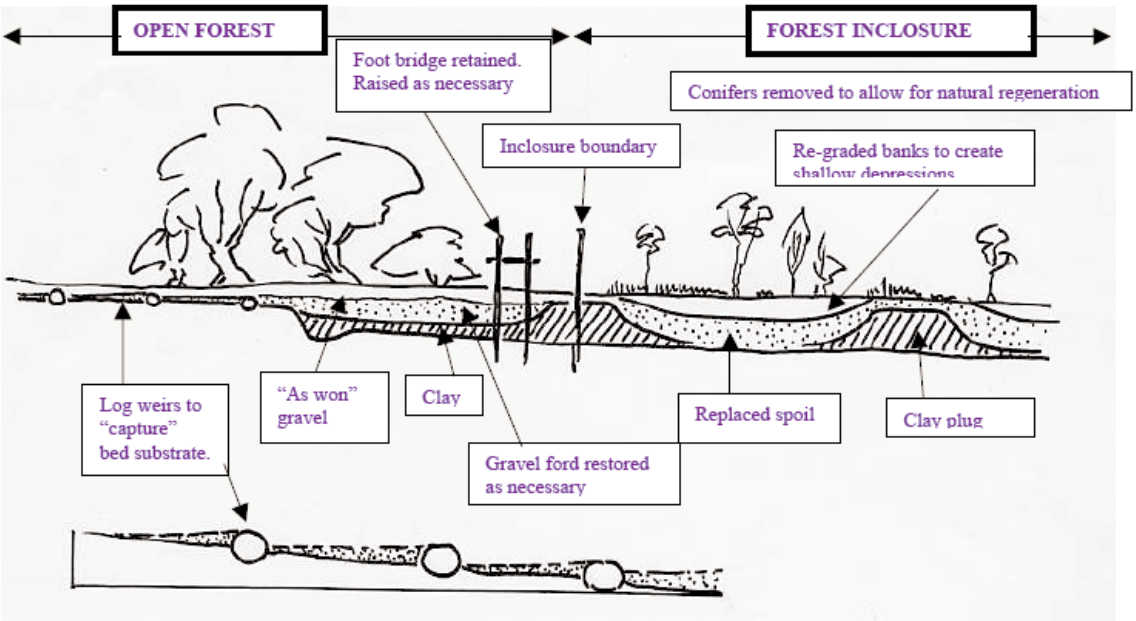
Repair of deeply incised drainage channels using heather bales. The drains were migrating beyond the Inclosure boundary causing damage to mire and wet heath habitats on the open Forest. At its worst point the bed level of this drainage channel was 2.5m deep.

4.9.3 River Restoration Techniques

A) Installation of Log Weirs

Where bed gravels have been scoured and lost from headwater sections of a stream but where the solid geology (e.g. underlying clay) is still intact, low log weirs can be installed in the river bed to act as sediment traps. The weirs capture and retain any gravels that still remain in that part of the system or that are being washed down from further upstream. They also help to stabalise the bed and prevent erosion and scour progressing further upstream. Figure 37 shows how this technique was used successfully at Holmsley.

Figure 37: Use of Log Weirs



Source: Environment Agency

Log Weirs - Holmesley Inclosure

B) Bed level Raising

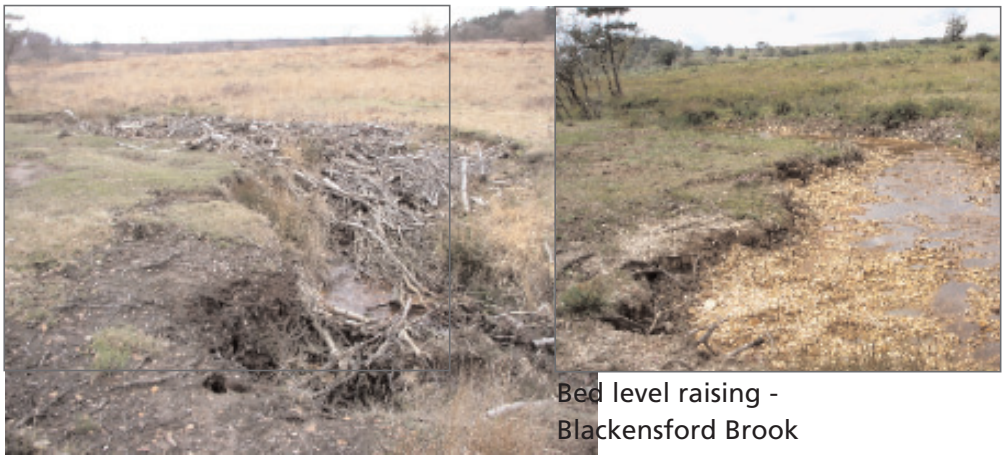
Where channels have become over deepened due to scour and erosion it is often necessary to raise the bed back up to the original level using infill material as closely matched in character to that originally lost (refer to section 3.4). Local sources of material include:

