Figure 3.7) – the upland margin, the modern floodplain and the river bund.

The upland itself is restricted to a small area in the northeast corner of the site. This is a slightly elevated platform with a distinct, curving margin. The sward is dominated by the lush growth of perennial ryegrass; associates are chickweed, red dead-nettle, shepherd's-purse and nettle. It corresponds to the OV23 *Lolium perenne-Dactylis glomerata* community found in occasionally disturbed areas with no drainage constraints. No phreatophytes were observed.

The modern floodplain meets the upland along the line of the Blyth Road except in the northeast corner. The boundary between these two units grades over a very shallow slope traceable on the ground as a transition from the group of fertile-soil ruderals on the upland to a palimpsest of groundwater-dependent species, of which hard rush is the most noticeable.

The floodplain itself can be separated into three elements by the segregation of hard rush and soft rush through moister parts of the sward, and by the gradual transition over the floodplain to the dry, species-poor sward of the river bund.

Hard rush represents a small group of species scattered through an otherwise species-poor grass-dominated sward along a ribbon of ground dissected by the catch dyke. This is the focus of species influenced by near-surface groundwater. On the northern side of the catch dyke the ground slopes very gently onto the upland and here there is little evidence for surface water detention. Hard rush is scattered throughout a grass matrix dominated by perennial ryegrass and rough meadowgrass with scattered meadow foxtail and cuckooflower.

On the river-side of the Catch-dyke, creeping bent increasingly replaces perennial ryegrass, and is accompanied by frequent common sorrel, meadow buttercup and common mouse-ear, with scattered dandelions (sections Celtica and Ruderalia).

Also present are occasional patches (often c.2 m in diameter) of a slender-leaved jointed rush. The jointed rush patches were largely composed of slim, round slightly curved leaves in groups of 3-7, with cross-partitions and no evidence for a longitudinal partition; laterally compressed stems were uncommon and only found in shallow hollows. At this early stage in the growing season, and from the evidence available, it is assumed that the latter is Jointed Rush but that the former is more likely to be the hybrid with

Sharp-flowered Rush, *Juncus* x *surrejanus*, which appears to be common in slightly flushed valley margin locations in Suffolk.

The central part of this stand corresponds to the *Juncus inflexus* sub-community of the *Holco-Juncetum effusi* rush-pasture (MG10b); on the upland margin the vegetation grades to the *Lolium perenne-Poa trivialis* leys of *Lolio-Plantaginion* grasslands (MG7b) with the loss of species associated with groundwater-influence. The boundary with the open rush-pasture with soft rush is typically within 15 m of the catch dyke.

The area of soft rush is most clearly defined in the northeast of the site, where low-lying land supports a species-poor grassland approaches rush-pasture in its physiognomy. Creeping bent is abundant here, with frequent soft rush, white clover and creeping buttercup with occasional tufted hairgrass and cuckooflower. The site-owner commented on the wet ground between ditches 1 and 2, and the preponderance of creeping bent is indicative of surface water detention. Similar vegetation is also present between ditches 2 and 3 along the low-lying strip on the riverside of the catch-dyke. This is also a grass-dominated rush-pasture with abundant creeping bent, frequent soft rush, white clover and creeping buttercup with occasional cuckooflower and marsh thistle.

The vegetation corresponds to the Typical sub-community of the *Holco-Juncetum effusi* rush-pasture (MG10a). No phreatophytes were observed. Over a large part of the floodplain, however, rushes are no more than occasional, and here occasional shoots of creeping thistle define the more free-draining soils of much of the floodplain. Perennial ryegrass is abundant with common rough meadowgrass; creeping thistle is also frequent with occasional hard rush. The river bund itself is composed of species-poor grassland dominated by perennial ryegrass with very few constant associates apart from rough meadowgrass. This relatively extensive sward is a species-poor version of the *Lolium perenne-Poa trivialis* leys of *Lolio-Plantaginion* grasslands (MG7b).

In the south eastern corner of the site, where the cut-off meander slopes merge into the lower bund slopes, there is an area of short sward where the dominant ryegrass is accompanied by frequent white clover and occasional rough meadowgrass, cock's-foot and hard rush. This type of grassland also corresponds to the *Lolium perenne-Poa trivialis* leys of *Lolio-Plantaginion* grasslands (MG7b).

Following Londo's (1988) classification of groundwater-dependency, seven of the listed species are regarded as 'non-obligate phreatophytes', that is : 'Species growing mainly or almost exclusively within the sphere of influence of the water table, which is generally below the soil surface' (see Section 2). The German 'phytosociological flora' (Oberdorfer 2001[6]) suggests that these species can be divided into three groups according to the vegetation with which they are associated:

- Fen-meadow - Marsh thistle, Jointed Rush, hybrid Jointed Rush;
- Calcareous rush-pasture - Cuckooflower, Hard Rush; and
- Acid-neutral rush-pasture - Tufted Hair-grass, Soft Rush.

The 'fen-meadow' and 'calcareous rush-pasture' species are largely restricted to the 'hard rush' areas either side of the catch dyke. The remaining species are typical of the 'soft rush area'. Their preference for less base-rich substrates is likely to reflect the declining groundwater influence away from the upland margin, coupled with an increasing dependence on surface water detention.

Aquatic (Ditch) flora present

Due to their inter-connectedness, there is little variation in the species composition of the combined network of the catch dyke and five cross-floodplain ditches. Sampling data is given in Appendix D. Greater and lesser pond-sedges and branched bur-reed were each recorded as abundant in different ditch sections. Of equal

[6] Oberdorfer E. (2001) Pflanzensoziologische Exkursionsflora für Deutschland und angrenzende Gebiete, 8. Auflage. : Eugen Ulmer, Stuttgart.

significance was the group of shorter emergents represented most frequently by lesser water-parsnip and water forget-me-not. True aquatic species were rarely encountered as little open water was present; ivy-leaved duckweed and various-leaved water-starwort were the only species observed.

The frequent presence of immature alder along the entire ditch network is recognised as an indication of constant water levels within the ditches, typically created by sub-surface water movement. This is also borne out by the habit of the shorter emergents to occur as wholly or largely submerged plants within the ditches. This group also includes fool's water-cress, water mint and watercress.

Three species were wholly or largely recorded within the 'Hard Rush' zone: ivy-leaved duckweed, fool's watercress, watercress and blunt-flowered rush. The latter was only recorded from one locality and is known as a character species for fen-meadow vegetation.

The lower sections of ditches also show the development of ochreous sediment and patches of natural oils. This is particularly evident in Ditch 1 on the eastern margin, where the basal sediment is also discoloured dark grey by the suspected presence of suspended sulphide particles, a potential precursor of acid sulphate soils. This type of chemical environment is frequent in Suffolk rivers where the lower reaches have been subjected to marine incursions and tends to be focussed around peat-mineral boundaries periodically exposed by water table fluctuations. This is most likely to occur where the floodplain water table falls towards the river level.

Soil survey

The site was sampled by three transects, as shown in Figure 3.8., which also indicates the location of three zones suggested by the coring results. A summary of the soil survey is provided as a log of soil cores in Table 3.6; full site notes are given in Appendix D.

Zone A represents the small area of upland in the northeast corner of the site, and the fringes of the floodplain where the upland sediments are near the ground surface. Manganiferous streaks (in cores 1 and 4) provide evidence for the depth in each core where the water table has typically fluctuated; the streaks are also associated with evidence for periodic wetting and drying where ferrous iron has been mobilised within a high water table and precipitated out as ferric (rust-coloured) iron in soil voids when the water table falls. The occurrence of streaks, in particular, is evidence for relatively high groundwater levels along the valley margin. Core 5, on the margin of this zone, confirms the relative dispositions of the floodplain sediments. In the past, groundwater seepage through the sands and freshwater river incursions have led to the development of reed-carr peats except along the valley edge. These have subsequently been buried by a layer of brackish clay. The subsequent deposition of a silt loam alluvium has also extended to the valley margin.

Zone B reveals a substantial development of peat on the valley floor buried beneath the silty clay; here, subsequent alluvial deposition seems to have been sporadic and was not recorded from two of the cores sampling this area. Cores 6 and 10 appear to lack modern alluvial deposits but have a relatively thick 'peaty top' at the ground surface, which was recorded directly over silty clay. Core 2 proved the full sequence of mineral sediments and, in this, is transitional to Zone C.

Zone C covers much of the floodplain and demonstrates that the silt-clay-peat sequence is widespread. Cores 7 and 9 lack the peaty top found in Zone B but are otherwise similar; Core 8 demonstrates that the peat thins in the southwest and overlies sand, while Core 3 records a local deposit of dark-grey (probably sulphidic) silty clay beneath the spread of silt clay recorded across the floodplain.

Table 3.6 Blyth Road, Halesworth – Log of soil cores

	Zone A			Zone B			Zone C			
Core / Soil type	**1**	**4**	**5**	**2**	**6**	**10**	**3**	**7**	**8**	**9**
					cm b.g.l					
Peaty top		0		0	0	0	0			
Silt loam			0	6			1	0	0	0
Silty clay			18	30	8	9	31	29	39	29
Peat				40	41	48		41	65	42
Coarse angular sand									116	
Humic sand	0	6								
Light yellow sand	56	36	35							
Light grey-green sand		71	57							
End of core	82	82	97	125	125	125	125	125	121	125
Mottling	38	20	7	6	8	9	2	5		3
Manganiferous streaks	66	71								
Yellow iron mottles	66									
Sulphidic							31			
Water table - initial	-	62	57	62	66	72	82	90	-	89
Water table - final	-	62	57	45	66	72	68	90	-	89

The disposition of these floodplain sediments and the water table broadly correspond with the distribution of groundwater-influenced species on the floodplain. The silty clay layer is likely to impede movement of groundwater, rainwater and also floodwater.

It should be noted that the modern water table - recorded from most floodplain cores - lies at some depth below the upper peat surface across the floodplain. This is undoubtedly at a lower level than would have been required for peat formation, and also suggests that the groundwater is under insufficient hydrostatic pressure over most of the floodplain to influence near-surface conditions.

Local exceptions are indicated in Core 2 (Zone B) and Core 3 (Zone C). Core 2 sampled Soft Rush pasture near the margin of the Hard Rush area; the water table depth rose during coring to near the top of the peat layer but did not enter the silty clay deposit. The rise recorded in Core 3 is likely to be the local influence of the abandoned meander channel.

The peat is uniformly hemic above the water table and has been protected from decomposition to a large extent by the overlying bed of silt clay. Below the water table, woody peat is prevalent in the upper part and increasingly sapric with depth. No crystalline precipitation was observed, which suggests that groundwater flows from upslope have been sufficient to maintain a stable freshwater environment.

The silty clay and overlying silt loam both show the effects of periodic waterlogging. This is most pronounced in Zone B, where strong mottling reaches almost to the ground surface in cores 2 and 6, and in the lower-lying parts of Zone A, sampled by Core 5. As the water table was recorded at depth in these cores, these effects are certainly the result of surface water detention and are concentrated in those areas where rush growth is frequent. Over the rest of the floodplain, mottling is less concentrated and is encountered lower in the soil profiles; this may be viewed as impeded drainage rather than water detention.

On the valley margin, the cores in the sands of Zone A show evidence of active water table movement above the height of the recorded water table. This is interpreted as the influence of near-surface groundwater in the vicinity of the catch drain. As at other sampled parts of the site, the current water table may be influenced by the low rainfall total through the winter and into this spring.

Assessment of potential for fen meadow restoration

There is significant potential to re-create fen meadow vegetation at the Blyth Road site using the inflow of waters from the valley margin. The surveys have indicated that the catch dyke collects near-surface groundwater, which is distributed across the valley foot and runs across the floodplain as a series of drains. These provide the opportunity to collect and distribute the water onto the land between the drains and expand the areas already supporting several groundwater dependent species.

The primary locus for fen-meadow development is the area where the existing vegetation indicates groundwater influence near the ground surface (indicated by the solid line on Figure 3.9), which comprises an approximate area of approximately **1.2ha**. Notwithstanding, there is also a large area of the floodplain where ditch water could be detained above the layer of silty clay, indicated by the dotted line on Figure 3.9, an additional area of approximately **1.3ha**. It is not evident at this stage what the role of river flooding might be, or whether undesirable surface drainage is connected to the ditch system.

In conclusion, it is considered that there is good potential for fen meadow habitat to be deliverable on this site, subject to the results of further studies and detailed conceptualisation.

3.4 Site No. 54 Pakenham Fen

General description

Site No. 54 Pakenham Fen (Figure 1.5) lies in a shallow basin bisected by the Pakenham Stream, a headwater channel that drains a calcareous sub-catchment of the River Blackbourn.

The site area visited is under the ownership of two separate parties sharing a common boundary – a tongue of upland which divides the surface hydrology of the western side of the valley. These sites are distinguished as the 'north' and 'south' parts of the site area (Figure 1.5). Although mapped at the same time they are, with the exception of Figure 3.10 (Locations of ditches referred to), presented separately in the figures referred to in this section (Figures 3.11-3.13).

The north site on the downstream side is bounded to the west by a break of slope separating the upland from the valley floor. The margin of this upland is composed of sands and gravels. The upland also has a pronounced sandy terrace toeslope occupying much of the northern part of this site. The upland also extends far into the valley along the southern boundary, reaching the Pakenham Stream, which partly forms the eastern boundary of the site with the exception of one field which extends to the upland margin to the east of the stream.

A large block of adjacent land – the eastern side of Pakenham Stream – is designated as Pakenham Meadow SSSI (Figure 3.13a), for which wet grassland (i.e. fen meadow) is the primary interest feature. The SSSI is also the subject of a short hydro-ecological account in Wheeler & Shaw (2000)[7].

A straight drain runs through the centre of this site, bisected to the north by a second primary drain; both ditches appear to be carriers for near-surface groundwater. The stream is, at least in appearance, elevated above the floodplain.

The north site supports areas of improved (*Lolio-Plantaginion* (MG7b)) grassland (Figure 3.11a), dominated by perennial ryegrass, rush pasture with abundant hard rush and also a large block of fen meadow, with abundant pond-sedges and blunt-flowered rush.

The south site on the upstream side is also bounded to the west by a break of slope separating the upland from the valley floor (Figure 3.11b). The margin of this upland is composed of sands and gravels, though chalky boulder clay and chalk were also encountered near the ground surface. The upland also extends far into the valley along the northern boundary, reaching the Pakenham Stream, which forms the eastern boundary of the site.

The south site is shaped as an inverted 'V', the two arms separated by valley woodland. A boundary drain along the upland margin and a simple drain system across the valley takes near-surface groundwater to the same straight drain that runs through both the north and south sites. The south site supports areas of improved grassland, dominated by perennial ryegrass, a large block of fen meadow, with abundant pond-sedges and blunt-flowered rush and a small area of incipient rush pasture with frequent hard rush (Figure 3.11b).

To the south of the surveyed areas, three small meadows on the eastern side of the stream are designated as Pakenham Fen County Wildlife Site.

It should also be noted that almost the whole of the north site is included within a Mid Tier Countryside Stewardship Agreement. This type of agreement type was not included in the initial GIS based site screening exercise and was also not identified as a constraint to the site identification process by stakeholders. Nonetheless, it is considered that further consideration is required of the constraint that such an agreement places on the potential inclusion of this site within the process. The south sites is not covered by a similar agreement.

Ditch Network

A summary of observations made in relation to the ditch network are given in Table 3.7.

Table 3.7 Ditch network observation summary

ID	Description	Width (m)	Freeboard (m)	Water depth (m)	Flow	Notes
W1	Western boundary ditch	1.5	2 to west, 1.5 to east		No apparent flow	There is a track crossing here and the ditch contains some water on the north side but is dry on the south side.
W2	Drainage ditch	4	0.7	0.7	No apparent flow	Wide drainage ditch containing water, but not clearly flowing. Interconnected at right angles with central channel (W5).

[7] Wheeler B.D. & Shaw S.C. (2000) A Wetland Framework for Impact Assessment at Statutory Sites in Eastern England. Site Accounts. R&D Technical Report W6-068/TR2. Environment Agency, Almondsbury.

