European Site Conservation Objectives: supplementary advice on conserving and restoring site features

Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses Special Area of Conservation (SAC) Site Code: UK0012912

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About this document

This document provides Natural England's supplementary advice about the European Site Conservation Objectives relating to Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SAC. This advice should therefore be read together with the SAC Conservation Objectives available here.

You should use the Conservation Objectives, this Supplementary Advice and any case-specific advice given by Natural England, when developing, proposing or assessing an activity, plan or project that may affect this site.

This SAC is a cross-border site. You should also refer to the SAC Core Management Plan previously published by Natural Resources Wales.

This Supplementary Advice to the Conservation Objectives presents attributes which are ecological characteristics of the designated species and habitats within a site. The listed attributes are considered to be those that best describe the site's ecological integrity and which, if safeguarded, will enable achievement of the Conservation Objectives. Each attribute has a target which is either quantified or qualitative depending on the available evidence. The target identifies as far as possible the desired state to be achieved for the attribute.

The tables provided below bring together the findings of the best available scientific evidence relating to the site's qualifying features, which may be updated or supplemented in further publications from Natural England and other sources. The local evidence used in preparing this supplementary advice has been cited. The references to the national evidence used are available on request. Where evidence and references have not been indicated, Natural England has applied ecological knowledge and expert judgement. You may decide to use other additional sources of information.

In many cases, the attribute targets shown in the tables indicate whether the current objective is to 'maintain' or 'restore' the attribute. This is based on the best available information, including that gathered during monitoring of the feature's current condition. As new information on feature condition becomes available, this will be added so that the advice remains up to date.

The targets given for each attribute do not represent thresholds to assess the significance of any given impact in Habitats Regulations Assessments. You will need to assess this on a case-by-case basis using the most current information available.

Some, but not all, of these attributes can also be used for regular monitoring of the actual condition of the designated features. The attributes selected for monitoring the features, and the standards used to assess their condition, are listed in separate monitoring documents, which will be available from Natural England.

These tables do not give advice about SSSI features or other legally protected species which may also be present within the European Site.

If you have any comments or queries about this Supplementary Advice document please contact your local Natural England adviser or email HDIRConservationObjectivesNE@naturalengland.org.uk

About this site

European Site information

Name of European Site	Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses Special Area of Conservation (SAC)
Location	Shropshire
Site Maps	The designated boundary of this site can be viewed on the MAGIC website
Designation Date	1st April 2005 (Welsh Section designated 13th December 2004)
Qualifying Features	See section below
Designation Area	949.21 ha
Designation Changes	N/A
Feature Condition Status	Details of the feature condition assessments made at this site can be found using Natural England's Designated Sites System
Names of component Sites of Special Scientific Interest (SSSIs)	Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SSSI
Relationship with other European or International Site designations	Ramsar Site: Midland Meres & Mosses Phase 2. http://jncc.defra.gov.uk/pdf/RIS/UK11080.pdf

Site background and geography

This is a large lowland raised bog that straddles the English/Welsh border. It is amongst the largest and most southerly raised bogs in the UK. The site lies within the Shropshire, Cheshire and Staffordshire Plain National Character Area, a landscape characterised by an extensive, gently undulating plain, dominated by thick glacial till from the late Pleistocene Period and which produces productive, clay soils and characteristic glacial landforms including eskers, glacial fans, kettle holes, moraines and a landscape of meres and mosses.

Although much of the site has been historically subject to peat extraction, areas of partially-cut and uncut mire still remain. In areas formerly subject to commercial peat-cutting, conservation management has led to the regeneration of bog-forming vegetation. Mire vegetation includes the bog-mosses *Sphagnum papillosum*, *Sphagnum magellanicum*, and *Sphagnum pulchrum*, all three British species of sundew *Drosera* spp., cranberry *Vaccinium oxycoccos*, bog asphodel *Narthecium ossifragum*, royal fern *Osmunda regalis*, white beak-sedge *Rhynchospora alba* and bog-rosemary *Andromeda polifolia*, together with the nationally scarce moss *Dicranum affine*. Over 1,700 invertebrate species have been recorded here, including 29 nationally rare species.

The SAC forms part of Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses SSSI, the Midland Meres and Mosses Phase 2 Ramsar site and Fenn's Whixall and Bettisfield Mosses and Wem Moss National Nature Reserves.

About the qualifying features of the SAC

The following section gives you additional, site-specific information about this SAC's qualifying features. These are the natural habitats and/or species for which this SAC has been designated.

Qualifying habitats:

- **H7110 Active Raised Bogs* (Priority feature)**

  Active raised bogs are peat-forming ecosystems that have developed during thousands of years of peat accumulation, to such an extent that the depth of peat isolates them from the influence of groundwater.

  Typically, lowland raised bogs form a raised dome of peat irrigated solely by precipitation (rainfall, snow, fog). The vegetation considered to be actively peat-forming is a mixture of heather *Calluna vulgaris*, cross-leaved heath *Erica tetralix*, deer-grass *Trichophorum germanicum*, common cotton-grass *Eriophorum angustifolium* and hare's-tail cotton-grass *E. vaginatum* with a high cover of a variety of bog-mosses.

  This SAC is amongst the largest and most southerly raised bogs in the UK. Although much of the site has been subject to peat extraction, areas of partially-cut and uncut mire still remain. In areas formerly subject to commercial peat-cutting, recent conservation management has led to the regeneration of bog-forming vegetation. Mire vegetation includes *Sphagnum papillosum*, *Sphagnum magellanicum*, *Sphagnum pulchrum*, all three British species of sundew *Drosera* spp., cranberry *Vaccinium oxycoccos*, bog asphodel *Narthecium ossifragum*, royal fern *Osmunda regalis*, white beak-sedge *Rhynchospora alba* and bog-rosemary *Andromeda polifolia*, together with the nationally scarce moss *Dicranum affine*.

  Over 1,700 invertebrate species have been recorded here, including 29 nationally rare Red Data Book species.

- **H7120 Degraded raised bogs still capable of natural regeneration ('Degraded raised bog')**

  Degraded raised bogs occur where there has been widespread disruption, usually by man, to the structure and function of the peat body. This can involve changes to the hydrology, vegetation, and physical structure of the bog, leading to desiccation, oxidation and loss of species or changes in the balance of the species composition.

