Natural Flood Management
Design Specification
Catalogue

2021 scheme
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Purpose of Measure

Vegetated buffer strips are typically located along field boundaries or adjacent to watercourses and drainage ditches. They provide a structured vegetated corridor typically composed of a mixture of grasses, herbs and wildflower. These act to protect watercourses and field edges from water and sediment run off and livestock grazing. Buffer strips also aid in maintaining the land surface roughness, slowing overland flow and increasing infiltration into the soil. By slowing water movement, buffer strips trap sediment before it enters the drainage system, enhancing local water quality and encouraging plant establishment. Where planted alongside a watercourse, bank stability may also be improved by the stabilising effects of root development.

Vegetated buffer strips also enhance local biodiversity and landscape connectivity through the creation of wildlife corridors. Thaler quality may also be improved through a reduction in nitrate runoff to watercourses. The reduction of sediment transfer to watercourses may also aid with the Farming Rules for Water.

Design Parameters

Buffer strips shall be created either in-field, between fields, or adjacent to watercourses (riparian), including rivers, streams and ditch systems. In-field buffer strips shall be at a minimum 4 m wide and run for the length of the field where practicable, with wider strips considered in areas of slower gradient to maximise effectiveness. Riparian buffer strips shall be wider, typically between 6 m and 12 m. Fencing riparian buffer strips (Figure 1) can be undertaken to manage the interface between crops/grassland. Vegetation of riparian buffer strips is recommended to increase the range of wildlife species that can be supported and to improve soil quality and productivity. The presence of riparian buffers can aid with nitrogen and phosphorus retention, and support the development of new riparian plant species. The mixture shall aim to provide a year-round coverage and complex root development. Deep rooted species are desirable as they will improve soil structure, increase infiltration and reduce water flow more effectively.

Consequent to creating a buffer strip the location shall be checked for the presence of scarce plants that would be lost following the development of a vegetated buffer strip.

Equipment and Materials

Equipment—Buffer strips may be implemented in conjunction with other land management (LM) or overland flow route (OFR) measures. Buffer strips may aid with sediment management to improve performance and reduce maintenance requirements of other measures. Complementary measures may include reducing soil compaction (LM 01.1) in adjacent fields to reduce the water and sediment runoff being intercepted by the buffer strip. Another complementary measure may be to include cross slope amelioration (LM 01.2), where planted in proximity to a buffer strip. This may further support the improvement of soil structure and increase infiltration rates.

Notes

This Design Specification Sheet is to be read in conjunction with the Treatment Design Specification—Vegetated buffer strip (LM01.1) and the Environment Fund Handbook. The design parameters and materials usage will vary by design, site characteristics and material availability, therefore, the list should not be taken as exhaustive.

Notes for Design

Equipment and Materials

The list provided within the ‘Equipment and Materials’ section is typical of measures, however additional equipment and materials usage will vary by design, site characteristics and material availability, therefore, the list should not be taken as exhaustive.

Consents and Permissions

The information provided is NOT an exhaustive list but includes guidance on common requirements for the measure. For further consenting and environmental information see, please contact the Environment Agency and the Catchment Advisory Services team who will be in a position to quote specific requirements for the measure.

Further Reading

For further information on vegetated buffer strips refer to the following sections within the Referens (REFS) specification sheet.

General—references 1, 2, 3, 4, 14, 15 and 16

Figure Specific—LM01.1—Vegetated Buffer Strips—references 1, 2, 3, 4, 5 and 6

Consents and Permissions—references 5, 6, 7 and 14
**LM01.2: Cross-slope Woodland & Hedgerows**

**Purpose of Measure**

Cross-slope woodland and hedgerow planting acts to reduce flood risk by slowing the rate at which overland flow enters the drainage network and watercourses. This occurs through the interception of rainfall and overland flow, evapotranspiration, infiltration to ground (through soil improvements due to enhanced root growth) and by increasing surface roughness. Woodland underrun planting may also be considered as a way to further enhance soil structure and roughen the ground beneath. The planting of cross-slope woodland and hedgerows will improve local wildlife, biodiversity and soil health. Cross-slope woodland may also be planted in conjunction with many other natural flood management measures for added benefit.