ID	Description	Width (m)	Freeboard (m)	Water depth (m)	Flow	Notes
W3	Western boundary ditch	3	0.5	0.4	No apparent flow	Very shaded ditch on western boundary.
W4	Western boundary ditch	2.5	3.5	0.3	No apparent flow	Western boundary ditch with culvert connection beneath track. Much lower level than adjacent land to the east.
W5	Central channel	2-4	0.5-2	0.2-0.7	Flow to north	This channel cuts south to north across the centre of the site. The freeboard varies but is greatest in the centre of the site and shallows out to the north and south. Northwards flow can be observed in the southern half of the site but as the channel widens and interconnects in the northern half of the site the flow is no longer obvious.
W6	Pakenham Stream (north)	4	1	0.3-0.5	Flow to north	Shallow and low flowing. Peaty silt on bed.
W7	Field scrapes	2	0.4	Boggy	No flow	Two field scrapes in the northern field. Not interconnected with other ditches.
W8	Pakenham Stream (central)	5	0.5	0.3-0.5	Flow to north	Shallow and low flowing. Peaty silt on bed. Banks are raised 0.5-1m above land level.
W9	Drainage ditch	3	2.5	0.1	No apparent flow	Pakenham Stream dissects these two W-E ditches but is not interconnected.
W10	Eastern boundary ditch	1	1.5	0.1	No apparent flow	This ditch borders the back of the houses on Fen Road.
W11	Dam	3	1		No flow	A dam separates the southern boundary ditch from Pakenham Stream. The southern boundary ditch is dry so the presence of the dam implies that the ditch may have previously been taking water from the stream or that water in encouraged to drain to the central channel rather than to Pakenham Stream.
W12	Central channel	2	2	0.3	Flow to north	The central channel passes through a culvert at this location.
W13	Dry western boundary ditch	2	1	Dry	No flow	
W14	Eastern boundary ditch	2	3	0.2	Low flow to the south	
W15	N-S drainage ditch	3	0.5	0.2	No apparent flow	Lots of leaf litter in ditch. The ditch dries to the north and water deepens to the south.
W16	W-E drainage ditch	3	0.5	0.2	No apparent flow	Lots of leaf litter in ditch. Woodland to the south but land suggest the ditch drains to the east.

Note: Dimensions are approximate. The ID field references label on Figure 3.10.

The drainage network of the south site drains towards the central drain (W12) which channels water up to the north site. There is an existing dam (W11) which disconnects the southern drainage ditch from Pakenham Stream. The southern ditch was dry at the time of the visit indicating that drainage in this area is directed towards the central drain rather than to Pakenham Stream, hence the presence of the dam. There is potential to introduce water level control structures either on the central drain or within the internal ditches to raise water levels in this area, however this could potentially impact on the water supply to the north site.

The central drain (W5) is the key water carrier in the north site, receiving water from the south and distributing via the main perpendicular drain (W2). Both these ditches also appear to be carriers of near-surface groundwater. There does not seem to be an abundant supply of water in the western ditches (W1, W3 and W4) and the freeboard increases towards the north, limiting the potential to introduce water control structures of any use. The central drain would therefore be focus for potential water management structures and/or a supply of water for irrigating the land. The impact of such structures or water use would need to be considered in relation to the existing fen meadows areas in the north site.

Terrestrial flora present

The survey area as a whole is composed of two landscape units – the upland margin and the modern floodplain. The former has sands and gravels at the surface where sampled, though the British Geological Survey map areas as periglacial hillwash, where sands and gravels are mixed with silt and clay. The disposition of the upland seemingly occurs as two units, marginal and within-valley. The latter enclose large areas of the modern floodplain in both north and south areas.

The distribution of vegetation types on the valley floor in the north area is indicated in Figure 3.11a. Groundwater-influenced species occur in both an area of fen meadow (most likely M22 *Juncus subnodulosus – Cirsium palustre* fen meadow community) and on ditch banks; the channel itself supports few species, with only various-leaved water-starwort being more than occasional. The fen meadow area had recently been topped; marsh marigold was flowering prolifically in the western field and Meadow Valerian in the eastern field. Pond-sedges and blunt-flowered rush were abundant in both areas.

Part of the north site is improved grassland, where Perennial Ryegrass dominates both the areas of upland and also contiguous blocks either side of the stream in the south of this site, where the swards can be assigned to *Lolio-Plantaginion* grasslands. Colonisation by the meso-calcic hard rush is evident in parts of this habitat, though rush pasture is only strongly developed on what appears to be the weakly flushed western slope in the centre of the site (Figure 3.11a). Here, hard rush is typically abundant and associates grade from a ruderal flora – including nettle and curled dock – to a more established sward beside the central drain, where the moss *Calliergonella cuspidata* is indicative of groundwater-influence.

The distribution of vegetation types on the valley floor in the south area in indicated in Figure 3.11b. Much of this land is classified as improved swards of the *Lolio-Plantaginion* alliance, with Hard Rush scattered through a low-lying area alongside the stream.

The area of much higher conservation value lies in a partial embayment at the western tip of the site. In the wettest areas, small stands of greater tussock-sedge have developed. The greater part of the field, however, is dominated by Blunt-flowered rush with frequent hard rush and an associated grass-dominated under-storey. In the south-east corner of this field, a flushed grassland supports tawny sedge.

Records for saw sedge (north site) and tawny sedge (south site) are both notable. Sanford & Fisk (2010) include a record of tawny sedge from Pakenham Fen[8], one of only seven in Suffolk; saw sedge has not been previously recorded from the fen and only 14 records are registered for Suffolk.

[8] Tawny Sedge is a species characterizing the interest feature described in the SSSI notification.

Aquatic (Ditch) flora present

The north and south sites have three types of open water channel, the Pakenham Stream itself, ditches on the upland edges, and the network of internal ditches. Of particular concern in the context of this survey was the lack of a significant water supply from the upland edge ditches.

Pakenham Stream

The stream bed appears to be elevated above the level of the floodplain. This may not have been the case in the past, but the modern channel is likely to be acting largely as a 'carrier', conveying catchment waters across the floodplain. At the time of survey, the channel bed was masked by an unknown thickness of peaty silt and the water level in the vicinity of Ditches 14 and 15 appeared to be c.1 m above ditch level.

The stream was sampled in four places. In the north, samples 6 and 13 noted good clarity and colour in the water column over dark peaty silt. Aquatic vegetation was no more than occasional in the channel, though Mare's-tail was frequent in sample 6. This species is usually found in clear, base-rich water and is particularly vigorous where growing in soft, eutrophic substrates[9]. In this section of the river, Greater Pond-sedge was recorded as abundant on the shallow banks, with occasional associates of groundwater-influenced species. In this section of the stream, the species composition therefore indicates the influence of groundwater.

This is less obvious in the south. Although in sample 25 various-leaved water-starwort and water mint were present, reed was often abundant on the banks and, as in sample 24, in the channel too. In the latter sample, the water quality was far more turbid and coloured than further north.

Internal ditches

Many internal ditches were over-shaded by broadleaved trees and shrubs, which affected plant growth on the channel and banks. The majority of the samples were taken from the denser network of ditches in the north. Here, all ditches contained at least some water and both the channel and wet banks supported groundwater influenced species. The preponderance of Greater Tussock-sedge and Greater Pond-sedge, often abundant on the wet banks or the channel, signals eutrophic base-rich groundwater-influenced conditions. The channels were relatively impoverished, with only various-leaved water-starwort displaying any frequency in some ditch sections. In this northern part of Pakenham Fen there seems to be some correspondence between the density of the ditch network, the distribution and frequency of these species and the presence of fen meadow vegetation.

There are also a number of internal ditches in the south. These were largely over-shaded and supported few aquatic or bank species with little indication of groundwater influence. Much of this ditch network contained little water and water quality was only observed from the central ditch at samples 23 and 27.

Upland edge ditches

The majority of the samples were taken from the western ditch which typically lies at the foot of the upland. In long stretches, this ditch had been deepened and was often 2-3 metres deep, as recorded in samples 5 and 21. No sample recorded a water column of any depth and the only aquatic species recorded was Common Duckweed and groundwater-influenced species were rare. Water quality appeared to be poor in the vicinity of samples 1 and 21. The long, western drain did not appear to act as a catch dyke at the time of survey, though is very likely to be its original function. Five upland ditches are connected to it, with one draining from the complex of buildings at Old Hall.

[9] Preston C.D. & Croft J.M. (1997) Aquatic Plants in Britain and Ireland. Harley Books, Colchester.

In the north site, two samples (16 and 17) were taken of the fringing ditch surrounding the gardens leading to the fen edge from Fen Road. These lie at the start of a marginal drain and were either dry or shallow, with very few groundwater-influenced plants present.

Soil survey

The site was sampled by 17 cores, as shown in Figure 3.12a and 3.12b, which also indicates the location of two zones suggested by the coring results. The valley floor zone is sub-divided by the dominant sediment encountered. A summary of the soil survey is provided as a log of soil cores in Table 3.8; full site notes are given in Appendix E.

Overall, the site is notable for the prolonged groundwater influence evident from the beds of fen peat and calcareous marl deposited at or near the ground surface. Beds of precipitated marl were widely encountered and their extent – as indicated by the core samples – is given in Figure 3.12a and b. Most cores exhibited the deposition of peat over sand, with chalky boulder clay or 'putty' chalk proved in cores in the centre of the survey or the southwest corner, respectively. Beds of marl varied widely in thickness and disposition, typically occurring within the peats but also found above it. A wetland-forming environment was only absent in 3 cores: core 3 sampled an area of the upland toeslope, but cores 9 and 14 lie within the modern floodplain; these soils all support *Lolio-Plantaginion* grasslands.

The remaining floodplain cores were taken from areas which now support fen meadow, rush pasture and improved grasslands. It is likely that the areas currently supporting fen meadow denote locations with groundwater upwelling, while the main area of rush pasture is a weakly flushed slope. Unfortunately, low rainfall levels meant that the water table was seldom encountered and Table 3.8 therefore reports (in brackets) the depth at which wet soils were first encountered. It is likely that the historical water table relates to the zones of sapric peat or, in Core 9, where manganiferous streaks were proved. It is also evident that where peat is at the ground surface, it is in poor condition, and recorded as earthy peat. The reduction of the water table from the ground surface is clearly long-standing.

Table 3.8 Pakenham Fen North and South sites – Log of soil cores

Core / Soil type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
					cm b.g.l												
Peaty sand	0				0												
Humic sand					3		0										
Sand	8				22												
Earthy peat		0		0		0		0			0	0	0		0	0	0
Humic sand						15						24					
Hemic peat	29	12				30				0		43					
Marl				24	34		23			15	18					24	
Hemic peat				65	61											45	
Hemic-Fibric peat		52								25							
Sapric peat	71	110		85	70		28	34		57	31	58			35		38
Hemic peat																	82
Humic sand			0						0				42				
Sand			25				102	54	30				59	0			
Chalky Boulder Clay								84	99								
Putty' Chalk										98		75					
End of core	125	125	37	125	125	125	125	125	125	125	125	125	100	60	125	125	125

Core / Soil type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Mottling	12				22			57	41					38			
Manganiferous streaks									62								
Sulphurous odour				110	110												
Initial water table (or wet)	(82)	52		70		(62)	(66)	(84)		62	(73)	(58)	(80)		(50)	(80)	(63)
Final water table		46		53		62				43							

Assessment of potential for fen meadow restoration

There is significant potential to develop fen meadow vegetation at the Pakenham Fen sites, though there are significant issues relating to groundwater supply and to the poor condition of surface peats.

The primary locus for fen-meadow development at the north site (Figure 3.13a) is along the western slope and around the north side of the area of fen meadow, which comprises an approximate area of **3.2ha**. If control is exerted over the central drain, then large areas of rush pasture and improved grassland also have the potential to act as fen meadow compensation (an approximate additional **6.2ha**).

The greatest potential for developing fen meadow on the south site (Figure 3.13b) lies in controlling the internal ditches connected to the central drain, which would encompass an approximate area of **1.7ha**. The potential also exists to detain water in the topsoil within the surrounding improved grassland (an approximate additional **4.3ha**).

Although there is significant potential for fen meadow habitat to be deliverable on one or both parts of this site, it may not be straightforward. For the north site the potential constraint that inclusion of the site within a Mid Tier Countryside Stewardship Agreement places on inclusion of the site in this process needs to be confirmed, and further detailed studies will be required to determine whether likely issues with groundwater supply and the poor condition of the peat surfaces are insurmountable. Although the presence of existing good quality fen meadow habitats on the adjacent SSSI, immediately to the north of the north site and in the south-western corner of the south site is encouraging for this location, their presence may also present a constraint on the management possible without putting these areas at risk.

Further detailed studies and conceptualisation would be required to determine with certainty the potential afforded by these sites.

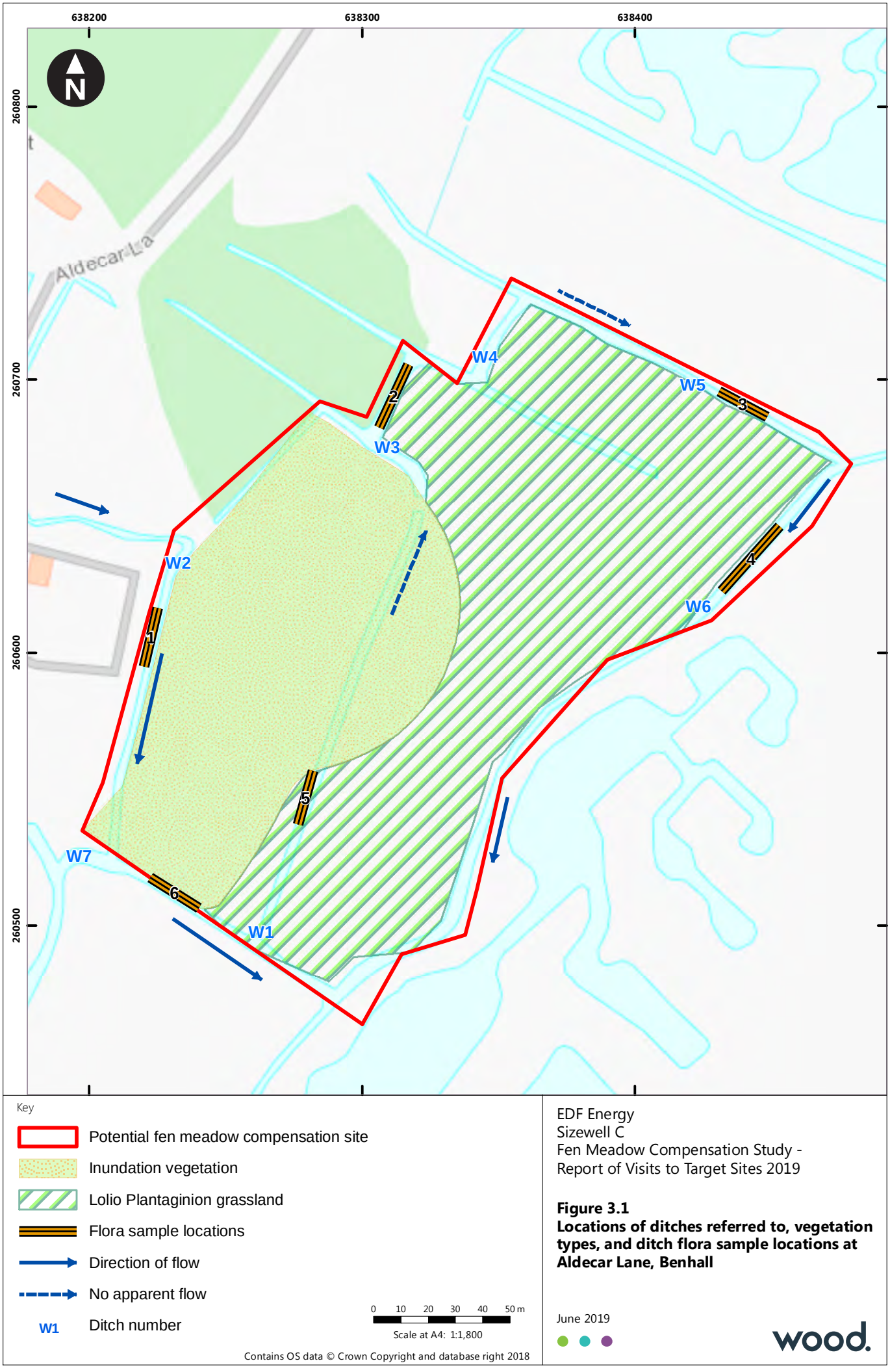

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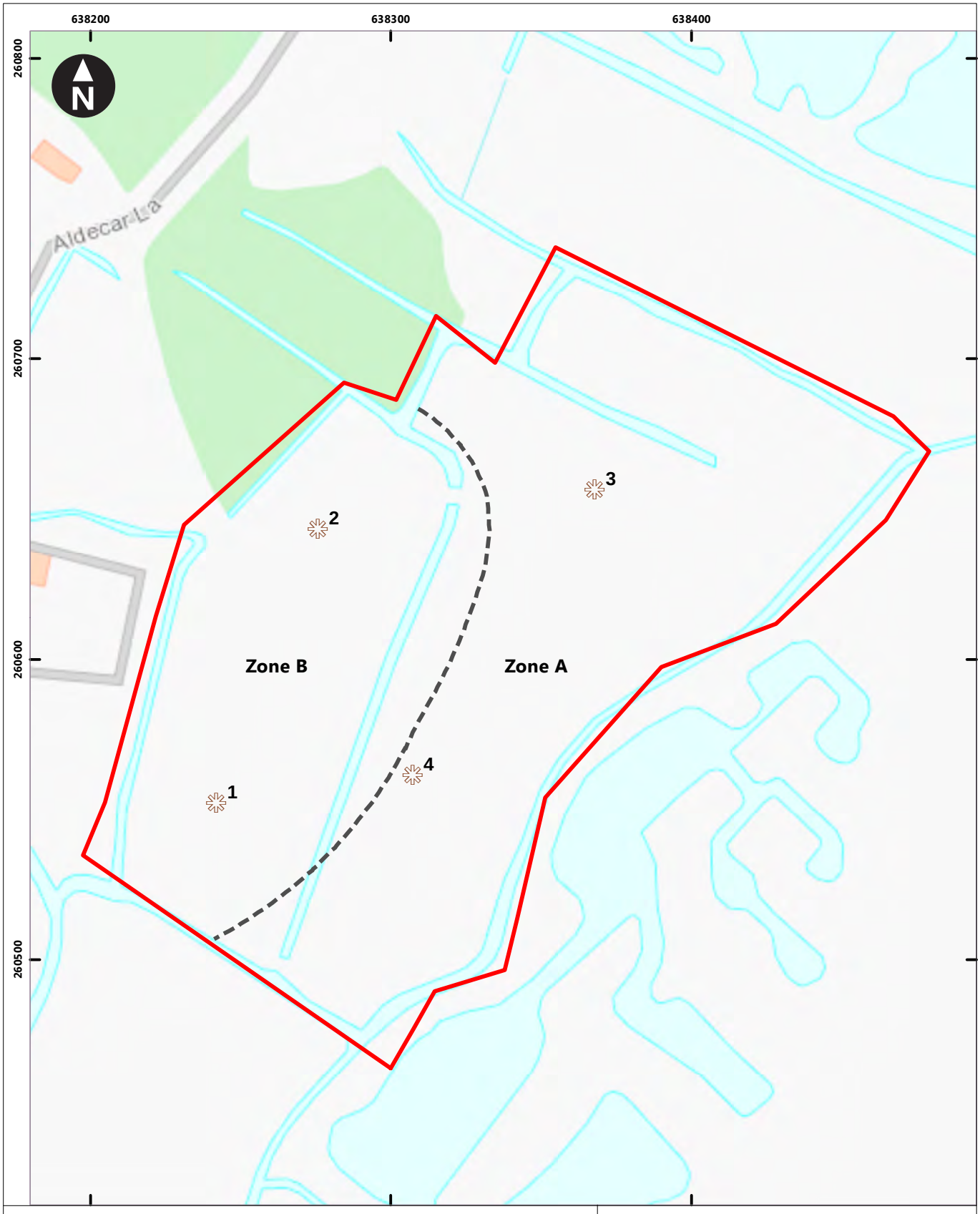
Figure 3.1
Locations of ditches referred to, vegetation types, and ditch flora sample locations at Aldecar Lane, Benhall

June 2019

wood.