- Local Quarries – e.g. Hamer Warren (Cemex), Pennington (New Milton Sand & Ballast)
- Areas along the stream network where excess eroded gravels have been deposited
- Spoil Heaps

In order to prevent the new material being washed out, malleable clay plugs can be used in limited areas to form cells to hold the material in place on the upstream side. Over time the river will naturally sort and regrade the new material into a natural bed form. Where appropriate, the new raised bed level can be used to re-connect the river into former meanders on the downstream side as described further below.

Good examples of bed level raising can be seen at:

- Blackensford Bottom
- Highland Water



Bed level raising - Blackensford Brook

C) Restoration of flow back into natural meanders

Once bed levels have been raised as appropriate upstream, the channel can be restored to its natural course by the reinstatement of the original channel and old meanders (Figure 37).

The design of the meanders where possible should follow the original course of the river by linking up the old paleomeanders. The course of the old meanders is usually possible to trace through topographic remnants and patterns of organic debris on thefloodplain supported by survey work and reference to historic maps. Excavation of the soil surface often reveals the gravels forming the original river bed. Where this is not clear trial holes can also be dug to establish original bed levels.

Usually it has only been necessary to scrape back the organic debris to reveal the old substrate with an emphasis on under rather than over excavation and a preference for leaving the river to wash out any remaining excess organic debris.

In order to connect the river to its restored channel the straightened channel is blocked off using a plug of compacted malleable clay topped off with material from surrounding excavations or excavated spoil banks. A similar plug may also be required at the downstream end if the old channel is being backfilled depending upon location and fisheries issues. It may also be necessary to incorporate a v-notch in the downstream plug to facilitate fish passage. It is important that the plug is set at a high enough level and is big enough to deflect flows into the new restored channel. Experience has shown that clay plugs can breach when water is allowed spill directly over the plugs during times of flood flow, particularly in the period post restoration before material has had a chance to consolidate.

Once the river has been diverted into its newly restored channel, it is preferable to fill in the old straightened channel with excess material from old spoil banks and material excavated in the process of restoring the new channel. Although it can take substantial material to do so is preferable to fill in the old channel because:

- Leaving the old channel open will cause it to function as a deep ditch drawing in water from the surround floodplain.

- At times of raised flow it can act as a long backwater trapping fish when the water level falls again. The creation of short backwaters can add diversity and provide large pools as seen at the lower end of the Highland Water restoration works.