  In contrast to H7110 Active raised bogs, peat is not currently forming in degraded bog. The vegetation of degraded bog contains several, but not all, of the species typical of active raised bogs, but the relative abundance and distribution of individual species differs.

  The Interpretation Manual of European Habitats (European Commission DG Environment 1999) stresses that the Annex I habitat type of degraded raised bogs only includes examples which are 'capable of natural regeneration', i.e. "where the hydrology can be repaired and where, with appropriate rehabilitation management, there is a reasonable expectation of re-establishing vegetation with peat-forming capability within 30 years". This is to be assessed on a case-by-case basis.

Table 1: Supplementary Advice for Qualifying Features: H7110. Active raised bogs*

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Extent and distribution of the feature	**Extent of the feature within the site**	Restore the total extent of the H7110 feature to 948.84 ha.	There should be no measurable net reduction (excluding any trivial loss)in the extent and area of this feature, and in some cases, the full extent of the feature may need to be restored. The baseline-value of extent given has been generated using data gathered from the listed site-based surveys. Area measurements given may be approximate depending on the methods, age and accuracy of data collection, and as a result this value may be updated in future to reflect more accurate information. The extent of an Annex I habitat feature covers the sum extent of all of the component vegetation communities present and may include transitions and mosaics with other closely-associated habitat features. Where a feature is susceptible to natural dynamic processes, there may be acceptable variations in its extent through natural fluctuations. Where a reduction in the extent of a feature is considered necessary to meet the Conservation Objective for another Annex I feature, Natural England will advise on this on a case-by-case basis. For this feature, the term 'Bog' is taken here to be the peat deposit together with typical bog vegetation, irrespective of the precise nature and condition of that vegetation. 'Lagg fen' comprises both peat deposit and vegetation, irrespective of nature and condition. Approximately 676.24ha is considered to currently comprise SAC designated active raised bog; the remaining extent comprising SAC designated degraded raised bog (see Figure 1). Total extent within England equals 258.41ha.	AMORROSTA, A.A. 2005 ARRESE, I.B. 2005. ASHMORE, F. 2014. CUARTERO VILLALVILLA, A. 2006. DANIELS, J.L. 1998 DANIELS, J. L. 2000 DANIELS, J.L. 2004 DANIELS, J.L. 2010 DORE, S. 2005. ENGLISH NATURE 2001 ENVIRONMENTAL SIMULATIONS INTERNATIONAL 2003 FERNANDEZ DE CASTRO MENDIZABAL, U 2005 FORRESTER R. A. 2005. GONZALEZ, R.S. 2005. GYOPARI, M.C. 1990. HARGREAVES, S. 2005. HORTON, K. 2004 HORTON, K. 2008 MARSON, L.C. 1989. ROSENBURG, A. 2015
	Spatial distribution of the feature within the site	Restore the distribution and configuration of the H7110 feature, including where applicable its component vegetation types, across the site	A contraction in the range, or geographic spread, of the feature (and its component vegetation and typical species, plus transitional communities) across the site will reduce its overall area, the local diversity and variations in its structure and composition, and may undermine its resilience to adapt to future environmental changes. This may also reduce and break up the continuity of a habitat within a site and how well its typical species are able to move around the site to occupy and use habitat. Such fragmentation can impact on their viability and the wider ecological composition of the Annex I habitat. Smaller fragments of habitat can typically	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			support smaller and more isolated populations which are more vulnerable to extinction. These fragments also have a greater amount of open edge habitat which will differ in the amount of light, temperature, wind, and even noise that it receives compared to its interior. These conditions may not be suitable for some of the typical and more specialist species associated with the Annex I habitat feature.	
Structure and function (including its typical species)	**Vegetation community composition**	Ensure the component vegetation communities of the H7110 feature are broadly referable to and characterised by the following National Vegetation Classification types; M18 raised and blanket mire; M2 bog pool community; M23 rush-pasture; M25 mire W5 woodland and W6 woodland (lagg)]	This Annex I feature may comprise a number of characteristic but different, naturally occurring vegetation types, which will depend on the geographical location of the site, altitude, aspect, soil conditions (especially base-status and drainage), any maritime influence and grazing intensity and management. Maintaining or restoring these distinctive vegetation types, and the range of types as appropriate, will be important to sustaining the overall habitat feature. M18 *Erica tetralix-Sphagnum papillosum* raised and blanket mire M2 *Sphagnum cuspidatum/Sphagnum recurvum* bog pool community (mire expanse and rand) M23 *Juncus effusus/acutiflorus-Galium palustre* rush-pasture M25 *Molinia caerulea-Potentilla erecta* mire W5 *Alnus glutinosa – Carex paniculata* woodland W6 *Alnus glutinosa – Urtica dioica* woodland	
	Structural diversity	Restore the full range of typical structural features associated with the H7110 feature at this site, e.g. vegetation cover, surface patterning and hydrological zonations	Active raised bogs in particular show varying degrees of structural variation and surface patterning reflecting hydrological gradations (which may be natural or the result of previous damage). These can occur at both macro and micro scales across the habitat and include alternative aquatic and terrestrial surface features, such as pools and hummocks, and terrestrial features such as ridges and hollows. These features will support distinctive patterns of bog vegetation, and so will be sensitive to changes in topography and hydrology. These can be modified or disrupted by activities such as drainage, burning, grazing, vehicular access and peat digging.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Structure and function (including its typical species)	**Invasive, non-native and/or introduced species**	Ensure invasive and introduced non-native species are either rare or absent, but if present are causing minimal damage to the H7110 feature	Invasive or introduced non-native species can be a serious potential threat to the structure and function of these habitats, because they are able to exclude, damage or suppress the growth of their associated typical species, reduce structural diversity of the habitat and prevent the natural regeneration of characteristic site-native species. Once established, the measures to control such species may also impact negatively on the features of interest (e.g. use of broad spectrum pesticides).	
