Project 2: Greenlands Mire Restoration Plan

Background

The Dorset Peat Partnership has identified the catchment draining to Greenlands Farm as a potential site for further restoration of natural processes. It has been identified that the watercourse within the catchment area has, in places, been disconnected from the adjacent floodplain area through a combination of drainage management, incision and entrenchment. The dominance of a single channel flow has reduced floodplain connectivity and associated water table. An investigation has been undertaken by Peter Stone and the National Trust to identify if there is a potential mechanism to restore floodplain connectivity and is reported below. The investigation to identify potential restoration opportunities has:

- Undertaken desk-based site characterisation from mapping and interrogated the Environment Agency LiDAR (DTM) data for an understanding of localised topography;
- Completed site visits to develop site specific detail, identifying site-specific processes and defining floodplain environments and locations for connection;
- Developed a restoration approach and techniques for reconnection.

Potential Floodplain Connection Sites

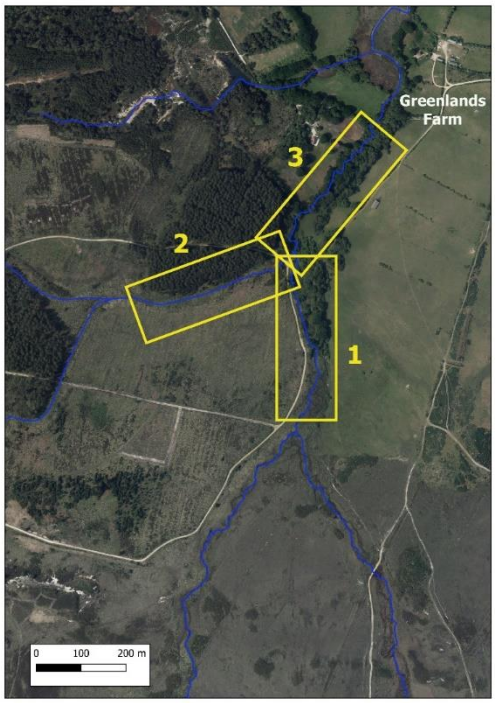
The tributary stream draining to Greenlands Farm was divided into three reaches for initial consideration of potential for floodplain reconnection. (See diagram below).

Reach 1 flows in a mix of mire habitat and woodland and was identified as having a channel that has been detached from its adjacent floodplain area through the woodland reach. It has been selected as a potential site for floodplain reconnection.

Reach 2 is a mire within an existing floodplain area. The channel has been somewhat influenced by grass tussocks but sits within the floodplain. Blocking of the channel with woody debris will help to retain water of the floodplain but no further connection was considered.

Reach 3 is separated from the upstream reaches by a farm access track/bridleway crossing the stream.

A need to maintain the crossing is a constraint to floodplain connection. The channel between the crossing and the farm also flows within a relatively narrow floodplain and was not considered suitable for further attempts at floodplain connection. **The focus of restoration was therefore on Reach 1.**