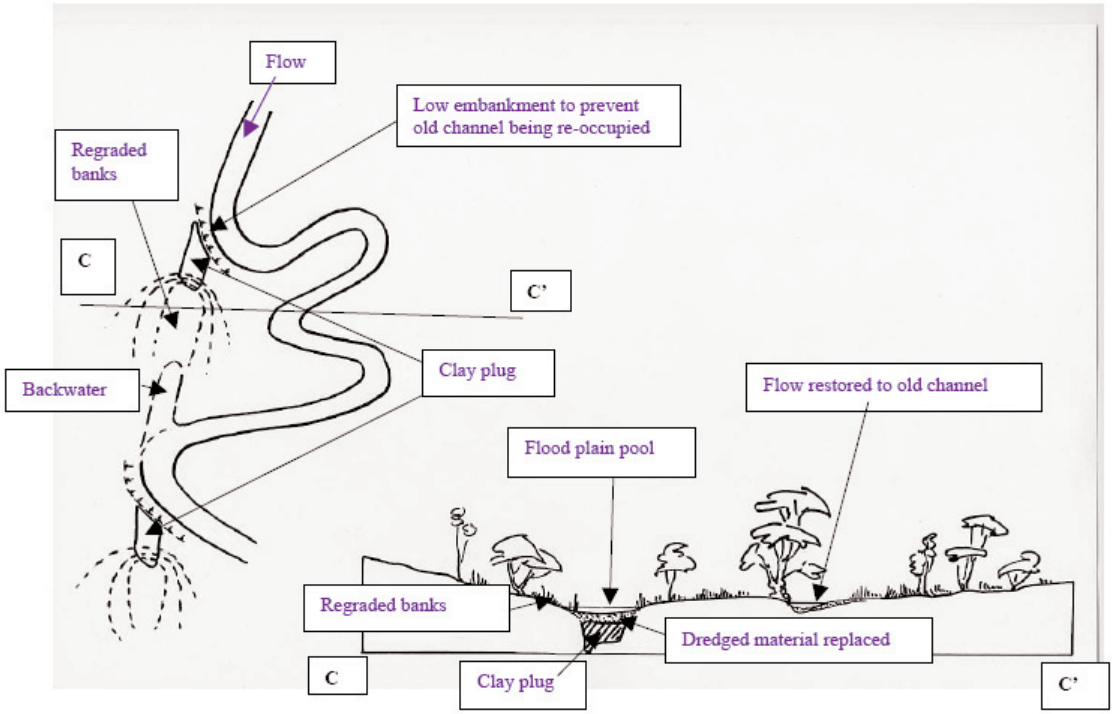
- Leaves potential for the new channel to breach back into the old channel especially where the two channels run close to one another and run out of bank during times of flood flow.

- Potential safety hazard

Where there is a shortage of fill material, large conifer tree trunks and stumps which would otherwise be removed from the floodplain can be used to provide bulk fill before being covered with mineral infill. However, consideration needs to be given to any pollution risk from the degradation of organic material.

In other sections it may be appropriate to partially infill and/or regrade the channel banks to form shallow hollows or floodplain pools.

Figure 37: Restoration of natural meanders



Source: Environment Agency

Constructing clay plug - Markway

Meander restoration - Highland Water

Good examples of channel restoration can be seen at:

- Highland Water
- Rhinefield
- Markway
- Dames Slough
- Blackensford

D) Installation of Debris Dams

As discussed in Section 3.4 debris dams are important components in restoring a river and it's associated habitats. When considering the use of debris dams as a restoration technique it is important to consider the individual river reaches and determine whether they would naturally support debris dams depending upon the nature of the surrounding habitat relative to the availability of woody debris. For example stream reaches running through open heathland (e.g. Ditchend Brook) are less likely to support the density of debris dams found in the highly forested catchments such as Highland Water or the lower reaches of the Beaulieu.

It can take tens or even hundreds of years to form dams by natural processes depending upon the availability of large woody debris (LWD). However, the provision of woody debris can be accelerated as a by-product of complimentary activities such as pollarding of ash, oak and holly species. The arising can contribute to flood plain flow processes or can help the formation of in-steam debris dams if they are washed into the channel. In order to further secure the availability of natural woody debris to supply debris dams it is recommended that where possible natural tree and branch falls are left in situ where they fall on a floodplain. This is in line with the Timber Management Protocol agreed between the Environment Agency, English Nature and the Forestry Commission (**Appendix O**).

However, the presence of straight, cut material can create an impermeable debris dam that can be detrimental to the movement of fish. This is particularly relevant to the harvesting of conifers on the floodplain within Inclosures and in such instances such timber/arisings should be removed from the floodplain.

To further aid the natural process, large pieces of woody debris can be introduced into the channel:

- By placing individual pieces of debris in stream using machines
- Push over adjacent trees so that either the branches or trunk are in the stream
- Felling adjacent trees but retaining a hinge so that the tree is still alive
- Digging in live material that has been cut for the purpose, for example willow or alder

When placing woody debris in channel the following general principles need to be considered (Mott, 2005):

- The length of the pieces should be at least as long as the channel width
- The diameter needs to at least 0.1m or 5% of the channel width (whichever is the largest)

- The Large Woody Debris may need to be securely keyed into the bed of the watercourse at an angle of 20o-40o to the channel/flow direction.
- In highly wooded catchments, to replicate the natural density of New Forest debris dams it is recommended that very large pieces of woody debris are placed across the channel at 150m intervals. Once a key piece is in place natural processes will do the rest when debris becomes snagged during times of flood flow.