	Supporting off-site habitat	Restore the extent, quality and spatial configuration of land or habitat surrounding or adjacent to the site which is known to support the H7110 feature	The structure and function of the qualifying habitat, including its typical species, may rely upon the continued presence of areas which surround and are outside of the designated site boundary. Changes in surrounding land-use may adversely (directly/indirectly) affect the functioning of the feature and its component species. This supporting habitat may be critical to the typical species of the feature to support their feeding, breeding, roosting, population dynamics ('meta-populations'), pollination or to prevent/reduce/absorb damaging impacts from adjacent land uses e.g. pesticide drift, nutrient enrichment. For this feature the protection and management of any peripheral peat and the land immediately around the peat body will be of critical functional importance to the restoration or maintenance of the hydrology of active bog and its management must also be compatible with long-term maintenance of the bog. There are no known areas of H7110 surrounding or adjacent to this SAC. However, off-site H7120 habitat extends across peat soils adjoining the SAC. These have been mapped and are shown on Figure 2 below. The sandy hill catchment to the north and north-east of the SAC has been identified as being critical in that water abstraction from this area would affect the amount of run-in to the bog (Symonds Group Ltd. 2004). Establishing an appropriate hydrological regime on the marginal peats may mean re-wetting some presently drained farmland on mineral ground around the peat edge. This means re-routing the lagg streams (e.g. the Bronington Manor Drain) to the margins of the bog and then ultimately raising their water levels. Currently many lagg streams have been canalised within the peat to enable marginal peats and mineral ground to be drained (Martin Wright Associates, 2014). Water intensive land uses on the critical sand parts of the catchment such as evergreen plantations may intercept and evaporate up to 30% of the scarce water	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			supplies and so may affect water resources in the sands below the peat.	
Structure and function (including its typical species)	**Hydrology**	At a site, unit and/or catchment level, restore natural hydrological processes to provide the conditions necessary to sustain the H7110 feature within the site	Defining and maintaining the appropriate hydrological regime is a key step in moving towards achieving the conservation objectives for this site and sustaining this feature. Changes in source, depth, duration, frequency, magnitude and timing of water supply can have significant implications for the assemblage of characteristic plants and animals present. See also notes for 'supporting off-site habitat' above.	BOARDMAN, P.1993. BOARDMAN, P. 2003 ENVIRONMENTAL SIMULATIONS INTERNATIONAL 2001, 2003, 2017 GILMAN, K. 1996a, 1996b, 2000a. 2000b. 2001. HALL, L. 1995. HAYSTED, Z. 2013. HOLLIDAY, C. 1993. HYDROLOGIC Ltd. 2001. KARPOUZLI, E. 1994. KILLINGWORTH, B. 2009. 2011. MARTIN WRIGHT ASSOCIATES. 2014. PHILLIPS, J . 1992. ROBINSON, N. 2003. ROBINSON, T. 2012. SMITH, C.S. 1987, 1992. SZULC, K., BESENYEI, L., SZULC, B. AND RAKOWSKA, B. 2014.
	Water chemistry	Restore the surface water and groundwater feeding the H7110 feature to a low nutrient status.	This habitat type is predominantly cloud-fed and should be naturally low in nutrients to sustain its characteristic bog communities and associated typical species. Any additional sources of water which contribute to supporting the bog habitat, including the margins of the bog and the lagg (the peripheral zone around the bog) should similarly be lacking in nutrients.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
				SYMONDS GROUP Ltd. 2004 WATER MANAGEMENT CONSULTANTS. 2009.
Structure and function (including its typical species)	**Soils, substrate and nutrient cycling**	Restore the properties of the underlying peat, including structure, bulk density, total carbon, pH, soil nutrient status and fungal/bacterial ratio, to within typical values for the H7110 habitat.	Soil is the foundation of basic ecosystem function and a vital part of the natural environment. Its properties strongly influence the colonisation, growth and distribution of those plant species which together form vegetation types, and therefore provides a habitat used by a wide range of organisms. Changes to natural soil properties may therefore affect the ecological structure, function and processes associated with this Annex I feature. The typical substrate for this feature is acidic and nutrient/mineral-poor peat with a water content of over 85%. Peat is distinguished from other soil types by its high content of organic matter, which results from plant growth and waterlogging combining to reduce decomposition rates and allow a build-up, over time, of semi-decomposed plant material to form peat.	See above
	Adaptation and resilience	Restore the feature's ability, and that of its supporting processes, to adapt or evolve to wider environmental change, either within or external to the site	This recognises the increasing likelihood of natural habitat features to absorb or adapt to wider environmental changes. Resilience may be described as the ability of an ecological system to cope with, and adapt to environmental stress and change whilst retaining the same basic structure and ways of functioning. Such environmental changes may include changes in sea levels, precipitation and temperature for example, which are likely to affect the extent, distribution, composition and functioning of a feature within a site. The vulnerability and response of features to such changes will vary. Using best available information, any necessary or likely adaptation or adjustment by the feature and its management in response to actual or expected climatic change should be allowed for, as far as practicable, in order to ensure the feature's long-term viability. The overall vulnerability of this particular SAC to climate change has been assessed by Natural England as being high, taking into account the sensitivity, fragmentation, topography and management of its habitats/supporting habitats (Natural England, 2015). These sites are considered to be the most vulnerable sites overall and are likely to require the most adaptation action, most urgently. Action to address specific issues is likely, such as reducing habitat fragmentation, creating more habitat to buffer the site or expand the habitat into more varied	NATURAL ENGLAND, 2015. Climate Change Theme Plan and National Biodiversity Climate Change Vulnerability Assessments (NBCCVAs). Available at http://publications.naturalengland.org.uk/publication/4954594591375360

