

# Best practice in raised bog restoration in Ireland



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Cultúir, Oidhreacht agus Gaeltachta  
Department of  
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## Best practice in raised bog restoration in Ireland

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# Raised Bog Restoration Guidance Note

<b>Measure:</b>	Peat dams on high bog and cutover
<b>Description:</b>	
Peat dams are typically installed on high bog using a tracked machine. They aim to bring the water table up to the bog surface and to maintain it within 10cm of the ground surface for most of the year. This is to restore suitable hydrological conditions to allow active raised bog (ARB) to develop on high bog. On cutover bog these dams aim to reduce vertical loss of water from the high bog and provide suitable hydrological conditions for peat-forming vegetation to develop. Even in areas where ARB cannot be restored, drains should be blocked as this can help to reduce the rate of flow off the bog.	
<b>Examples of where this has been used:</b>	
<ul style="list-style-type: none"><li>• Lisnageeragh Bog and Ballinastack Turlough SAC</li><li>• Carrownagappul Bog SAC</li><li>• Clara Bog SAC</li><li>• Ballydangan Bog (Bord na Móna bog)</li><li>• Cuckoo Hill Bog (Bord na Móna bog)</li><li>• Girley Bog NHA (Coillte LIFE site)</li></ul>	
<b>Installation method:</b>	
Peat dams are installed using a specially adapted tracked machine (bearing pressure no more than 1.6 lb/inch <sup>2</sup> ) following the approach outlined by McDonagh (1996): <ul style="list-style-type: none"><li>• Place a dam every 10cm fall in elevation with a minimum of three and maximum of ten dams per 100m (topographic survey carried out in advance of drain blocking to identify and mark locations for dams).</li><li>• Determine appropriate machine tracking routes and plan drain blocking to minimise number of machine passes.</li><li>• Identify suitable location for machine checks, refuelling, and storage in advance of undertaking works.</li><li>• Remove scraw (place close-by for replacement later) and clear peat from both sides of the drain.</li><li>• Cut a key in the drain, ensuring that this is wider than the actual drain (c. 50cm either side).</li><li>• Remove scraw from area behind machine to be used as a borrow pit.</li><li>• Dig out peat from the borrow pit and place into the drain compacting as additional layers are added. Only use the deeper, more compacted peat to build the dam.</li><li>• Build the dam at least 30-50cm above the surface of the bog to allow for subsequent shrinkage of the peat as it dries and extend the sides at least 50cm into the bog.</li><li>• Place and compact scraw on top and sides of the dam to stabilise the dam and prevent erosion.</li><li>• Re-profile and backfill borrow pit with the peat removed from sides of drain to form the key and any peat from the borrow pit.</li><li>• Replace and compact any remaining scraw into the borrow pit.</li></ul>	



<b>Effectiveness:</b>
Has been proven very effective at many bogs. Success in restoring ARB will depend on surface slope, flow patterns and extent of vertical losses of water through the peat to depth. The build quality of the dam will also have a significant influence on the success in restoring ARB. Poorly constructed dams may fail completely or fail to maintain a high water level. If there is significant water flows in the drain this can cause erosion of the dams. In cases such of this consideration should be given to using plastic pile to reinforce and protect the peat dams.
<b>Maintenance:</b>
Maintenance requirements are low providing dams are installed correctly. Most damage will typically occur within the first year of installation during times of high flow. This may require a survey to check dam integrity and identify locations where dams require replacement or where reinforcement is required.
<b>Lessons learned:</b>
<ul style="list-style-type: none"><li>• Machine blocking is usually more effective, faster and cheaper than hand-blocking.</li><li>• Machine must be adapted to work on the high bog e.g. longer and wider tracks to reduce bearing pressure.</li><li>• Highly skilled driver required.</li><li>• Requires checks during the first winter to ensure integrity of dam is maintained and the first summer to ensure that they are fully water tight.</li><li>• Some peat dams can require plastic reinforcement if there is a risk of erosion.</li><li>• May not be suitable for very wide and deep drains where a bespoke solution is needed.</li></ul>



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## Costs:

Varies with drain dimensions – typical high bog drain c. 1m deep estimated to cost c. €30 per dam, including lifetime cost of specially adapted machine, labour and fuel. When undertaken by machine this is the cheapest drain blocking method.