Key

Potential fen meadow compensation site

Zone boundary

Soil core sample location

0 10 20 30 40 50 m

Scale at A4: 1:1,800

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Figure 3.2
Location of soil core samples and indicative soil zones for Aldecar Lane, Benhall

June 2019

wood.

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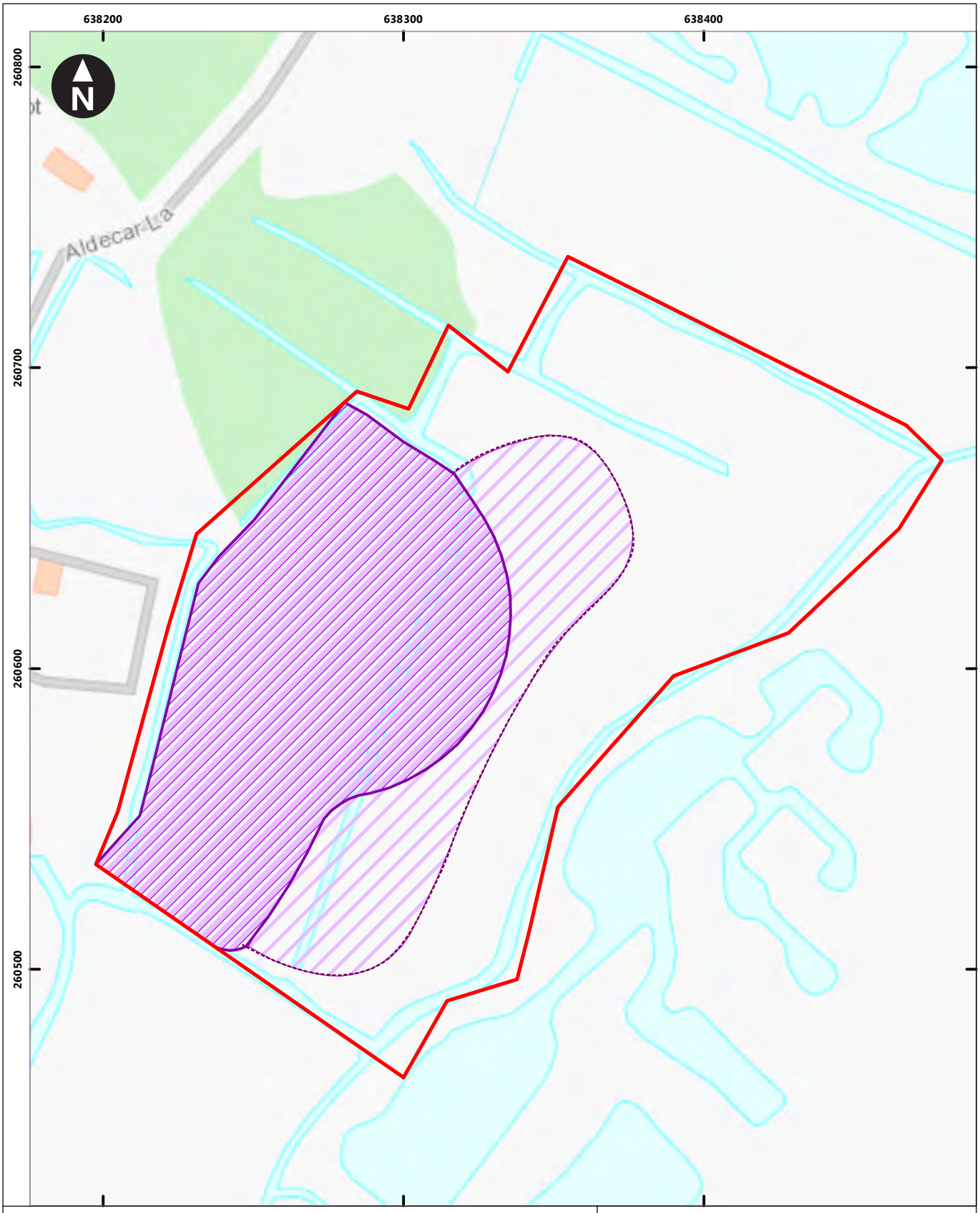

Key

- Potential fen meadow compensation site
- Primary locus for fen meadow
- Potential additional area for fen meadow

0 10 20 30 40 50 m

Scale at A4: 1:1,800

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Figure 3.3
Fen meadow compensation potential for Aldecar Lane, Benhall

June 2019

wood.

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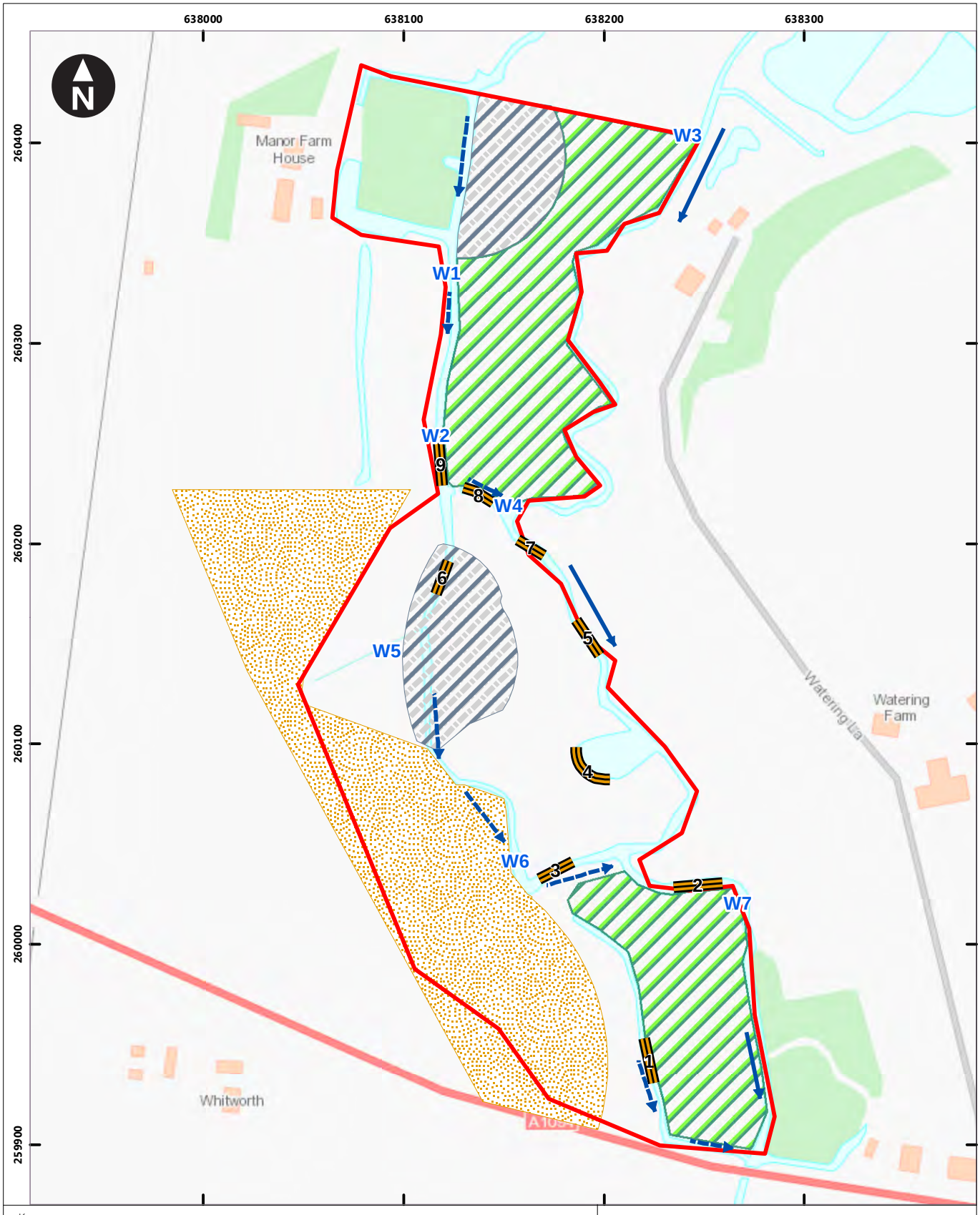

Key

- Potential fen meadow compensation site
- Lolio Plantaginion grassland
- Dry grasslands
- Groundwater influenced
- Flora sample locations
- Direction of flow
- No apparent flow
- W1 Ditch number

0 20 40 60 80 100 m

Scale at A4: 1:2,700

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Figure 3.4
Locations of ditches referred to, vegetation types, and ditch flora sample locations at Watering Lane, Benhall

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wood.

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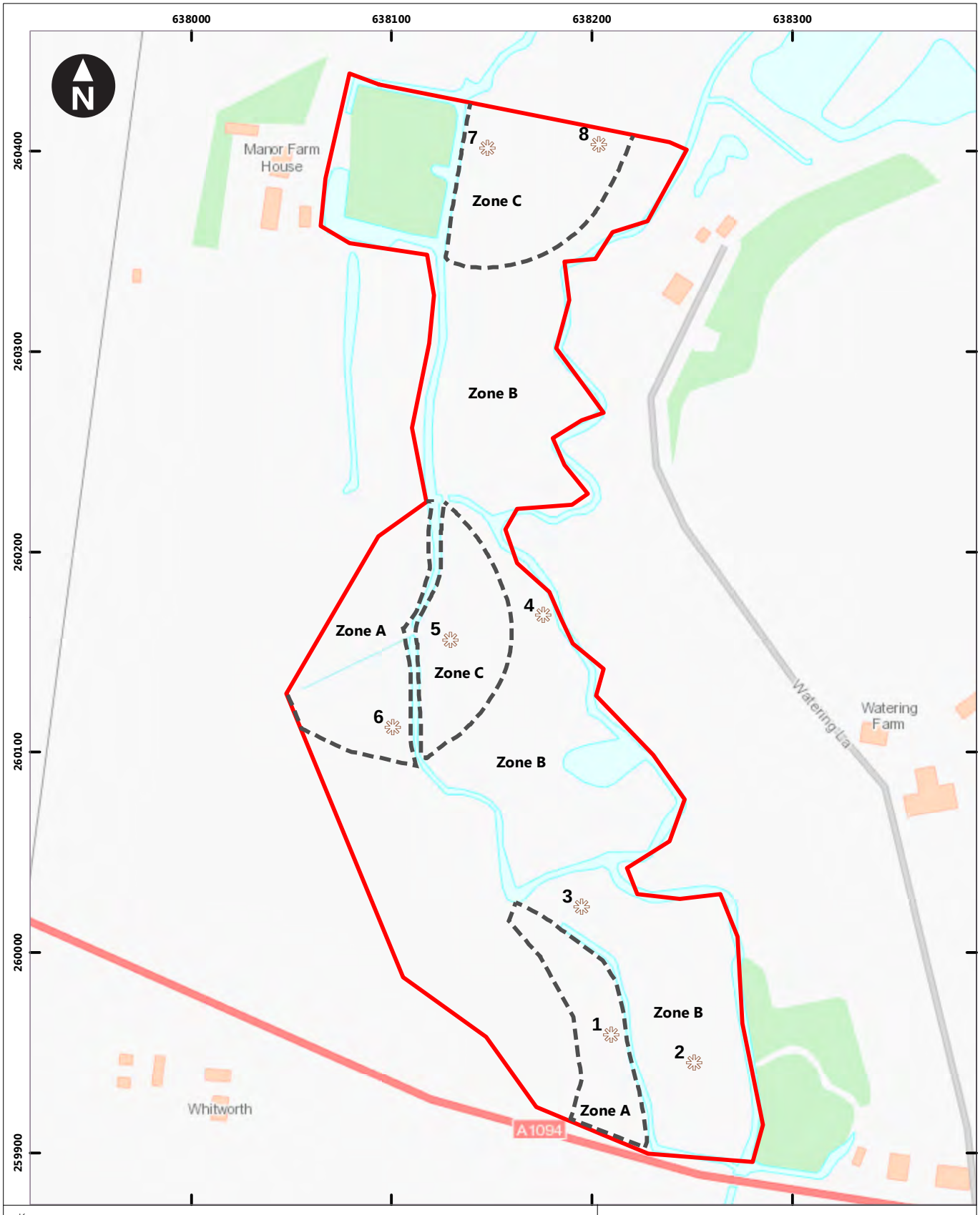

Key

Potential fen meadow compensation site

Zone boundary

Soil core sample location

0 20 40 60 80 100 m

Scale at A4: 1:2,700

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Figure 3.5
Location of soil core samples and indicative soil zones at Watering Lane, Benhall

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wood.