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			landscapes and addressing particular management and condition issues. Individual species may be more or less vulnerable than their habitat itself. In many cases, change will be inevitable so appropriate monitoring would be required.	
Supporting processes (on which the feature relies)	**Air quality**	Restore the concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for the H7110 feature of the site on the Air Pollution Information System (www.apis.ac.uk).	This habitat type is considered sensitive to changes in air quality. Exceedance of critical values for air pollutants may modify the chemical status of its substrate, accelerating or damaging plant growth, altering its vegetation structure and composition and causing the loss of sensitive typical species associated with it. Critical Loads and Levels are recognised thresholds below which such harmful effects on sensitive UK habitats will not occur to a significant level, according to current levels of scientific understanding. There are critical levels for ammonia (NH3), oxides of nitrogen (NOx) and sulphur dioxide (SO2), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis. Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales. Critical loads for nitrogen and acidity are currently being exceeded at this SAC (APIS, August 2017)	More information about site-relevant Critical Loads and Levels for this SAC is available by using the 'search by site' tool on www.apis.ac.uk
	Functional connectivity with wider landscape	Restore the overall extent, quality and function of any supporting features within the local landscape which provide a critical functional connection with the site	This recognises the potential need at this site to maintain or restore the connectivity of the site to its wider landscape in order to meet the conservation objectives. These connections may take the form of landscape features, such as habitat patches, hedges, watercourses and verges, outside of the designated site boundary which are either important for the migration, dispersal and genetic exchange of those typical species closely associated with qualifying Annex I habitat features of the site. These features may also be important to the operation of the supporting ecological processes on which the designated site and its features may rely. In most cases increasing actual and functional landscape-scale connectivity would be beneficial. Where there is a lack of detailed knowledge of the connectivity requirements of the qualifying feature, Natural England will advise as to whether these are applicable on a case by case basis.	See above
	Conservation measures	Restore the management measures (either within	Active and ongoing conservation management is needed to protect, maintain or restore this feature at this site.	NATURAL ENGLAND, 2014.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		and/or outside the site boundary as appropriate) which are necessary to restore the structure, functions and supporting processes associated with the H7110 feature	Further details about the necessary conservation measures for this site can be provided by contacting Natural England. This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and/or management agreements.	Site Improvement Plan: Fenn's, Whixall, Bettisfield, Wem & Cadney Mosses (SIP085) ENGLISH NATURE & THE COUNTRYSIDE COUNCIL FOR WALES, 2005. Views about the Management of Fenn's, Whixall, Bettisfield, Wem & Cadney Mosses SSSI.
Structure and function (including its typical species)	**Key structural, influential and/or distinctive species**	Restore the abundance of the species listed below to enable each of them to be a viable component of H7110 Active Raised Bog habitat; Mixed assemblage of typical bryophytes (predominantly *Sphagnum* spp) Dwarf shrubs (mainly Ericaceae but including *Empetrum nigrum Vaccinium oxycoccus, Vaccinium vitis-idaea*) *Utricularia minor, Narthecium ossifragum, Frangula alnus,*	Some plant or animal species (or related groups of such species) make a particularly important contribution to the structure, function and/or quality of an Annex I habitat feature at a particular site. These species will include; – Structural species which form a key part of the habitat's structure or help to define an Annex I habitat on a site (see also the attribute for 'vegetation community composition'). – Influential species which are likely to have a key role affecting the structure and function of the habitat (such as bioturbators (mixers of soil/sediment), grazers, surface borers, predators or other species with a significant functional role linked to the habitat). – Site-distinctive species which are considered to be a particularly special and distinguishing component of an Annex I habitat on a particular site. There may be natural fluctuations in the frequency and cover of each of these species. The relative contribution made by them to the overall ecological integrity of a site may vary, and Natural England will provide bespoke advice on this as necessary.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		Rubus chamaemorus, Osmunda regalis, Hottonia palustris, Trichophorum caespitosum, Dactylorhiza incarnate, Drosera anglica, Platanthera bifolia, Eleocharis multicaulis, Cirsium dissectum, Drosera intermedia, Carex lasiocarpa Assemblage of nationally rare invertebrates associated with active raised bog	The list of species given here for this Annex I habitat feature at this SAC is not necessarily exhaustive. The list may evolve, and species may be added or deleted, as new information about this site becomes available. For this feature, the vegetation of the mire expanse should comprise an inter-mix of typical bryophytes (predominantly *Sphagnum* spp), grasses and dwarf shrubs, with no one group dominating at the expense of others on 'active' sites. Although *Sphagnum* may predominate on hyper-oceanic sites, purple moor-grass *Molinia* may be typical and abundant on the bog margin ('rand') of active sites, and more widely on degraded sites.	
Version Control Advice last updated: n/a				
Variations from national feature-framework of integrity-guidance: n/a				

