Restoration Scheme for Bolton Fell Moss

PART 3

Appendices

Planning Application Version

Prepared by: Alasdair Brock

Deborah Land

www.naturalengland.org.uk

Contents

Restoration Methodologies Introduction

1.1 The following methodologies rely on the different properties of peat and clay. Clay on the whole is impermeable i.e. water does not flow through it easily – it has a low conductivity for water.

1.2 Peat can be divided into three in terms of its properties:

a Ombrotrophic peat – the remains of mainly Sphagnum plants that have due to the acid, cold and wet nature of a bog surface have barely decomposed, instead they have become humified - a process that increase with depth. It forms the majority of the peat found at BFM and underlies intact vegetation and degraded eat surfaces.

- This type of peat is the principal constituent of a Lowland Raised bog found just beneath the active growing layer. It is a combination of plant material holding water in a matrix. It has a very low conductivity akin to that of clay which makes it for the purposes of restoration an important material as it is almost impermeable and ideal for constructing dams/bunds. In the following methodology it is referred to as 'clay like' peat.

b Degraded peat – when peat is dried out it starts to decompose and lose its ability to hold water. It rapidly becomes a material with high conductivity – which means water can move through it. It cannot be turned back into the 'clay like' peat instead if you add water to dried peat you get peat particles floating in water. It is of no use i bog restoration apart from acting as a filler for drains but only if the drains have been blocked using 'clay like' peat.

c Fen peat/sticks – these peats are formed from reeds and often contain the remains of trees and tree roots. Because of their coarse nature they have a relatively high conductivity.

Appendix 1
SAC Level Conservation Objectives

European Site Conservation Objectives for Bolton Fell Moss Special Area of Conservation Site code: UK0030362

With regard to the natural habitats and/or species for which the site has been designated ("the Qualifying Features" listed below);

Avoid the deterioration of the qualifying natural habitats and the habitats of qualifying species, and the significant disturbance of those qualifying species, ensuring the integrity of the site is maintained and the site makes a full contribution to achieving Favourable Conservation Status of each of the qualifying features.

Subject to natural change, to maintain or restore:

- The extent and distribution of qualifying natural habitats and habitats of qualifying species;
- The structure and function (including typical species) of qualifying natural habitats and habitats of qualifying species;
- The supporting processes on which qualifying natural habitats and habitats of qualifying species rely;
- The populations of qualifying species;
- The distribution of qualifying species within the site.

Qualifying Features:

H7120. Degraded raised bogs still capable of natural regeneration

Explanatory Notes: European Site Conservation Objectives

European Site Conservation Objectives are those referred to in the Conservation of Habitats and Species Regulations 2010 (the "Habitats Regulations") and Article 6(3) of the Habitats Directive 1992.They are for use when either the appropriate nature conservation body or competent authority is required to make an Appropriate Assessment under the relevant parts of the respective legislation.

These conservation objectives are set for each habitat or species of a Special Area of Conservation (SAC). Where the objectives are met, the site can be said to demonstrate a high degree of integrity and the site itself makes a full contribution to achieving favourable conservation status for those features.

This document is also intended for those who are preparing information to be used for an appropriate assessment by either the appropriate nature conservation body or a competent authority. As such this document cannot be definitive in how the impacts of a project can be determined. Links to selected sources of information, data and guidance which may be helpful can be found on Natural England's website. This list is far from exhaustive.

Appendix 2
Favourable Conditions Tables for Bolton Fell Moss

Definitions of Favourable Condition for designated features of interest

These definitions relate to all designated features on the SSSI, whether designated as SSSI, SPA, SAC or Ramsar features.

Solway, Border & Eden Team
Juniper House
Murley Moss
Oxenholme Road
Kendal LA9 7RL
Telephone: 0845 600 3078
enquiries@naturalengland.org.uk

Name of Site of Special Scientific Interest (SSSI)	
Bolton Fell Moss	
Names of designated international sites	
Special Area of Conservation (SAC)	Bolton Fell – Site of Community Interest
Special Protection Area (SPA)	n/a
Ramsar	n/a
Relationship between site designations	
The SSSI boundary is currently smaller than the SCI boundary but it is proposed to be extended to fully encompass the SCI and additional land which is required for restoration.	

Version control information		
Status of this Version (Draft, Consultation Draft, Final)	Final	
Prepared by	Deborah Land	
Date of this version	25 October 2012	
Date of generic guidance on favourable condition used	Cumbrian Bogs Guidance 2008 approved by Iain Diack Oct 2008	
Other notes/version history	Draft prepared by Deborah Rusbridge 05 December 2008	
Quality assurance information		
Checked by	**Name**	**Date**
	Signature	

Definitions of Favourable Condition: notes for users

Definitions of Favourable Condition
The definitions comprise one or more condition definitions for the special interest features at this site. These are subject to periodic review and may be updated to reflect new information or knowledge. They will be used by Natural England to determine if a site is in a favourable condition. The standards for favourable condition have been developed and are applied throughout the UK.

Standards for favourable condition are defined with particular reference to the specific designated features listed in Table 1, and are based on a selected set of attributes for features which most effectively define favourable condition as set out in Tables 2, 2a and 3. When an SSSI's features meet these attributes, then they are said to be in 'favourable condition'.

Explanatory text for Tables 2 and 3
Tables 2, 2a and 3 set out the measures of condition which we will use to provide evidence to support our assessment of whether features are in favourable condition. They have been tailored by local staff to reflect the particular characteristics and site-specific circumstances of individual sites. Quality Assurance has ensured that such site-specific tailoring remains within a nationally consistent set of standards. The tables include an audit trail to provide a summary of the reasoning behind any site-specific targets etc. In some cases the requirements of features or designations may conflict; the detailed basis for any reconciliation of conflicts on this site may be recorded elsewhere.