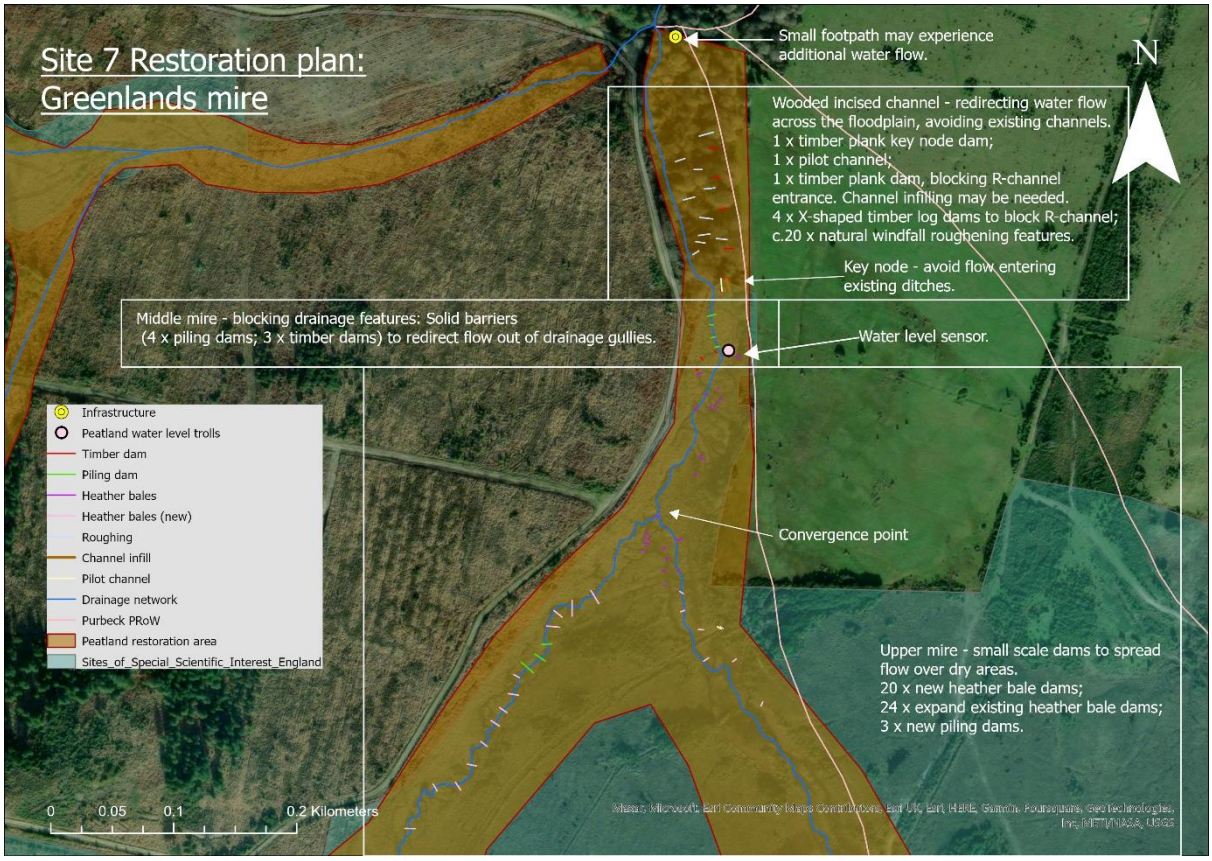


Approach to floodplain connection of Reach 1.

Reach 1 is characterised by two distinct environments; an upstream mire with multiple channels and a wooded reach largely drained by a single incised channel. The project has however, been divided into three areas based on the scale of intervention required:

(1) Upper mire – small scale interventions to retain and spread flow over drier areas.
(2) Middle mire – blocking drainage features with solid barriers to redirect flow from existing drainage gullies, retaining water for longer on the mire.
(3) Wooded incised channel – redirecting water across the floodplain, avoiding deeply incised existing channels to create wet woodland habitat.

The Greenlands Mire plan has been summarised with the restoration plan map below.



Details for the restoration of each project area follow.

1. Upper mire

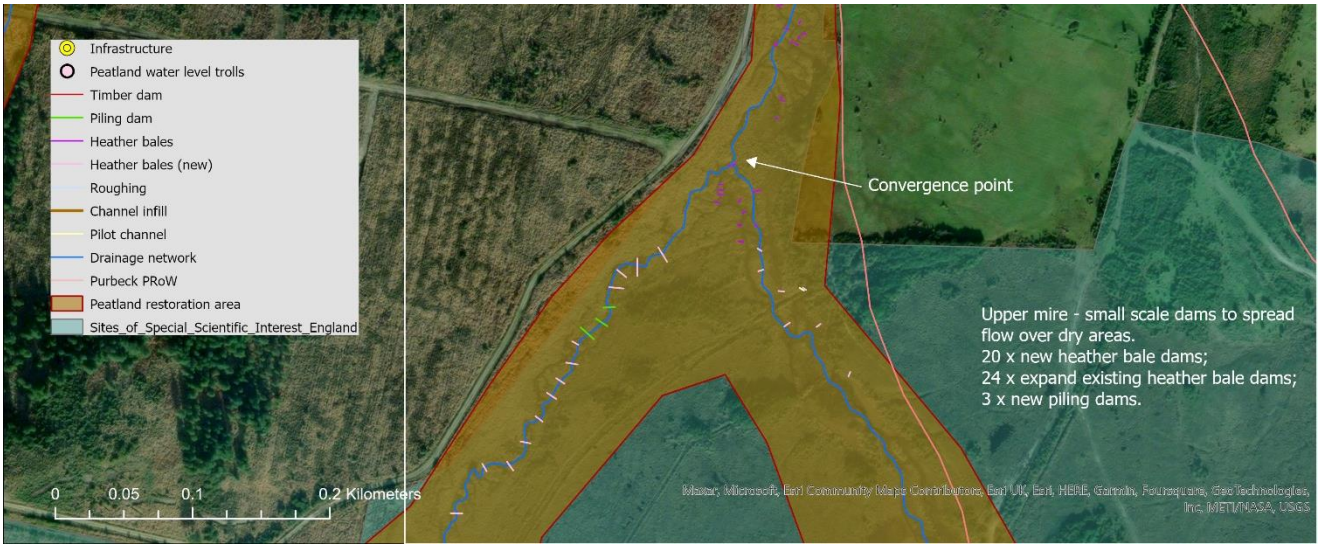
The mire environment contains multiple channels within the width of the floodplain. In the upper reaches of the mire, the habitat is in better condition, however within the project area, more incised channels have disconnected the flow from the surface vegetation, creating deepened channels with drier raised vegetation cut off from the flow of water.

Some measures (organic leaky dams) have already been installed into the channels to retain water within the floodplain, successfully causing water to back up and distribute flow amongst the channel network. At the outset of this project, the multiple channel flow was retaining water across the site, with some seepage occurring in dry areas following the interventions.

Additional leaky dams are required to continue to further spread the flow of water into additional routes, with the aim of rewetting as much of the mire as possible. Water should be retained, raising the water level to that of the vegetation, rather than forming obvious incised and disconnected channels through the mire.