**Design Parameters**

Cross-slope planting is typically undertaken along contours in areas prone to overland flow, and adjacent to watercourses (Figure 1). Planting need not be extensive if strategically placed to target key flow routes (Figure 2). Functional and ecological value is often improved where the measure is used to extend cross-slope woodland, shelter belts and/or as a gap-up measure for existing hedgerogds. Standard street trees will be planted at a density of 4 trees per 1 to 2 m² and as staggered rows where possible. Cross-slope woodland is best supplied as bare root whips and/or feathered stock and planted at a depth of 1 to 1.5 times their root ball. Cross-slope woodlands are best planted as a mixed species stand, typically with a minimum of five species. For hedgerows, hedge species should be set out in blocks, 200 mm apart with plants at 450 mm centres (Figure 3). Bare root hedge species shall be planted as whips in same species groupings of three, five and seven. Standard tree species can be incorporated into hedgerows but should be offset from the hedge by 1 m and at approximately 10 m intervals. Planting shall occur between November and March, avoiding waterlogged or frozen conditions, and following the fallow period using species with the highest success rates in the plot. After planting can also be beneficial where planted adjacent to storage ponds (Figure 4).

Following winter planting, summer/autumn checks are required to quantify any losses and assess establishment. The potential implications of tree planting on the function of adjacent habitats shall be considered e.g. potential for spreading of amenity species and loss of habitat. The designer shall implement appropriate controls to minimise or remove the risks. Consents and Permissions

Planting shall occur between November and March, avoiding waterlogged or frozen conditions, and following the fallow period using species with the highest success rates in the plot. After planting can also be beneficial where planted adjacent to storage ponds (Figure 4).

**Maintenance Requirements**

A medium level of maintenance is typically required for cross-slope woodland and hedgerows. Greatest effort is often required for the first 3 to 5 years after planting in relation to checks and maintenance of plants, guards and stakes. Following winter planting, summer autumn checks are required to quantify any losses and assess establishment condition of plants. Where tree/hedge species have failed, re-planting is recommended for the following winter period using species with the highest success rates in the plot. After 2–3 years all stakes and guards should be removed as plants shall be well rooted. The removal of branches and trees, is typically required as an annual event, each spring/summer for the first few years. Weeding to remove competition is also required on an annual basis, each spring/summer for the first few years. This may include mechanical weeding or mowing. There shall be no cutting of newly planted hedgerows for the first 5 years after planting, with which maintenance to encourage hedge development and thickening, such as laying by hand, is recommended first 5 years, regular checks and the replacement of damaged, stakes and guards is required.

**Consents and Permissions**

Consents are unlikely to be needed for small-scale tree planting, however, there may be some exceptions to this. Should tree planting be large-scale or within a protected habitats (e.g. SSSI, ACORN) then permissions will be required from the Forestry Commission and/or local and statutory authorities. If planting is being undertaken within 8 m of a main river, Environment Agency consent may be required in the form of a flood risk activity environment permit. If trees are being planted adjacent to an ordinary watercourse, a land drainage consent may be required from the lead local authority.

**Further Reading**

For further information on cross-slope woodland & hedgerows refer to the following sections within the References (REFX) specification sheet:

| General—references 1, 2, 3, 4, 5, 6, 7, 12 and 15 |
| Cross-slope Woodland & Hedgerows—references 1, 2 and 3 |
| Consents and Permissions—references 3, 10, 12, 13 and 14 |

**Equipment and Materials**

The following is a list of equipment and material that are typically required for planting cross-slope woodland and hedgerows:

- **Equipment:**
  - Tree planting spade
  - Lopping/hedge hammer—for driving tree stakes
  - Tree planting machine—if a large number of trees are to be planted and access/side conditions permit

- **Fencing tools—to construct and secure fencing and wire**

- **Materials:**
  - Trees and hedging plants—typically supplied as bare root whips and/or feathered stock
  - Stakes and tree guards—for tree protection
  - Fence posts, wire, staples and staples—to construct exclusion fencing around planted area