## Risks/optimum time of year for operations:

Potential impacts on water table in surrounding areas must be assessed, particularly for drain blocking on cutover areas. Optimum time of year for operations is summer months when water levels are lowest making working conditions more favourable. However, work can be carried out throughout the year provided conditions are suitable.

## Installation schematic:

### 1. Remove scraw



### 2. Cut key in drain and remove loose peat



### 3. Dig peat from borrow pit



### 4. Place peat into drain and compact



### 5. Build up dam and place scraw on top of dam



### 6. Re-profile and backfill borrow pit, replacing any scraw

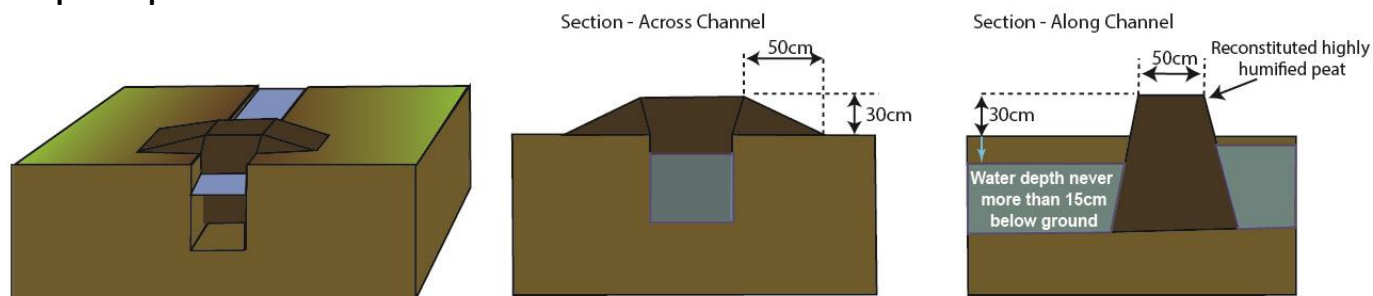


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## Completed peat dam:



## Reference:

McDonagh, E. (1996). *Drain Blocking by machine on Raised Bogs*. National Parks and Wildlife Service, Dublin.



# Raised Bog Restoration Guidance Note

<b>Measure:</b>	Complete infilling of drains
<b>Description:</b>	
Infilling drains on the cutover is a measure that is only carried out in a limited number of circumstances where it is essential to attempt to limit or reduce the extent of subsidence occurring on the high bog caused by drainage in the margins. Infilling drains aims to reduce the upwelling of regional groundwater in the drain and thereby to increase the head in the aquifer underlying the bog.	
<b>Examples of where this has been used:</b>	
<ul style="list-style-type: none"><li>No known examples of infilled drains</li></ul>	
<b>Installation method:</b>	
Infilling of drains requires considerable site-specific design to ensure that an appropriate approach is used. As there are no known applications of this measure, use should be limited to exceptional circumstances and site-specific design should be undertaken. The following outlines the general approach to infilling of drains:	
<ul style="list-style-type: none"><li>A hydrological survey should be carried out to determine the impact the drain is having on raised bog habitats and on other habitats already present in the cutover areas (e.g. fen). This should aim to characterise the problem and assess whether infilling is likely to improve hydrological conditions on the high bog.</li><li>If the hydrological survey determines that infilling is likely to improve hydrological conditions then a suitable infill material should be identified. In some cases use of other materials (e.g. bentonite) may be necessary if highly humified peat or clay is not available or if these materials are unlikely to be effective in reducing the rate of upwelling. In determining the most appropriate material the hydraulic gradient between the water table in the peat and underlying substrate should be assessed as well as the hydraulic conductivity of the infill material.</li><li>Infilling should be carried out at a time of low flow to be most effective; this may require upstream drains to be blocked in advance.</li><li>Prior to infilling any loose or very dried out peat in the base or sides of the drain should be removed.</li><li>The infill material should then be placed into the drain, using appropriate machine depending on working conditions (e.g. a specially adapted tracked machine with a low bearing pressure may be required if ground conditions are very soft). The material should be compacted to ensure it forms a tight seal in the drain.</li><li>If the drain occurs in cutover bog the top layers of the drain should be infilled with peat and vegetation placed on top of the bare peat to reduce risk of erosion.</li></ul>	