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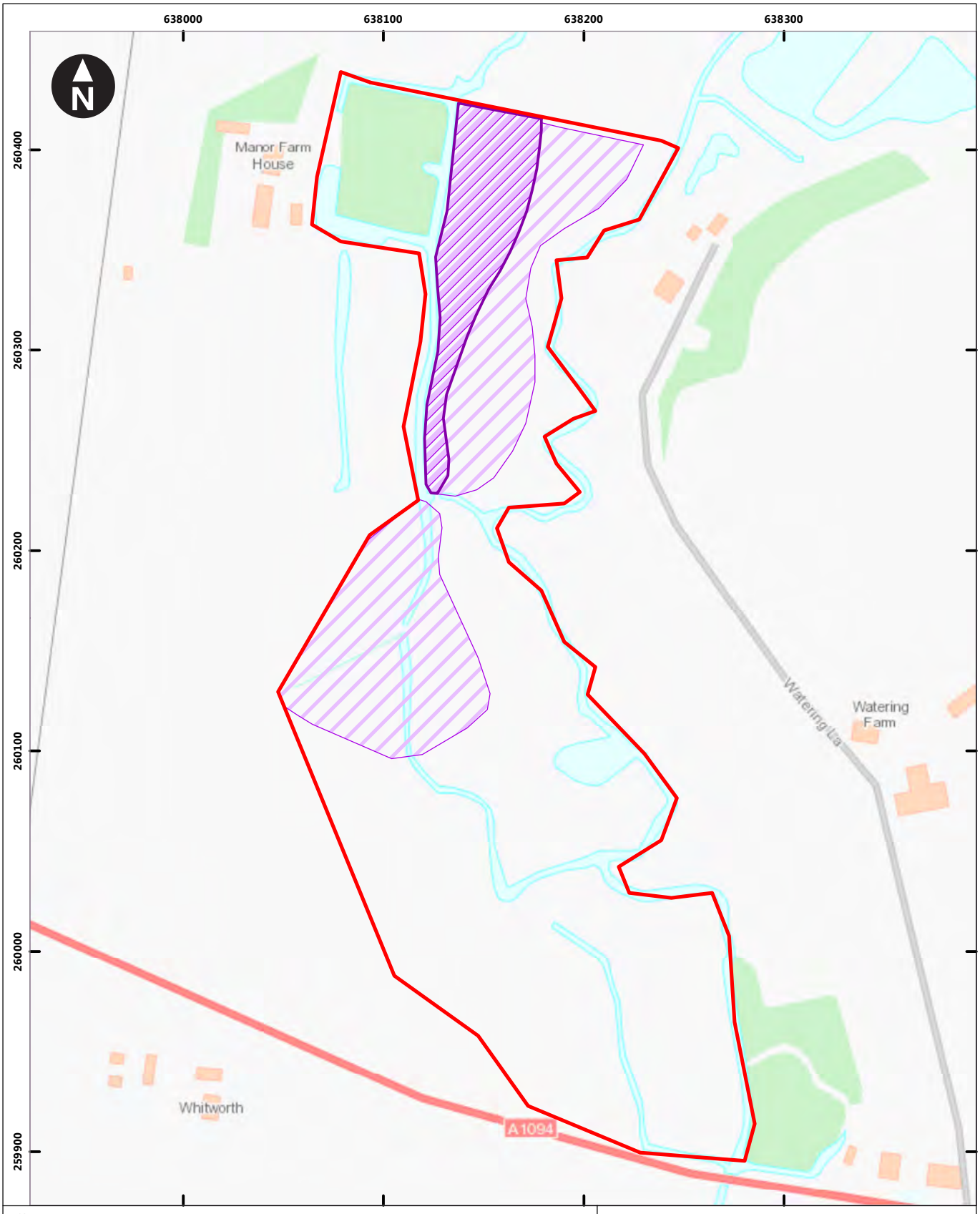

Key

- Potential fen meadow compensation site
- Primary locus for fen meadow
- Potential additional area for fen meadow

0 20 40 60 80 100 m

Scale at A4: 1:2,700

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Figure 3.6
Fen meadow compensation potential for Watering Lane, Benhall

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wood.

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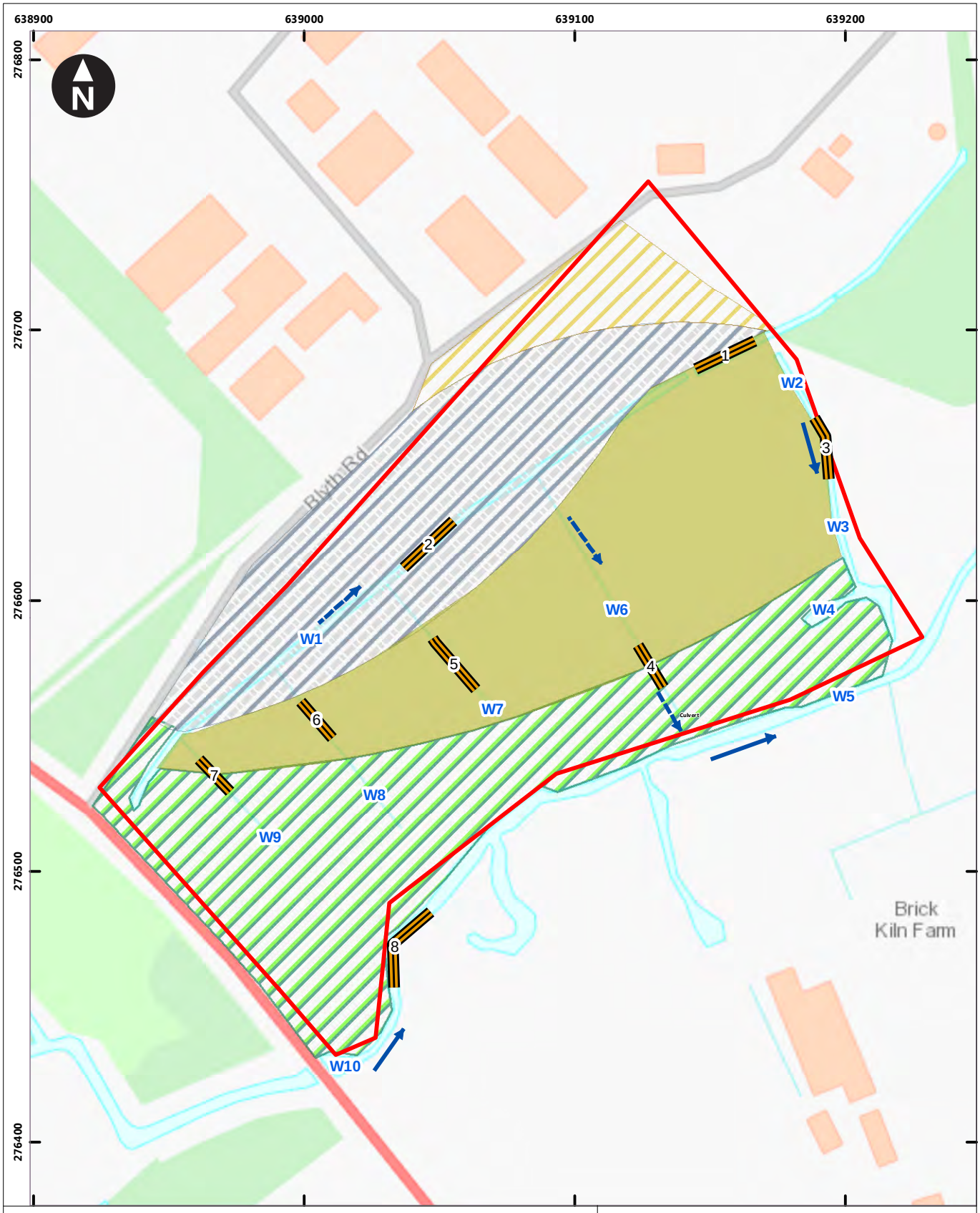

Key

- Potential fen meadow compensation site
- Lolio Plantaginion grassland
- Groundwater influenced
- Upland
- Rush pasture
- Direction of flow
- No apparent flow
- Flora sample location
- W1 Ditch number

0 10 20 30 40 50 60 m

Scale at A4: 1:2,000

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Figure 3.7
Locations of ditches referred to, vegetation types, and ditch flora sample locations at Blyth Road, Halesworth

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wood.

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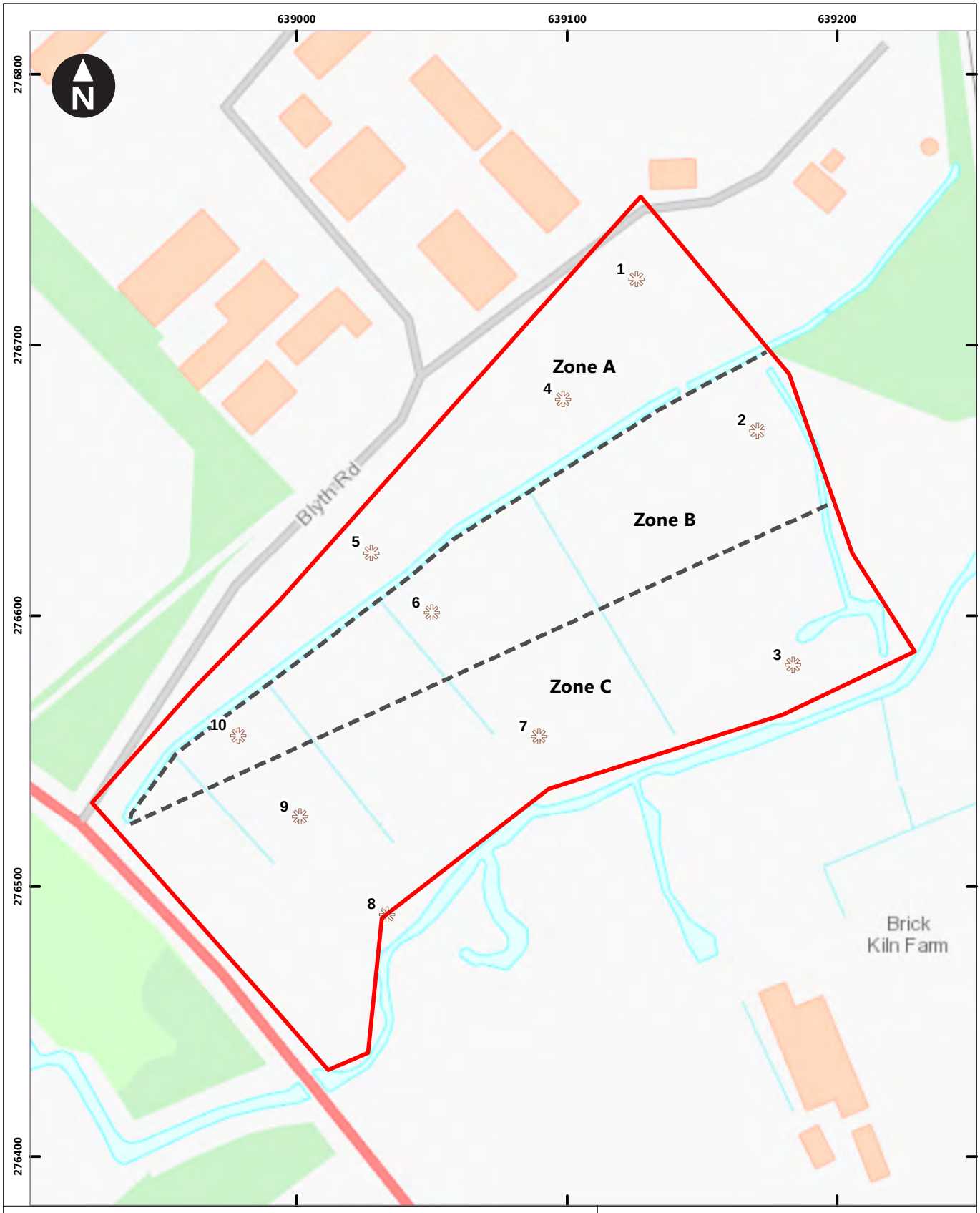

Key

Potential fen meadow compensation site

Zone boundary

Soil core sample location

0 10 20 30 40 50 60 m

Scale at A4: 1:2,000

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Figure 3.8
Location of soil core samples and indicative soil zones for Blyth Road, Halesworth

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wood.

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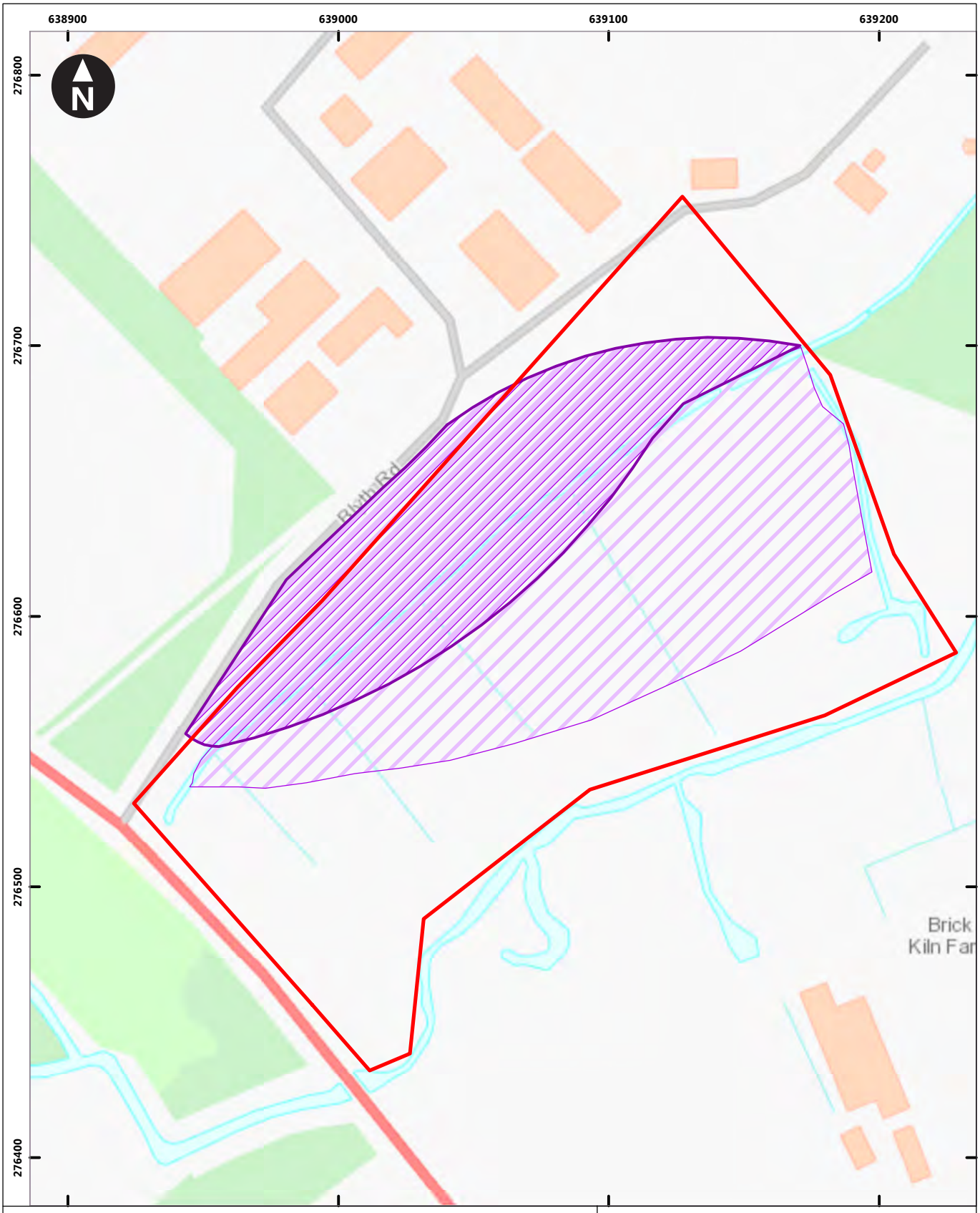

Key

- Potential fen meadow compensation site
- Primary locus for fen meadow
- Potential additional area for fen meadow

0 10 20 30 40 50 60 m

Scale at A4: 1:2,000

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Figure 3.9
Fen meadow compensation potential for Blyth Road, Halesworth

June 2019

wood.

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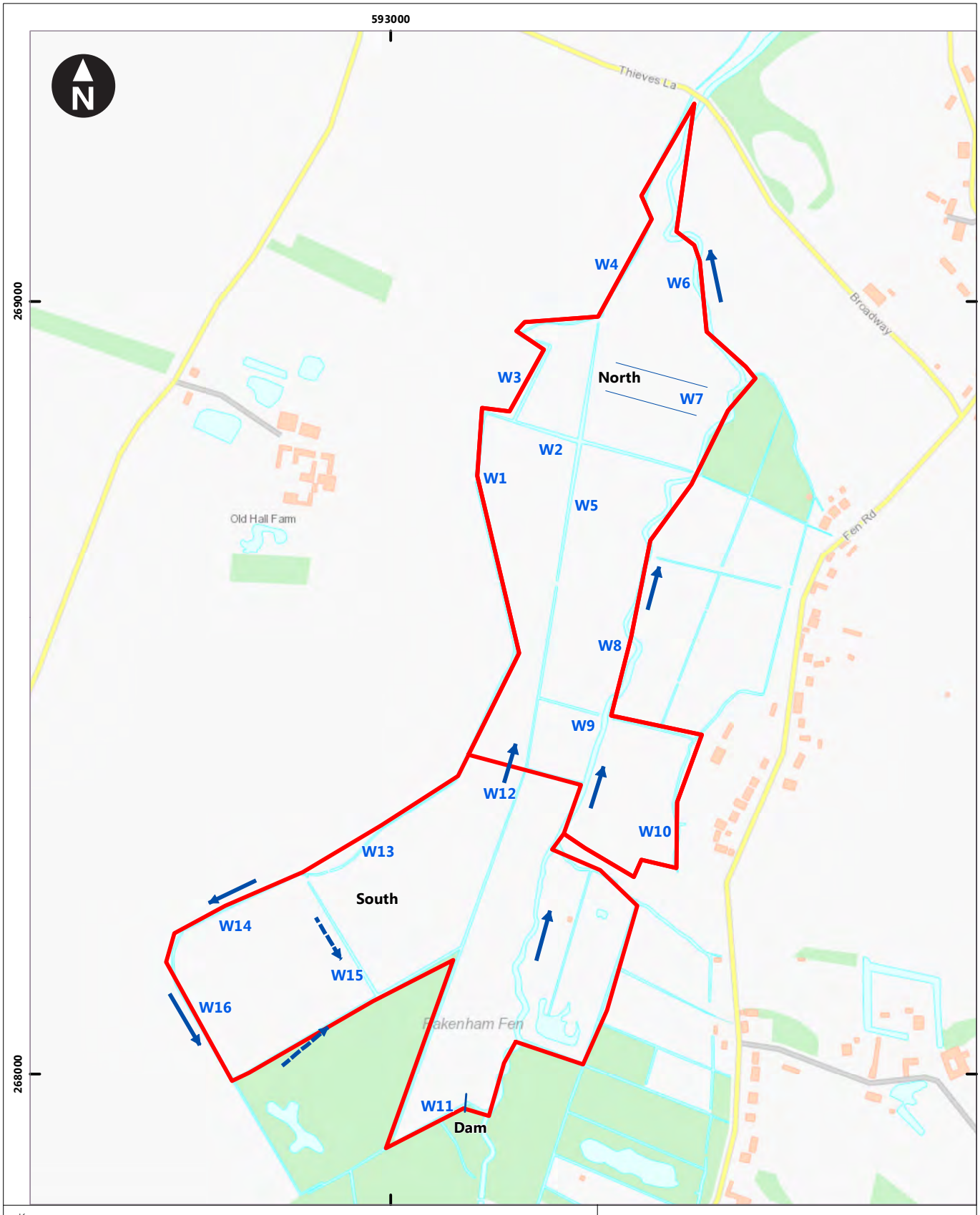

Key

- Potential fen meadow compensation site
- Direction of flow
- No apparent flow
- W1 Ditch number

0 50 100 150 200 250 300 m

Scale at A4: 1:7,000

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Figure 3.10
Locations of ditches referred to

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wood.