In this section, the following tasks are required:

a) Maintain existing dams (24) – raising the height and expanding the width where required.
b) Install new heather bale dams (20) - in the locations mapped, as needed to redirect and retain flow.
c) Install piling dams in a short, deeply disconnected stretch of channel.



a) Maintain existing dams (24) – raising the height and expanding the width where required. Existing dams (built to date by volunteers) have been reviewed for extensions/maintenance. 24 dams have been constructed and require around 90 bales and 50 chestnut stakes to sufficiently expand them. Locations of these dams have been mapped for reference. The heather bales will be sourced and provided to the contractor. The contractor will provide the chestnut stakes.

b) Install new heather bale dams (20) - in the locations mapped, as needed to redirect and retain flow. The heather bales will be sourced and provided to the contractor. The contractor will provide the chestnut stakes.

New dam locations further up in the two arms of the mire have been mapped to the extent of the disconnected habitat. On average each new dam should be allocated 8 bales and 4 stakes, with some flexibility depending on the width of the channel. Bales = 160; Stakes = 80.

This brings the total materials to:
Heather bales: 250 (the NT will provide these at the end of the November).

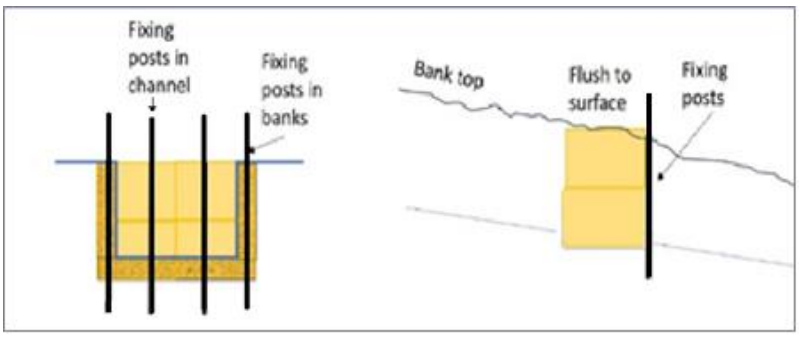
Approximately L750mm X W500mm X H400mm

Chestnut stakes: 130 (the contractor will provide these).
5'6" Chestnut (1/2 & 1/4 split) stakes

The heather bales will be installed manually, and any fixings will be manually installed. The approach to installation will be:

- The blockage should be to full channel height, in line with the height of the land either side of the channel , to retain as much water as possible and encourage any overflow onto the land either side.
- Heather bales should be keyed into the bank to prevent side-cutting

- Where possible the heather stalks will lie parallel to the gully and the baling twine lies across the gully. It is important that the bale abuts tightly to the surrounding peat in order to prevent scouring around the sides of the dam;
- Additional heather, tufts of grasses or cotton grass can also be used to seal the joints between bales; and
- Stakes securing the bales should be on the downstream side, angled so the top of the stake is pointing upstream. The stakes should be left high and not cut flush so that additional bales can be added to in the future.



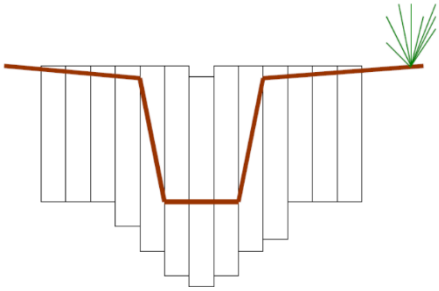
The intention of the blocks is to cause backing up of flow which then spills outside of the channel onto the adjacent valley floor, creating shallow flow over the surface.

In addition to spilling flow, the bales prevent a downstream transport of sediment and leading to a natural infill of the channel to raise bed levels. The blockage will be within the channel and the crest should be flush with the adjacent bank height to allow water to spill onto the adjacent valley floor.

c) Install piling dams in a short, deeply disconnected stretch of channel.

One short stretch of channel in the Western mire arm has been identified as being more disconnected and incised. This is most likely due to the geology underneath the mire but has caused a sharp change in bed levels for a limited distance. In order to return this water flow to the surface, piling dams are recommended, to retain and spread the water, allowing it to spill onto the surrounding valley floor.

Three plastic piling dams are to be installed by slotting sections into the sides of the channel, and inserting it into the ground, so that the top is level with the surrounding valley.
The channel is very narrow in this location, so c.1m in width should be sufficient. Depth here is estimated at 2m.



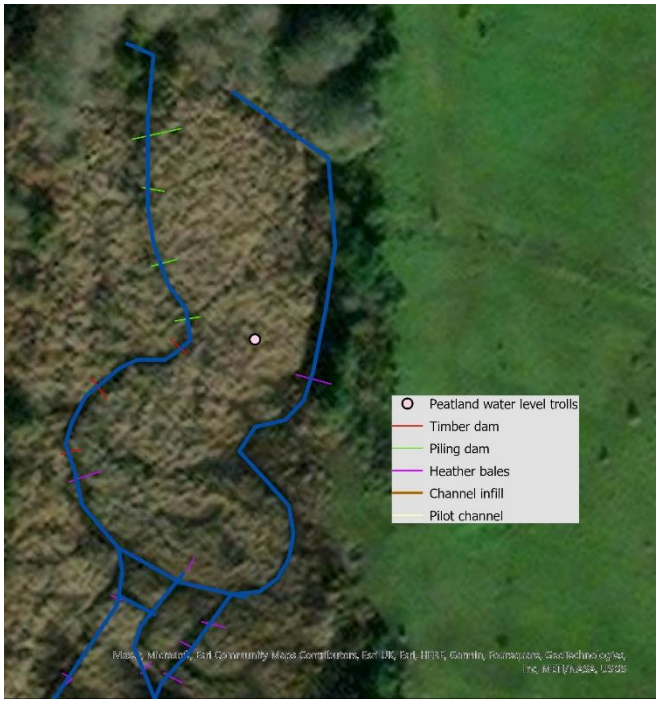
Piling dams installed as follows:

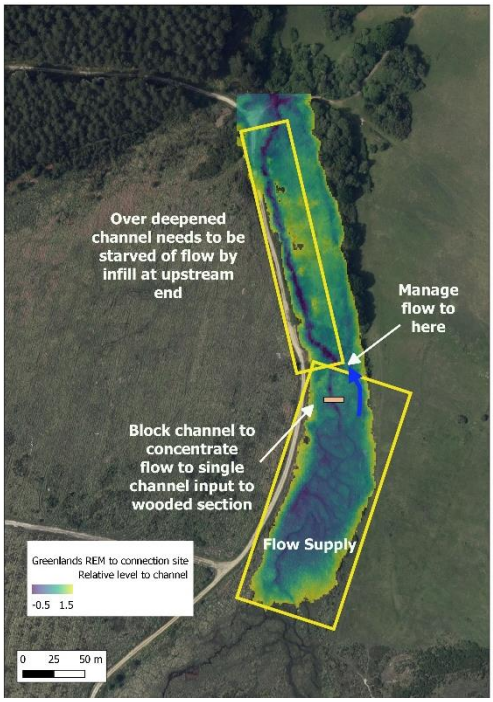
- Hammer piles in starting from the centre of the ditch. Position the longest pile in the deepest part of the drain. Use a sharp spade to pre-cut the outline of each pile in the surface vegetation. Push the pile into the peat using your own weight.
- Ensure that the piles remain vertical as it will become increasingly difficult to insert piles if they lean in any direction. Using a maul, drive further and when firm guide adjacent piles into their cams, repeating the process. Continue until all piles are firm in the peat.
- Piling will only create a good seal if driven into at least 75cm of solid peat, usually found below the 50 cm of soft peat in the base of the ditch.
- The top edge of the pile may require shielding from the metal of the maul. Several methods are used but the most effective is a timber batten resting on the pile.
- Shape the dam to form a gently curving upstream ‘C’ shape at the ends. This shape assists dam strength and increases the amount of water retained. The dam must extend well into the banks of the ditch. A rule of thumb is the extensions into the bank on each side, equal the width of the ditch. On slopes, the wings of the dam can be angled down the slope to re-distribute water over the site and reduce pressure behind the dam.

2. Middle mire

At the transition between the mire section and the wooded section there is a key middle area where water becomes largely concentrated into incised, over deepened channels and consequently becomes disconnected from the natural floodplain. Maintaining the upstream water level at the transition point is key to restoring floodplain connection.

There are 2 main channels flowing through this section as we transition out of heather bale territory towards the woodland. One which starts at the left side of the mire, flows around a tight corner towards a very deeply incised and disconnected channel in the centre; and one which flows down the right-hand side of the mire.





The central channel is deeply incised and significantly removed from the floodplain. A plausible explanation for this is that the steep drop in levels at the waterfall (key node) just downstream (see wooded incised section), is having a knock-on erosion effect, dragging the base level down towards the level of the deeply incised ditch below.

Because the central channel is so incised, and because it flows most easily towards incised ditches downstream, the plan is to get as much water into the right-hand channel as possible, using heather bale dams in line with and upstream of the last existing dams, as described in the Upper Mire section of this report. This is the priority, prior to working on the key node in section 3, starving the central channel of water and reducing pressure on the key node dam downstream.

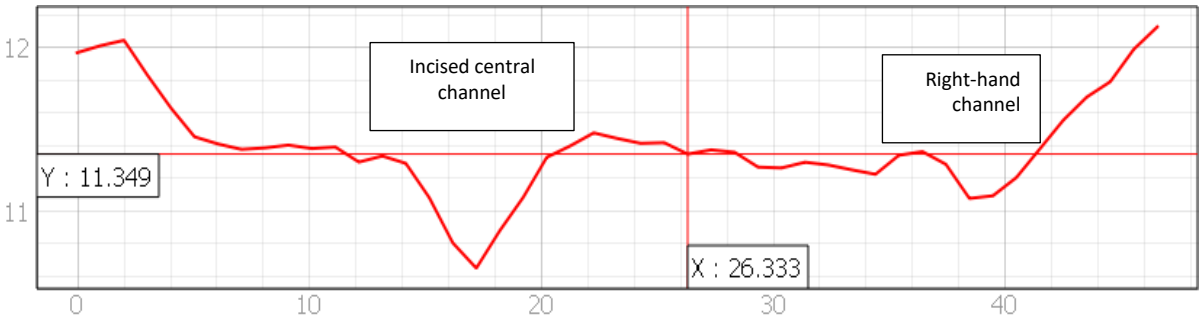
An assessment will be made on whether further interventions are necessary. If so the following options are available and discussed below:

a) Pilot channels – less likely to be beneficial
b) Piling dams – expected
c) Timber log dams - expected

a) As far as the topography allows, add pilot channels to the left of the right-hand channel, to encourage some water across the dry and high area. Additional heather dams in this channel could further encourage this direction of flow, but it is more beneficial for the woodland section below to retain the water in this side channel, whilst the central channel recovers.