Table 2: Supplementary Advice for Qualifying Features: H7120. Degraded raised bogs still capable of natural regeneration; Degraded raised bog

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Extent and distribution of the feature	**Extent of the feature within the site**	Avoid further degradation of the extent of the H7120 feature, whilst restoring 237.64ha of the H7120 feature to H7110 Active Raised Bogs	There should be no measurable net increase in the extent and area of this feature, and in most cases, the full extent of the feature should be restored to H7110 Active Raised Bogs. For this feature, 'Bog' is taken here to be the peat deposit together with typical bog vegetation, irrespective of the precise nature and condition of that vegetation. 'Lagg fen' comprises both peat deposit and vegetation, irrespective of nature and condition. An area 2.23 ha of degraded bog habitat within the SAC will not be restored to H7110. This area has been used as a breakers yard since the 1960s for salvaged vehicles and the underlying peat is contaminated with materials associated with this use e.g. crushed hard-core, asbestos, and hydro-carbons. Whilst the use of the site as a scrapyard ceased in 2015 when it was purchased by Shropshire Wildlife Trust, the remediation strategy for the area prepared in consultation with the EA, Shropshire Council and NE concluded that attempts to decontaminate the peat would increase the contamination hazards to the SAC and wider environment. As result most of the area is to be covered by peat soil turves cut within the SAC and left as a non-intervention area and will not be capable of restoration to active bog.	Please refer to references provided in Table 1
	Spatial distribution of the feature within the site	Reduce the further degradation of the distribution of the H7120 feature, whilst expanding the distribution of the H7110 Active Raised Bog feature within the site	See notes for this attribute above in Table 1	
Structure and function (including its typical species)	**Soils, substrate and nutrient cycling**	Reduce or restrict further degradation of the peat substrate of the H7120 feature and restore the properties of the underlying peat type, including its structure, bulk density, total carbon, pH, soil nutrient status and	See notes for this attribute in Table 1 above	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		fungal/bacterial ratio, to within typical values for H7110 Active Raised Bog habitat.		
Structure and function (including its typical species)	**Vegetation community composition**	Restore the component vegetation communities of the H7210 feature to those broadly resembling and characterised by the following National Vegetation Classification type typical of H7110 Active Raised Bog. M18 *Erica tetralix-Sphagnum papillosum* raised and blanket mire M2 *Sphagnum cuspidatum/Sphagnum recurvum* bog pool community (mire expanse and rand) M23 *Juncus effusus/acutiflorus-Galium palustre* rush-pasture M25 *Molinia caerulea-Potentilla erecta* mire W5 *Alnus glutinosa – Carex paniculata* woodland W6 *Alnus glutinosa – Urtica dioica* woodland (lagg)]	This habitat feature when restored will comprise a number of associated semi-natural and natural vegetation types associated with H7110 Active Raised Bog and their transitional zones, reflecting the geographical location of the site, altitude, aspect, soil conditions (especially base-status and hydrology) and vegetation management. In the UK these have been categorised by the National Vegetation Classification (NVC). Restoring degraded bog vegetation to characteristic and distinctive H7110 active bog vegetation types will be important to restoring the overall habitat feature. This will also help to conserve their typical plant species (including the constant and preferential species of a vegetation community), and therefore those of the SAC feature, at appropriate levels (recognising natural fluctuations). The component wetland types of active raised bog will comprise the bog expanse, the sloping margins of the bog (or 'rand') (although this may not always be mappable) and lagg fen. The bog expanse will typically be characterised by cloud-fed or ombrotrophic vegetation (such as M18 raised and blanket mire and M2 bog pool community). It should comprise an intimate mix of typical bryophytes (predominantly *Sphagnum* spp), grasses/sedges and dwarf shrubs, with no one group dominating at the expense of others on 'active' sites. Sphagnum should predominate on hyper-oceanic sites, while its cover may be slightly lower on eastern sites with lower rainfall. The bog rand will typically consist of communities of drier peat and the lagg fen by vegetation associated with swamp and fen habitats.	
Structure and function (including its	**Structural diversity**	Restore the full range of structural features (e.g. vegetation cover,	Active raised bogs in particular show varying degrees of structural variation and surface patterning reflecting hydrological gradations (which may be natural or the result of previous damage). These can occur at both macro and micro scales across	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
typical species)		surface patterning and hydrological transitions) typically associated with H7110 Active Raised Bog to the H7120 feature at this site.	the habitat and include alternative aquatic and terrestrial surface features, such as bog pools and hummocks, ridges and hollows. These features will support distinctive patterns of bog vegetation, and so will be sensitive to changes in topography and hydrology. These can be modified or disrupted by activities such as drainage, burning, grazing, vehicular access and peat digging.	
Structure and function (including its typical species)	**Key structural, influential and/or distinctive species**	Restore the abundance of the species listed below to enable each of them to be a viable component of H7110 Active Raised Bog habitat; Mixed assemblage of typical bryophytes (predominantly *Sphagnum* spp) Dwarf shrubs (mainly Ericaceae but including *Empetrum nigrum Vaccinium oxycoccus, Vaccinium vitis-idaea*) *Utricularia minor, Narthecium ossifragum, Frangula alnus, Rubus chamaemorus, Osmunda regalis, Hottonia palustris, Trichophorum caespitosum, Dactylorhiza incarnate, Drosera anglica, Platanthera bifolia, Eleocharis multicaulis, Cirsium dissectum, Drosera intermedia,*	See notes for this attribute in Table 1 above	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		Carex lasiocarpa Assemblage of nationally rare invertebrates associated with active raised bog		
Structure and function (including its typical species)	**Invasive, non-native and/or introduced species**	Ensure invasive and introduced non-native species are either rare or absent, and if present are not undermining the restoration of the H7120 feature	Invasive or introduced non-native species can be a serious potential threat to the structure and function of these habitats, because they are able to exclude, damage or suppress the growth of their associated typical species, reduce structural diversity of the habitat and prevent the natural regeneration of characteristic site-native species. Once established, the measures to control such species may also impact negatively on the features of interest (eg use of broad spectrum herbicides).	
	Supporting off-site habitat	Restore the extent, quality and spatial configuration of land or habitat surrounding or adjacent to the site which is known to support the restoration of the H7120 raised bog feature	See notes for this attribute in Table 1 above	
	Hydrology	At a site, unit and/or catchment level (as necessary), restore natural hydrological processes to provide the water levels and conditions necessary to prevent further degradation of the H7120 feature and to enable its restoration to H7110 active raised bog	Defining and maintaining the appropriate hydrological regime is a key step in moving towards achieving the conservation objectives for this site. The restoration of this structural attribute of the H7120 degraded bog feature will be a key element of its recovery to H7110 active raised bog. The hydrology of degraded raised bog fails to support the processes and vegetation of active raised bog, which is the desired feature on this part of the site. Low and/or fluctuating water levels in the peat leads to oxidation and loss (wastage) of the peat along with loss of ability of the peat body to retain rainwater and accumulate peat. Bog species adapted to waterlogged, acidic and nutrient-poor conditions will be lost. Changes in source, depth, duration, frequency, magnitude and timing of water supply can have significant implications for the assemblage of characteristic plants and animals present.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			The surface of an active raised bog has low nutrient, waterlogged or high water table conditions. An abundance of the bog-mosses *Sphagnum papillosum, S. capillifolium, S.tenellum* and *S. magellanicum* will often indicate good surface conditions. Typically, the hydrology of the H7120 habitat feature has already been degraded but is considered capable of recovery. Further detrimental changes to the hydrology of a degraded raised bog can lead to further desiccation, oxidation and a further loss of species and will undermine the aim to restore this feature to active raised bog.	
Structure and function (including its typical species)	**Water chemistry**	Restore the surface water and groundwater feeding the H7210 feature to a low nutrient status.	Active raised bog in an undamaged state is characterised by a dome of peat which has developed through several thousand years of peat accumulation. This dome stands above the level of the surrounding land surface and effectively isolates the surface of the raised bog from the influence of groundwater. By being elevated, the raised bog is directly fed by atmospheric precipitation and so it has an acidic nature that is naturally poor in nutrients and which sustains its characteristic bog communities and associated typical species. Active raised bogs are naturally lacking in nutrients, with typically low values of calcium, phosphate, nitrate and pH. The mire expanse of an active raised bog typically has low nutrient, waterlogged or high water table conditions. An abundance of the bog-mosses will often indicate good surface condition. Any sources of water which contribute to supporting the bog habitat, including the margins of the bog and the lagg (the peripheral zone around the bog), should similarly be low in nutrients.	
	Adaptation and resilience	Reduce the further degradation of the H7120 feature's ability, and that of its supporting processes, to adapt or evolve to wider environmental change, either within or external to the site	See notes for this attribute in Table 1 above.	
Supporting processes (on which the feature relies)	**Air quality**	Restore the concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for this feature of	See notes for this attribute in Table 1 above	More information about site-relevant Critical Loads and Levels for this SAC is available by using the 'search by site' tool on the Air