<b>Effectiveness:</b>
Success of infilling of drains is likely to vary significantly depending on site-specific conditions. In most cases infilling is unlikely to result in observable impacts, as it is typically undertaken to prevent further damage. However, when applied in suitable situations it is likely to significantly reduce future impacts of drainage on active raised bog habitat.
<b>Maintenance:</b>
Complete infilling of drains requires no ongoing maintenance if carried out to a high standard. Infilled drains should be inspected for groundwater seepage to ensure that it is working effectively. This may require installation of piezometers to monitor groundwater head.
<b>Lessons learned:</b>
<ul style="list-style-type: none"><li>Relatively new measure that has not been applied widely to date in Ireland. Further lessons will need to be learned following application of this measure at specific locations.</li><li>Requires very careful consideration to ensure that the measure is only applied in exceptional circumstances where a specific problem has been identified.</li><li>It is important to ensure that wherever infill material is to be extracted from that this will not result in adverse impacts on raised bog habitats or other qualifying interests.</li></ul>
<b>Costs:</b>
Highly varied – depends on drain dimensions, source and availability of suitable infill material from nearby and the specific material available.
<b>Risks/optimum time of year for operations:</b>
Potential impacts on water table in surrounding areas must be assessed. Optimum time of year for operations is summer months when water levels are lowest.



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## Installation schematic:

### 1. Block upstream drains (if required)



### 2. Remove loose or very dried peat from base/sides of drain



### 3. Place infill material into drain



### 4. Continue to place material in drain and compact



### 5. Place vegetation on top of infill material to reduce erosion



## References:

Schouten, M., Streefkerk, J. & Zandstra, R. (1994). *General Proposals for Technical Measures for the Conservation and Restoration of the Raised Bogs Clara and Raheenmore*, National Parks & Wildlife Service - Dublin, Geological Survey of Ireland - Dublin, Department of Nature Conservation, Environmental Protection and Wildlife Management - The Hague, National Forestry Service of the Netherlands - Driebergen