**Costs**

Material costs will vary depending on the species mix used, density of planting and the level of protection required. Costs are typically £21,600 per hectare. Tree and hedging plant prices range between £0.5 and £3 per plant. Material costs will vary depending on the species mix used, density of planting and the level of protection required. Cross-slope woodland planting can also be beneficial where planted adjacent to storage ponds (Figure 4). Material costs will vary depending on the species mix used, density of planting and the level of protection required. Cross-slope woodland planting can also be beneficial where planted adjacent to storage ponds (Figure 4). Maintenance and safety in agriculture is available from the Health and Safety Executive on the Health and Safety Executive website (© Atkins Ltd).
**Purpose of Measure**

Soil compaction occurs as a result of high pressure being exerted on the soil surface. This acts to reduce the infiltration capacity of the soil by reducing soil pore space, which in turn can increase run-off from the land and lead to flooding. Soil compaction can also be detrimental to root growth and can create conditions of waterlogging. Compacted soils can be subject to greater levels of erosion and sediment transport to watercourses.

**Design Parameters**

Methods to reduce compaction are site-specific, dependent on the soil type, land-use, the level of compaction and current soil health. They are best applied at the field scale.

In targeting the measures, local knowledge is best applied to identify where soil is most compacted or in the poorest health. Workshops and further assistance are required to inform the process e.g. the use of a soil particle size detector to identify soil compaction (by measuring the resistance of the soil), conducting bulk density tests and digging of small trial holes to assess compaction. Common signs of soil compaction include waterlogging, standing water and crop discoloration (an indicator of your nutrient levels resulting from highly compacted soils). Mechanical-decompaction measures are best implemented at the field scale and may provide a more effective NFM function on slopes that link to the drainage network.

Compaction of soils is typically reduced through aerating (mechanical working of the soil) (Figure 3), sward-lifting (breaking up the topsoil) without damaging the sward (Figure 4) or subsoiling (breaking up the topsoil) (Figure 5). The equipment required will be dependent on the depth of compaction; informed through the digging of soil pits. Soil aerators typically work to depths of around 10 cm and shall be used when soils are neither too wet, nor too dry. In wet conditions soil aerators will penetrate to deeper levels and may damage topsoil whilst if soil is too dry, aerators may not penetrate far enough to be effective. Soil aerators shall be set at 90 cm to the direction of travel to avoid soil damage. Sward lifters work to depths of 20-30 cm and are typically more effective than aerators at de-compacting soil. As a guide the minimum horsepower required for sward lifters is 140-180 HP. Again, as with soil aerators, sward lifters shall not be used in very wet or dry conditions to avoid further soil damage and maximize their effectiveness. Subsoilers typically operate at depths of 35-50 cm and commonly used in arable fields for deep de-compaction. Equipment is set at the incorrect level, the issue of compaction may be exacerbated rather than improved.

For assistance in implementing this measure, please speak to the local Catchment Advisor.

Generally, the frequency required for mechanical de-compression will depend on land-use and soil characteristics, with greater levels of compaction requiring more frequent attention. However in all instances, mechanical-decompaction should be a cyclical process and not a single-use measure (typically undertaken once every second year) and may be implemented in sequence with crop rotations. For further advice on this measure, please see the local Catchment Advisor. Other management options may also be applied to reduce compaction, including stocking density changes, mob grazing, avoiding the topsoil without damaging the sward) (Figure 3) and cover crops (LM02.2) with deep rooting species may help to break up and aerate soil compaction, and may be used following the use of aerators, sward lifters or subsoilers. Vegetated buffer strips (LM01.1) may also be implemented across the field and along field boundaries if they do not compromise this activity.

**Maintenance Requirements**

Conserving good soil health is an ongoing process which requires a low to medium level of maintenance following implementation of the measures described here. Mechanical-de-compressors, whilst effective in the short-term, may only partially address the issues of soil compaction. Other supplementary methods may be required to maintain soil health in the long-term. These measures include, but are not limited to, controlled traffic (including using optimum tyre pressure and avoiding excessive heavy machinery use on wet soils), minimum tillage techniques, cover crops, changes to livestock management and herbal leys with mixed deep rooting species.

Further assessment of soil compaction will be required to inform on the need and frequency of repeated soil aeration and/or subsoiling.

**Cost**

Reducing soil compaction through the use of mechanical-de-compressors can cost between £50 and £100 per hectare depending on whether the appropriate machinery is owned, rented or a contract hire is required. The cost of additional land management actions to maintain low soil compaction is typically low and may result in higher grass and crop growth if compaction is remedied, making land more profitable. For further information on additional measures for maintenance, see the "maintenance requirements" section and the specification sheets for mixed species herbal leys (LM02.2) and cover crops (LM03.2).