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		the site on the Air Pollution Information System (www.apis.ac.uk).		Pollution Information System (www.apis.ac.uk).
Supporting processes (on which the feature relies)	**Functional connectivity with wider landscape**	Restore the overall extent, quality and function of any supporting features within the local landscape which provide a critical functional connection with the site	See notes for this attribute in Table 1 above	Please refer to references provided in Table 1
Supporting processes (on which the feature relies)	**Conservation measures**	Restore the management measures (either within and/or outside the site boundary as appropriate) which are necessary to restore the structure, functions and supporting processes for restoration to H7110 Active Raised Bog	Active and ongoing conservation management is needed to prevent further degradation of the H7120 Degraded Raised Bog feature at this site, and, more importantly, to restore it to H7110 Active Raised Bog habitat. Usually, raised bog restoration measures will aim to elevate and stabilise the underlying water table and re-establish waterlogged conditions, so the bog can re-grow and regain its characteristic structural features (e.g. bog pools) and its typical plant assemblages. Further details about the necessary conservation measures for this site can be provided by contacting Natural England. This information will typically be found within, where applicable, supporting documents such as the Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and/or management agreements.	
Version Control Advice last updated: n/a				
Variations from national feature-framework of integrity-guidance: n/a				

Figure 1: SAC Designated Active and Degraded Raised Bog

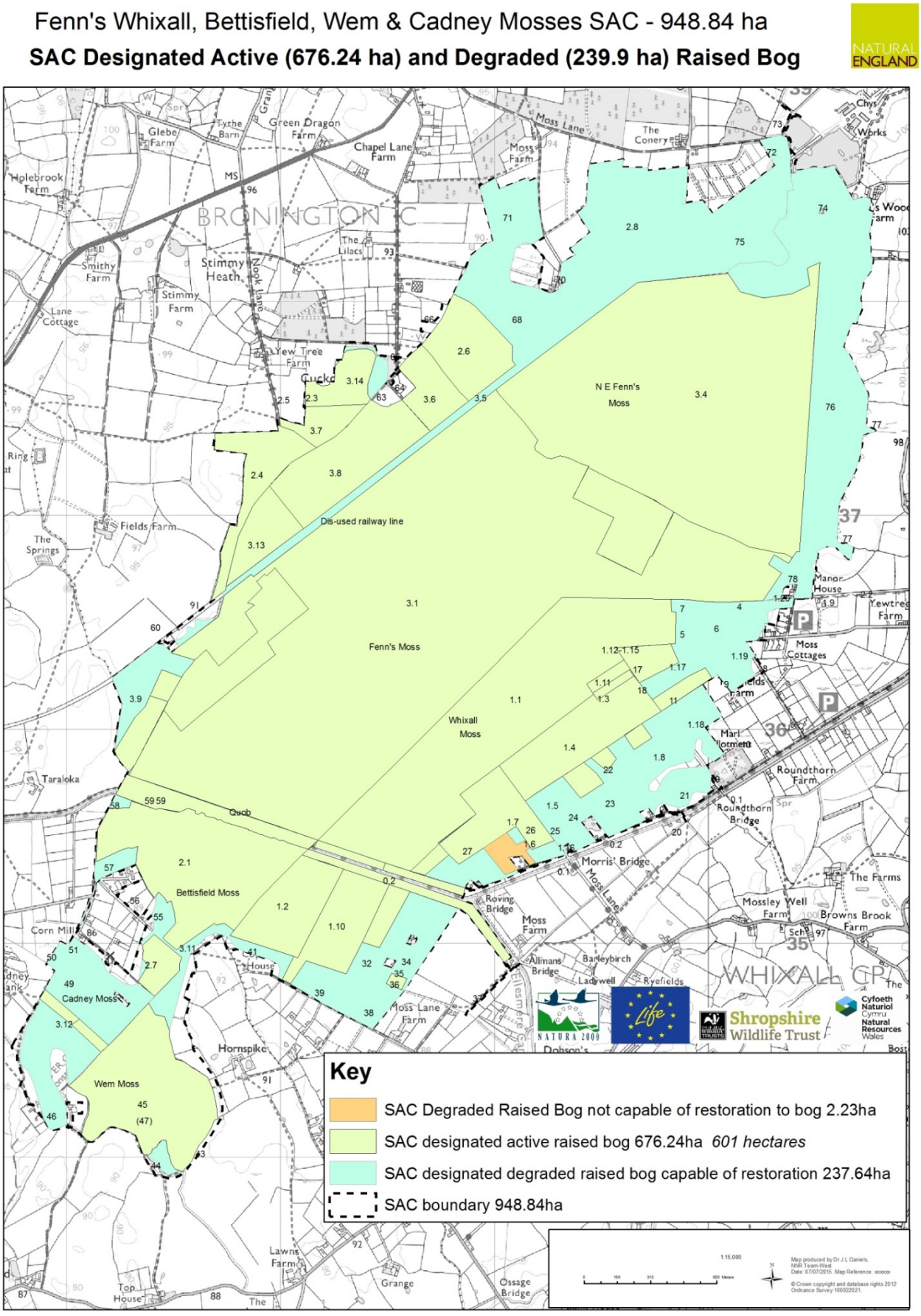
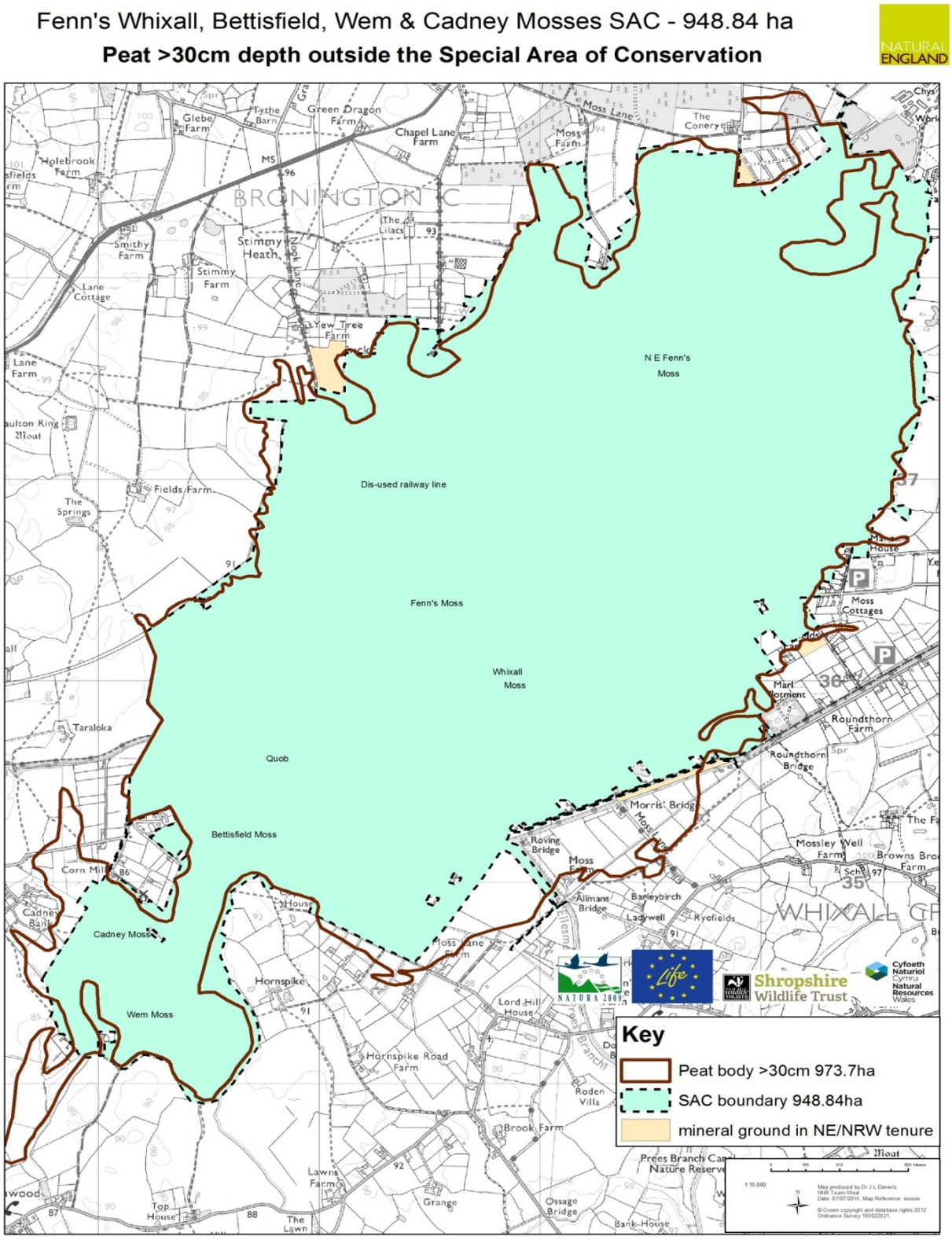