<b>Measure:</b>	Marginal bunds
<b>Description:</b>	
<p>Marginal bunds are constructed on the cutover area surrounding high bog. The aim of these bunds is to retain a shallow area of water (typically 0-20cm) behind the bund to promote establishment of peat-forming habitats on cutover areas, typically <i>Sphagnum</i> regeneration. They are most suited to locations where the cutover is extremely flat, there is contributing flow from nearby high bog, peat conditions are suitable to prevent significant infiltration and there is an adequate marginal drain in place behind the proposed dam location. Water depth behind a marginal bund should not exceed 50cm as above this depth <i>Sphagnum</i> growth is inhibited. Due to uneven topography behind the dam this technique typically leads to a range of wet areas within depressions and close to the dam, as well as some drier areas on areas of higher ground. Weirs/outlets must be included to enable water from the cutover to discharge into adjacent marginal drains when water levels rise. This measure may also be useful in reducing subsidence on the high bog by reducing losses of water to depth.</p>	
<b>Examples of where this has been used:</b>	
<ul style="list-style-type: none"> <li>Killyconny (Cloghbally) Bog SAC</li> </ul>	
<b>Installation method:</b>	
<p>Marginal bunds are typically constructed from highly humified peat and include a low permeability core/liner to limit water flowing through the dam.</p> <ul style="list-style-type: none"> <li>Peat should (ideally) be excavated from a suitable area within the site or this is not possible, imported from another bog and left to drain in a suitable dry location on-site.</li> <li>A 1.5m deep x 0.5m wide trench should be excavated along the proposed location of the embankment (using suitably adapted tracked machine). (Note: it is essential that prior to excavation of peat or a trench an assessment is carried out to ensure that removal of peat or digging into mineral soils will not have adverse hydrological impacts on peatland habitats or any other qualifying interests of the site.)</li> <li>A low permeability liner (e.g. HDPE) should then be placed along the base, extending up the side of the trench and at least 50cm of the liner extending above the surface of the trench.</li> <li>The trench should then be infilled with highly humified peat and compacted in layers until the fully infilled.</li> <li>Locations of overflow weirs should be identified and pre-fabricated weirs put into place.</li> <li>Compacted peat should continue to be placed, either side of the liner until it is fully covered. The embankment should be approximately 1.5m wide.</li> <li>Further layers of compacted peat should be placed on top until it is a minimum of 1.0m above the ground surface.</li> <li>A layer of scraw should be placed on the top and sides of the embankment to prevent erosion.</li> </ul>	



## Effectiveness:

Has been proven as very effective at Killyconny Bog (Cloghbally) SAC where it was trialled in 2008. Construction of a marginal bund has resulted in significant development of peat-forming habitats on cutover areas. This measure is ineffective in areas where there is significant infiltration through the peat as water cannot be retained. Weirs are required to ensure appropriate water levels are maintained levels (<50cm).

## Maintenance:

Marginal bunds require ongoing maintenance to ensure that weirs are operating correctly and that the structural integrity of the dam has not been compromised. Costs may be high initially but reduce significantly over time. Typically a survey is required during and following heavy rainfall events following installation to identify locations where weirs are operating ineffectively. These surveys should be carried out regularly immediately after construction but can be reduced to an annual survey if no issues are identified following significant rainfall events.

## Lessons learned:

- Adequate outlet weirs, (preferably pre-fabricated), are required to ensure water levels do not rise too high. These should ensure that when water levels reach a maximum of 0.5m that water is discharged into a drain behind the dam. Weirs should be designed to ensure erosion of the dam is prevented and that water flows into the adjacent drain without causing erosion.
- The marginal drain behind the dam should be of adequate capacity to accept flows from cutover areas. This may require an assessment of conveyance capacity and possible drainage management measures.





# Raised Bog Restoration Guidance Note

## Costs:

Estimated costs of €25-€30 per linear metre based on costs at Killyconny Bog (Cloghbally) SAC.

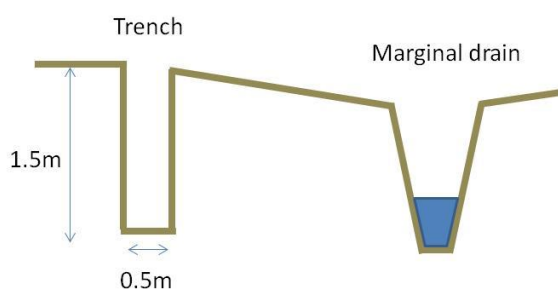
Costs may be significantly more expensive if peat has to be sourced from another site.