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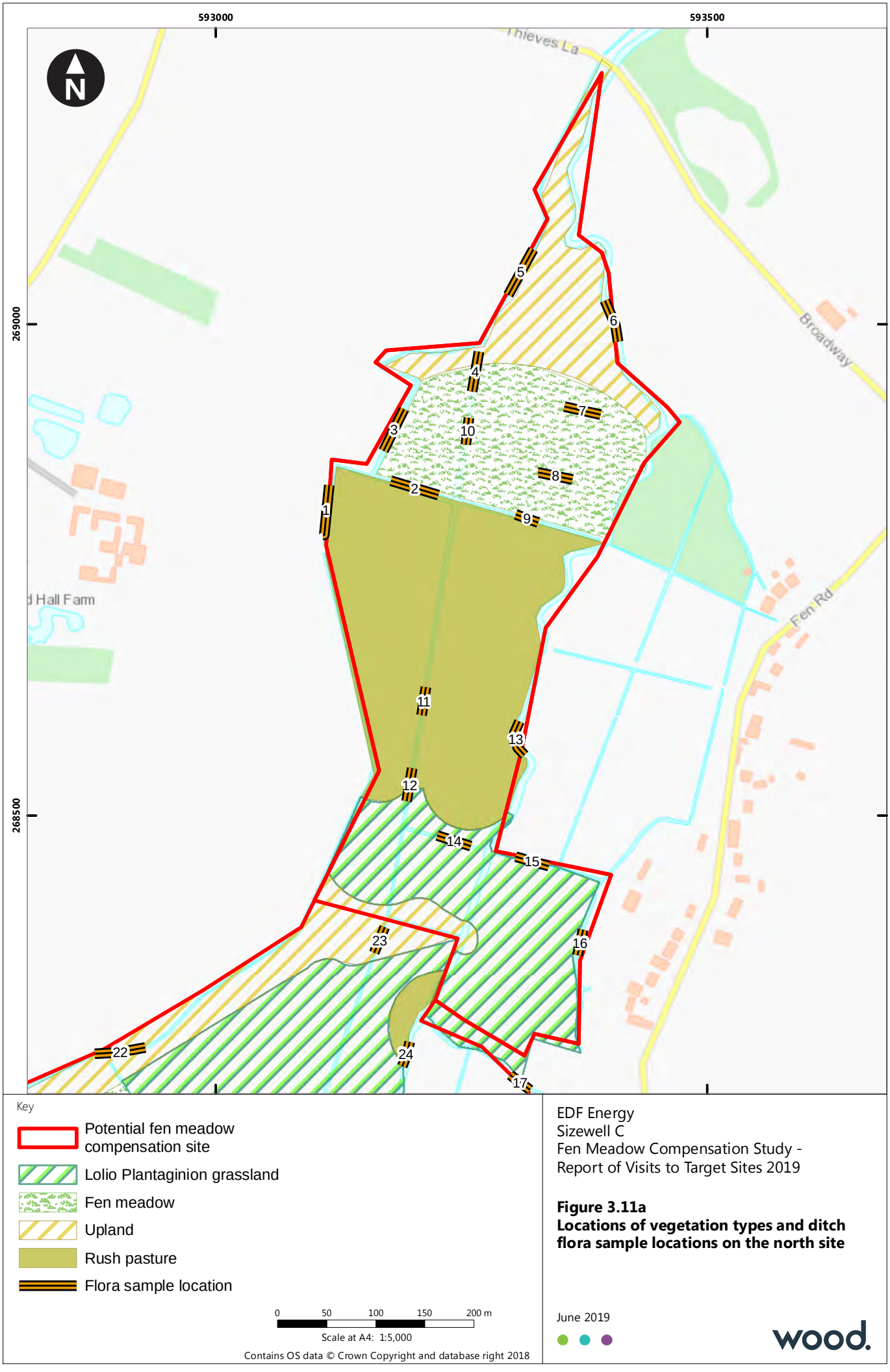

EDF Energy
Sizewell C
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Figure 3.11a
Locations of vegetation types and ditch flora sample locations on the north site

June 2019

wood.

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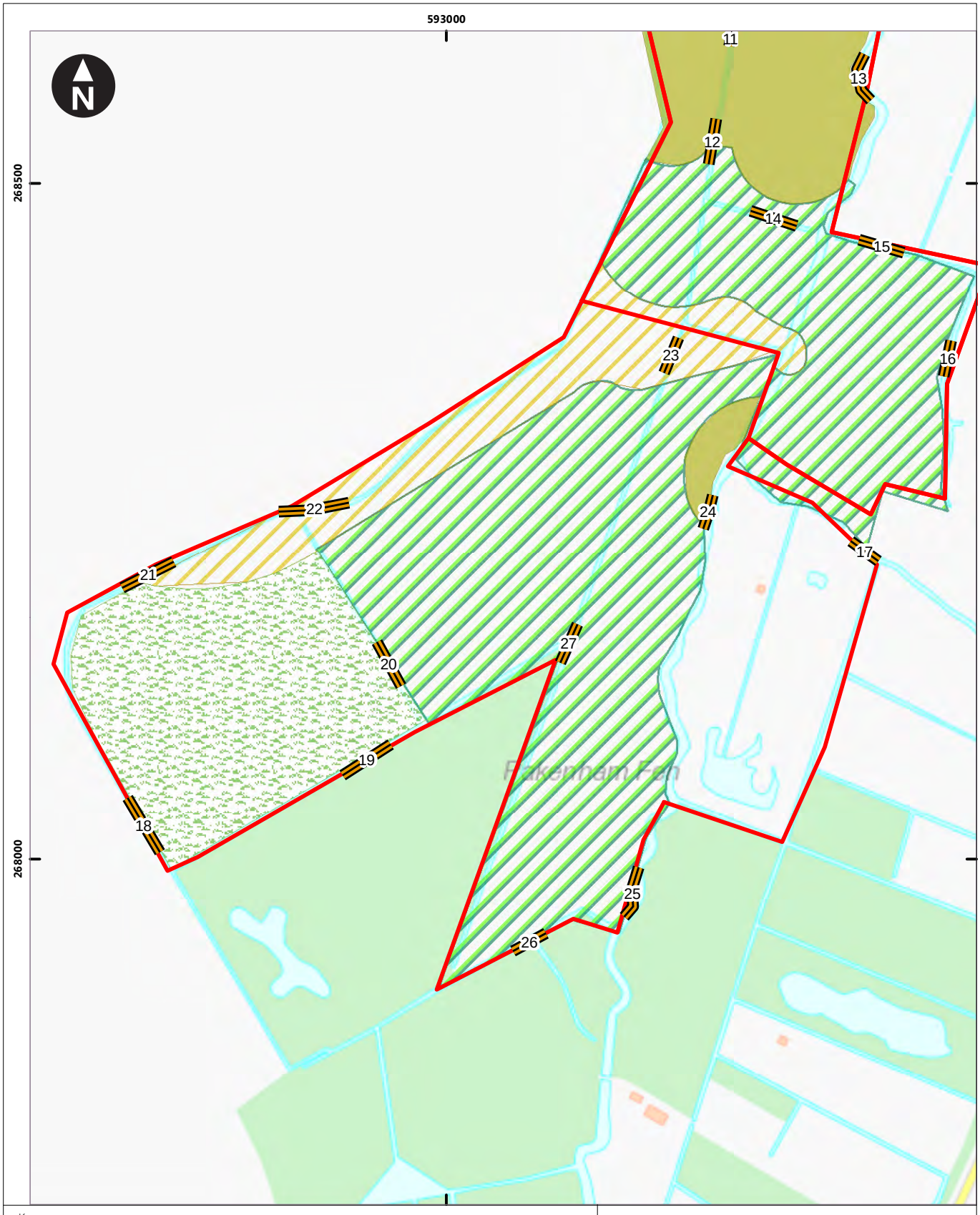

Key

- Potential fen meadow compensation site
- Lolio Plantaginion grassland
- Fen meadow
- Upland
- Rush pasture
- Flora sample location

0 50 100 150 200 m

Scale at A4: 1:4,000

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Figure 3.11b
Locations of vegetation types and ditch flora sample locations on the south site

June 2019

wood.

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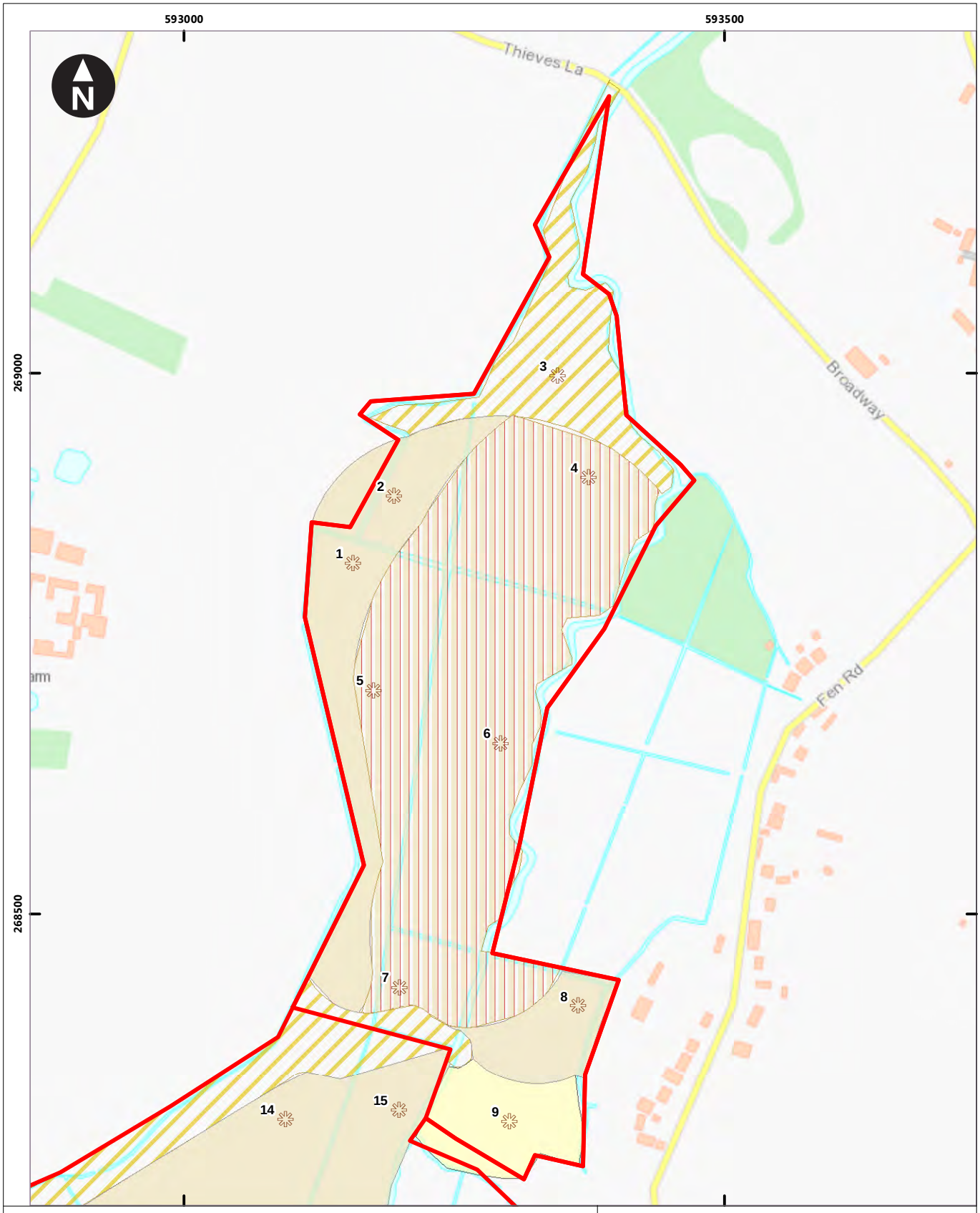

Key

- Potential fen meadow compensation site
- Sand
- Peat and marl
- Peat
- Upland
- Soil core sample location

0 50 100 150 200 m

Scale at A4: 1:5,000

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Figure 3.12a
Location of soil core samples and indicative soil zones for Pakenham Fen on the north site

June 2019

wood.

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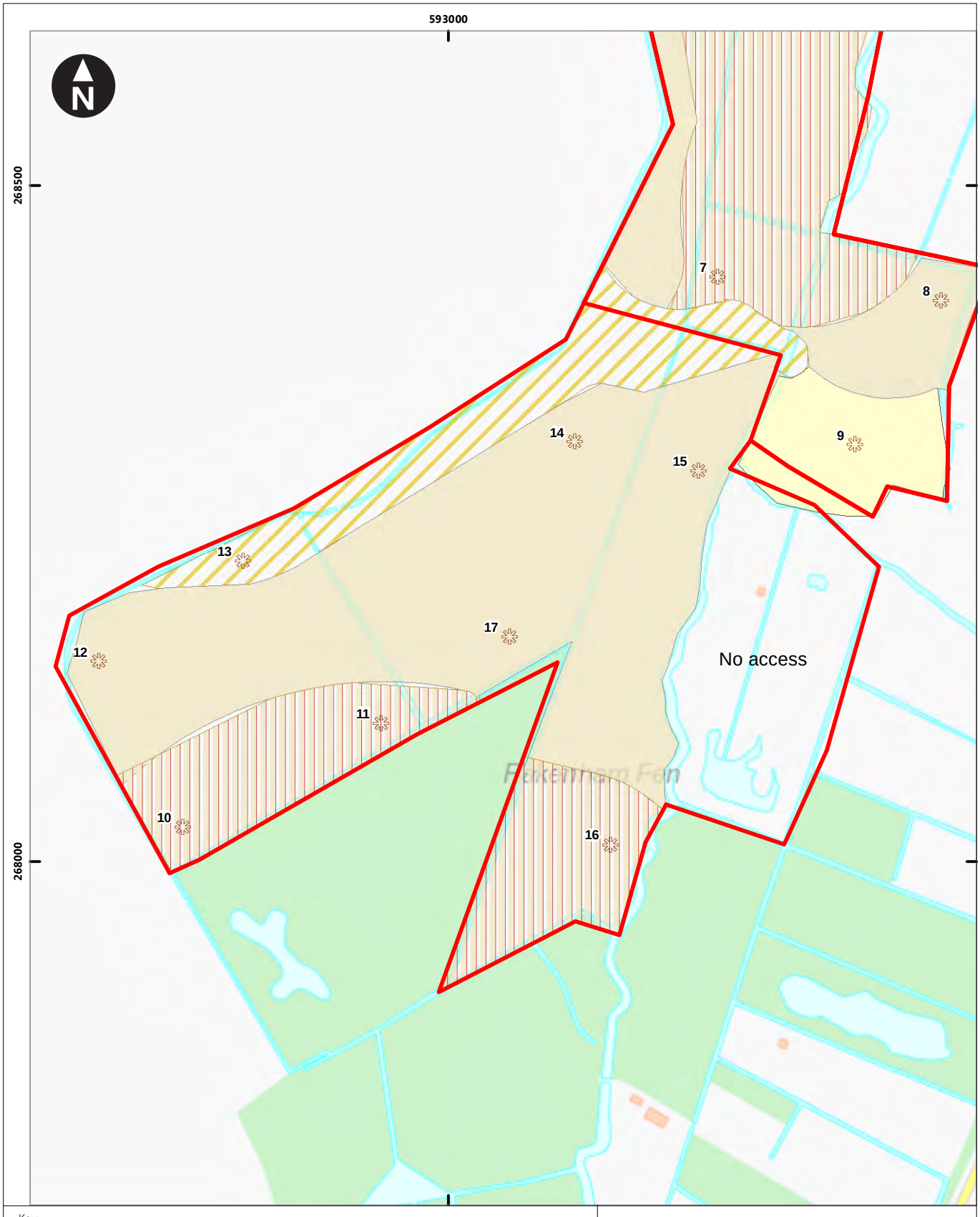

Key

- Potential fen meadow compensation site
- Sand
- Peat and marl
- Peat
- Upland
- Soil core sample location

0 50 100 150 200 m

Scale at A4: 1:4,000

EDF Energy
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Figure 3.12b
Location of soil core samples and indicative soil zones for Pakenham Fen on the south site

June 2019

wood.