Additional costs may be associated with planning and consultation requirements.

**Equipment and Materials**

The following is a list of equipment and materials that are typically required in the reduction of soil compaction.

**Equipment**

- **Tractor**
- **Aerator/sward lifter/subsoiler machinery**—to be associated with
tractor
- **Enclosure/tractor—should trial holes be required to assess soil compaction**
- **Soil penetrometer—to measure soil compaction**

**Materials**

- **Movable feed/water trough**—to avoid poaching and soil
trampling over the same patch of the field

**Notes**

This Design Specification Sheet is to be used in conjunction with theatsby Norwich Women's Business Bristol Design Group. Further information on adding value to your land and planning for sustainable development is available from the Natural Flood Management Fund website [https://www.naturalfloodmanagementfund.org.uk](https://www.naturalfloodmanagementfund.org.uk).

**Design Considerations**

This sheet is for design information only and is NOT to be used as a fit for construction. For design specification, please contact the Design Group. For further information on planning and consultation, please make contact with the Catchment Advisor (v3.0)

**Maintenance and Liability**

The landowner shall be responsible for the implementation and maintenance of any NFM measures on their land and will hold the liability for soil compaction. For further information on NFM maintenance, please refer to the Natural Flood Management Fund Handbook for Terms & Conditions governing participation in the Fund.

**Consents and Permissions**

The information provided is not exhaustive list but includes guidance common requirements for the measure. For further consenting and permissions advice, please make contact with the Catchment Advisor.

**Health and Safety Considerations**

The Construction (Design and Management) (CDM) 2015 provides a helpful reference for identifying the risks and responsibilities for people involved in the design and construction processes and what is required of the client, designer and contractor to ensure health and safety in accordance with the Health and Safety Executive (HSE) guidelines. For more information on health and safety in agriculture is available from the Health and Safety Executive (HSE) guide to farm safety.

**Design**

A design risk assessment is required to identify the hazards and evaluate the risks that may arise from the design. Upon completion of the design, the hazard and the associated risks shall be reviewed. The designer shall implement appropriate controls to minimise or remove the hazard, the associated risks or control the risk to an acceptable level. Specifications and ensure that all necessary measures are included to protect them from harm. Further specific information on health and safety in agriculture is available from the Health and Safety Executive (HSE) guide to farm safety.

**Construction**

Working method statements, risk assessments, housekeeping procedures and environmental management plans shall be prepared and adhered to throughout. Ensure the construction phase is safe for work, appropriately trained, hold the correct qualifications and have NFM knowledge and on-site welfare.

**Operation/Maintenance**

Post-construction activities will also need to be considered in project planning to ensure that specified inspection and maintenance requirements can be implemented safely. As with the construction phase, inspections and maintenance activities need to be designed to avoid hazards to the environment and the individual. During operation ensure that any interferences with the public are appropriately controlled and maintained.
LM02.2: Mixed Species Herbal Ley

Purpose of Measure
Mixed species herbal ley is a measure particularly focused on improving soil health of grassland productivity over large field-scales. Over time, land used exclusively for grazing can become compacted by livestock and soil structure can be damaged. Mixed species herbal ley involves using diverse and deep-rooting species to enhance soil structure and increase water infiltration capacity. Through a greater diversity of plant and grass species, soil can be enhanced with greater amounts of carbon, soil organic matter and a reduced bulk density (compaction), leading to greater water storage potential and a reduction in overall water flow.

This may be particularly important where extensively grazed grassland is adjacent to watercourses. This measure may have many additional benefits for livestock farming, including a reduction in fertiliser use, reduced expenditure on feed and reduced veterinary bills. Herbal leys may also increase local biodiversity and water quality.