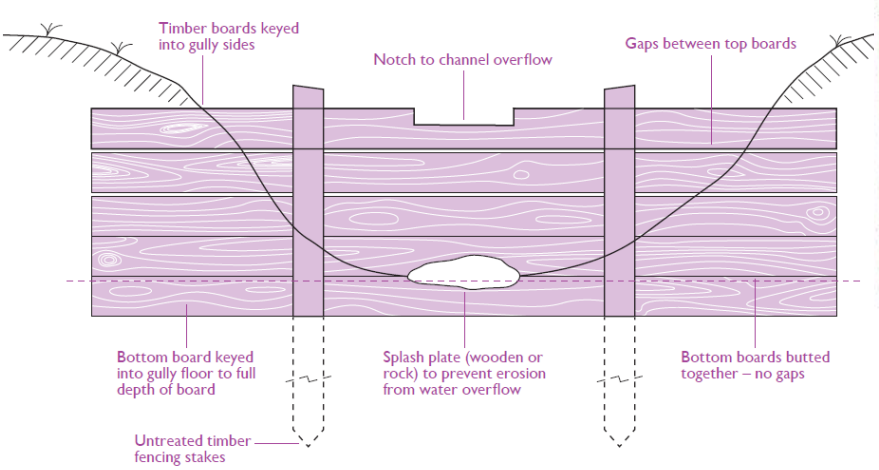
b) Further block up the central, incised channel with metal piling dams. This will allow the water remaining in the middle channel to pool up, and will gradually allow sediment to accumulate, reducing the incision of the channel over time. Four metal piling dams will be sufficient, as mapped. The method for installation is as described in the upper mire chapter of this report.

A cross-section of the topography in this part of the floodplain, provided by Peter Stone, suggests that the metal piling dams in this ravine should be at least 6m wide x 2m (1m above surface + up to 1m below surface) in dimension. The piling should be driven down into the surrounding peat, so that the top is flush with the surrounding floodplain (pictured above).



c) Three timber log dams could also be beneficial in the corner section (pictured below) to further slow and limit the flow entering the central channel. Timber log dams have been chosen for this task as they will be less leaky than the organic heather bale dams and will further reduce the magnitude of flow heading towards the piling dams, retaining water on the mire and stopping it from flowing into the key node below.

Timber log dams refer to a design described in the below image, using logs or gate posts rather than boards. The objective is that they should leak:



The timber log dams will be fixed in place by digging logs into the banks of the channel and using fence posts on the downstream side, in the banks and within the channel to secure the wood. Flow will overtop the structure when the stream is fully swollen and but will hold back an element of the mid-range flows that pass through the channel. The intention is to create storage of water within the channel by backing up, along with slowing the delivery of downstream flow. The dam will be within the channel and their crest not exceed the full bank height.

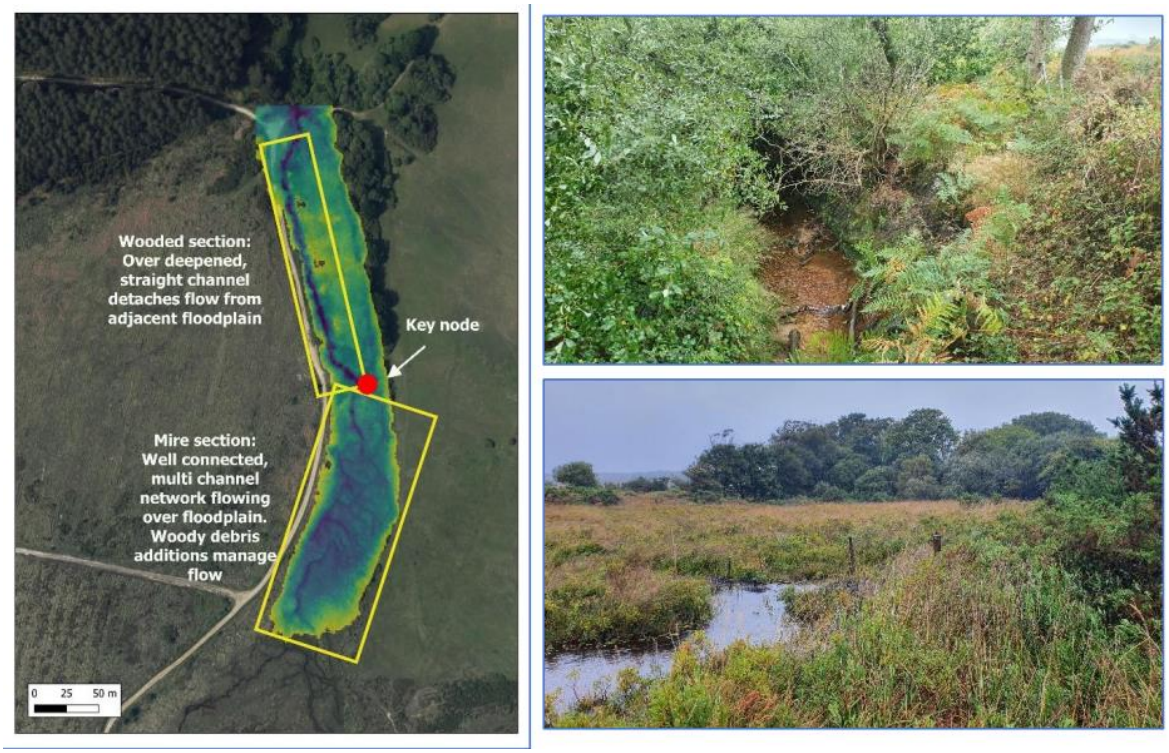
The timber log dams will be installed manually. Works will be undertaken using a chainsaw and the logs manually manoeuvred into place. Any fixings will be manually installed. The approach to installation will be:

- Lever the pre-cut logs into the watercourse from the edge of the channel;
- Secure the head of the trunk within the bank by digging in and fixing with stakes made from Chestnut;
- Stakes securing the trunk should be on the downstream side, angled so the top of the stake is pointing upstream;
- Where stakes are used to secure the logs to the sides of the channel, wire and staples will be used to attach the log to the stake to minimise the risk that the logs float away.

Following installation, an inspection will be required following the first spate event to review how the leaky structure has established. The first inspection will be carried out by DPP. Following initial establishment, annual inspections will be required of the fixing to banks and retaining post in-channel by DPP to ensure the structure is secured from removal downstream.

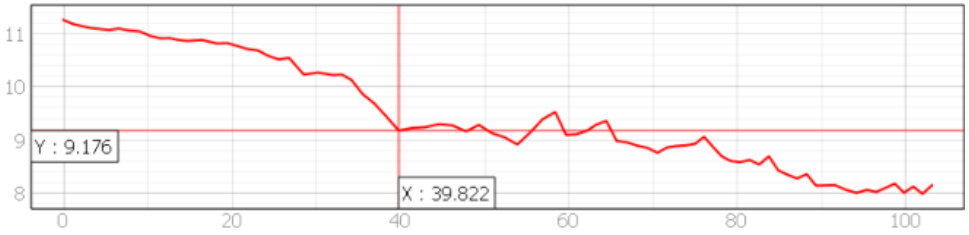
3. Lower wooded section

The downstream wooded section of the Greenlands mire system is currently largely drained by a straightened single channel, over deepened and orientated to the western margin of the floodplain area. The channel provides efficient drainage of the reach, retaining most of the water flow within the channel and not connecting to the adjacent floodplain. Some water does accumulate on the floodplain area of the woodland but is likely to be locally sourced or only connected during spate events of high flows.

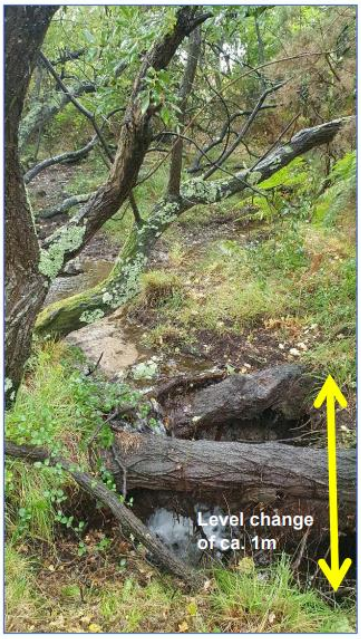


At the transition between the mire section and the wooded section there is a key point where water becomes concentrated into the incised, over deepened channel and consequently becomes disconnected from the natural floodplain. Water level changes at the transition point and falls by in the order of 1m as a cascade which coincides with tree roots/wood in the channel.

The proposed approach to restoration here needs to take advantage of the mire area being a “header tank” to control and supply water to the floodplain reconnection. The current bed/water levels in the multi-channel flow on the mire are in connection with the level of the floodplain in the downstream wooded area. The channel bed levels change at a key node where the channel subsequently becomes incised and straightened through the wooded area. A long profile through the bed of streams in the mire area downstream to the incised channel in the wooded area shows that channel bed level falls by in the order of 1m at the key node.



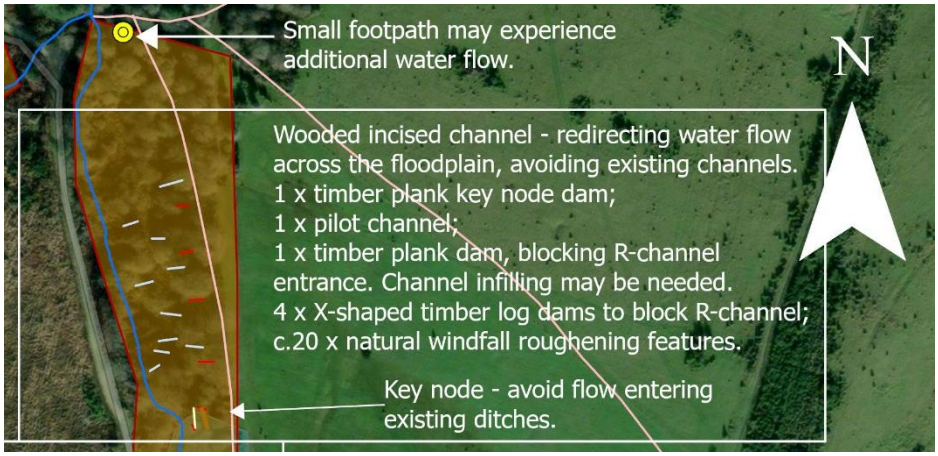
To restore flow on to the wooded area floodplain, flow will need to be disconnected from joining the incised channel. A combination of approaches is proposed to restore flow on to the natural floodplain in the wooded reach.