Use under the Habitats Regulations
The Definitions of Favourable Condition (DFCs) are used to periodically measure and assess the condition of both notified SSSI features and designated European Site features.

Where SSSIs also form part of a European Site (such as a SAC or SPA), a separate document containing specific European Site Conservation Objectives will have been prepared. These objectives are those referred to in the Conservation of Habitats and Species Regulations 2010 (the "Habitats Regulations") and the Habitats Directive 1992. They are for use when either the appropriate nature conservation body or a competent authority is required to make an 'appropriate assessment' of the likely effects of a proposed plan or project on the integrity of a European Site under the relevant parts of the respective legislation. The European Site Conservation Objectives are available at www.naturalengland.org.uk.

The concepts of 'site integrity' and 'favourable condition' are similar and the assessment of a site's condition will measure attributes that also represent aspects of a site's ecological integrity. However, the periodic determination of a site's condition is separate from a judgement about the effect upon a site's overall integrity. This is because the DFCs do not represent a comprehensive or definitive list of all of the elements that might contribute to site integrity, merely those that are most appropriate to monitor in order to rapidly determine site condition. The full range of factors that are components of a site's integrity, and which may need to be considered by an appropriate assessment, will be specified in the European Site Conservation Objectives. Some of the information contained within the DFCs may however contribute to such assessments.

Table 1 Individual designated interest features

BAP Broad Habitat type / Geological Site Type	Specific designated features	Explanatory description of the feature for clarification	SSSI notified interest features	SAC qualifying interest features	SPA qualifying interest features dependency on specific habitats			Ramsar criteria applicable to specific habitats			
					Annex 1 species	Migratory species	Waterfowl assemblage	1a Wetland characteristics	2a Hosting rare species &c	3a 20000 waterfowl	3c 1% of population
Lowland raised bog	M18 Erica tetralix – Sphagnum papillosum raised & blanket mire		*	*							

NB. Features where asterisks are in brackets (*) indicate habitats which are not notified for specific habitat interest (under the relevant designation) but because they support notified species.

Table 2 Habitat extent objectives

Extent - Dynamic balance	To maintain the designated features in favourable condition, which is defined in part in relation to a balance of habitat extents (extent attribute). Favourable condition is defined at this site in terms of the following site-specific standards.
	On this site favourable condition requires the maintenance of the extent of each habitat type (either designated habitat or habitat supporting designated species). Maintenance implies restoration if evidence from condition assessment suggests a reduction in extent.

Habitat Feature (BAP Broad Habitat level, or more detailed level if applicable)	Estimated extent (ha) and date of data source/estimate	Site Specific Target range and Measures	Comments
Lowland raised bog	A baseline map, showing the boundary of the bog and any associated lagg fen, should be used to assess any changes in extent. Aerial photographs can offer a convenient means of rapidly assessing extent.	There should be no reduction in the total extent of bog, including mire expanse, any associated pools, rand and lagg fen, in relation to the established baseline	'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. 'Extent' is not necessarily the same as the SSSI boundary.

Audit Trail
Rationale for habitat extent attribute (Include methods of estimation (measures), and the approximate degree of change which these are capable of detecting).
The current extents are pre-restoration and therefore only represent the remnant bog habitat remaining on Bolton Fell moss. It is anticipated that the extent of bare peat will be restored to M18 bog vegetation
Rationale for site-specific targets (including any variations from generic guidance)
Other Notes

Other Notes

Table 3 Site specific Habitat/geological condition objectives *[insert separate Table 3 for each BAP broad habitat]*

To maintain the **Lowland raised bog** at **Bolton Fell Moss** in favourable condition, with particular reference to relevant specific designated interest features. Favourable condition is defined at this site in terms of the following site-specific standards:
Site-specific details of any geographical variation or limitations (where the favourable condition standards apply)

Site-specific standards defining favourable condition

Criteria feature	Attribute term in guidance	Measure	Site-specific Targets	Comments	Use for Condition Assessment?
Lowland raised bog **Whole site**	Habitat composition	Visual assessment of presence and cover, using structured walk or transects. Aerial photographs may also be useful.	The component vegetation types should be present – mire expanse, rand, lagg fen (including wet woodland and wet grassland), and structural features in appropriate proportions as shown on the conservation objectives map1	Mire expanse is rainfall-fed (bog). Lagg forms in the contact zone between water from bog and minerotrophic water. On damaged sites these components of the bog will be defined primarily hydrologically rather than by vegetation. (See sect. 7.1 JNCC guidance 2004).	YES
Lowland raised bog **Whole site**	Vegetation composition: indicators of negative change - non-woody vascular plant species	Visual assessment of cover, using structured walk or transects and recording quadrats	Invasive non-native plant species should be absent2.	Specify species known from the site e.g Rhododendron ponticum	YES