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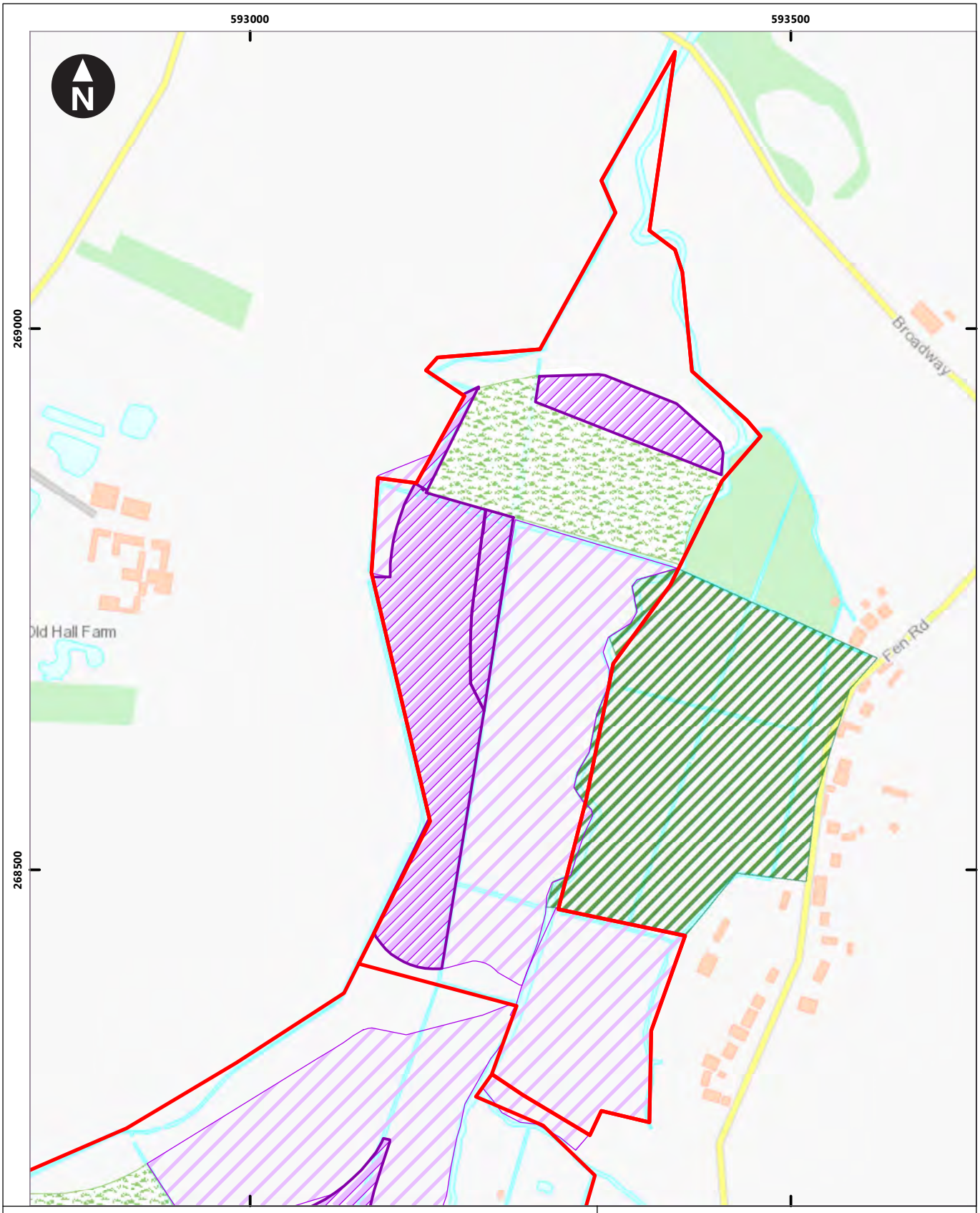

Key

- Potential fen meadow compensation site
- Existing fen meadow
- Site of Special Scientific Interest
- Primary locus for fen meadow
- Potential additional area for fen meadow

0 50 100 150 200 m

Scale at A4: 1:5,000

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Figure 3.13a
Fen meadow compensation potential for Pakenham Fen north site

June 2019

wood.

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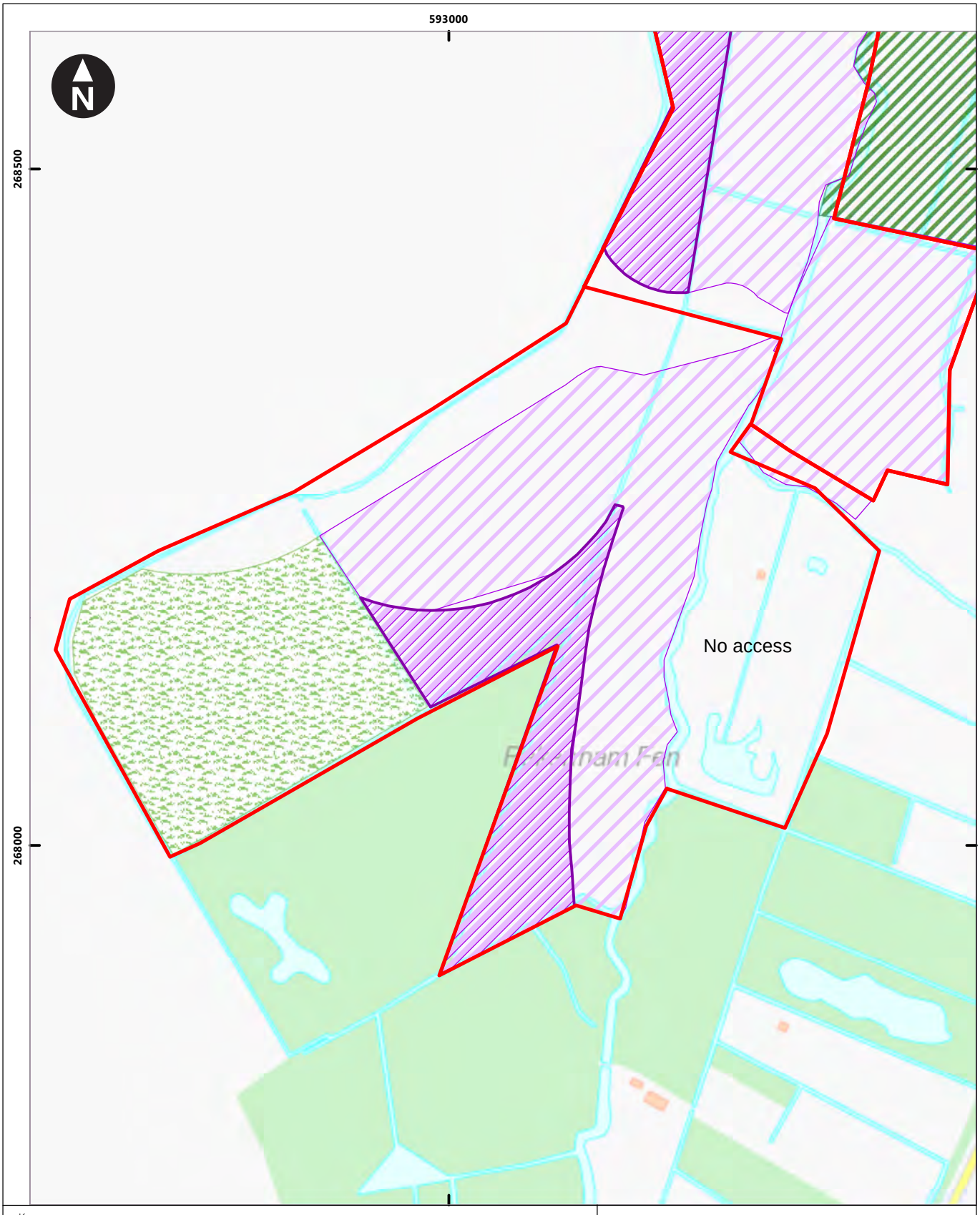

Key

- Potential fen meadow compensation site
- Existing fen meadow
- Site of Special Scientific Interest
- Primary locus for fen meadow
- Potential additional area for fen meadow

0 50 100 150 200 m

Scale at A4: 1:4,000

EDF Energy
Sizewell C
Fen Meadow Compensation Study - Report of Visits to Target Sites 2019

Figure 3.13b
Fen meadow compensation potential for Pakenham Fen south site

June 2019

wood.

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4. Summary and Next Steps

4.1 Summary

Sites 10, 11 and 28 were visited on 9 and 10 April 2019, with two accessible areas of Site 54 visited on 30 April and 1 May 2019. No access to Site 33 had been arranged at the time of writing.

Two key survey types were undertaken on each site visited:

- Walkabout survey; and
- Shallow soil core survey.

Based on the results of these studies, it is considered that Sites 10, 28 and 54 all have potential for the development of fen meadow as follows:

- Site 10: primary locus 1.5ha, further area 0.7ha;
- Site 28: primary locus 1.2ha, further area 1.3ha;
- Site 54 north: primary locus 3.2ha, further area 6.2ha; and
- Site 54 south: primary locus 1.7ha, further area: 4.3ha.

Site 11 has relatively limited potential but is close to Site 10, so warrants further consideration in that context. A key consideration in determining the next steps will be determining the quantum of fen meadow habitat to be delivered in compensation for the loss from Sizewell Marshes. Although the area has not been confirmed, it may be of the order of 2.7ha to 4.5ha.

Initial consideration of potential 'ease' of delivery suggests that Sites 28 and/or Site 10 would be favoured although, based on these initial analyses, neither by themselves would deliver the full area of compensatory habitat needed. Whilst Site 54 has potential to deliver a greater area of fen meadow habitat, significant issues relating to groundwater supply, the poor condition of surface peats and also the ability to deliver the habitat without increasing risk to nearby good quality fen meadow, will need to be addressed.

4.2 Next Steps

The potential next steps should comprise confirming which site or sites to assess further. Further detailed site conceptualisation and feasibility assessment work will be required for each of the sites. Conceptual models would need to be developed for the site(s) selected based on detailed data review and investigations and would include:

- Detailed ecological survey;
- Review of available groundwater level data (including output from the Environment Agency model for high, low and average groundwater level conditions) and the seasonal variation in groundwater levels. Also effects of groundwater abstraction on groundwater levels below the site;
- Collection of topographic data;
- Collection of surface water level and groundwater level data to determine the relationship between groundwater and surface water levels on site. Also detailed study of the existing and wider ditch network to determine potential for water management without risk to upstream receptors; and

- Collection of hydrochemical data.

Assessment of feasibility of restoration of fen meadow habitat and preliminary conceptual design of the preferred option(s) will consider:

- Most appropriate restoration methods;
- How water levels could be managed (if needed);
- To what extent earthworks will be required. EDF has previously indicated that it would ideally prefer to avoid significant earthworks as this would be costly, would likely require loss of existing habitats/start from scratch and hence introduce significant uncertainty into the outcome.

The long term security of the chosen site is critical. Once selected the site will need to be owned by a conservation organisation or there should be a management agreement with a conservation organisation. Appropriate resources will be needed to implement the management plan. Monitoring will be required and measures put in place to amend the management plan if necessary to ensure favourable condition of the site. EDF intends to put such measures in place for the chosen site(s) for the long term.

Appendix A
Recorded species with Londo category

Table A.1 Recorded species with Londo category

Common Name	Scientific Name	Londo
Alder	*Alnus glutinosa*	K
Annual Meadowgrass	*Poa annua*	A
Bittersweet	*Solanum dulcamara*	P
Branched Bur-reed	*Sparganium erectum*	W
Broad-leaved Pondweed	*Potamogeton natans*	H
Brown Sedge	*Carex disticha*	W
Chickweed	*Stellaria media*	A
Cock's-foot	*Dactylis glomerata*	A
Common Duckweed	*Lemna minor*	H
Common Mouse-ear	*Cerastium fontanum*	A
Common Nettle	*Urtica dioica*	A
Common Reed	*Phragmites australis*	W
Common Sorrel	*Rumex acetosa*	A
Creeping Bent	*Agrostis stolonifera*	P
Creeping Buttercup	*Ranunculus repens*	P
Creeping Thistle	*Cirsium arvense*	A
Cuckooflower	*Cardamine pratensis*	V
Curled Dock	*Rumex crispus*	A
Daisy	*Bellis perennis*	A
Dandelion	*Taraxacum* agg.	P
Flag Iris	*Iris pseudacorus*	W
Fool's Watercress	*Helosciadum nodiflorum*	W
Giant Hogweed	*Heracleum mantegazzianum*	A
Great Yellow-cress	*Rorippa amphibia*	W

Common Name	Scientific Name	Londo
Greater Pond-sedge	*Carex riparia*	W
Hairy Sedge	*Carex hirta*	A
Hard Rush	*Juncus inflexus*	V
Hemlock	*Conium maculatum*	A
hybrid jointed rush	*Juncus x surrejanus*	V/W
Ivy-leaved Duckweed	*Lemna trisulca*	H
Jointed Rush	*Juncus articulatus*	V
Lesser Celandine	*Ficaria verna*	P
Lesser Pond-sedge	*Carex acutiformis*	W
Lesser Water parsnip	*Berula erecta*	W
Marsh Horsetail	*Equisetum palustre*	W
Marsh Thistle	*Cirsium palustre*	V
Marsh-marigold	*Caltha palustris*	W
Meadow Buttercup	*Ranunculus acris*	A
Meadow Foxtail	*Alopecurus pratensis*	P
Perennial Ryegrass	*Lolium perenne*	A
Red Dead-nettle	*Lamium purpureum*	A
Reed Canary-grass	*Phalaris arundinacea*	V
Reedmace	*Typha latifolia*	W
Rough Meadowgrass	*Poa trivialis*	A
Shepherd's Purse	*Capsella bursa-pastoris*	A
Soft Rush	*Juncus effusus*	V
Tufted Hair-grass	*Deschampsia cespitosa*	V
Various-leaved Water-starwort	*Callitriche platycarpa*	H
Water Forget-me-not	*Myosotis scorpioides*	W
Water Horsetail	*Equisetum fluviatile*	W
Water Mint	*Mentha aquatica*	F
Water Plantain	*Alisma plantago-aquatica*	W
Watercress	*Nasturtium officinale* agg.	W

Common Name	Scientific Name	Londo
White Clover	*Trifolium repens*	A
Wild Angelica	*Angelica sylvestris*	V
Yellow Waterlily	*Nuphar lutea*	H

Appendix B
Site No. 10 –Ditch sample and soil core results

Site No. 10 – Ditch samples

1. Boundary Drain 1, TM 38223 60605
This section of drain is overstood by Alder and ochre seeps are evident from the shallow banks. Emergent and submerged forms of Water Mint and Lesser Water-parsnip are both frequent and Marsh Marigold is rare as a marginal.

2. Boundary Drain 2, TM 38312 60694
Further along the same ditch, in full sunlight, the tall emergent Branched Bur-reed was frequent, with occasional Yellow Iris and Lesser Water-parsnip and rare Water Mint.

3. Boundary Drain 3, TM 38420 60700
This section of deep drain is connected to the main channel and runs alongside the Marsh Farm Caravan site. The water is a cloudy grey colour and quite different from that of the boundary drain to the west. An algal mat cover much of the channel bed. Common Reed is frequent along the foot of the banks; occasional strands of Various-leaved Water-starwort are also present.

4. Main channel 1, TM 38444 60639
The main channel also runs alongside the Marsh Farm Caravan Site and, like the Boundary Drain 3 sample, the water is a cloudy grey colour and supports filamentous algae. Here, Common Reed is also frequent along the banks with occasional Branched Bur-reed.

5. Central ditch, TM 38286 60552
The central ditch through the site supports stands of Reed Canary-grass in the shallows and Branched Bur-reed which extends across the ditch. Both species are abundant and there are few associates, with Lesser Water-parsnip being occasional and Water Mint rare.

6. Southern ditch, TM 38240 60508
A slow flow in this ditch is likely to derive from water brought to this section of the valley from the small stream that drains from a catchment extending west of the A12 road. Branched Bur-reed and Various-leaved Water-starwort (both frequent) are joined by Greater Reedmace (frequent) and occasional Bittersweet.