Figure 2: Map showing peat soils adjoining but outside the SAC boundary supporting H71120 Degraded Raised Bog habitat



References

AMORROSTA, A.A. 2005, The effects of rehabilitation of Fenn's Whixall & Bettisfield Mosses NNR lowland raised mire. Unpublished BSc. Honours project. Wolverhampton University

ARRESE, I.B. 2005. The Effects of the Rehabilitation Management of the Vegetation of Fenn's and Whixall Mosses National Nature Reserve. Unpublished B.Sc. Honours project. Wolverhampton University

ASHMORE, F. 2014. Evaluating Raised Lowland Bog Regeneration: A Multi-indicator Investigation at Fenn's NNR. B.Sc thesis Z0931301, Dept. Geography, University of Durham.

BOARDMAN, P.1993. General Water Level Survey, February, 1993, Fenn`s, Whixall & Bettisfield Mosses. E.N. internal report.

BOARDMAN, P. 2003 The hydrology of raised mire restoration. Transcripts and presentations from a workshop held at Fenn's, Whixall & Bettisfield Mosses National Nature Reserve, 5-6 March 2002. English Nature Research Report (in production).

CUARTERO VILLALVILLA, A. 2006. Analysis of the regeneration of the vegetation on Bettisfield Moss National Nature Reserve. M.Sc dissertation, Conservation and Utilisation of Plant Genetic Resources. University of Birmingham.

DANIELS, J.L. 1998 Fenn's, Whixall, Bettisfield, Wem & Cadney Mosses SSSI and Fenn's, Whixall & Bettisfield Mosses NNR Management Plan,

DANIELS, J. L. 2000 Assessment of Site Condition at Fenn's, Whixall & Bettisfield Mosses National Nature Reserve. in Nailing the Paradox - demonstrating favourable condition on damaged raised bogs. Ed. Tantram D. et al. English Nature Research Report No. 365.

DANIELS, J.L. 2004 Fenn's, Whixall, Bettisfield, Wem & Cadney Mosses SSSI and Fenn's, Whixall & Bettisfield Mosses NNR Management Plan, 2003/4 – 2007/8. Internal English Nature report.

DANIELS, J.L. 2010 Fenn's, Whixall, Bettisfield, Wem & Cadney Mosses SSSI and Fenn's, Whixall & Bettisfield Mosses NNR Management Plan, April 2008– March 2013. Internal Natural England report.

DORE, S. 2005. Nutrient dynamics in peat soils and the effect of removal of Pinus sylvestris on soil nutrient concentrations over time. Unpublished B.Sc Hons. Geog. & Geol. project, Manchester University.

ENGLISH NATURE 2001 English Nature -Eurosite Workshop 10-14 October 2000. Sphagnum or not? Variations in peat forming vegetation in relation to restored water levels. Report to Eurosite and English Nature.