Criteria feature	Attribute term in guidance	Measure	Site-specific Targets	Comments	Use for Condition Assessment?
Lowland raised bog **Mire expanse**	Habitat structure Structural features	Aerial photographs can offer a convenient means of rapidly assessing these. It may also be necessary to make a visual assessment using a structured walk or transects.	There should be no obvious modification to structural features (e.g. diplotelmic structure, dome/rand/lagg, surface patterning and well-developed microform3).	The surface of an active raised bog has a typical structure consisting of a pattern of hollows and ridges or pools and hummocks. Bog microform relates to single surface features such as pools4. These can be disrupted by activities such as drainage, burning, grazing, vehicular access and peat digging. At present (2008) no Cumbrian sites are known to have surface patterning and most have no or a reduced rand/lagg. The development of these features is an indicator of restoration success.	YES
Lowland raised bog **Mire expanse** Select for each site	Indicators of local distinctiveness – micro-topography*	% length of transects intersecting bog pools or other microtopographic features.	No reduction in extent of microtopographic features (e.g. bog pools).	The quality of microtopographic features may also be assessed by providing a definition of target composition – for example, for a bog pool to count as such it could be defined as having little cover of living dwarf shrubs or Eriophorum vaginatum; a complete or extensive cover of sphagna with S. pulchrum and/or S. cuspidatum predominant. Some open water or bare peat may be present. At present (2008) no Cumbrian sites are known to have microtopography, though bog pools may be developing in some restored areas. Microtopography is a desirable feature for the future.	YES

Criteria feature	Attribute term in guidance	Measure	Site-specific Targets	Comments	Use for Condition Assessment?
Lowland raised bog **Mire expanse**	Habitat structure Exposed substrate	Aerial photographs can offer a convenient means of rapidly assessing this. It may also be necessary to make a visual assessment using a structured walk or transects.	Total extent across the area assessed should be no more than 1%5.	Note if bare ground persists more than 5 years or spreads following a fire or management. Paths or tracks caused by trampling, hound trailing or vehicular access can cause erosion, break bunds and act as drains6.	YES
Lowland raised bog **Mire expanse**	Habitat structure Drainage7	No artificial functioning drains	There should be no active drainage on the mire expanse.	Raised bogs depend on a water level near the surface for most of the year and drainage of the mire expanse has a number of detrimental effects. Drainage should be considered active if it has altered or is likely to alter, remove, or prevent recovery or establishment of the desired plant communities. Water courses in soligenous areas are acceptable unless inappropriate in location or size.	YES
Lowland raised bog **Mire expanse**	Vegetation composition: positive indicators - vascular plants	Visual assessment of cover and frequency, using structured walk or transects and recording quadrats	Targets for the mire expanse only: (1) At least 3 of Calluna vulgaris, Erica tetralix, Eriophorum angustifolium, E. vaginatum & Trichophorum cespitosum constant, with a combined cover not exceeding 80%; (2) no single species > 50% cover;	The vegetation of the mire expanse should comprise an inter-mix of bryophytes (predominantly Sphagnum spp), graminoids and dwarf shrubs, with no one group dominating at the expense of others on 'active' sites. Although Sphagnum may predominate on hyper-oceanic sites (coastal raised mires).	YES

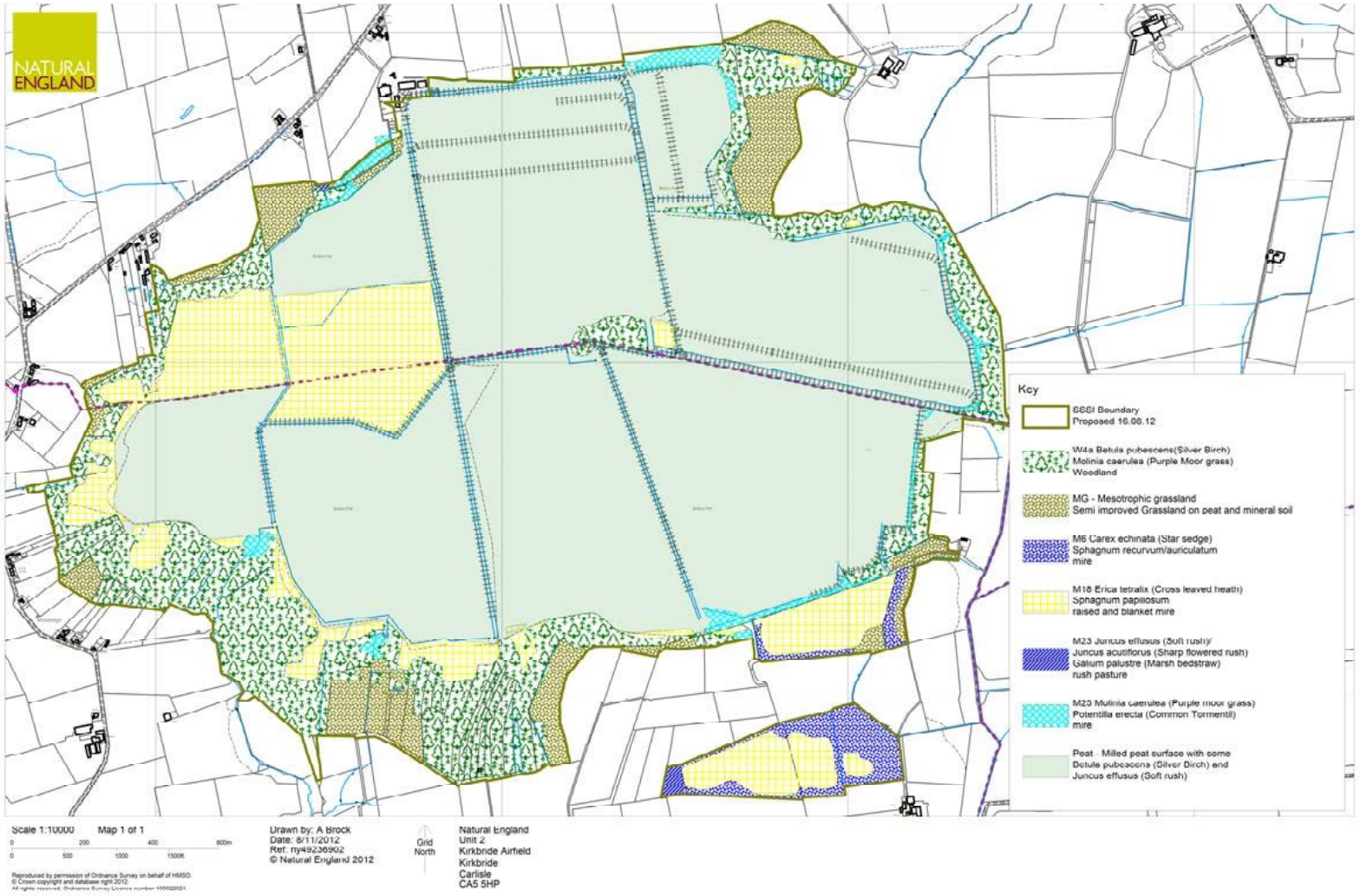
Criteria feature	Attribute term in guidance	Measure	Site-specific Targets	Comments	Use for Condition Assessment?
Lowland raised bog **Mire expanse**	Vegetation composition: positive indicators - vascular plants	Visual assessment of cover and frequency, using structured walk or transects and recording quadrats	(3) At least one of Andromeda polifolia, Drosera rotundifolia, Empetrum nigrum, Narthecium ossifragum and Vaccinium oxycoccos at least frequent	'Frequent' is defined as being present at 41-60% of random points. Drosera overwinters below ground and plants are not visible in the winter.	YES
Lowland raised bog **Mire expanse**	Vegetation composition: positive indicators - bryophytes	Visual assessment of cover, using structured walk or transects and recording quadrats	Targets for the mire expanse only: (1) At least 2 of the following spp. constant, with a combined cover > 20%: Sphagnum capillifolium, S. magellanicum, S. papillosum, S. tenellum	Total Sphagnum cover on mire expanse in good hydrological order is likely to be 70-90% but indicator species are normally below the target on damaged or newly-restored sites. 'Constant' is defined as being present at more than 60% of random points	YES
			(2) Sphagnum cuspidatum and/or S. pulchrum at least occasional	S.cuspidatum cover is a surrogate indicator for year-round high water table position. Sphagnum cuspidatum present in at least 10% of quadrats, or at least occasional indicates 'unfavourable recovering' condition, where the other targets are not achieved (particularly important for degraded bogs). 'Occasional' is defined as being present at 21-40% of random points	
Lowland raised bog **Mire expanse**	Vegetation composition: indicators of negative change - bryophytes	Visual assessment of cover, using structured walk or transects and recording quadrats	Polytrichum spp. other than P. alpestre no more than occasional	'Occasional' is defined as being present at 21-40% of random points	YES