Debris dams can be critical in maintaining and building up bed levels. In some reaches where damage is not extreme, bed levels in the existing channel may have remained fairly constant. In such locations the strategic placement of debris dams may be the only restoration technique required, allowing the river's own dynamic processes to do the restoration.

Examples of debris dams at work can be found on most of the Forest streams with some key examples located:

- along the length of Highland Water and Blackwater
- Queen North Wood - Fritham , Dockens Water

In accordance with its former duties, the Forestry Commission has historically been responsible for the removal of woody debris to maintain free-flowing watercourses. This has been undertaken for many decades and as a consequence the streams of the Forest are impoverished in respect of woody debris. Moving away from the traditional management of woody debris to a more enlightened view has required a cultural shift among staff in this organisation. To disseminate the understanding of the role of woody debris, the Forestry Commission has written a policy document (Appendix N) for the New Forest in consultation with English Nature and the Environment Agency. This has been presented to staff to encourage a more sensitive approach to the management of riparian corridors.

E) Vegetation management including holly management, scrub clearance, grazing and fence realignment

Any forestry works are carried out in accordance with The UK Forestry Standard and associated Forestry Commission Guidelines

i) Holly Management

Holly management is a seasonal activity which starts in late December, depending upon the severity of the winter, and continues to the end of February. It is beneficial because it opens up the ground to light and allows regeneration of rare lower plant communities (e.g. lichen) on adjacent oak and beech trees. Preserving the main holly stem protects any rare lichens that may be colonising the holly. Traditionally, cut holly also provides valuable winter fodder for grazing ponies. The general treatment methods for Holly is given in Table 4.12.

Holly prior to pollarding

Holly post pollarding – holly leaves have been eaten by ponies

Table 4.12: Holly Treatment Methods

Holly Type	Treatment Method
Dense holly < 2m in height	◆ Do not cut ◆ Useful for protection for young saplings + not palatable to ponies
Dense holly > 2m in height but dominated by small diameter holly	◆ Cutting good for nature conservation purposes ◆ Best cut in blocks of 30-100m across, close to a path to allow ponies to find the cut holly. ◆ Do not cut holly at the edge of a wood to maintain shelter ◆ All holly <10cm (4") diameter should be coppiced ◆ All holly >10cm(4") diameter should be pollarded ◆ Hollies well colonised by lichens (i.e. those with extensive white splashes on the bark) should be favoured over those with bare bark (i.e with a uniform greyish brown bark) ◆ Where possible green growth should be left on new pollards ◆ Old pollards, especially those >0.3m in diameter should be repollarded using a safe platform or handtools or left uncut ◆ Occasional old Holly trees or Holly grown into the canopy can be left ◆ Only cut enough holly per work day in each site that can be eaten by the ponies before it goes off ◆ Leafy material should be cut up and spread ◆ If access allows, larger wood can be cut into cordwood lengths (4ft) and left stacked for removal in the summer
Older stands dominated by holly over 15cm (6") in diameter	◆ Only cut in series of small scattered sites or isolated specimens ◆ Do not cut at the edge of a wood or holm to maintain shelter ◆ Where alternatives are available Holly in old woods should be cut instead of Holly in the open in Holly holms ◆ Any small diameter holly can be coppiced, especially near mature trees ◆ Maiden hollies should be pollarded at shoulder height ◆ On multi-stemmed Holly only 1 or 2 stems should be pollarded ◆ Old pollards, especially those >0.3m in diameter should be repollarded using a safe platform or handtools or left uncut ◆ Occasional old Holly trees or Holly grown into the canopy can be left ◆ Only cut enough holly per work day in each site that can be eaten by the ponies before it goes off ◆ Leafy material should be cut up and spread ◆ If access allows, larger wood can be cut into cordwood lengths (4ft) and left stacked for removal in the summer

Source: Review of Holly Cutting in the New Forest 1997

ii) Scrub management

Scrub clearance is generally carried out using chainsaws or tractor-mounted flail. Brushwood is gathered up burnt on site, although the number of burn sites are restricted to as few as possible to avoid damaging the ground surface. Any cut timber is stacked and left on site to dry before being sold and removed from site in the spring (if accessible).

