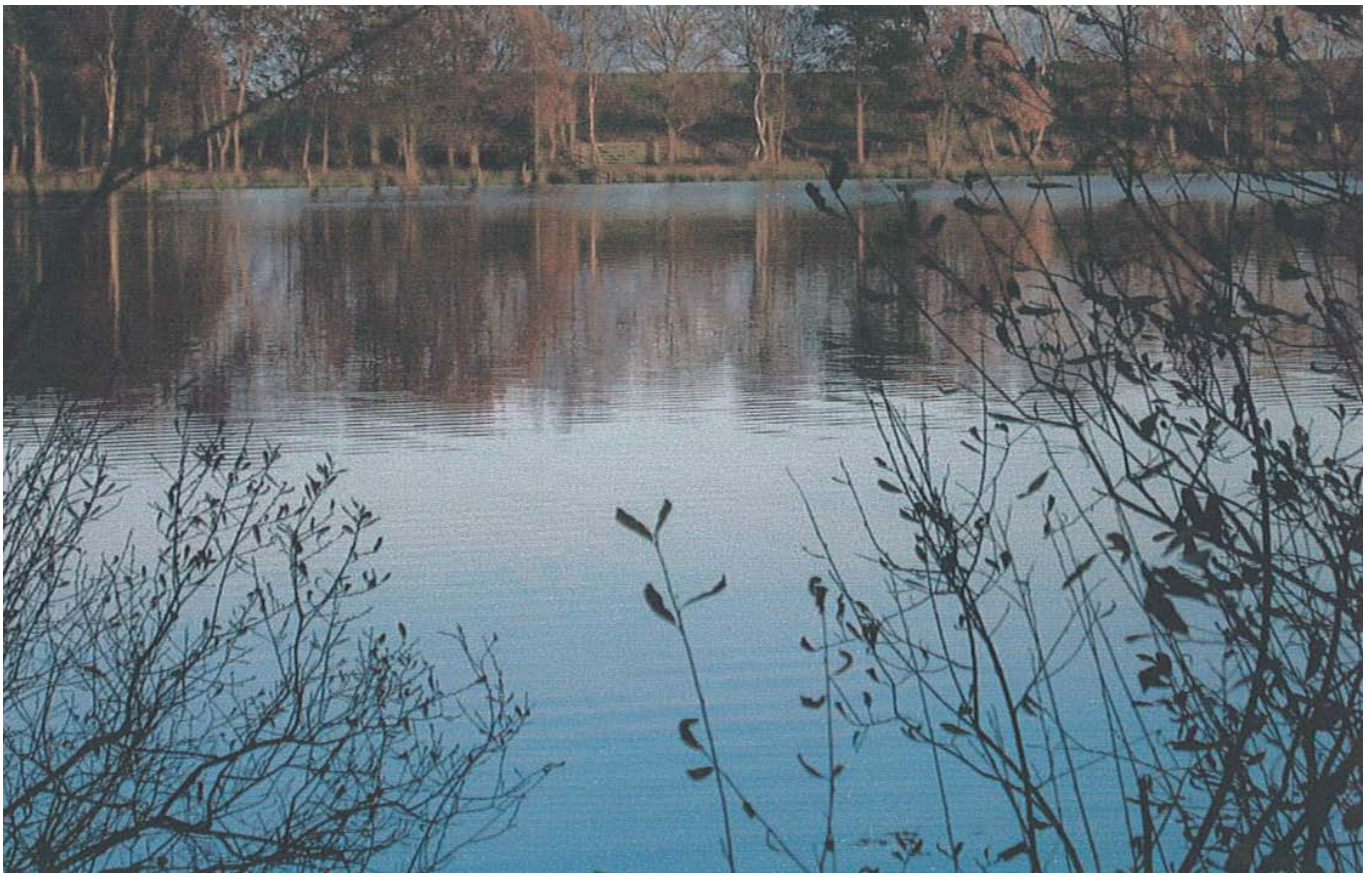
European Site Conservation Objectives: Supplementary advice on conserving and restoring site features

Oak Mere Special Area of Conservation (SAC)
Site Code: UK001970



Date of Publication: 7 February 2019

About this document

This document provides Natural England's supplementary advice about the European Site Conservation Objectives relating to Oak Mere SAC.

This advice should therefore be read together with the SAC Conservation Objectives available here.

Where this site overlaps with other European Sites, you should also refer to the separate European Site Conservation Objectives and Supplementary Advice (where available) provided for those sites.