Criteria feature	Attribute term in guidance	Measure	Site-specific Targets	Comments	Use for Condition Assessment?
Lowland raised bog **Mire expanse**	Vegetation composition: indicators of negative change - non-woody vascular plant species	Visual assessment of cover, using structured walk or transects and recording quadrats	(1) No more than 1% cover of the following on the mire expanse: Phragmites australis, Phalaris arundinacea, Glyceria maxima, Epilobium hirsutum, Urtica dioica, Pteridium aquilinum, Rubus fruticosus, Juncus effusus, Deschampsia cespitosa, Cirsium spp. (2) Areas of tussocky Molinia absent8	The plants listed are indicators of enrichment or of drying out of the bog. Phragmites is acceptable around upwellings or their equivalent on ditched bogs. Molinia is acceptable in flow channels that will exist post-restoration and on rand. Elsewhere on the mire expanse it indicates lateral or vertical water movement. It has a high transpiration rate so can cause significant water movement. It will not be dominant in a permanently high, stagnant water table.	YES
Lowland raised bog **Mire expanse**	Vegetation composition: indicators of negative change – undesirable woody species	Visual assessment of cover of the whole mire expanse, using structured walk or transects Aerial photography may be a useful aid though not for seedlings.	On the mire expanse, trees and shrubs (Betula, Salix, Rhododendron, Pinus species, other gymnosperms no more than rare and < 5% cover.	Invasion by woody species and their development to healthy maturity may indicate drying out and/or enrichment. Trees and shrubs will exacerbate drying out. Salix spp. and Myrica gale can occur on raised bogs, but scrub generally constrains itself to areas where it receives a source of nutrients (e.g. near water that has passed through or over a mineral soil). As a result, it often is found close to or on the 'rand' of the raised bog, where it is more acceptable.	YES

Criteria feature	Attribute term in guidance	Measure	Site-specific Targets	Comments	Use for Condition Assessment?
Lowland raised bog **Rand**	Vegetation composition: indicators of negative change – undesirable woody species	Visual assessment of cover of the whole rand, using structured walk or transects Aerial photography may be a useful aid though not for seedlings.	On the bog margin (rand) woody species < 10% cover	Invasion by woody species and their development to healthy maturity may indicate drying out and/or enrichment. Trees and shrubs will exacerbate drying out. Salix spp. and Myrica gale can occur on raised bogs, but scrub generally constrains itself to areas where it receives a source of nutrients (e.g. near water that has passed through or over a mineral soil). As a result, it often is found close to or on the 'rand' of the raised bog, where it is more acceptable. Note that the rand of lowland raised bogs has usually been removed. Peat-cutting faces should not be considered as rand. Location of any rand should be shown on the map.	YES
Lowland raised bog **Lagg9**	Habitat structure Water table	Visual assessment of soil conditions	The water table should be at or near the surface for most of the year	This is a vital condition for the best achievable hydrological regime on the mire expanse and for the formation of lagg communities. It can be applied to land around the bog that is of hydrological importance but does not currently support target vegetation types M4, M6, M23, M25, M27, S4, S27, W5-6)10 Lowest water levels are generally found around July	YES