## Risks/optimum time of year for operations:

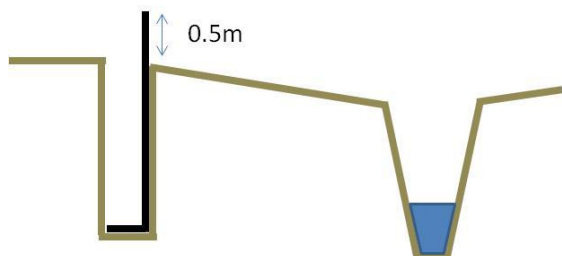
Potential impacts on water table in surrounding areas must be assessed, particularly for drain blocking on cutover areas. Optimum time of year for operations is summer months when water levels are lowest meaning the dam can be constructed without experiencing significant flows.

## Installation schematic:

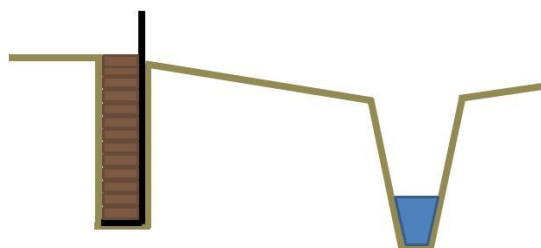
### 1. Excavate trench



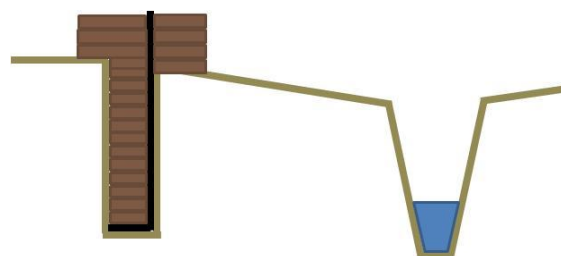
### 2. Place dam liner into trench



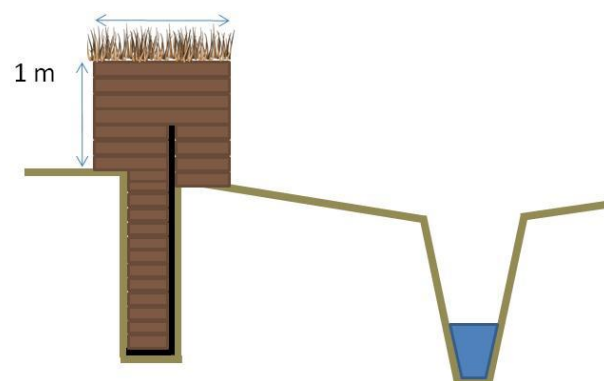
### 3. Infill trench with compacted peat



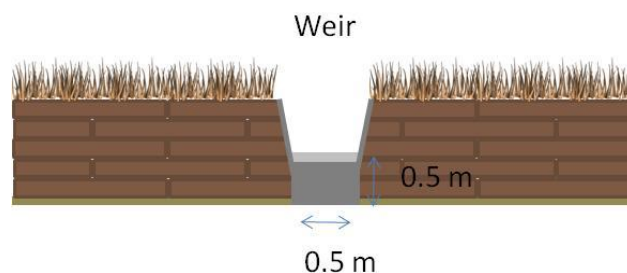
### 4. Continue to place compacted peat either side of liner until it is covered



### 5. Build up layers of compacted peat, place scraw on top and sides of completed embankment



### 6. Completed marginal bund with weir overflow and bank protection for embankment



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## Reference:

Schouten, M., Streefkerk, J. & Zandstra, R. (1994). *General Proposals for Technical Measures for the Conservation and Restoration of the Raised Bogs Clara and Raheenmore*, National Parks & Wildlife Service - Dublin, Geological Survey of Ireland - Dublin, Department of Nature Conservation, Environmental Protection and Wildlife Management - The Hague, National Forestry Service of the Netherlands – Driebergen

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## References:

McDonagh, E. (1996). *Drain Blocking by machine on Raised Bogs*. National Parks and Wildlife Service, Dublin.

Qunity, F. & Rochefort, L. (2003) *Peatland Restoration Guide*. Second Edition. Canadian *Sphagnum* Peat Moss Association and New Brunswick Department of Natural Resources and Energy.