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 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	Oak Mere Special Area of Conservation (SAC)
Location	Cheshire
Site Map	The designated boundary of this site can be viewed here on the MAGIC website
Designation Date	1st April 2005
Qualifying Features	See section below
Designation Area	68.82 ha
Designation Changes	None
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)	Oak Mere SSSI
Relationship with other European or International Site designations	Midland Meres and Mosses – Phase 2 Ramsar

Site background and geography

Oak mere, is a shallow lake formed in glacial drift some 15,000 years ago where three kettle holes coalesced and is unique among the Midland meres. The water is acidic (pH 4.5 approximately), but compared to other acidic lakes is slightly nutrient-rich (mesotrophic). Because of its unusual water chemistry it contains an outstanding assemblage of aquatic plants including shore weed *Littorella uniflora* and narrow small-reed *Calamagrostis stricta*, and animals, including species more typical of upland waters on acidic rocks, a number of which are regionally and nationally rare. The hydrology of the site is complex, involving perched water tables and the underlying groundwater, such that large fluctuations of the water level are experience, periodically leaving wide draw-down zones. The surrounding drier land is largely wooded with the southern catchment under agricultural use. To the north-west and north-east peat has developed which has been cut in the past, leaving boggy pools and basin mires where active peat growth continues.

Oak mere is one of the few lakes in Britain where large populations of the planktonic alga *Botryococcus braunii* develop on occasions on the water turning it orange by its 'blooms'. Aquatic plants include *Callitriche spp. Nuphar lutea* and, in the shallows, dense stands of *Littorella uniflora*, a plant which is rare in Cheshire. The Shoreline flora consists of *Juncus effusus*, Equisetum fluviatile*, Hydrocotyle vulgaris, Eleocharis palustris and locally Typha latifolia.* Floating and submerged mats of mosses *Sphagnum denticulatum* and *Drepanocladus fluitans* are present. Of particular note is the abundance of the Nationally Rare *Calamagrostis stricta*.

On the east side of the mere the littoral zone contains a diverse bryophyte community including two mosses *Atrichum crispum* and *Pohlia bulbifera* which are very rare in the Midlands.

A variety of woodland types occur around the mere. At the north end is extensive Carr Woodland dominated by *Betula pubescens*, *Alnus glutinosa* and *Salix caprea*, with a ground flora dominated by *Molinia* and *Juncus effusus*. The fringing band of woodland around the southern half is dominated by birch and oak, with willows nearer the shore. Heather and bilberry occur in the ground flora.
The zooplankton includes many species common in lowland lakes but also some found in upland systems such as *Ceriodaphnia quadrangular.* The site is further important for many aquatic invertebrate groups including dragonflies and beetles.

The solid geology comprise the Lower Keuper Saliferous Beds beneath the mere with Lower Keuper Marl to the east, and Keuper Sandstone to the west, the latter being separated by the East Delamere Fault running close to the site. The surface deposits are principally Glacial Sands and Gravels drift together with localised alluvium and peat deposits overlying Triassic mudstones that are exposed at the western edge of the catchment.

As part of the Water Framework Directive, Oak Mere is Groundwater Waterbody GB41202G991700 Weaver and Dane Quaternary Sand and Gravel Aquifers. Oak Mere SAC is also part of the National Character Area Profile: 62 Cheshire Sandstone Ridge (NE551).

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:

- **H3110. Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*); Nutrient-poor shallow waters with aquatic vegetation on sandy plains**

This type of waterbody is restricted to sandy plains that are acidic and low in nutrients, and are therefore very scarce. The water is typically very clear and moderately acid. Destruction of lowland heaths, land drainage and nutrient enrichment have contributed to the scarcity of the habitat type.

The habitat type is characterised by the presence of *Littorelletalia*-type vegetation. Such vegetation is characterised by the presence of water lobelia *Lobelia dortmanna*, shoreweed *Littorella uniflora*, or quillwort *Isoetes lacustris*. Only one species needs to be present to conform to the definition of this Annex I type and typically the vegetation consists of zones in which the individual species form submerged, monospecific lawns.

Oak Mere, in the West Midlands of England, is a lake formed within sediments that are low in nutrients and oligotrophic. It is a large waterbody that has formed in a kettle hole in the fluvio-glacial sands of the Cheshire Plain. The site has clear water of low nutrient status characteristic of oligotrophic waters and a marginal zone of shoreweed *Littorella uniflora*. The site supports an assemblage of plants that are now rare in the lowlands of England, including floating mats of bog-moss *Sphagnum* spp. and the scarce narrow small-reed *Calamagrostis stricta*.

- **H7140. Transition mires and quaking bogs; Very wet mires often identified by an unstable `quaking` surface**

The term 'transition mire' relates to vegetation that in floristic composition and general ecological characteristics is transitional between acid bog and H7230 Alkaline fens, in which the surface conditions range from markedly acidic to slightly base-rich. The vegetation normally has intimate mixtures of species considered to be acidophile and others thought of as calciphile or basophile. In some cases the mire occupies a physically transitional location between bog and fen vegetation, as for example on the marginal lagg of raised bog or associated with certain valley and basin mires. In other cases these intermediate properties may reflect the actual process of succession, as peat accumulates in groundwater-fed fen or open water to produce rainwater-fed bog isolated from groundwater influence. Many of these systems are very unstable underfoot and can therefore also be described as 'quaking bogs'.