Firstly, flow will need to be concentrated from the multi-thread channels on the mire into the eastern channel (see middle mire interventions) and away from the disconnected central channel. Clearly there will be seepage through woody structures and the mire itself, but the aim will be to redirect the water away from its existing path.

At the key node, a preferential flow onto the floodplain area of the wooded area will need to be managed through a combination of interventions:

- Key node dams
- Key node pilot channel
- Lower woodland floodplain roughening
- Reconnecting to existing drainage pathways at the base of the restoration site



a) Key node dams:
2x sturdy timber board dam structures will be required at this key node point.

(i) 1x dam (c.3m x c.1.5m) is required to block off the channel leading to the “key node waterfall”. This should cross the channel and allow for extra width to be securely dug into the banks (c.3m wide).

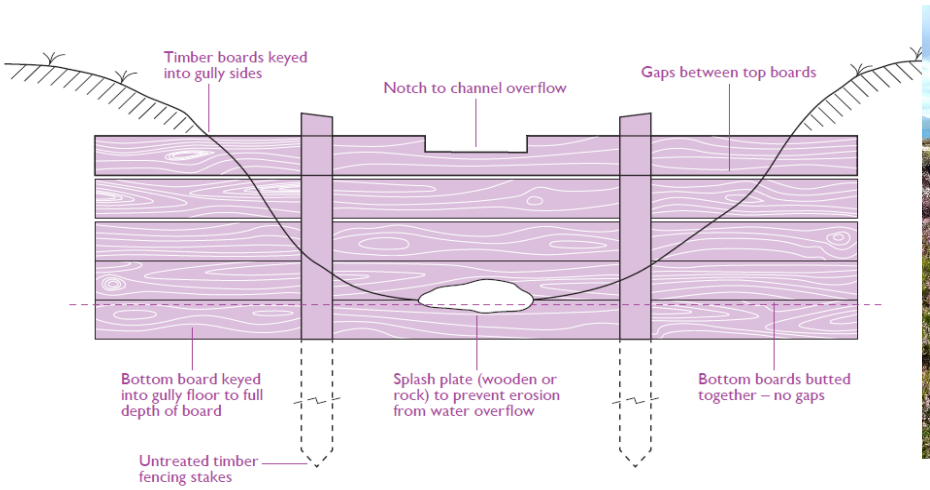
The dam does not need to be very tall (c.1m above ground) but should allow enough height to be dug into the channel at the bottom, and for the top to be equal or higher than the surrounding land. It is estimated that 1.5m height will suffice.

The deeply incised channel downstream should be cut off completely by this intervention and allowed to dry out. Damming of the major incised channel below will not be beneficial or feasible, as it is so deep and disconnected. The trick will be to avoid water getting into that channel in the first place.

(ii) Another similar dam (c.3m x c.2m) will be required to block the right-hand channel, preventing the water flow from entering this channel at this point. This dam should also be c.3m wide. It will also need to be dug into the bottom of the channel but the water is much deeper here, so it will need to be taller than the other key node dam (c.2m).

A degree of channel infilling should be completed at the initial entry to this channel, to prevent water finding and prioritising this route. Although to a lesser extent than the major left channel, water flowing into the right channel would also remove the flow from the floodplain and prevent restoration of the wet woodland habitat. As such, it is crucial that this is avoided.

Timber board dams refer to a design described in the below image, this time using boards rather than logs in order to effectively hold back as much water as possible:



The timber board dams will be fixed in place by digging boards into the banks of the channel and using fence posts on the downstream side, in the banks and within the channel to secure them. These are not dams that we want water to flow over or around, but should act as blockades, which funnels the water past the existing routes on its way to the natural floodplain.

The timber board dams will be installed manually. Works will be undertaken using a chainsaw and the boards manually manoeuvred into place. Any fixings will be manually installed. The approach to installation will be:

- Lever the pre-cut boards into the watercourse from the edge of the channel, taking care to avoid tree root obstructions.
- Secure the boards within the bank by digging in and fixing with chestnut stakes;
- Stakes securing the tree should be on the downstream side, angled so the top of the stake is pointing upstream;
- Where stakes are used to secure the logs to the sides of the channel, hemp rope and staples will be used to attach the log to the stake to minimise the risk that the logs float away.

Securing the logs in-channel will require the installer to enter the channel to secure the leaky dam. The associated disturbance of sediment on the bed will be minimal and any disturbed material will be transported in suspension with a minimal local impact.