<b>Measure:</b>	Plastic dams on high bog and cutover
<b>Description:</b>	
Plastic dams are typically installed by hand on high bog or cutovers, especially where peat dams may erode. On the high bog they are used in areas where machine access is not possible or where relatively few dams are required meaning the costs of a machine are not justifiable. These dams aim to bring the water table up to the bog surface and to maintain it within 10cm of the ground surface for most of the year. This is to restore suitable hydrological conditions to allow active raised bog (ARB) to develop on high bog. On cutover bog these dams aim to reduce vertical loss of water from the high bog and provide suitable hydrological conditions for peat-forming vegetation to develop. Even in areas where ARB cannot be restored, drains should be blocked as this can help to reduce the rate of flow off the bog.	
<b>Examples of where this has been used:</b>	
<ul style="list-style-type: none"> <li>Kilsallagh Bog SAC</li> <li>Mount Hevey Bog SAC</li> <li>Coolrain Bog SAC</li> <li>Aughrim Bog NHA</li> <li>Girley Bog NHA (Coillte LIFE Site)</li> </ul>	
<b>Installation method:</b>	
<p>Plastic dams are typically installed by hand using lengths of inter-locking plastic piles. These can be supplied in varying lengths and if necessary cut to size depending on the depth of the drain. It is important that the piles are long enough to extend sufficiently below the base of the drain in order to be secure and minimise water flow under the base of the dam. This may vary depending on the characteristics of the drain. Plastic dams should be installed in drains every 10cm fall in elevation (McDonagh, 1996). The installation process is outlined below:</p> <ul style="list-style-type: none"> <li>Push the first plastic pile into the centre of the drain, ensuring it remains vertical.</li> <li>Drive the pile into the peat further until it is held firm using a large rubber mallet (if necessary protect the top of the plastic using a timber batten).</li> <li>Once the centre pile is in a secure position guide adjacent piles into position, pushing into the peat and using the rubber mallet to drive into a firm position.</li> <li>The dam should extend beyond the width of the drain into the bog, typically by a minimum of 50cm to prevent water flowing around the dam and eroding the sides of the drain.</li> <li>Once all piles have been positioned and are secure they should be driven to a final position, starting from the centre until all piles are approximately 30cm above the level of the surface.</li> <li>This plastic should extend at least 50cm below the base of the drain if the peat is very firm. If the peat is weak the plastic should be driven in further until the plastic is held secure.</li> <li>If significant flow is expected which could cause erosion around the dam, create a notch for water to overflow by driving the centre pile(s) slightly further until it is below the level of the adjacent bog surface.</li> </ul>	



## Effectiveness:

Has been proven very effective at many bogs where it has been used and installed correctly. Very ineffective if plastic is not installed deep enough into the drain or does not extend far enough laterally into the bog. In some areas where significant water level fluctuations occur a gap may open up between the peat and plastic allowing increasing water losses over time.

## Maintenance:

Maintenance requirements are low provided dams are installed correctly. Most damage will typically occur within the first year of installation during times of high flow. This may require a survey to check dam integrity and identify locations where dams require replacement or where reinforcement is required.

## Lessons learned:

- Plastic dams can fail if they are not installed correctly or can be ineffective in some situations e.g. where cracks are present in the peat.
- Plastic dams can provide effective reinforcement for peat dams in areas where significant flow can be anticipated such as steeply sloping high bog margins or on the cutover. The design of these hybrid dams will vary depending on the specific conditions of the site.
- More expensive than peat dams but can be more economical if machinery access is not feasible or if very few dams are required.
- Requires checks to ensure integrity of dam is maintained.