Transition mires and quaking bogs can occur in a variety of situations, related to different geomorphological processes: in flood plain mires, valley bogs, basin mires and the lagg zone of raised bogs, and as regeneration surfaces within mires that have been cut-over for peat or areas of mineral soil influence within H7130 Blanket bogs (e.g. ladder fens).

Within Oak Mere SAC open water and peat deposits lie in this kettle-hole depression within Delamere Forest, and peat-cutting has given rise to additional pools and fens. The water is acidic, but slightly nutrient-rich. There are transitions at the water's edge with soft rush *Juncus effusus*, water horsetail *Equisetum fluviatile*, common spike-rush *Eleocharis palustris*, marsh pennywort *Hydrocotyle vulgaris*, the moss *Drepanocladus fluitans* and bulrush *Typha latifolia*. Small depressions in the peat are occupied by bottle sedge *Carex rostrata*, common cottongrass *Eriophorum angustifolium*, purple moor-grass *Molinia caerulea*, cross-leaved heath *Erica tetralix* and round-leaved sundew *Drosera rotundifolia*.

Qualifying Species:

None

Table 1: Supplementary Advice for Qualifying Features: H3110. Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*); Nutrient-poor shallow waters with aquatic vegetation on sandy plains

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**	Maintain the total extent of the feature to a feature extent baseline-value of 17.3 hectares.	There should be no measurable 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.	JNCC. 2005. Natura 2000 Standard data form. Available here This attribute will be periodically monitored as part of Natural England's site condition assessments and recorded within the Consultation Draft (2009) for Oak Mere SSSI FCT.
Structure and function (including its typical species)	**Key structural, influential and/or distinctive species**	Maintain the abundance of the typical species listed below to enable each of them to be a viable component of the Annex 1 habitat; The constant and preferential plants of the NVC community type which forms a key component of a SAC habitat that is present including *Littorella uniflora, Isoetes lacustris, Isoetes echinospora, Lobelia dortmanna, Eleogiton fluitans, Elatine hexandra, Myriophyllum*	Some plant or animal species (or related groups of such species) make a particularly important contribution to the necessary 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 Annex I habitat's structure or help to define that habitat on a particular SAC (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)	This attribute will be periodically monitored as part of Natural England's site condition assessments and recorded within the Consultation Draft (2009) for Oak Mere SSSI FCT.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		alterniflorum, Apium inundatum, Pilularia globulifera and Luronium natans.	• **Site-distinctive species** which are considered to be a particularly special and distinguishing component of an Annex I habitat on a particular SAC. 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. 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. The vegetation community is characterised by amphibious short perennial vegetation, with shoreweed *Littorella uniflora* being considered a defining component. The extremely oligotrophic community with *Subularia aquatica, Littorella uniflora, Isoetes lacustris, Myriophyllum alterniflorum, Lobelia dortmanna* and *Sparganium angustifolium* is also present.	
Structure and function (including its typical species)	**Invasive, non-native and/or introduced species**	Non-native species categorised as 'high-impact' in the UK under the Water Framework Directive should be either rare or absent but if present are causing minimal damage to the feature. *Crassula helmsii* at least not expanding in extent *Elodea nuttalli* <40%	Non-native species constitute a major threat to many open water systems. Impacts may be on the habitat itself (e.g. damage to banks and consequent siltation) or directly on characteristic biota (through predation, competition and disease), or a combination of these. For example, species such as signal crayfish have been responsible for much of the decline of native crayfish through competition, habitat damage and the introduction of crayfish plague. The UK Technical Advisory Group of the Water Framework Directive produces a regularly updated classification of aquatic alien species (plants and animals) according to their level of impact. In general high impact species are of greatest concern but low or unknown impact species may be included in the target on a site-specific basis where there is evidence that they are causing a negative impact (for example high cover values	Natural England. 2014. Site Improvement Plan – Oak Mere SAC