ENVIRONMENTAL SIMULATIONS INTERNATIONAL, 2003 Assessment of the impacts of water abstraction on Fenn's, Whixall, Bettisfield, Wem and Cadney Moss. Report 6271DR1D1 to the Environment Agency.

ENVIRONMENTAL SIMULATIONS INTERNATIONAL, 2001 Upper Severn Area: Hydrogeological and hydrological assessment of selected wetland sites. Fenn's, Whixall, Bettisfield, Wem and Cadney Mosses NGR SJ490365. Report to the Environment Agency.

ENVIRONMENTAL SIMULATIONS INTERNATIONAL, 2017 Contaminated land remediation strategy:former W J Furbers Scrapyard, Whixall Moss

FERNANDEZ DE CASTRO MENDIZABAL, U 2005 The effects of rehabilitation management on the vegetation of a cut-over of a lowland raised mire in Whixall and Fenn's Mosses. B.Sc. Hons dissertation , Environmental Sciences, Univ. of Wolverhampton.

FORRESTER R. A. 2005. An investigation into the development of a lowland raised mire at Bettisfield Moss in North Shropshire, over a two year period. B. Sc. Hons dissertation, Harper Adams University College.

GILMAN, K. 1996a. Assessment of the hydrological significance of a disused railway across Fenn's & Whixall Mosses, Clwyd/Shropshire border. NERC Institute of Hydrology, Report to CCW, March 1996

GILMAN, K.1996b.Fenn's Whixall & Bettisfield Mosses SSSI, Clwyd/Shropshire - Evaluation of Hydrological connections across the Bronington Manor Drain NERC Institute of Hydrology; Report to CCW. October 1996.

GILMAN, K. 2000a. Hydrological assessment of the implications of NNR management at Fenn's, Whixall & Bettisfield Mosses. Report to English Nature & Countryside Council for Wales.

GILMAN, K. 2000b. Hydrological assessment of the implications of NNR management at Fenn's, Whixall & Bettisfield Mosses - Summary. Report to English Nature & Countryside Council for Wales

GILMAN, K. 2001. Winter flow measurements on Fenn's, Whixall & Bettisfield Mosses. Report to English Nature. Contract No Q9/00

HALL, L . 1995. Oaf's Orchard: A hydrological investigation. MSc. project report. School of Earth Science, University of Birmingham.

GONZALEZ, R.S. 2005. The effects of the rehabilitation management on the vegetation of Fenn's and Whixall Mosses National Nature Reserve. Unpublished BSc. Honours project. Wolverhampton University

GYOPARI, M.C. 1990. Why is Wem Moss drying out? Unpublished MSc. thesis, University of Birmingham.

HAYSTED, Z. 2013. An investigation into water pH levels across Fenn's and Whixall Moss using mapping software. HAUC Company Project.

HARGREAVES, S. 2005. A Report on the Regeneration of Vegetation on the Bettisfield Moss National Nature Reserve. MSc thesis. University of Birmingham

HOLLIDAY, C. 1993. Investigation into the effects of canal water on Fenn's Moss, Shropshire . Undergraduate thesis. University of Wolverhampton

HORTON, K. 2004 The effects of rehabilitation management on the vegetation of Fenn's, Whixall & bettisfield Mosses National Nature reserve – A cut-over lowland raised mire. Transfer report from M. Phil to PhD. University of Wolverhampton.

HORTON, K. 2008 The effects of rehabilitation management on the vegetation of Fenn's, Whixall & Bettisfield Mosses National Nature Reserve – A cut-over lowland raised mire. PhD. University of Wolverhampton.

HYDROLOGIC Ltd. 2001. Investigation of flooding problems at Whixall. Report 1847/1 to Whixall Parish Council.

KARPOUZLI, E. 1994. An investigation into the water pollution and its effects on the vegetation distribution of Whixall Moss, Shropshire.. Unpublished B.Sc. Honours project. Wolverhampton University.

KILLINGWORTH, B. 2009. Drainage report. Whixall Manor Drain Diversion. Internal report to Natural England by Martin Wright Associates - MWA Job No CH023.

KILLINGWORTH, B. 2011. Water Level Management. Fenn's Moss Main Drain, Whixall, Shropshire. Internal report to Natural England by Martin Wright Associates.

MARSON,L.C. 1989. An investigation into the causes of change in the vegetation communities of Wem Moss, a mire in Shropshire. Undergraduate thesis.

MARTIN WRIGHT ASSOCIATES. 2014. Fenn's, Whixall, Bettisfield, Wem & Cadney Mosses SSSI/SAC- Water Level Control Structures Survey and Sub-catchment Water Level Management Plans. Final report to Natural England

PHILLIPS, J . 1992. Survey of the nutrient status of surface water and associated vegetation of Fenn's and Whixall Mosses, SSSI. Undergraduate thesis, Chester College

ROBINSON, N. 2003. The influence of peat water level on vegetation type on North East Fenn's Moss, Shropshire. Student project.

ROBINSON, T. 2012. Fenn's, Whixall and Bettisfield Moss National Nature Reserve. A Study on the Effects of Water-level Control Structures on Water Levels at The Moss. Undergraduate dissertation, Harper Adams University College.

ROSENBURG, A. 2015 Restoration and recovery of degraded blanket bog PhD Manchester Metropolitan University.

SMITH, C.S. 1987. An investigation into possible chemical eutrophication of Wem Moss, Shropshire. Undegraduate thesis, Applied Chemistry, Wolverhampton Polytechnic.

SMITH, C.S. 1992. Review of Wem Moss Hydrological Monitoring, March 1990 to March 1992. Report to SWT.

SZULC, K., BESENYEI, L., SZULC, B. AND RAKOWSKA, B. 2014. Diatomological aspects of the Fenn's and Whixall Mosses complex (Shropshire U.K.) Oceanological and Hydrobiological Studies vol 43, Issue 3, pp 274 – 282.

SYMONDS GROUP Ltd. 2004 Characterisation of hydrological protection zones at the Margins of designated Lowland Raised peat Bog Sites. Final Report. Internal English Nature Report.

WATER MANAGEMENT CONSULTANTS. 2009. Wem Moss SSSI. Hydrogeological Monitoring Review. Contract report 1-341/R1 to the Environment Agency, Shrewsbury