Scrub clearance
- Stony Moors

iii) Rhododendron Clearance

Large areas of rhododendron clearance are tackled using an excavator as shown below. The arisings are burnt and stumps are then treated with Glyphosphate and High Trees Mixture B to prevent regrowth.

iv) Regeneration of alluvial and bog woodland using fence realignment & introduction of grazing

To date the use of deer exclosure plots has been used as standard silviculture practice in promoting the natural regeneration of native tree species in the New Forest. However, this method promotes tree colonisation with a relatively even aged stand structure. Timescales for regeneration within exclosure plots operate over far shorter time periods of between 5-10 years compared to natural regeneration in unfenced areas that is slow and inconspicuous. However, a review of woodland cover dating back to the 1860's shows that Riparian and Bog woodland has been expanding steadily in key locations over the last 140 years (Sanderson, 2004).

As the key aim of habitat restoration is to regenerate near-natural bog and alluvial woodland, the use of deer exclosure plots has been considered less appropriate. Instead, fences have been realigned to open up parts of Inclosures to allow variable but significant grazing pressure and link the habitats back into the floodplain and Open Forest. This technique has a number of advantages:

- It avoids the situation in ungrazed sites where bracken dominates on drier areas preventing the colonisation by trees leaving the wetter areas to become densely colonised by trees. This results in a woodland structure atypical of the existing riparian woodlands.

- The early 19th century Oak plantations provide an existing resource for restoring high quality riparian woodland. However they lack the structural diversity typical of riparian woodland on the Open Forest, in particular a shrub layer comprising species such as Dogwood, Spindle, Crab Apple, Hazel, Wych Elm, Field Maple and Yew.

- Where the aim is to allow the development of riverine and bog woodland with minimal intervention, variable but significant grazing pressure is required to maintain structural and species diversity. Grazing is essential in controlling invasive species, such as Bracken,

Molinia and Holly. Inter-linking the stands back into the open forest should allow stock to stray and graze these areas.

- Grazing by stock is essential in maintaining the traditional linkages between open mire and bog woodland. For example grazing maintains the quality of the open mire by reducing molinia dominance and preventing tree growth in all but the wettest areas.

- Intact patches of riverine and bog woodland still survive within some of the later Inclosures. These woodlands were "captured" during the formation of the Inclosures and have survived because of protection from clearance under the 1877 New Forest Act.

Examples where fencing re-alignment has taken place include:

- Highland Water Inclosure
- Dames Slough & Burley New Inclosures
- Wootton Inclosure
- Vinney Ridge Inclosure
- Newlands Plantation

F) Road and track maintenance

In the New Forest wetland restoration work associated with the maintenance of roadside drains mainly applies where the watercourse cuts across or through/under a structure. Areas where works may need to be carried out include:

- Areas where tracks pond the through-flow of water
- Where water flows across a track and washes out gravels into the surrounding habitat
- Areas of wetland where a well designed crossing point is required to prevent the spread of erosion from riders/walkers accessing the area.

Design, construction and maintenance of road and bridges are the responsibility of the Forestry Commission Civil Engineering Division.

Good design principles for forestry roads and bridges taking account of the effects on the water environment are set out in Chapter 6 of the Forest and Water Guidelines.

Rakes Brakes Bottom Bridge Causeway

Ferny KnappCauseway

4.10 Issues & Actions

Table 4.13 summarises the key wetland restoration issues (identified in Chapter 3) together with potential actions for consideration when identifying future works and formulating work plans.

FURTHER READING

Sanderson N.A., Fencing Proposals Under Life 3 Ecological Report

Environment Agency (2004) Sustainable Wetland Restoration in the New Forest – River Restoration Proposals

Forestry Commission (1997) Review of Holly Cutting in the New Forest

Forestry Commission (2003) Forest & Water Guidelines, Fourth Edition

Mott N. (2005) Managing Woody Debris in Rivers and Streams, Staffordshire Wildlife Trust