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			or abundances). Those taxa considered likely to colonise lakes, are indicated by an 'L' in the UKTAG guidance. Examples of such high-impact species may include Water Fern *Azolla filiculoides*, New Zealand pygmyweed *Crassula helmsii* and the zebra mussel *Dreissena polymorpha*. Species of particular concern are: *Crassula helmsii, Hydrocotyle ranunculoides, Myriophyllum aquaticum and Azolla filiculoides*. Crassula is present at high frequencies in both the open water and marginal zones of the mere, and appears to be competing with the native plant species.	
Structure and function (including its typical species)	**Macrophyte community structure**	Maintain characteristic zonations of vegetation with increasing depth, should be represented by *Littorella uniflora* then with overlapping zones of *Littorella uniflora* with *Lobelia dortmana* then *Isoetes spp.*	This is a strongly characteristic structural aspect of this habitat feature. It will be a response to water transparency, sediment type and disturbance. Characteristic zonation with increasing depth should be (typically): *Littorella*, then overlapping zones of *Littorella* with Lobelia, then Isoetes *L. uniflora* and *L. dortmanna* dominant in depths <1.5 m; Isoetes dominant > 1.5 m. Further, the maximum depth of Isoetes colonisation should be examined, but also the depth of colonisation of other taxa in richer waters within this range e.g. *Potamogeton spp*.	This attribute will be periodically monitored as part of Natural England's site condition assessments and recorded within the Consultation Draft (2009) for Oak Mere SSSI FCT.
Structure and function (including its typical species)	**Macrophyte community structure**	Maintain maximum depth of plant colonisation. This will often be the maximum depth colonised by Isoetes.	This is a strongly characteristic structural aspect of this habitat feature. It will be a response to water transparency, sediment type and disturbance.	
Structure and function (including its typical species)	**Macrophyte community structure**	Maintain a characteristic and well defined hydrosere associated with the water body where this is present.	A hydrosere is a naturally-occurring plant succession which occurs in an area of standing fresh water. Over time, an area of open freshwater will naturally dry out, ultimately becoming woodland. During this change, a range of different wetland habitat types such as swamp and marsh, will succeed each	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			other. This structure around the margins of the lake creates a buffer zone that can help protect the lake from a limited amount of sediment and nutrient inputs. It also increases habitat heterogeneity providing additional food sources and refugia.	
Structure and function (including its typical species)	**Physical structure - lake shoreline**	Restore the natural shoreline of the lake.	Inclusion of hard engineering solutions to lake management may have detrimental effects on lake ecology, replacing near-natural substrates with man-made materials. Alteration of the shoreline may also result in changes in water movements within the lake, which would have effects on patterns of sediment deposition. The extent and nature of the shoreline is important for plants and invertebrates. Although there are no explicit input or output ditches to regulate, limits must be established as a benchmark against which to measure the effects of dewatering the sand aquifer through drainage, abstraction or evapotranspiration caused by changes in plant cover. A small proportion (5%) of the open water area may be taken by water-fringe fen though it must not obscure the open shoreline or be attributable to enrichment.	This attribute will be periodically monitored as part of Natural England's site condition assessments and recorded within the Consultation Draft (2009) for Oak Mere SSSI FCT.
Structure and function (including its typical species)	**Physical structure - lake substrate**	Restore the natural and characteristic substrate for the lake. Substrate is typically sand, gravel and stones with low organic content, <5% loss on ignition.	The distribution of sediment particle size and organic content influences the biology of the lake and will affect the suitability of within-lake habitats for invertebrates and macrophytes, and fish spawning grounds. Increases in sediment loading from activities in the catchment area, including those on the lake shore, may result in the smothering of coarse sediments. Increased inputs of leaf litter, as a result of scrub encroachment, may also be cause for concern, as organic-rich sediments may be a poor rooting medium for macrophytes. The mere itself is considered to be incompletely lined with alluvium deposits allowing exchange of base-rich water between the groundwater and the mere from around 4m depth. Peat deposits are present at the northern end along with	Natural England. 2014. Site Improvement Plan – Oak Mere SAC Savage, A.A., Bradburne, S.J.A. and MacPherson, A.A.1992. The morphometry and hydrology of Oak Mere, a lowland kataglacial lake in the North West Midlands, England. Environmental Consultancy University of Sheffield (ECUS), 2001. Meres and Mosses Conservation Plans – Oak Mere.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			alternate peat and mud layers along the north-west indicating fluctuating water levels (ECUS 2001). Substrate is typically sand with low organic content but locally high peat content. Sediment quality and quantity when enriched can cause excessive growths of *Juncus bulbosus var. fluitans* or growths of algae. Further, scrub encroachment is an ongoing problem, which if un-managed leads to a reduction in botanical interest and hydrological changes.	ECUS.
Supporting processes (on which the feature relies)	**Water quality - phosphate**	Restore stable nutrient levels appropriate for lake type. The maximum annual mean concentration of TP is 10 µg P l-1 for oligotrophic lakes. These should be met unless site specific targets are available.	Increased loadings of P to a water body are likely to lead to higher algal biomass in the water column, which in turn can have significant impacts on the standing water ecosystem through, for example, competition with vascular plants for nutrients and light, changes in pH, oxygen depletion and production of toxins. Decreasing dissolved oxygen and increasing ammonia levels are associated with death and decay of algal blooms, as is a release of toxins from toxin-producing species. If palaeolimnological techniques or hindcast modelling have been employed to reconstruct natural background phosphorus concentrations for a particular lake, these can be used to set targets, although it may be necessary to accept a small deviation from these background conditions. Alternatively, historical water chemistry data may exist for individual lakes. Where existing, site-specific water column TP concentrations are consistently lower than the standard appropriate for the habitat type, a lower target should be applied to prevent deterioration from current status. Oak Mere SAC is designated as an oligotrophic lake, therefore the JNCC target is the current standard. The targets are currently being reviewed by Natural England's standing water senior specialist.	Natural England. 2014. Oak Mere Diffuse Water Pollution Plan. Available from Natural England