# Raised Bog Restoration Guidance Note

## Costs:

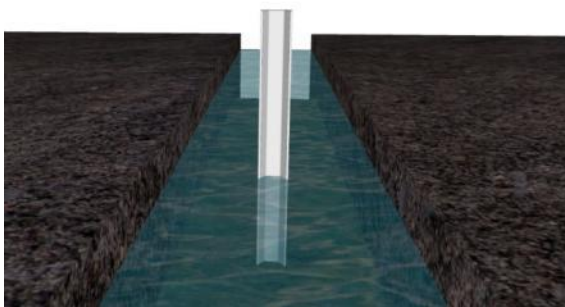
Varies with drain dimensions – typical high bog drain c. 1m deep estimated to cost c. €90 to block including materials and labour.

## Risks/optimum time of year for operations:

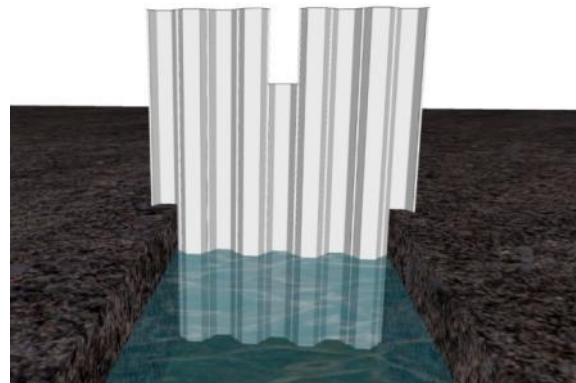
Potential impacts on water table in surrounding areas must be assessed, particularly for drain blocking on cutover areas. Optimum time of year for operations is summer months when water levels are lowest making working conditions more favourable. However, work can be carried out throughout the year provided conditions are suitable.

## Installation schematic:

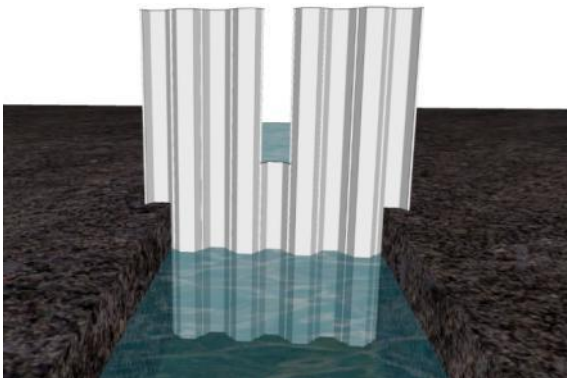
1. Push first pile into centre of drain and drive until secure



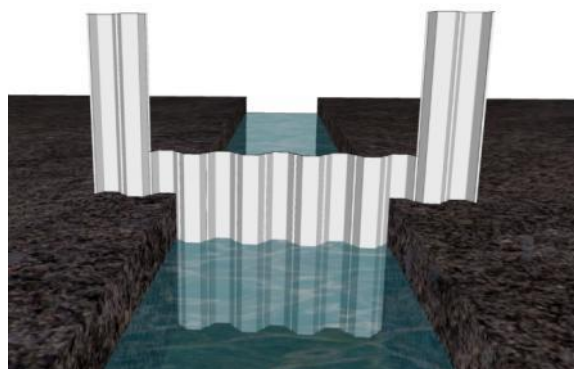
2. Guide adjacent piles into position



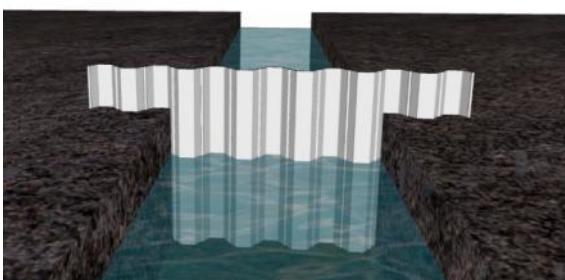
3. Drive piles to final position (starting with centre)