Issue	Action	Priority	Responsibility
Climate			
Climate Change	Restoration of mire and other wetland habitats to provide better buffer for habitats to cope and adapt to climate change	Immediate and on-going through next 10 years and beyond	All Partners
Increased evaporation due to vegetation clearance and natural low summer flows	Consider effects of vegetation clearance as part of work plan and if necessary retain strategic areas of shade.	On-going	FC/EN/EA/NT
Geological, Geomorphology & Soils			
Susceptibility of the soil to damage	Consider location, soil sensitivity and appropriate timing of works particularly when using heavy machinery. Use surface protection (e.g. brush mats or geotextile mat where necessary) Negotiate budget contracts clauses to allow lee way to delay spending money during periods of extreme wet weather when environmental damage could out weigh benefits	On-going	FC/EA/NT
Hydrology & Drainage			
Historic modification of drains and watercourses	Drain infilling, bed level raising & river restoration	On-going from high to low priority depending upon location	FC/EA
Management of Debris Dams	Manage in accordance with debris dam policy	On-going	All
Trapped pre-Inclosure riverine & bog woodland Down stream flooding	Restoration of natural flood regime Continue work on data collection, existing modelling and monitoring Further data collection and modelling work may be required for new restoration works	High On-going	All EA/Southampton University
Natural Low Summer Flows	Mire restoration to retain more water in the system Stakeholder interest in New Forest CAMS process	High High	FC/EN All
Water quality & diffuse pollution	Identification of diffuse pollution sources Identify initiatives to encourage maintenance and replacement of old septic tanks Need appropriate budget allocation to FC Estates to allow replacement of old tanks	Medium Medium High	All All FC
Change in Forest Cover	Scope to support PhD studies	Medium	FC/EA/stakeholders

Issue	Action	Priority	Responsibility
Ecological & Nature Conservation Issues			
Condition status of habitats	Restoration of wetland habitats to achieve 95% SSSI favourable condition status by 2010	On-going/High	FC/EN/EA/NT
Drying of Mires	Mire Restoration	On-going /High	FC/EN
Drainage & Canalisation resulting in loss of flooding regime resulting in habitat degradation	Restoration of rivers and associated floodplain function	High –low depending upon habitat value & location	FC/EA/EN
Invasion of pest and exotic species	Removal of exotics and pest species Increase knowledge of distribution of pest species	High-medium	FC
Dead wood removal & Debris Dams	Remove cut timber & brash, especially conifer fellings from the floodplain	On-going	FC
Coppice of alder/sallow stands in riverine woodland	Undertake coppicing and pollarding work in selected locations	On-going	FC
Trapped pre-inclosure riverine & bog woodland	Restoration of natural flood regime, selective felling & scrub removal, reintroduction of grazing.	On-going	FC/NT
Effect of river restoration on fish species	Monitoring Planning timing of works to avoid migration and spawning periods Use of sediment mats in sensitive location to avoid smothering of downstream gravels	On-going High Medium	EA FC/EA/EN FC/EA
Effects of Debris dams on fish	Monitoring of debris dams to ensure that passage of migratory fish is unimpeded	High	FC/EA/EN
Effect of channelisation on macroinvertebrate communities	Restoration of hydraulic connectivity and channel variation Survey & Monitor existing & future works	High-medium On-going	FC/EA/EN EA
Decline in breeding wader populations	Implementation of initiatives from Progress Project On-going wetland habitat restoration Continued survey & monitoring	High	FC/Stakeholders All Partners FC/RSPB
Low flows placing stress on fish populations	Continue Mire restoration Support CAMS process Support/help with initiatives to improve water quality	On-going High Medium	FC/EN All/Stakeholders All/stakeholders

Issue	Action	Priority	Responsibility
Archaeological Issues			
Protection of Known Archaeological Sites	Continue to liaise with statutory and voluntary organisations to identify vulnerable sites	High/on-going	All
	Mark/temporarily fence sites for their protection during works	High/on-going	All
Archaeological Potential	Carry out more detailed archaeological field surveys where advised by statutory bodies	High	All
	Consider or support opportunities to carry out further archaeological investigations around the Forest	Medium	All/stakeholders
Landscape Issues			
Landscape change	Spread out work over time and location and where possible adhere to timing for Forest Working Blocks	On-going/medium	All
Landscape features and exotics	Retention of key stands of trees or isolation specimens certain locations	On-going	FC/EN
Forest Furniture	Appropriate selection & design of Forest furniture	On-going	FC
	Appropriate consultation with verderers	On-going	FC
Land Use			
Restricted access to timber harvesting sites during winter	Be aware of potential restrictions during planning of timber extraction programme.	Medium-Low	FC
	Include pollution control measures at ford crossings during timber harvesting.	High	FC
Location of works relative to recreational activities	Temporarily restrict access on safety grounds during construction phase	On-going	FC
	Re-route any footpath networks using existing net-work	Medium	FC
	Maintain/improve crossing points	On-going/High	FC/EA
Honey Pot effects along rivers and streams	Advance & careful planning associated with any future car park closures	High	FC/EN
Grazing Patterns	Continue opportunity to provide areas of new grazing as part of restoration works	Medium	FC/EN/Verderers