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Supporting processes (on which the feature relies)	**Water quality - nitrogen**	Restore a stable nitrogen concentration which is typically between 0.4mg/l	There is an increasing understanding that some standing waters are sensitive to nitrogen (N) enrichment and eutrophication may be driven by increases in N, but site-specific information is usually required to determine whether N or P is more important. Where P levels are significantly above their target values and there is evidence that the lake is N limited (for example by N levels falling to negligible levels in summer), N targets should be set in addition to P targets. We recommend that such targets should preferably be developed using site-specific information, but should be based around the threshold of 1-2mg/l identified by James *et al.* (2005). In this situation N targets should be used in combination with P targets to drive a management strategy for the lake that reduces all nutrient inputs. Potential local sources for Oak Mere SAC of Nitrogen deposition and of aerial nutrient enrichment include from local poultry, dairy, pig units and industrial sources.	James C, Fisher J, Russell V, Collings S, Moss B. 2005. Nitrate availability and hydrophyte species richness in shallow lakes. Freshwater Biology, 50, 1049-1063. Maberly, S.C. and Carvalho, L., 2010. Reviewing phosphorus and nitrogen targets for the SSSI meres. Centre for Ecology & Hydrology, Lancaster Environment Centre.
Supporting processes (on which the feature relies)	**Water quality - acidity**	Acidity levels should reflect unimpacted conditions, typically with a pH value < 7.	Changes in pH can alter the entire freshwater community present within a water body affecting all trophic levels. Potential causes of a shift in pH include air pollution and direct application of lime to the water column as an acidification amelioration strategy (this should not be carried out). Although, pH naturally fluctuates throughout the year, e.g. snow melt may lead to pulses of acid water, and increased plant biomass in summer may result in large fluctuations in pH, including daytime increases in pH values. Therefore pH is not used as a monitoring target, however its importance in affecting many in lake processes means that the pH of a water body should not be artificially altered. The mere currently has eutrophic waters with relatively high mineral content and pH.	This attribute will be periodically monitored as part of Natural England's site condition assessments and recorded within the Consultation Draft (2009) for Oak Mere SSSI FCT.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Supporting processes (on which the feature relies)	**Water quality - other pollutants**	Achieve Good chemical status (i.e. compliance with relevant Environmental Quality Standards).	A wide range of pollutants may impact on habitat integrity depending on local circumstance. Good chemical status includes a list of EQSs for individual pollutants that are designed to protect aquatic biota with high levels of precaution.	
Supporting processes (on which the feature relies)	**Water quality - dissolved oxygen**	Adequate dissolved oxygen levels for health of characteristic fauna. Dissolved oxygen standards should be appropriate for health of salmonid fish (> 7.0mg/l throughout the year), as low nutrient waters would be expected to support this type of fish.	As for species in terrestrial environments, dissolved oxygen (DO) is required for respiration by aquatic organisms. Anthropogenic activities leading to phytoplankton blooms and increased loadings of organic matter to lakes can cause decreases in the concentration of dissolved oxygen available to support the species present. Mean dissolved oxygen refers to DO being measured at 0.5m intervals throughout the entire water column where the water column is not stratified and measurements taken at 0.5 m intervals below the thermocline only where stratification occurs.	
Supporting processes (on which the feature relies)	**Water transparency**	Maintain the clarity of water at or to at least a depth of 3.5 metres.	Water transparency is the major determinant of the depth of colonisation by macrophytes, therefore, it should not be reduced. This should allow plant colonisation to at least 3.5m, but if maximum depth of colonisation has previously been recorded at greater water depths this should be maintained. Increased nutrient loads leading to increased algal growth will reduce water transparency, disturbance of the sediment by water sports and bottom feeding fish such as carp and bream also increase turbidity and reduce water transparency. Increased sediment loads to a lake would also have this effect.	
Supporting processes (on which the feature relies)	**Water quality - algae**	Chlorophyll a concentration should comply with WFD high ecological status and not have a negative impact on the ecosystem. Blooms of blue-green or green algae should not occur in low nutrient waters.	Chlorophyll is the pigment used for photosynthesis by plants, and the concentration of chlorophyll in the water column during the growing season therefore provides a good measure of the abundance of phytoplankton. Phytoplankton is an important driver of structure and function in lakes and high phytoplankton levels (algal blooms) are usually associated with nutrient enrichment. UKTAG Lake Assessment Methods: Phytoplankton. Chlorophyll a and Percentage Nuisance Cyanobacteria. Available online at:	This attribute will be periodically monitored as part of Natural England's site condition assessments and recorded within the Consultation Draft (2009) for Oak Mere SSSI FCT.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			http://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Biological%20Method%20Statements/lake%20phytoplankton.pdf There should be no evidence of blue-green or green algal blooms. These should not be confused with protometal growths of bryophytes such as *Drepanocladus fluitans.* Submerged *Sphagnum cuspidatum* is known to occur and is consistent with an oligotrophic lake, though may indicate gradual transition to a schwingmoor poor fen. Algal dominance: cover of benthic and epiphytic filamentous algae less than 10%. Excessive growths of filamentous algae on lake substrate or macrophytes are indicative of nutrient.	
Supporting processes (on which the feature relies)	**Air quality**	Restore as necessary, the concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for this 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 these 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	More information about site-relevant Critical Loads and Levels for this SAC is available by using the 'search by site' tool on the Air Pollution Information System.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales.	
Supporting processes (on which the feature relies)	**Hydrology**	At a site, unit and/or catchment level (as necessary, restore natural hydrological processes to provide the conditions necessary to sustain the 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. This target is generic and further site-specific investigations may be required to fully inform conservation measures and/or the likelihood of impacts. Hydrology influences lake ecosystem functioning in two ways: determining residence time (flushing) and water level fluctuations. Flushing of lakes is important for dilution and removal of nutrients and phytoplankton, and for reduction in sedimentation. The timing of different flushing rates within the year influences the biology of the lake. For example, reduced flushing in summer would encourage bloom conditions. Modifications of inflows and outlets or changes in hydrology, e.g. from flood control regimes, abstraction and gravel removal can lead to unnatural changes in lake levels. An investigation is required to add to the current understanding of the site's hydrology. Historic Victorian era records suggest water levels at Oak Mere were significantly higher, especially for Nitrates in the groundwater around the SAC. Several factors may be implicated in these levels including an overflow pipe at the north end which limits water levels. The adjacent Four ways Quarry could have implications for the water levels in the SAC in terms of the height of the water levels maintained in the quarry and via the effect of such a large void on the gradient of the groundwater.	Natural England. 2014. Site Improvement Plan – Oak Mere SAC Natural England. 2014. Oak Mere Diffuse Water Pollution Plan. Available from Natural England. Environment Agency. Water Quality Archive – Oak Mere SAC. Available: https://environment.data.gov.uk/water-quality/view/explore?search=oak mere&area=4-12&samplingPointType.group=&samplingPointStatus%5B%5D=open&loc=&_limit=500#