Audit Trail
Rationale for limiting standards to specified parts of the site
Rationale for site-specific targets (including any variations from generic guidance)
Based on guidelines: JNCC (2004) Common Standards Monitoring Guidance for Lowland Wetland Version 2004 ISSN 1743 - 8160 Changes are: 1. Supplementary guidance (draft) Roger Meade December 2005 2. 'No more than rare' deleted as invasive aliens are a serious threat and large populations can be difficult to manage (e.g. *Sarracenia* on Wedholme Flow, *Rhododendron* on most S. Cumbrian bogs). 3. Examples of structure taken from advice note by Roger Meade August 2000. 4. Quote from section 7.1.1.6 of JNCC CSM guidance August 2004 5. Amended from 10% to 1% as 10% felt to be too high for areas with appropriate hydrological conditions. 6. Note on paths and tracks added following field observations 7. Drainage is a major cause of unfavourable hydrology. Wording based on JNCC Wet heathland guidance February 2004. 8. *Molinia* target added as this species is used in planning restoration works in Cumbria as an indicator of water movement, peat aeration and possible enrichment or peat breakdown. Its decreased dominance or disappearance follows successful maintenance of a high water table, when it is replaced by ericoids, *Eriophorum* and *Sphagnum*. 9. Separate lagg criteria added to allow assessments of units that (will) contain only lagg. Acceptable communities taken from JNCC guidance 10. W4 deleted as it is not wet enough to normally be an acceptable lagg community in Cumbria. S27 added after discussion with Iain Diack.
Rationale for selection of measures of condition (features and attributes for use in condition assessment) (The selected vegetation attributes are those considered to most economically define favourable condition at this site for the broad habitat type and any dependent designated species).
Other Notes
Frequency classes are 1-20% rare, 21-40% occasional, 41-60% frequent, >60% constant. Frequency is defined as the chance of finding a species at a point positioned at random in a stand.

Annex 1 Map of existing areas of vegetation prior to restoration.



Appendix 3

Indicative Traffic Movements generated by the Restoration Works

			2012 May/June/ July				2013 May/June/July/August/September				2014 May/June/July/August/September				2015 May/June/July/August/September			
			Low loader	Wagons	Excavator/ spreading equipment	Cars	Low loader	Wagons	Excavator/ spreading equipment	Cars	Low loader	Wagons	Excavator/ spreading equipment	Cars	Low loader	Wagons	Excavator/ spreading equipment	Cars
Sinclairs/Romp			Bringing in machines	bringing in straw/ heather	On site	Bringing operators onto site	Bringing in machines	bringing in straw/ heather	On site	Bringing operators onto site	Bringing in machines	bringing in straw/ heather	On site	Bringing operators onto site	Bringing in machines	bringing in straw/ heather	On site	Bringing operators onto site
Milling fields	Area ha	Works	1 journey to and 1 journey from site	1 journey to and 1 journey from site	Machine days	1 journey to and 1 journey from site	1 journey to and 1 journey from site	1 journey to and 1 journey from site	Machine days	1 journey to and 1 journey from site	1 journey to and 1 journey from site	1 journey to and 1 journey from site	Machine days	1 journey to and 1 journey from site	1 journey to and 1 journey from site	1 journey to and 1 journey from site	Machine days	1 journey to and 1 journey from site
Dalgleish (12 weeks)	50	Groundworks	2		300	75												
	50	Sphagnum					1		5	5								
	50	Straw/heather					1	15	10	10								
Old Mill	50	Groundworks					2		300	75								
	50	Re veg					1		5	5								
	50	Straw/heather					1	15	10	10								
New Mill	15	Groundworks					2		90	22.5								
	15	Re veg					1		1.5	1.5								
	15	Straw/heather					1	4.5	3	3								
Slacks	12	Groundworks									2		72	18				
	12	Re veg									1		1.2	10				
	12	Straw/heather									1	3.6	2.4	20				
Russell	50	Groundworks									2		300	75				
	50	Re veg									1		5	5				
	50	Straw/heather									1	15	10	10				
North/ South	44	Groundworks									2		264	66				
	44	Re veg									1		4.4	5				
	44	Straw/heather									1	13.2	8.8	9				
West1/2	38	Groundworks									2		228	57				
	38	Re veg									1		3.8	4				
	38	St									1	11.4	7.6	8				
West 3	16	Groundworks									2		96	24				
	16	Re veg									1		1.6	2				
	16	Straw/heather									1	4.8	3.2	3				

			2012 May/June/ July				2013 May/June/July/August/September				2014 May/June/July/August/September				2015 May/June/July/August/September			
			Low loader	Wagons	Excavator/ spreading equipment	Cars	Low loader	Wagons	Excavator/ spreading equipment	Cars	Low loader	Wagons	Excavator/ spreading equipment	Cars	Low loader	Wagons	Excavator/ spreading equipment	Cars
			Bringing in machines	bringing in straw/ heather	On site	Bringing operators onto site	Bringing in machines	bringing in straw/ heather	On site	Bringing operators onto site	Bringing in machines	bringing in straw/ heather	On site	Bringing operators onto site	Bringing in machines	bringing in straw/ heather	On site	Bringing operators onto site
Reserve																		
	15	Tree Felling					2		15	3.75								
SSSI																		
	60	Tree felling											30	7.5			30	7.5
	89	Groundworks											534	267			534	267
Totals			2	0	300	75	12	34.5	439.5	135.75	20	48	1572	590.5	0	0	564	274.5