Issue	Action	Priority	Responsibility
Fencing & Drift Lines	Maintain appropriate drift lines Check Foot & Mouth Contingency Plan when planning any changes to Inclosure fencing	High High	FC/Verderers FC/Verderers
Creation of Increased Grazing	Continue opportunities to reinstate lost grazing through restoration work Monitor changes in bracken cover adjacent to restored watercourses	On-going/High Medium	FC/Verderers FC/EN/Verderers
Stock Watering	Improve availability of water to stock during dry summer months due to mire restoration & bed-level raising	Medium	FC/Verderers
Improved stock safety	Infilling of deep drainage ditches and bed level raising	Medium	FC/Verderers
Consultation & Consent	Continue to undertake consultation on proposed works and take views into consideration when formulating work plans.	On-going/High	All
Legislation, Plans & Policies	Legislation, Plans & Policies		
Compliance with existing legislation, Plans & Policies	Ensure that adequate consultation and liaison takes place between staff updating the Forest Design Plan and those taking forward the Implementation Plan to ensure that the Plans match up. Check that any works are compliant with legislation, key plans & policies and consult/negotiate where appropriate	High All
Stakeholder interest in other plans & Strategies	Ensure that adequate interest is taken in the consultation process for other strategies being prepared for the Forest that could be relevant to wetland restoration	Medium/High	All
Actions arising from other plans & strategies	Seek scope for mutual co-operation with organisations to address projects/strategies to forward wetland restoration	Medium	All

PART 5
CASE STUDIES

CASE STUDY 1: HOLLY HATCH BOTTOM MIRE RESTORATION

Background

Holly Hatch Bottom (S.U. 224 124) is located on the northern side of Ocknell Plain from where it conveys runoff into the Dockens Water. The valley supports a range of habitat types including seepage mires, soakway, vegetation, humid & wet heath, wet grassland, scrub and woodland.

Shallow drains have historically been dug at the lower end of the mire/soakway system. In addition peripheral drains dug around the adjacent Holly Hatch Inclosure had become blocked leading to water being re-routed into the mire drainage system resulting in increased run off leading to extensive gully and headward erosion.

The restoration proposals aimed to:

- Take away the excess runoff from the mire system by re-route the flow from the Inclosure boundary back into its the original drainage ditch adjacent to the Inclosure embankment.

- Restore the original bed levels in the stream draining the mire system and repair the headward erosion.

- Fell scattered Scots Pine encroaching on the mire system but retaining any landscape character trees

The Works

The works focused on 6 areas as shown on Figure A.

Area 1 – Site of the Inclosure boundary . Works comprised installation of a culvert beneath the access route into the Inclosure, raising of the upstream drain by 0.3m. On the down-stream side two beech stems obstructing the ditch were removed and general leaf litter and woody material dredged out.

Area 2 – Removal of incised ditch that was conveying water from the Inclosure boundary to the mire system. The ditch measured 15 m long by 1-1.3m deep and 1.25-1.5 m wide. This was achieved by infilling the ditch to bank height using staked heather bales and clay plugs. Remnant spoil was scattered over the surface of the bales to aid colonisation.

Area 3 – Upstream channel. At the most upstream nick point the channel was infilled for 3-4m down to a stock crossing point followed by infill of a 2mX2m plunge pool created by nick point erosion to within 0.15m of bank height. The downstream 10 m long channel which was suffering from subsidence and erosion creating a channel 2.5m wide x 1.2m deep was infilled to the same level as the plunge pool upstream gradually tapering to 0.3m below bank height downstream. This was achieved using staked heather bales and clay plugs.