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			Water retention time in the mere is considered to be in the range of 0.81 to 2 years.	
Supporting processes (on which the feature relies)	**Sediment load**	Restore the natural sediment load	Increased sediment loadings may result in clogging of the lake bed, increased siltation in the basin and deoxygenation of sediments. Blockage of coarser substrates with finer sediment restricts water flow-through, whilst increases in organic matter increase biochemical oxygen demand. Increases in the sediment load also increases nutrient loads to a site. Examples of causes of increases in siltation include: increased lake productivity, changes in catchment land-use (particularly over-grazing), lake level fluctuations or climatic fluctuations.	
Supporting processes (on which the feature relies)	**Supporting off-site habitat**	Maintain the extent, quality and spatial configuration of land or habitat surrounding or adjacent to the site which is known to support the feature.	Include only where applicable. 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 ('metapopulations'), pollination or to prevent/reduce/absorb damaging impacts from adjacent land uses e.g. pesticide drift, nutrient enrichment. Oak Mere lacks obvious direct inflows or outflows and its hydrology is considered to be supported almost entirely from direct precipitation, shallow subsurface flow and groundwater inputs. A small inflow channel to the north-west of the site which may bring in surface and sub-surface water from the adjacent land. In addition there is the possibility of springs inputting into the site along the south-east edge although there is no evidence of this.	Natural England. 2014. Oak Mere Diffuse Water Pollution Plan. Available from Natural England.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Supporting processes (on which the feature relies)	**Functional connectivity/isolation**	Maintain as appropriate the natural lack of connectivity of the water body to other water bodies	The natural isolation of some standing water bodies can provide some protection from threats such as pollution and invasive species. Hydrological isolation can also lead to unique or diverse species assemblages this may be due to genetic isolation or the absence of predators. These water bodies should have their isolated state maintained. In contrast other standing water bodies naturally rely on hydrological connectivity to other freshwater systems for water supply, and can support migratory species. Hydrological connectivity may also be important for gene flow, and habitat and species resilience. These water bodies should have their hydrological connectivity maintained. Connectivity between lakes and surrounding wetlands are important for resource protection and ecosystem functioning and are particularly at risk from drainage, water level stabilisation and shoreline modifications.	
Version Control N/A				
Variations from national feature-framework of integrity-guidance: **Water Quality** attribute – a revised target for stable nitrogen concentration of 0.4mg/l TN has been set for Oak Mere (compared to a typical value of between 1-2mg/l. This revised target is taken from Maberly and Carvalho, 2010 which sets specific N & P targets for most of the meres and mosses, these have been used in all of the Natural England's Area Team's DWPPs.				