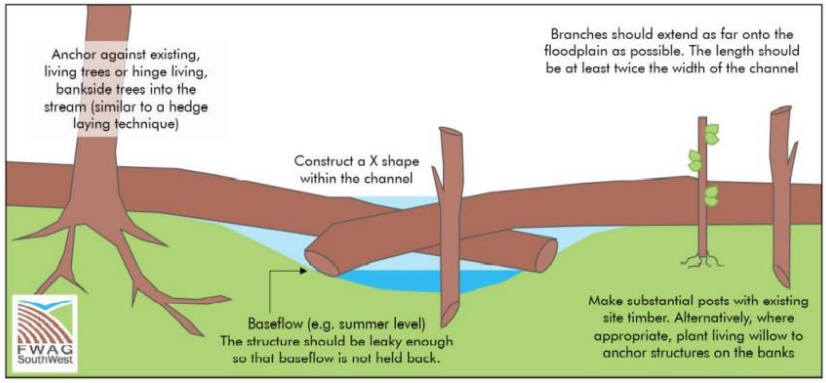
b) Key node pilot channel:
A pilot channel should be created at the key node, that allows the water to flow straight downstream onto the floodplain. This will reduce pressure on the key node dam structure. This must be in the centre of the floodplain, away from the existing channels on either side. Considering the natural topography, this is where the water should "want" to go, and so once pointed in the right direction, it should not easily find its way back to the disconnected drainage ditch.

c) Lower woodland floodplain:
The aim for the wooded area below the key node is to better retain water and for the water to spread across the floodplain. If the key node works are effective, water should flow onto the centre of the natural floodplain and not try to return to the channels either side.

(i) As an additional measure, and due to the fact that the right-hand channel is more achievably blocked, 4 timber dams have been proposed at regular intervals, in case water is still finding its way into the smaller right-hand channel further down.

X-shaped timber log dams are an appropriate design in this location, with small pilot channels heading to the left in front of each one, to bring the water back onto the floodplain again. Additional stakes (c.12-15) should be allocated for this but fallen timber should be sufficient for leaky dam construction, built manually using a chain saw / hand tools. Estimated 4 x (3m x 1m) in dimensions.

A basic design of woody debris in the channel is shown below, along with an example. Given the incised nature of the channel the structure will be secured into the banks of the channel rather than sitting on top.



The leaky woody debris dams will be installed manually. Works will be undertaken using a chainsaw and debris manually manoeuvred into place. Any fixings will be manually installed. The approach to installation will be:

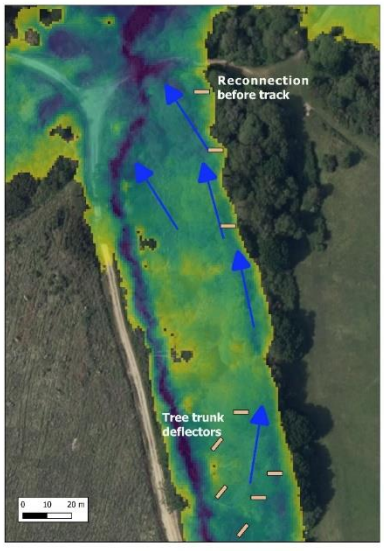
- Fell and lever the entire tree partially or entirely into the channel from the bank, with the branches facing either upstream or downstream;
- Fell with one of the following techniques:
  - where possible leave a hinge to enable the tree to carry on living, and to naturally secure it to the bank;
  - If no hinge can be left and the tree is detached from the stump, the felled timber should be staked to the bank or secured to other trees
- Secure the head of the tree (main branches) and the trunk, with stakes made from local durable wood;
- Stakes securing the tree should be on the downstream side, angled so the top of the stake is pointing upstream and >0.1m above the top of the felled tree/log;
- Where stakes are used to secure the tree/log to the bank and retain in-channel, the wood will be attached to the stake to minimise the risk that the tree floats away.

(ii) Once connected, flow should be allowed to occupy the floodplain in an unconstrained way. Some manipulation may be required to increase the “roughness” on the floodplain area by the addition of tree trunks into key potential pathways. The intention of the introduction of logs will be to create localised storage on the floodplain and encourage multi-thread flow paths to develop.

One location is also noted along the floodplain area where the topography may divert some flow towards the incised channel and judgement will be required during the restoration process when locating tree trunks to manage flow away from any potential micro-topographical links that could send flow towards the left side of the floodplain. Use of a laser level during installation is recommended.

Flow along the floodplain area is likely to naturally focus to the right (looking downstream) of the floodplain. The existing topography and shallow channel pattern on the floodplain will help concentrate flow back into a single channel before passing downstream through the ford at the forest track and bridleway. Some addition of fallen trees or tree trunks can be used to encourage the flow to be concentrated back to a single thread channel.

There are lots of fallen trees already in this area, providing plenty of material for this roughening, which can be cut with a chainsaw and winched into position as required. No felling licences have been sought or should be required for this area, although rewetting the area may eventually cause some of the trees to die off naturally.



d) Reconnecting to the ford:
The intention is to rejoin the flow of water to its current path at the downstream end of the restoration area, reconnecting flows at SZ 01522 84191, at the point where the ford crossing allows for public access to the Rempstone Estate.

Despite being very dry and disconnected, there are plenty of existing flow pathways across the wooded floodplain, which suggests that in periods of high flow, water is finding it's way into these shallow channels already. As a result, these naturally flow back into the managed stream at the base of the woodland and there is no intervention required here to bring the water back into control at the bottom of the site.

However, if the majority of the flow was to follow this new route, the current informal "mini footbridge" created from sleepers, which has been constructed to allow for access across a muddy section, prior to the proper footbridge, is likely to be insufficient to cross the magnitude of water which will be coming from this angle. An upgrade in this infrastructure is likely to be necessary, to a similar spec as the existing footbridge. Requirements for this will be dependent on the magnitude of flow following restoration works and may be a bolt on request subject to budget availability.