Assumptions

A journey to and from site whether truck or operators car is counted as one movement
6 excavators - 3 excavators/low loader
1ha of groundworks/bunding etc = 6 machine days (based on recent tenders for similar work at Wedholme Flow)
1ha of straw/heather spreading requires = 0.3 wagon loads
1ha of heather/straw spreading requires 0.5 days of equipment time
Excavator Operator transport - assuming 4 people sharing a car

Appendix 4

Detailed Specification for Blocking Drains

1.1 This methodology is to be used on all drains regardless of size.

Dams

1.2 On level surfaces dams should be around 10m apart. Where there is a gradient they should be 7.5metres or less apart.

1.3 Clean the sides and base of ditch of old degraded peat/vegetation.

1.4 Cut slots into the side of the drain walls to create a slot into which a dam will be constructed

1.5 Create a borrow pit on the upstream side (remove vegetation and any old degraded peat) and build a dam out of the good ombrotrophic 'clay like' peat found underneath. In a 1m deep drain the dam should be approximately 1.5m at its base and 1m at the surface.

1.6 The final height of the dam should be about 250mm above the surrounding surface to allow for settlement.

1.7 Cap with any spare vegetation or cover with heather brash/straw.

1.8 Any degraded peat should be placed in the borrow pit. Borrow pits should be kept as shallow as possible – not exceeding 1.0m deep before degraded peat/vegetation is returned to it.

Backfill

1.9 Where possible all drains should be backfilled to allow Sphagnum to grow.

1.10 Backfill can only be used in conjunction with dams.

1.11 Backfill will be old drain material, woodchip or degraded peat retrieved from the vicinity of the drain. Where possible the backfill should be brought up to ground level and if possible covered with turves.

1.12 Where there is not sufficient backfill to bring to ground level then chamfer drain edges down to an angle of less than 30° and use the material to cover the backfill and create a shallow swale.

Appendix 5

Detailed Specification for Bund and Cell Construction

1.1 Bunds are used to impede the flow of water across the surface of both vegetated and un-vegetated degraded peat surfaces. A bund is a linear dam created of impermeable material keyed into impermeable material in the ground.

1.2 Impermeable material will be either 'clay like' peat or the underlying clay.

1.3 Bunds are then linked together to form impermeable cells which hold water at around ground level.

1.4 Bund height is between 150mm on most surfaces and 250mm below steep cut faces.

1.5 Cell size will vary between 6 x10m and 20 x10m depending on gradient and topography.

Construction

1.6 Construct a 1m wide x 150mm above ground level bund:

Where the peat is greater than 0.5m

1.7 Create a trench by:

a Removing between 0.75m and 1m width of vegetated turf if present. Put to side to be re used in covering the bund.

b Dig out the thin layer of degraded peat below possibly up to 0.5m deep and place in borrow pit that will be constructed.

c Dig down a further 1m into the ombrotrophic 'clay like' peat, turn this over and squash back in the trench. This will seal any cracks etc (if cracks are found which go deeper dig out to the bottom of the crack, then return the peat and squash in).

d Create a borrow pit on the uphill side of the bund and acquire 'clay like ' peat which is then used to fill the trench to ground level and is then topped off with an additional 150mm. Form this peat into an appropriate shape and top with vegetation if it exists and if not cover with heather brash/straw..

e Any degraded peat/tree roots to be put in borrow pit and the borrow pit flattened off as much as possible.

f Borrow pits must be at least 2m's from the bund and not joined up to form a new ditch/drain.

g At 20m intervals create bunds at right angles either to link with next line of bunds. This is to slow lateral movement of water.

Where the peat is less than 0.5m deep

1.8 Here the core of the bund can be constructed using the underlying clay.

a Construct the trench as above but dig to the clay layer below.

b Use clay from a borrow pit to bring the trench to 25cm below ground level.

c Fill to the surface and top off to 150mm with 'clay like' peat.

d Cover with turves, heather brash or straw.

Appendix 6

Detailed Specification for Re-profiling Slopes and Bunds

1.1 Remove turf from area to be re-profiled including upper surface and lower surface and set aside.

1.2 Re-profile the cut face to form an approximate 30 degree slope by moving peat from the upper area and infilling lower area

1.3 Turf to be replaced and bare areas to have Sphagnum propagules spread then and covered with heather brash to a depth of 50mm.

1.4 Construct a 150mm high x 1m wide bund along the top of the cut face in good peat. (Diagram I)

1.5 At 20m intervals a small bund is required at right angles linking this bund with bunds/cells being constructed on the upper peat surface. This is to slow lateral movement of water.

1.6 Construct a similar bund at the bottom of the re-profiled slope this one to be 0.25m above ground level before vegetation is added. (Diagram II)

1.7 At 20m intervals a small bund is required linking the bottom bund with the foot of the re-profiled slope. This is to slow lateral movement of water.

1.8 This bund links into cells which are being built on the lower area of the site see (Diagram II)

Appendix 7

Detailed Specification for Re-Vegetation through Inoculation with Sphagnum

1.1 This methodology is based on trials by Quinty/Rocheforte in Canada and by Natural England on Wedholme Flow SSSI in North Cumbria.

Ground preparation

1.2 The surface is scarified to loosen the thin decomposed peat crust or the if there is a gradient as at Bolton Fell Moss then the surface is managed to produce flat contour terraces (Diagram III). These terraces will range in width from 6to 24 ms depending on the gradient.

1.3 In creating the terraces all the internal field drains are backfilled.

1.4 At the edges of the terrace slow bunds are constructed 1m wide by 150mm high which slow the movement of water off the site.