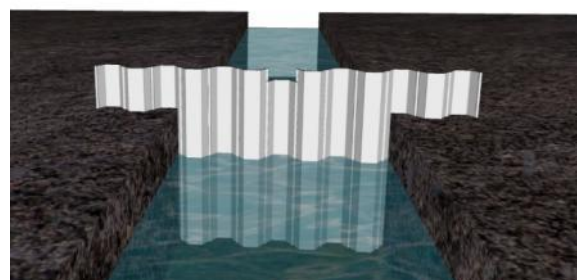
4. Ensure dam extends into bog by minimum of 50cm



5. Drive all piles to final position



6. If significant flow is expected create a notch in the dam

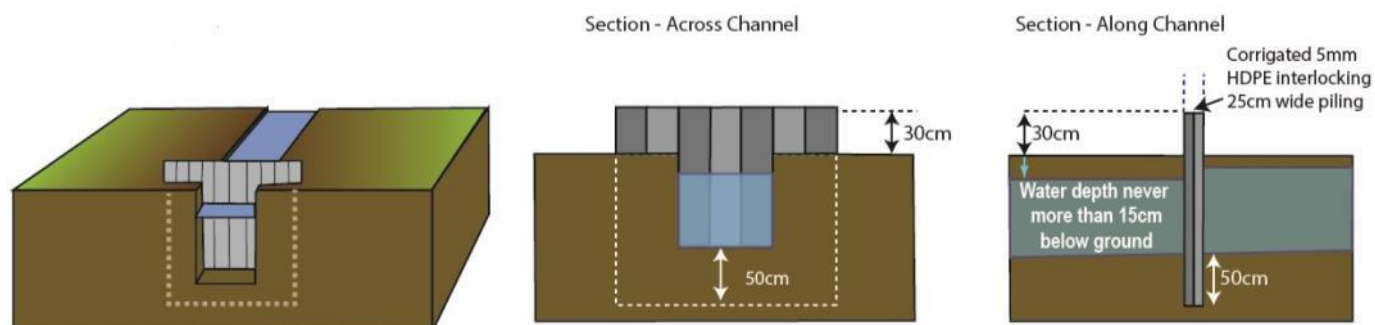


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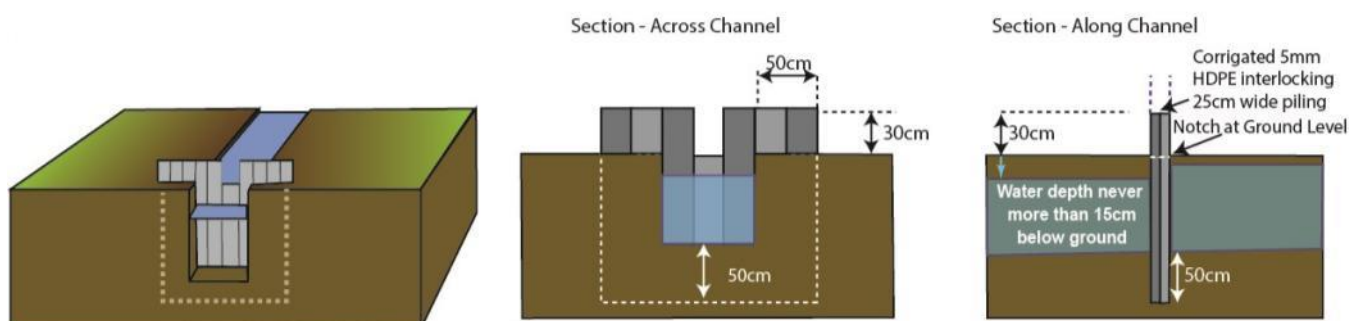


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## Completed plastic dam:



## Completed plastic dam with overflow notch (if significant flow is expected):



## References:

McDonagh, E. (1996). *Drain Blocking by machine on Raised Bogs*. National Parks and Wildlife Service, Dublin.

The Plastic Piling Company. Website, available at: <http://www.plasticpiling.co.uk/>