Table 2: Supplementary Advice for Qualifying Features: H7140. Transition mires and quaking bogs; Very wet mires often identified by an unstable `quaking` surface

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**	Maintain the total extent of the feature.	There should be no measurable 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. JNCC (2005) has estimated extent of H7140 Transition mires and quaking bogs for this site as being in the region of 6.85ha. However, the extent of feature is difficult to define due to the mosaics of habitats.	JNCC. 2005. Natura 2000 Standard data form. Available here This attribute will be periodically monitored as part of Natural England's site condition assessments and recorded within the Consultation Draft (2009) for Oak Mere SSSI FCT.
Extent and distribution of the feature	**Spatial distribution of the feature within the site**	Restore the distribution and configuration of the feature, including where applicable its component vegetation types, across the site	Distribution includes the spatial pattern or arrangement of this habitat feature, and its component vegetation types, across the site. Changes in distribution may affect the nature and range of the vegetation communities present, the operation of the physical, chemical, and biological processes in the system and the resiliency of the site and its features to changes or impacts.	This attribute will be periodically monitored as part of Natural England's site condition assessments and recorded within the Consultation Draft (2009) for Oak Mere SSSI FCT.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			A restore target is appropriate here because some areas of the habitat are subject to encroachment by *Molinia*.	
Structure and function (including its typical species)	**Vegetation community composition**	Ensure the component vegetation communities of the feature are referable to and characterised by the following National Vegetation Classification types: M2 *Sphagnum cuspidatum/recurvum* bog pool and M25 *Molinia caerulea-Potentilla*	This habitat feature will comprise a number of associated semi-natural vegetation types and their transitional zones, reflecting the geographical location of the site, altitude, aspect, soil conditions (especially base-status and drainage) and vegetation management. In the UK these have been categorised by the National Vegetation Classification (NVC). Maintaining or restoring these characteristic and distinctive vegetation types, and the range of types as appropriate, will be important to sustaining the overall habitat feature.	This attribute will be periodically monitored as part of Natural England's site condition assessments and recorded within the Consultation Draft (2009) for Oak Mere SSSI FCT.
Structure and function (including its typical species)	**Key structural, influential and/or distinctive species**	Restore the abundance of the typical species listed below to enable each of them to be a viable component of the Annex 1 habitat; Common cottongrass *Eriophorum angustifolium* Bottle sedge *Carex rostrata* Star sedge *Carex echinata* Marsh cinquefoil *Potentilla palustris* Bog asphodel *Narthecium ossifragum* Sphagnum including *S. fallax* and *S. cuspidatum.*	Some plant or animal species (or related groups of such species) make a particularly important contribution to the necessary 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 Annex I habitat's structure or help to define that habitat on a particular SAC (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 SAC. 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)
			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. Maintain the current extent of narrow small-reed grass *Calamagrostis stricta.*	
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 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). *Crassula* is present at high frequencies in both the open water and marginal zones of the mere, and appears to be competing with the native plant species. It has not yet been found in the transition mires but has the potential to migrate here also.	Natural England. 2014. Site Improvement Plan – Oak Mere SAC
Structure and function (including its typical species)	**Presence/cover of woody species**	Restore a low cover (<10% of the area) of scrub or trees within stands of H7140	Native trees and shrubs occur naturally on bog and fen surfaces but an abundance of scrub and trees on bogs and fens is sometimes regarded as detrimental because they are indicators and perpetrators of drying out and may cause damage to vegetation structure through shading effects. Birch, pine, willow and rhododendron (an invasive non-native species) are the main species of concern. The seeds of most invasive woody species are wind dispersed, so trees are able to establish on raised bog and fen surfaces. Woody species (including *Betula, Salix, Rhododendron, Pinus*, other gymnosperms) should be no more than scattered, predominantly <1.5m high. Cover should be <10% on open fen Saplings/seedlings should be no more than rare.	This attribute will be periodically monitored as part of Natural England's site condition assessments and recorded within the Consultation Draft (2009) for Oak Mere SSSI FCT. Natural England. 2014. Site Improvement Plan – Oak Mere SAC