1.5 Where the bund crosses a former drain it is dammed. (Appendix).

1.6 The terraces cascade to the lowest point of the milling fields where excess water exits into the internal main drains and then exits the site into the Perimeter Drain/Modified Lagg steam.

Introduce viable (living) Sphagnum particles (propagules)

1.7 In Canada and on Wedholme Flow SSSI, donor *Sphagnum* was sourced from adjacent good active mire surface by rotovation and collection using an excavator. This was spread on the recipient site with about 1ha donor site providing enough material for 5-10ha of recipient site.

1.8 In Canada good Sphagnum growth was recorded on recipient sites after three years, on Wedholme small colonies have been recorded after three years but probably covering only about 1% of the site.

1.9 The problem with this technique is that the only close sources of Sphagnum for Bolton Fell Moss are from adjacent peat bogs, all of which are protected by UK and European law. Since the resource of good intact mire surface in the UK is extremely small, damaging an intact site to provide donor material is not encouraged, as the donor site can take 5-10 years to partially recover and up to 20 years to fully recover.

1.10 Because of this source issue Natural England will be specifying that contractors need to find and use a viable alternative source of donor material. This material will need to be sourced from the UK but not from protected sites.

1.11 An example source is ‘Beada Moss’ developed by Micropropagation (ES) Ltd. They have developed a system where handfuls of sphagnum are chopped up, grown on and then encapsulated in a water gel coat. These are then ‘sown’ onto the prepared bare surface. Trials on Wedholme Flow SSSI and the Pennine Moors have shown up to 50% success rate of germination of these beads after three years. Each successive year show that more actually survived but they have just been slow to grow.

Protecting Sphagnum Propagules while they establish

1.12 Fresh straw was spread using a variety of pieces of machinery. This forms a blanket which insulates the living Sphagnum particles in winter from freeze and thaw and prevents the Sphagnum from desiccating in summer temperatures, as well as keeping it moist.

1.13 A second trial at Wedholme Flow SSSI used chopped heather as a blanket. However, no results have been recorded at Wedholme after two years.

1.14 In Canada and on the Pennines, *Sphagnum* and heather have started to grow after three years from the donor material. Cotton grass seeds have blown in and lodged in the rough straw surface and have also started to grow.

1.15 At Bolton Fell Moss both techniques will be used on alternating terraces. Using heather brash on alternative terraces has the advantage that it this will bring in heather and cotton grass seed to complement the sphagnum beads.

Adding fertiliser

1.16 The work in Canada advocated the use of small amounts of fertiliser to aid the growth of Sphagnum in the first three years. The results demonstrated a positive correlation.