Design Parameters
Mixed species herbal leys are preferably sown into a clean seedbed. Although, seed mixtures can be used to convert existing pasture into a herbal ley following appropriate ground preparation, in the case of existing arable crops, weeds should be seen as a primary considerate and herbicides targeted at reducing their growth. Cultivation of pests and weeds is an essential part of the establishment process and may need to be continued to ensure the desired outcome. Mixed species herbal ley involves using diverse and deep-rooting species to enhance soil structure and increase water infiltration capacity. Through a greater diversity of plant and grass species, soil can be enhanced with greater amounts of carbon, soil organic matter and a reduced bulk density (compaction), leading to greater water storage potential and a reduction in overall water flow.

Typically, mixed species herbal leys include grasses, legumes, herbs and wildflowers (Figure 1) to ensure that enough variance in rooting depths and characteristics is observed. For increased effectiveness, the ley shall have a minimum of 10 % legumes, 10 % herbs and 10 % wildflowers, whilst the number of species included within the ley shall be at a minimum of 15 species (5 grasses, 5 legumes, 5 herbs and 0 wildflowers). Typical species are shown in Figure 2. Ryegrass may not be sown within the mixed ley as it could restrict the effectiveness of the measure. Not all species are guaranteed to grow equally well in acidic soils (particularly below pH 6).

To promote effectiveness of herbal leys, they are best used on rotation (typically four years) to maximise benefits to soil and livestock (Figure 3). Herbal leys typically involve an extended grazing season. However, to facilitate the use of improved soil health and reducing flooding, herbal ley shall be rotationally grazed to avoid degradation. This will require management of livestock activity within the herbal ley through the erection of exclusion fencing. Herbal leys will be established in areas that best target issues of poor infiltration and run-off. The conversion of uncultivated or semi-natural land to herbal ley is best avoided (to reduce potential for converting and permitting, as are land parcels/fiel-
dings with known pests or weeds to limit the need for herbicides/pesticide application.

Linked measures—Prior to the sowing of mixed species herbal leys, measures to reduce compaction (LM12.1) may be implemented to improve the soil structure and allow for better establishment of grasses and herbs. This may aid the overall benefit experienced through the implementation of herbal leys.

Maintenance Requirements
Mixed species herbal leys will typically have a period of 4 years at optimum functionality before rotations are needed. A low level of maintenance is required following established due to its self-sufficiency and opportunities it presents for rotational grazing. Fertiliser shall not be applied to herbal leys as this will encourage the grass species in the sward to proliferate at the expense of herbs. However, it is possible to add fertiliser to improve the overall yield, as long as appropriate 
agricultural fertiliser input, further reducing maintenance requirements.

Other complementary soil and land management measures will further enhance soil health when implemented alongside artificial nitrogen fertiliser input, further reducing maintenance requirements. Of herbicide/pesticide application. This may aid the overall benefit experienced through the implementation of herbal leys.

Cost
The cost of implementing mixed species herbal ley is typically between £150 and £250 per hectare, depending on the supplier and the type of mixed species herbal ley. Costs at the lower end of the range may include simple herbal ley mixtures with smaller numbers of species, whilst costs at the upper end of the range may include more complex herbal ley mixtures with greater numbers of species and are more organic rather than conventional. Costs associated with implementation can vary depending on the ground preparation and machinery requirements.

Consents and Permissions
Mixed species herbal leys are typically implemented without fertiliser-use and can support healthier livestock and subsequently lower veterinary bills than observed with traditional ryegrass mixtures. Additional costs may be associated with planning and consultation requirements.

Equipment and Materials
The following is a list of equipment and materials that are typically required in the implementation of mixed species herbal ley.

<table>
<thead>
<tr>
<th>Equipment:</th>
<th>Material:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractor</td>
<td>Seed mix</td>
</tr>
<tr>
<td>Seed spreader/broadcaster or drill</td>
<td>Herbicides—lawn treatment of non-weedy areas</td>
</tr>
<tr>
<td>Soil lifter and roller—for ground preparation</td>
<td>Temporary exclusion fencing—should be ley used for rotational grazing</td>
</tr>
</tbody>
</table>

Notes
This Design Specification Sheet is to be used in conjunction with the National Flood Management Guidance BM01 and this Design Specification Sheet. For specific design parameters, further information can be sourced from the references listed below. This measure will be subject to environmental assessment. Further information can be sourced from the references listed below. This measure will be subject to environmental assessment.