Site No. 10 – Soil core results

Core 1, TM3825160554
Location: Within an inundated area on the floodplain.
Vegetation: A wet area close to the *Agrostio-Ranunculetum repentis* inundation community (OV28a) in composition, with much Soft Rush joining Creeping Bent and Creeping Buttercup.
Standing water 2 cm.
Grey-brown silt loam with strong mottling from a depth of 2 cm b.g.l., fading with depth, to 28 cm b.g.l.
Grey silty clay – very wet and sticky to 72 cm b.g.l. Water table at 72 cm, rising to 10 cm.
Peat – hemic at surface, becoming sapric from c. 90 cm b.g.l.
End of core at 125 cm b.g.l.

Core 2, TM3829060639
Location: Within an inundated area of the floodplain.
Vegetation: Dominated by Creeping Bent and Creeping Buttercup, assigned to the *Agrostio-Ranunculetum repentis* inundation community (OV28)
Standing water 5 cm.
Grey-brown silt loam with strong mottling from a depth of 2 cm b.g.l., fading with depth, to 25 cm b.g.l.
Grey silty clay to 92 cm b.g.l.
Peat – hemic at surface but unknown at depth.
End of core at 125 cm.
Water table unknown as core backfilled by standing water.
Standing water as auger 1. Straight onto silt loam. Silty clay, stiff at 25cm. Sandy Peat at 92cm. Water backfilling hole from surface

Core 3, TM3839460656
Location: In a relatively elevated area of the floodplain with a firm, dry ground surface.
Vegetation: Dominated by Perennial Ryegrass with frequent Rough Meadow-grass and Meadow Foxtail and occasional Meadow Buttercup, Creeping Thistle and Lesser Celandine. Corresponds to the *Lolium perenne-Poa trivialis* leys of the *Lolio-Plantaginion* grassland (MG7b).
Brown silt loam to 28 cm b.g.l.
Grey-brown silty clay, mottled from 41 cm to 49 cm b.g.l.
Peat earthy to water table at 60 cm (no rise) then hemic
End of core at 125 cm b.g.l

Core 4, TM3831660562
Location: In an area of moist soil, apparently transition bewteen the drier east and wetter west sides of the site.
Vegetation: Abundant Perennial Ryegrass with frequent Curled Dock; occasional Creeping Bent and Creeping Buttercup. Sward appears to be transitional between *Lolio-Plantaginion* grassland (MG7b) and the *Agrostio-Ranunculetum repentis* inundation community (OV28).
Brown silt loam with occasional mottles to 21 cm b.g.l.
Grey-brown silty clay, mottled from 44 cm to 56 cm b.g.l.; water table at 54 cm no rise
Silty clay grey to 110 cm b.g.l.
Peat hemic
End of core at 125 cm b.g.l

Appendix C
Site No. 11 –Ditch sample and soil core results

Site No. 11 – Ditch samples

1. Old channel 1
TM3821859950
Shallow, silt-filled channel with abundant Greater Pond-sedge and frequent Lesser Water-parsnip. Water Mint is occasional and Marsh Horsetail rare. Alder rooted on the low bank also present as a single individual.

2. Fromus main channel 1
TM3826759989
Frequent Various-leaved Water-starwort and occasional Branched Bur-reed. Rare Yellow Water-lily, Broad-leaved Pondweed, Water Plantain and Great Yellow-cress also present. Algae coating about half of the channel bed; no sign of ochre. Bank with freeboard of c.1 m; dominant Nettle with occasional Hemlock. Occasional Alder but willow and ash standards typical.

3. Connecting ditch 1
TM3818060041
Short channel between the old and main channels. Greater Pond-sedge abundant and frequent Water Mint. Marsh Horsetail and Lesser Water-parsnip occasional and Branched Bur-reed rare.

4. Cut-off meander loop
TM3819060093
Small colony of Giant Hogweed *Heracleum mantegazzianum* present in shaded meander bend around the base of mature Alders. 10 plants recorded.

5. Fromus main channel 2
TM3820160144
Occasional emergent Branched Bur-reed, Watercress, Water Mint and Lesser Water-parsnip, with occasional trails of Various-leaved Water-starwort.

6. Old channel 2
TM3812160139
Static, standing water in old channel, which is largely silted-up. Greater Pond-sedge and Branched Bur-reed frequent, with occasional Water Mint and Lesser Water-parsnip.

7. Fromus main channel 3
TM3813060186
Emergent Greater Pond-sedge, Branched Bur-reed and Water Mint all occasional; channel with occasional Various-leaved Water-starwort and filamentous algae.

8. Connecting channel 2
TM3815060206
Abundant Greater Pond-sedge occupying much of this channel, with frequent Water Mint, Lesser Water-parsnip and Fool's Water-cress emergent and submerged. Watercress occasional, largely submerged. The submerged 'fringing herbs' appear to indicate groundwater upwelling in the vicinity.

9. Boundary drain
TM 38120 60236

This section of drain abuts a sedge stand (greater Pond-sedge abundant) on the site margin. The ditch section is notable for the prolific growth of Various-leaved Water-starwort in the channel, with occasional emergent and submerged Watercress. The ditch bank is lined with frequent Greater Pond-sedge and occasional Branched Bur-reed.

Site No. 11 – Soil core results

Core 1, TM3820659951
Location: On 'degraded' footslope with transitional vegetation above secondary channel
Vegetation: Scattered Ragwort with Creeping Bent and Rough Meadow-grass; slightly damp immature grassland.

Shallow peaty top to 2 cm b.g.l.
Humic sands to 36 cm
Grey sand to 52 cm
Yellow sand from 52 cm, wet, mottling from 56 cm. Water table assumed from this depth.
End of core at 91 cm b.g.l.

Core 2, TM3824759954
Location: On floodplain between secondary and main channels at south of site
Vegetation: MG7b – Perennial Ryegrass with Rough Meadow-grass and White Clover. Some Creeping Buttercup indicates impeded drainage.

Humic silt loam to 20 cm b.g.l. Heavily mottled from c.4 cm.
Brown silt loam with less mottling to 38 cm b.g.l.
Mid grey silty clay with scattered mottles. Water table at 50 cm – no rise.
End of core at 125 cm

Core 3, TM3819660026
Location: Between secondary and main channels south of first connecting ditch.
Vegetation: MG7b short sward with frequent Daisy and White Clover, occasional Creeping Buttercup

Shallow peaty top to 2 cm b.g.l.
Brown silt loam (drier than core 2), with mottling from 20 cm to 33 cm b.g.l
Mid grey silty clay (with occasional inclusions of woody peat and sand); water table at 60 cm with no rise.
End of core at 125 cm

Core 4, TM3818860145
Location: North of cut-off meander in centre of floodplain.
Vegetation: As core 3: MG7b with low-growing Daisy-rich sward

Peaty top to 3 cm b.g.l.
Brown silt loam with occasional brick fragments. Only faintly mottled from 10 cm. Water table at 55 cm. At 85 cm …
Mid grey silty clay to end of core at 125 cm
[N.B. thicker silt loam – former meander?]

Core 5, TM3814460121
Location: West of floodplain between secondary and main channels.
Vegetation: Seemingly MG7b with scattered jointed rush (frequent) and occasional Hard Rush, Marsh Horsetail and Meadow Buttercup.

Peaty top to 5 cm b.g.l.
Grey-brown silt loam heavily mottled to 28 cm b.g.l
Mid-grey silty clay with manganiferous streaks in central part (c. 35 cm) to 45 cm b.g.l
Peat – hemic throughout but more sapric towards base – to 106 cm when water table (rose to 39 cm)
Sand and gravel to end of core at 125 cm.

Core 6, TM3810360124
Location: West of secondary channel in broad declavity of sandy toeslope.
Vegetation: MG7b with occasional jointed rush and Marsh Horsetail. Rare Brown Sedge shoots.

Thicker peat top with sand inclusions to 6 cm
Humic silt loam (organic matter grading out) to 28 cm b.g.l.
Yellow sand, damp to 35 cm
Grey sand, wet with manganiferous streaks at c. 74 cm (Water table?). Stabilised at c. 75 cm at end.
End of core at 125 cm

Core 7, TM3815260391
Location: At north of site near County Wildlife Site
Vegetation: Ryegrass-dominated sward with rare Marsh Horsetail, Water Mint and Lesser Celandine

Peaty top to 4 cm
Grey-brown silt loam with heavy mottling to 31cm b.g.l, diffuse boundary with
Silty clay grey to 41 cm
Peat – hemic with woody inclusions, slight sulphurous odour from c.100 cm; water table at 98 cm, rose to 60 cm
End of core at 125 cm

Core 8, TM3820860387
Location: Northeast corner of site, nearer main channel.
Vegetation: MG7b species-poor with strong growth of ryegrass and meadow-grass dominant; occasional Meadow Foxtail and rare Meadow Buttercup

Brown silt loam with no mottling, to 28 cm
Grey brown silty clay, mottled from c.25 cm; becoming mid grey at c.60 cm, down to 94 cm b.g.l.
No water table within 125 cm, though wetter from 87 cm. Water table confirmed at that depth.
Peat – hemic/sapric – to end of core at 125 cm

Appendix D
Site No. 28 –Ditch sample and soil core results

Site No. 28 – Ditch samples

1. Catch dyke 1
TM3915176688
Dense fringe of Hard Rush on ditch margin. Phreatophytes present in ditch: *Berula* (abundant) with Lesser Pond-sedge and *Apium* (frequent) and some Greater Pond-sedge and Water Forget-me-not. Occasional Ivy-leaved Duckweed *Lemna trisulca* in water-column. These phreatophytes indicate base-rich groundwater seepage. Very clear water. Sewage treatment works downstream.

2. Catch dyke 2
Here, branched bur-reed is the most common species, with groundwater-dependent species apparently restricted to the presence of scattered Ivy-leaved Duckweed.

3. Ditch 1
TM3918676674
Encroachment from ditch of Greater Pond-sedge (is this a phreatophyte?).
Alder lines along both banks at edge of ditch indicating stable groundwater-influenced waters (maybe 15 cm variation in water table).
Water in ditch could be similar level to water table.
Ochre on surface of ditch water, mixed with algae; patches of natural oils; black, sulphidic gel masking ditch base.
Water voles present (dung).

4. Ditch 2
At southern end, ochreous water with natural oil patches. Occupied by a dense stand of Branched Bur-reed with occasional *Callitriche platycarpa*, Lesser Pond-sedge, Water Forget-me-not and *Berula*. Scattered Alder occurs along all the ditch. At the northern end, gaps in the bur-reed contained Water-cress and Water Mint; scattered Wild Angelica found on inner fringes of Soft Rush occupying both ditch banks.
Three snipe flew up from the northern end of the ditch.

5. Ditch 3
Water Horsetail, Water Forget-me-not and *Berula* both occasional in ditch with abundant Branched Bur-reed and Greater Pond-sedge

6. Ditch 4
To the northern end: Greater Pond-sedge with occasional Blunt-flowered Rush, Water Mint, Water Forget-me-not and *Berula*. Occasional Alder saplings. In the central and southern parts, largely Branched Bur-reed with occasional *Berula* and Lesser Pond-sedge.

7. Ditch 5
Occasional Alder, but largely Branched Bur-reed and Lesser Pond-sedge. Scattered Water Mint, Forget-me-not and *Berula* also present.

8. River
TM3919776577

Freeboard estimated at 200 cm. Shallow dry berm at base. Branched Bur-reed abundant as marginal; occasional *Callitriche platycarpa* and Water Forget-me-not on inner fringes. Indicative of eutrophic, base-rich water.

Site No. 28 – Soil core results

Core 1, TM3912676728
Location: On an elevated platform with a distinct, curving margin in the northeast field corner; possibly toeslope of Head.
Vegetation: Weedy grassland dominated by lush Perennial Ryegrass, with scatters of Chickweed, Red Dead-nettle, Shepherd's-purse and Nettle. Corresponds to the OV23 *Lolium perenne-Dactylis glomerata* community.
No phreatophytes.

Surface and topsoil a humic sand with occasional chipped sub-rounded flints.
Mottling first observed at a depth of 38 cm in humic sand.
Below here, strongly mottled in light yellow sand matrix.
From 66 cm b.g.l pale yellow sand with manganiferous streaks and yellow iron mottles, suggesting more intense redox reactions in zone of water table fluctuation.
Core ended at 82 cm when hit gravel.

Core 2, TM3916776674
Location: in widespread, low-lying area on the riverside of the catch-dyke.
Vegetation: Grass-dominated rush-pasture with abundant Creeping bent, frequent Soft Rush, White Clover and Creeping Buttercup with occasional Tufted Hairgrass and Cuckooflower. Corresponds to the Typical sub-community of the *Holco-Juncetum effusi* rush-pasture (MG10a). No phreatophytes present.
This group of species is indicative of surface rainwater detention.

Peaty top
Humic silt loam from 6cm. Very mottled red.
At 30cm light grey-brown silty clay with mottles.
[absence of silt loam?]
Peat again at about 40cm. Slightly sulphurous woody peat.
Water table struck at 62cm. Water starting to fill hole. Water table risen to 0.45m after 3 mins
Base of core 1.25m.

Core 3, TM3918776606
Location: at base of rising slope onto river bund; likely to be the margin of an old meander section – off likely line of infill.
Vegetation: Short sward of Perennial Ryegrass with frequent White Clover and occasional Rough Meadow-grass, Cock's-foot and Hard Rush. Corresponds to the *Lolium perenne-Poa trivialis* leys of *Lolio-Plantaginion* grasslands (MG7b).

Surface peaty top of c.1 cm
Humic sandy sily loam with strong mottling to 31 cm
Light grey-brown silty clay with scattered mottles to 72 cm
Very dark grey (sulphidic) silty clay to end of core at 125 cm
Water table at 82 cm, rising to 68 cm
[N.B. No peat encountered.]

Core 4, TM3909476677
Location: in the jointed rush area on the upland side of the catch-dyke

Vegetation: On the upland margin of the *Juncus inflexus* sub-community of the *Holco-Juncetum effusi* rush-pasture (MG10b) where the appearance of Rough Meadow-grass with some Perennial Ryegrass and Meadow Foxtail indicate the transition over several metres to the *Lolium perenne-Poa trivialis* leys of *Lolio-Plantaginion* grasslands (MG7b).

A peaty top of 6 cm overlies
Humic sand to 36 cm, over
Light yellow sand with occasional red mottles to 71 cm, over
Slightly green (glauconitic) light grey sand with manganiferous streaking to the end of the core at 92 cm
Water table was encountered at 62 cm, showing no rise.

Core 5, TM3903476627
Location: in the jointed rush area on the upland side of the catch-dyke
Vegetation: In the central part of the Hard Rush stand (MG10b), with jointed rush and Cuckooflower

Humic silt loam from the surface, with strong mottling evident from 7 cm b.g.l.
Light grey-brown silty clay from 18cm, with scattered mottles, becoming sandy silty clay from 35 cm to approximately 57 cm b.g.l.
At 57 cm, light grey wet sand with scattered red mottles to end of core at 97 cm
Water table assumed at 57 cm b.g.l. with no rise.

Core 6, TM3905176603
Location: In the low-lying strip on the riverside of the catch-dyke.
Vegetation: Grass-dominated rush-pasture with abundant Creeping Bent, frequent Soft Rush, White Clover and Creeping Buttercup with occasional Cuckooflower and Marsh Thistle. Corresponds to the Typical sub-community of the *Holco-Juncetum effusi* rush-pasture (MG10a). No phreatophytes present.

Peaty top at the ground surface to 8 cm b.g.l., over
Initially humic silty clay [no evidence of silt loam] with strong mottles from the upper surface; abrupt boundary with
Peat at 41 cm to end of core at 125 cm.
Water table indicative at c.66 cm, not rising.

Core 7, TM3908376570
Location: on midslope of slightly elevated river bund, clearly above the level of the moist ground surface.
Vegetation: Perennial Ryegrass sward with few grass associates (mainly Rough Meadow-grass). Very occasional Hard Rush and scattered Creeping Thistle. Species-poor version of the Lolium perenne-Poa trivialis leys of Lolio-Plantaginion grasslands (MG7b).

No peaty top
Mid-brown rather sandy silt loam with earthworms and occasional mottles, to 29 cm b.g.l.
Sticky mid-grey silty clay (nearly clay) with no mottles, to 41 cm b.g.l, over
Peat (sapric) to end of core at 125 cm.
Water table indicative at c. 90 cm, not rising.

Core 8, TM3902876498
Location: On foot of slightly elevated river bund
Vegetation: Perennial Ryegrass dominant with some Rough Meadow-grass. Scattered Creeping Thistle. Species-poor version of the *Lolium perenne-Poa trivialis* leys of *Lolio-Plantaginion* grasslands (MG7b).

Mid-brown silt loam with occasional mottles from the surface, to 39 cm b.g.l.
Mid-grey silty clay with occasional strong mottles, to 65 cm b.g.l

Peat, with woody inclusions; moist but hemic-sapric, until 116 cm b.g.l
Sand, coarse angular, mid grey in colour
No water table

Core 9, TM3899876522
Location: towards northern margin of riverside grassland.
Vegetation: Perennial Ryegrass dominant with scattered Hard Rush and Creeping Thistle. Species-poor version of the *Lolium perenne-Poa trivialis* leys of *Lolio-Plantaginion* grasslands (MG7b).