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			Currently, scrub encroachment is an ongoing problem, which if un-managed leads to a reduction in botanical interest and hydrological changes.	
Structure and function (including its typical species)	**Exposed substrate**	Maintain a low cover of exposed substrate of between 5% & 10% across feature.	For this wetland habitat type, maintaining some continuous extent of exposed, open ground surface is required to support the establishment and supply of those component species which often rely on wet and sparsely-vegetated conditions.	
Structure and function (including its typical species)	**Hydrology**	At a site, unit and/or catchment level as necessary, maintain natural hydrological processes to provide the conditions necessary to sustain the 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. This target is generic and further site-specific investigations may be required to fully inform conservation measures and/or the likelihood of impacts. Wheeler et al. (2009) provide range and mean for summer & winter water levels for those wetland NVC types constituting Annex 1 habitats. This provides a rough guide to appropriate levels, but it is critical that individual sites and their needs are considered as there is considerable variation within the NVC communities listed and recorded water levels.	Wheeler, B.D, Shaw, S.C, and Tanner, K.A. 2009. Wetland Framework for Impact Assessment at Statutory Sites. EA Science report.
Structure and function (including its typical species)	**Water chemistry**	Restore the surface water and groundwater supporting the hydrology of the bog at a low nutrient status.	UKTAG (2012) provides threshold values for nitrate concentration in groundwaters for different wetland types. The threshold values will mainly be used in the characterisation of GWDTE status for the WFD, primarily as a risk screening tool, to assess if sites are 'at risk' or 'not at risk' from groundwater mediated nutrient pressure. Due to the complex cycling of nutrients within many GWDTE, these threshold values are less well suited for application within sites but rather just to groundwater that is directly feeding the site.	Natural England. 2014. Site Improvement Plan – Oak Mere SAC UKTAG. 2012. Technical report on groundwater dependent terrestrial ecosystem (GWDTE) threshold values. http://www.wfduk.org/resources%20/groundwater-dependent-terrestrial-ecosystem-threshold-

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			Nitrogen deposition exceeds the site relevant critical loads. Potential local sources of aerial nutrient enrichment include from local poultry, dairy, pig units and industrial sources.	values
Structure and function (including its typical species)	**Hydrology**	Maintain a high piezometric head and permanently high water table (allowing for natural seasonal fluctuations) on groundwater dependent sites.	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. This target is generic and further site-specific investigations may be required to fully inform conservation measures and/or the likelihood of impacts. Some examples of H7140 may be wholly or partly groundwater dependent. Others have a greater dependence on surface water or rain water inputs. It is critically important to understand the ecohydrological context of all sites.	
Structure and function (including its typical species)	**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 SAC to climate change has	Natural England, 2015. Climate Change Theme Plan and supporting NBCCV Assessments for SACs and SPAs [both available at http://publications.naturalengland.org.uk/publication/4954594591375360].

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			been assessed by Natural England (2015) as being moderate, taking into account the sensitivity, fragmentation, topography and management of its habitats and supporting habitats. This means that this site is considered to be vulnerable overall but moderately so. This means that some adaptation action for specific issues may be required, such as reducing habitat fragmentation, creating more habitat to buffer the site or expand the habitat into more varied 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 advisable.	
Structure and function (including its typical species)	**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 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 ('metapopulations'), pollination or to prevent/reduce/absorb damaging impacts from adjacent land uses e.g. pesticide drift, nutrient enrichment.	
Supporting processes (on which the feature relies)	**Air quality**	Restore as necessary, the concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for this 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 these 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	More information about site-relevant Critical Loads and Levels for this SAC is available by using the 'search by site' tool on the Air Pollution Information System.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			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.	
Supporting processes (on which the feature relies)	**Conservation measures**	Restore as appropriate the management measures (either within and/or outside the site boundary as appropriate) which are necessary to maintain the structure, functions and supporting processes associated with the feature	Active and ongoing conservation management is needed to protect, restore as appropriate this feature at this site. 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. This habitat in most cases requires ongoing cutting or grazing maintain its open character. Scrub encroachment is an ongoing problem, which if un-managed leads to a reduction in botanical interest and hydrological changes. Further Nitrogen deposition exceeds the site relevant critical loads. Potential local sources of aerial nutrient enrichment include from local poultry, dairy, pig units and industrial sources.	Natural England. 2014. Site Improvement Plan – Oak Mere SAC
Version Control N/A				
Variations from national feature-framework of integrity-guidance: N/A				