1.17 Fertiliser will be used on the Bolton fell Moss restoration

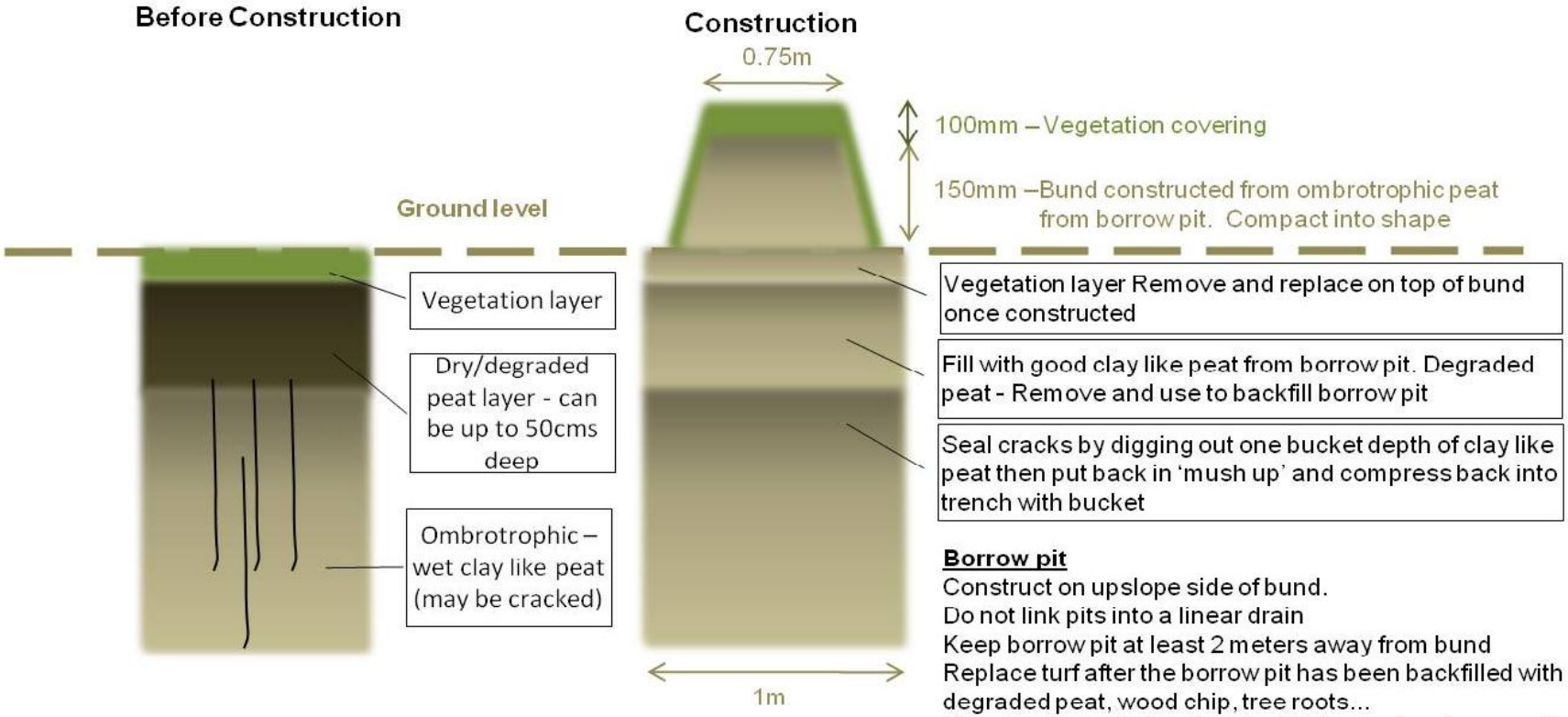
Construction of bunded cells

1.18 Once re-vegetation has been completed then the terraces need to be divided by the construction of bunds (Appendix). This work is done last to prevent damage to the bunds by machinery spreading vegetation.

Diagram I

Bund Construction

This bund profile is used in all locations. Where the bund crosses a drain, degraded peat and vegetation must be cleaned from the drain sides and base. A peat dam approximately 1.5m at its base, will be constructed to link with bund



Borrow pit

Construct on upslope side of bund.
Do not link pits into a linear drain
Keep borrow pit at least 2 meters away from bund
Replace turf after the borrow pit has been backfilled with degraded peat, wood chip, tree roots…
Remove degraded peat and put into previous borrow pit.
Remove good ombrotrophic clay like peat and use to fill bund to ground level and then raise and shape a bund above ground level.
Leave borrow pit as shallow as possible with vegetation on top.

Diagram II

Re- profiling of cut peat face and adjacent cut over areas.

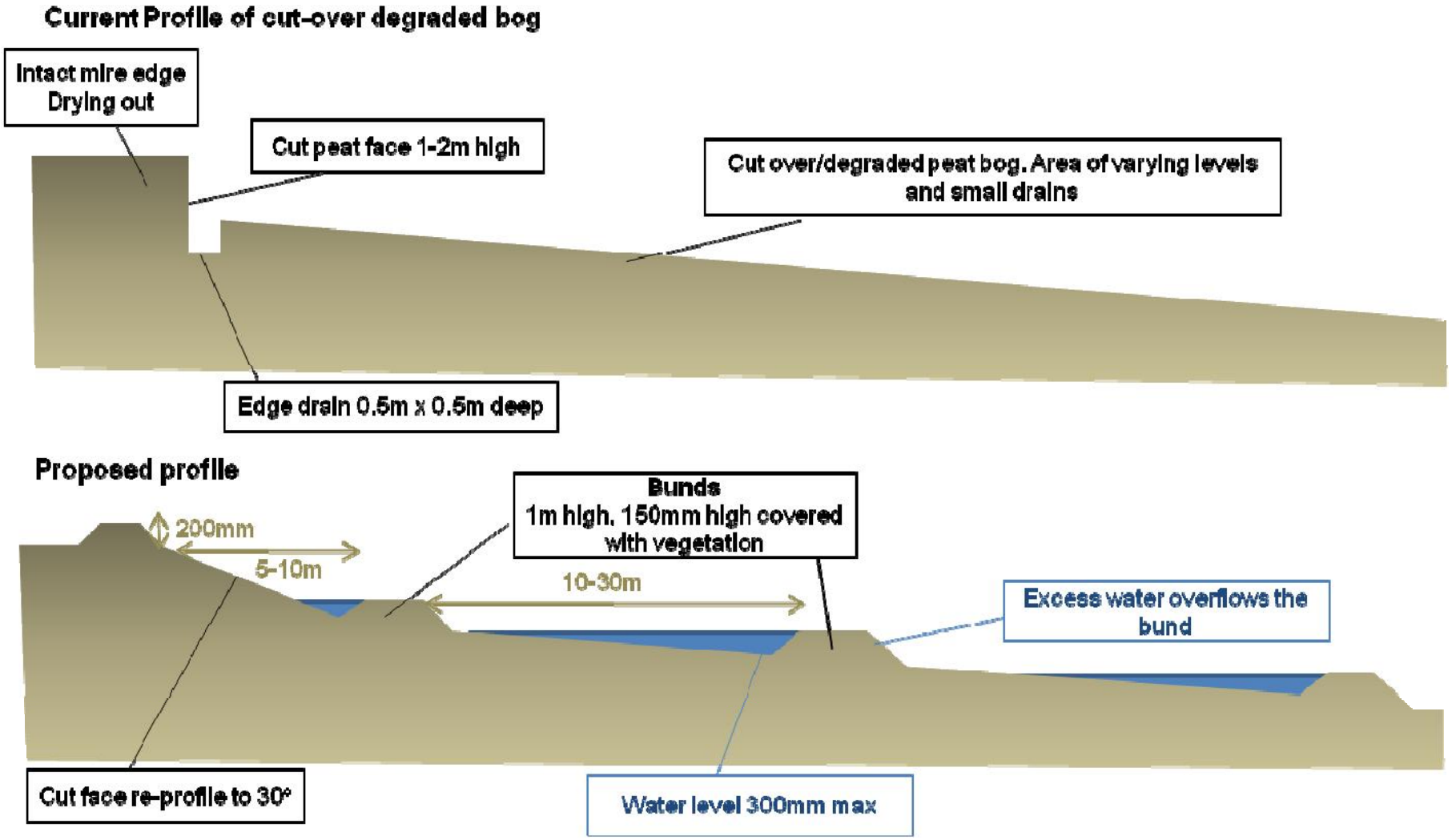


Diagram III

Construction of terraces and edge bunds on milled peat surfaces