Humic silt loam with scattered mottles to 29 cm
Mid-grey silty clay to 42 cm b.g.l
Peat to end of core at 125 cm
No water table evident, wet peat from 89 cm b.g.l.

Core 10, TM3898476542
Location: On the upland side of the slightly lower lying tract south of the catch-dyke
Vegetation: Jointed rush and occasional Hard Rush, with Common Sorrel, Meadow Buttercup, Common Mouseear and Dandelion in a matrix of Rough Meadow-grass and Creeping Bent. Corresponds to the *Juncus inflexus* sub-community of the *Holco-Juncetum effusi* rush-pasture (MG10b).

Peaty top to 9 cm b.g.l.,
Grey-brown silty clay strongly mottled to 48 cm b.g.l.,
Peat to 125 cm at end of core.
No water table evident, but wet from 72 cm b.g.l.

Appendix E
Site No. 54 –Ditch sample and soil core results

Site No. 54 – Ditch samples

North site

1. Upland edge 1
TL 93118 68817
Dark grey-brown coloured water with algae.
Lesser Water-parsnip occasional, Watercress rare.

2. Ditch 1
TL 93197 68833
Water dark grey-brown with algae.
Greater Tussock-sedge abundant on banks with frequent Lesser Pond Sedge.
Occasional Various-leaved Water Starwort in channel.

3.Upland edge 2
TL 93183 68901
Water dark brown.
Channel overstood by tree willows.
Banks with frequent Reed and occasional nettle.

4. Ditch 2
TL 93266 68946
Water dark brown with algae.
Reed-filled ditch (abundant) with occasional Common Duckweed and Bittersweet. Reed with occasional Nettle on banks.

5. Upland edge 3
TL 93286 69011
Dark red-brown water in deep ditch on the sandy margin of the valley floor.
Occasional Common duckweed.

6. River 1
TL 93401 69010
Fairly clean water over peat silt in channel. Indicative of level channel with little flow.
Colony of Mare's-tail frequent, with occasional Common Duckweed. Bank margin with abundant Greater Pond-sedge and rare Lesser Water-parsnip, Water Forget-me-not and Branched Bur-reed.

7. Ditch 3
TL 93372 68892
Damp ditch with abundant Lesser Pond-sedge, frequent Greater Pond Sedge and occasional Saw Sedge [TL 93385 68893] and Meadowsweet (in the sample section). Occasional Common Valerian along both bank tops.

8. Ditch 4
TL 93325 68835

Greater Pond-sedge in channel (frequent) and on bankside (abundant) with frequent mature tussocks of Common Sedge on banksides. Occasional Yellow Iris and Marsh Pennywort on bank tops.
Block of Saw Sedge to west [TL 93284 68845]

9. Ditch 5
TL 93294 68806
Water dark brown with frequent Various-leaved Water-starwort.
Abundant Greater Tussock Sedge and Greater Pond-sedge on banks, with occasional Meadowsweet and rare Yellow Iris.

10. Ditch 6
TL 93255 68886
Colour and clarity indicates quite good water quality; abundant Various-leaved Water-starwort.
Banks with abundant Greater Tussock-sedge and frequent Greater Pond-sedge; Lesser Pond-sedge occasional.

11. Ditch 7
TL 93218 68672
Dark, organic water, overstood by tree willows; occasional Various-leaved Water-starwort.
Occasional Greater Pond-sedge on bank and in channel.

12. Ditch 8
TL 93206 68581
Ditch overstood by tree willows.
Banks with rare Greater Tussock-sedge and Greater Pond-sedge; channel with frequent Common Duckweed.

13. River 2
TL 93328 68708
Dark, peaty silt with some algae; no aquatic plants.
Abundant Greater Pond-sedge on banks with occasional Greater Tussock-sedge.

14. Ditch 9
TL 93256 68472
Wet ditch channel filled with abundant Greater Pond-sedge and frequent Yellow Iris.

15. Ditch 10
TL 93310 68458
Wet ditch channel filled with abundant Greater Pond-sedge and Lesser Water-parsnip.
Banks with abundant Reed, frequent Nettle and rare Greater Tussock-sedge.

16. Upland edge 4
TL 93374 68375
Largely over-shaded ditch is draining through sapric peat. Red-brown waters with algae.
Occasional Greater Pond-sedge and rare Comfrey on banks.

17. Upland edge 5
TL 93323 68262
Overstood with trees. Dry ditch with no ditch flora.

South site

18. Upland edge 6
TL 92771 68040
Ditch flowing south, cutting through sand; heavily over-shaded – frequent Grey Willow - but water relatively clear with little colour. Occasional Lesser Water-parsnip.

19. Ditch 11
TL 92939 68074
Beneath tree canopy with shallow freeboard (c.30 cm).
Water very dark brown colour (peat and leaf litter); Tufted Hair-grass frequent along bank.

20. Ditch 12
TL 92956 68145
Largely overtopped by mixed hedge of Hawthorn, Grey Willow and tree willow.
Water cloudy brown-grey.
Open sections of bank and channel reed-filled (occasional).

21. Upland edge 7
TL 92786 68213
Overstood wet ditch with c.2.5 m freeboard.
Dark grey-brown water with no aquatic or bank plants.

22. Upland edge 8
TL 92896 68260
Boundary drain deep and shaded.
Common duckweed occasional in better-lit patches.

23. Ditch 13
TL 93169 68374
Shaded channel with fairly clean water.
Occasional Brooklime at base of banks.

24. River 3
TL 93163 68142
Abundant reed in channel and on banks. No aquatic species visible in cloudy grey-brown water.

25. River 4
TL 93139 67998
Channel largely overstood by tree willow and Grey Willow. Shallows with frequent Water Mint, Branched Bur-reed and rare Bittersweet. Frequent Reed on banks.
Channel with occasional Various-leaved Water-starwort and Common Duckweed.

26. Ditch 14
TL 93066 67944
Overstood by Alder; dry.

27. Ditch 15
TL 93098 68184
Largely-shaded channel with good clarity, little-coloured water; peat silt on channel bed.
No ditch plant species.

Site No. 54 – Soil core results

Core 1, TL 93162 68772
Location: This core represents part of the gently sloping upland toeslope.
Vegetation: Poor semi-improved grassland extensively colonised by Hard Rush; corresponds to the *Juncus inflexus* sub-community of the *Holco-Juncetum effusi* community (MG10b).

Peaty sand to 8 cm b.g.l.
Brown sands with occasional stones – with mottling from 12 cm – to 29 cm b.g.l.
Peat: hemic, mid-brown (fen peat) to c.71 cm b.g.l.
Peat: sapric, very dark brown to black
Wet from 82 cm, but no water table
End of core at 125 cm b.g.l.

Core 2, TL 93214 68880
Location: The core samples the low-lying soils occupied by fen meadow.
Vegetation: Greater Pond-sedge stand with constant Blunt-flowered Rush and a suite of fen-meadow associates; corresponds to a mown *Juncus subnodulosus-Cirsium palustre* fen-meadow, Typical sub-community (MG22a).

Earthy peat, very dark brown to 12 cm b.g.l.
Hemic peat, mid brown, to 52 cm b.g.l.
Hemic-fibric fen peat with occasional shell fragments to 110 cm b.g.l.
Sapric peat, very dark brown-grey to end of core at 125 cm b.g.l.
Water table at 52 cm, rising to 46 cm.

Core 3, TL 93345 69005
Location: This core represents part of an elevated area distinct from the modern floodplain.
Vegetation: Improved grassland, abundant Perennial Ryegrass, though with several other grass species occasional; Creeping Thistle and Common Sorrel occasional, Ribwort Plantain rare. Broadly corresponds to the *Lolio-Plantaginion* grasslands (MG7).

Humic sand to 25 cm b.g.l.
Light brown sand with occasional mottling; stony, to 37 cm b.g.l.
End of core 37 cm – too stony to penetrate.

Core 4, TL 93392 68917
Location: The core samples an area some 30 m south of the margin of an elevated platform fringing the modern floodplain.
Vegetation: Open Greater Pond-sedge sward (abundant) with Water Horsetail and Common Sorrel (frequent), with a number of grassland associates, including Cuckooflower and Red Fescue (both occasional). Close to more species-rich fen meadow (M22) with mown Common Valerian (frequent) flowering.

Earthy peat, very dark brown, with molehills showing subsurface marl, to 24 cm b.g.l.
Marl, grading from light brown to yellow-white to 65 cm b.g.l.
Peat, mid-brown, hemic, to 85 cm b.g.l.
Sapric peat, very dark grey-brown, faint sulphurous odour from c.110 cm, to end of core
Water table from c.70 cm, rising to 53 cm b.g.l.
End of core at 125 cm b.g.l.

Core 5, TL 93179 68667
Location: This core represents part of the gently sloping upland toeslope.
Vegetation: Hard Rush (abundant) pasture with strong ruderal element including Rough Meadow-grass and Curled Dock (both frequent), occasional Nettle.

Peaty top to 3 cm b.g.l.
Hemic sand to 22 cm b.g.l.
Light yellow-brown sand with occasional mottle. Evidence for burning and some gravel-sized brick fragments to 34 cm b.g.l.
Marl – light yellow-brown to 61 cm b.g.l.
Hemic peat, mid brown to 70 cm b.g.l
Sapric peat, very dark grey-brown, slightly sulphorous odour from c.110 cm
End of core 125 cm b.g.l.

Core 6, TL 93290 68649
Location: The core is close to the modern river on the low-lying soils occupied by rush pasture.
Vegetation: Abundant Perennial Ryegrass with Hard Rush, Hairy Sedge and Dandelion (all frequent).

Earthy peat to 15 cm b.g.l
Sand, humic at surface becoming light brown, to 30 cm b.g.l.
Marl, light yellow brown to 125 cm b.g.l.
Water table no evident on coring, but established at 62 cm b.g.l.
End of core at 125 b.g.l.

Core 7, TL 93225 68447
Location: Paired with Core 15, this core lies near the margin of low-lying land beside an elevated area that intrudes into the floodplain.
Vegetation: Perennial Ryegrass (abundant) with Rough Meadow-grass, White Clover and Dandelion (all frequent) and Hard Rush (occasional). Closest to *Lolio-Plantaginion* grassland (MG7).

Humic, rather silty sand to 23 cm b.g.l
Marl, light yellow-brown to 28 cm b.g.l.
Sapric peat, becoming wet at c.66 cm but no water table (no final water table evident), to 102 cm b.g.l
Rather bleached (albic) sand (damp only) to end of core at 125 cm

Core 8, TL 93355 68416
Location: The core samples part of an extensive area of low-lying land in improved grassland south of the main block of fen meadow.
Vegetation: *Lolio-Plantaginion* grassland (MG7) with some False Oat-grass (occasional) and Meadow Buttercup (rare).

Earthy peat with occasional shell fragments to 34 cm b.g.l
Sapric peat, almost black, to 54 cm b.g.l.
Rather bleached sand, with first mottle at 57 cm, to 84 cm
Boulder Clay with abundant small chalk pebbles (wet) to end of core at 125 cm b.g.l
No water table: likely to have been within sapric peat layer formerly; area may be sensitive to current rainfall conditions.

Core 9, TL 93323 68302
Location: The core samples part of an extensive area of low-lying land in improved grassland south of the main block of fen meadow.

Vegetation: Abundant Perennial Ryegrass with frequent Crested Dogs'-tail and White Clover; Dandelion occasional. Typical sub-community of *Lolio-Cynosuretum cristati* grasslands (MG6a).

Humic silty sand to 30 cm b.g.l
Yellow sand, first mottle at 41 cm, manganiferous streaks at c. 62, to 83 cm b.g.l.
Grey sand with chalk stones, to 99 cm b.g.l.
Boulder Clay with many chalk stones, to end of core at 125 cm b.g.l.

South site

Core 10, TL 92811 68038
Location: This core samples the soft peat soils within an area of fen meadow, near its upland margin.
Vegetation: Blunt-flowered Rush sward (abundant) with frequent Water Horsetail and occasional Hard Rush over a mixed carpet of the mosses *Brachythecium rutabulum* (abundant) and *Calliergonella cuspidata* (frequent). Corresponds to a recently unmown *Juncus subnodulosus-Cirsium palustre* fen-meadow, Typical sub-community (MG22a).

Hemic peat, mid-brown to 15 cm b.g.l.
Marl, light yellow-brown with white calcite concretions, to 25 cm b.g.l.
Hemic-fibric fen peat (light brown), to 57 cm b.g.l.
Sapric peat, with water table at 62 rising to 43 cm, to 98 cm b.g.l.
'Putty' chalk (periglacial weathering product: chalk pebbles in matrix of chalk paste) to end of core at 125 cm b.g.l.

Core 11, TL 92931 68113
Location: This core samples firm ground within an area of damp grassland in low-lying land beside an area of fen meadow.
Vegetation: Flushed circum-neutral grassland with abundant Red Fescue and the moss *Calliergonella cuspidata*, frequent Hard Rush and Dandelion and a range of occasional associates including Tawny Sedge *Carex hostiana*, a regional rarity. There is no clear association with the NVC but the species noted at the core location often occur together within the *Caricion davallianae* alliance.

Earthy peat, very dark brown, to 18 cm b.g.l.
Marl, pale yellow-brown, to 31 cm b.g.l.
Sapric peat, dark charcoal in colour, wet from 73, but not water table; no change, with fibric inclusions.
End of core at 125 cm b.g.l.

Core 12, TL 92764 68152
Location: This core samples the soft peat soils within an area of fen meadow, near its upland margin.
Vegetation: Blunt-flowered Rush sward (abundant) with frequent Water Horsetail and Yorkshire Fog and occasional Hard Rush over a mixed carpet of the mosses *Brachythecium rutabulum* (abundant) and *Calliergonella cuspidata* (frequent). Corresponds to a recently unmown *Juncus subnodulosus-Cirsium palustre* fen-meadow, Typical sub-community (MG22a).

Earthy peat to 24 cm b.g.l.
Humic sand to 43 cm b.g.l.
Hemic peat to 58 cm b.g.l.
Sapric peat, wet but no water table, to 75 cm b.g.l.
'Putty' chalk (see Core 10) to end of core at 125 cm b.g.l.

Core 13, TL 92844 68213
Location: The core represents part of the gently sloping upland toeslope.

Vegetation: Abundant Perennial Ryegrass with Frequent Hairy Sedge and Yorkshire Fog, with Hard Rush occasional. Transitional between *Lolio-Plantagion* grassland (MG7) and the *Juncus inflexus* sub-community of the *Holco-Juncetum effusi* community (MG10b).

Earthy peat, slightly sandy and noticeably more compact than other cores, to 42 cm b.g.l.
Humic sand, wetter from 52 cm, to 59 cm b.g.l.
Grey sand, heavily mottled, saturated by 80 cm but no water table evident.
End of core at 100 cm due to gravel.

Core 14, TL 93045 68320
Location: This core represents part of the gently sloping upland toeslope.
Vegetation: Perennial Ryegrass dominant with scattered Annual Meadow-grass, Chickweed and Sow-thistle; corresponds to the *Lolium perenne-Trifolium repens* ley grassland of *Lolio-Plantaginion* (MG7a).

Light brown sand (fine, compact sand with occasional stones); occasional mottles from 38 cm b.g.l.
End of core at 60 cm (compaction)

Core 15, TL 93201 68329
Location: Paired with Core 7, this core lies near the margin of low-lying land beside an elevated area that intrudes into the floodplain.
Vegetation: Perennial Ryegrass abundant with frequent Creeping Buttercup; Creeping Bent and Rough Meadow-grass were occasional and Hard Rush rare. This grassland is best placed within the *Lolium perenne-Poa trivialis* leys of the *Lolio-Plantaginion* grasslands (MG7b).

Earthy peat to 35 cm b.g.l.
Sapric peat, with shell fragments and woody inclusions from 70 cm; wet from c.50 cm but no water table.
End of core at 125 cm b.g.l.

Core 16, TL 93102 68017
Location: The core represents the soils of a large area of drier grassland near the river.
Vegetation: Perennial Ryegrass abundant with frequent Hairy Sedge and Creeping Buttercup; Dandelion and White Clover occasional with Common Mouse-ear rare. This grassland is best placed within the *Lolium perenne-Poa trivialis* leys of the *Lolio-Plantaginion* grasslands (MG7b).

Earthy peat to 24 cm b.g.l.
Marl to 45 cm b.g.l.
Hemic peat, becoming wet at c.80 cm but no water table, to end of core at 125 cm b.g.l.

Core 17, TL 93019 68171
Location: This core samples a block of damp grassland below the margin of the upland toeslope.
Vegetation: Perennial Ryegrass abundant with frequent Rough Meadow-grass; Dandelion, Daisy and Creeping Buttercup; White Clover occasional. This grassland is best placed within the *Lolium perenne-Poa trivialis* leys of the *Lolio-Plantaginion* grasslands (MG7b).

Earthy peat, with occasional stones, to 38 cm b.g.l.
Sapric peat, wet from 63 cm but no water table, to 82 cm b.g.l.
Hemic peat to end of core at 125 cm b.g.l.