Figure 1. A typical mixed species herbal ley (© Chloe Palmer)

Figure 2. Some of the different species to consider for mixed species leys and their differ-
ing rooting depths (© Cotswold Seeds Ltd)

Figure 3. Mixed species herbal ley being grazed off by cattle (© Chloe Palmer)
**LM02.3: Cover Crops**

**Purpose of Measure**

Cover crops are non-cash crops that provide a protective cover for the soil of arable land which may otherwise be prone to erosion from wind and water between cash-crop cycles. They are commonly grown over winter, when they can also act as an HF measure by reducing surface runoff.

Cover crops provide a natural flood management benefit as they act to intercept rainfall, maintain good soil structure and improve infiltration capacity through root development. They can also act to slow overland flow, reducing the rate at which water enters the drainage network and watercourses.

Cover crops may also provide additional benefits such as increasing cash-crop productivity, through improvements to and maintenance of soil health. A reduced amount of weed management and fertiliser is often also observed, which can reduce farming costs and improve local water quality. Cover crops can also provide feed for livestock as grazed biomass.

**Design Parameters**

The type of cover crop sown shall depend on soil characteristics, arable use, landowner requirements and existing operation. Depending on the length of rotation desired, certain cover crop species may be more preferable than others to fit within the cash-crop cycle. For further specific advice on cover crop species and design strategy, the local Catchment Advisor and agricultural specialists can be consulted.

Early sowing of cover crops (Figure 1) is desired where possible to allow time for successful establishment prior to the wetter winter period (Figure 2). Sowing shall have the ability to grow together and throughout the winter period (or period between cash crop growth), to ensure effective ground cover is maintained and a mix of species should be used. These include legumes, grasses and brassicas to provide variable rosette growth as shown in Figure 3, and above ground complexity to protect the soil surface from rain splash and wind erosion. Buckwheat provides a good option should the cover crop be required over the summer period. Cover crop establishment methods will vary depending on the species choice and ground conditions, with uniformly in distribution being key. Seeds shall be spaced using a seed spreader, at the rate indicated by the seed merchant. Where seed spreading is not feasible, seed mixtures may be sown directly, however, periodic mixing in the following growing season will be required for uniform coverage and establishment. Sowing window ranges depending on the species mix, however, are typically from August to late-September.

At the end of a cycle, cover crops can be directly tilled back into the soil for enhanced nutrient availability, or the bulkiness reduced through the use of a crimper roller. Alternatively, cover crops may be grazed off to directly provide feed for livestock and prepare the crop for fertiliser back into the soil. These approaches are in preference to spraying off with potentially harmful chemicals e.g. glyphosate. Cover crops shall be planted immediately following removal of cash crops and be terminated, as standing residue (grazed off), as close to the period of sowing on the next cash crop, to ensure as close to zero-round soil coverage as possible. Where annual cycles are not appropriate, cover crops may be maintained over longer periods, with the key to maintain soil coverage to maintain soil health, high infiltration capacity and protection from soil erosion.

Complementary Measures:

Cover crops may be implemented alongside other land management (LM) measures including grassed waterways (LM01.1) and the reduction of soil compaction (LM01.2). Buffer strips can aid with reducing rapid runoff from the field into adjacent watercourses or other land parcels. Soil compaction reduction measures may be implemented before the sowing of cover crops to aid with improving soil structure and encourage the development of cover crops.

**Maintenance Requirements**

Cover crops typically provide cover for 5-6 months and are implemented on a yearly basis, in conjunction with cash crops. A low level of maintenance is required with cover crops. After initial sowing and establishment some re-seeding may be required where the cover crop has not taken. Consideration shall be given in the on-going process of maintaining good soil structure and management, rather than regularly continuing crops as a single event.

Other complementary soil and land management measures shall further enhance soil health when implemented alongside cover crop use, such as controlled trafficking of heavy machinery (including use of optimum tyre pressures and avoiding extensive heavy machinery use on soil surface), minimum tillage techniques and changes to livestock management. Other measures may be specified as a landowner innovation (LM01.3).

**Cost**

Cover crop seed is typically costed between £20 and £200 a hectare per year, depending on the supplier and the type of cover crop mixture purchased. Costs at the lower end of the range may include simple cover crop mixes with smaller numbers of species, whilst costs at the upper end of the above range may include more complex cover crop mixes with greater numbers of species and are more organic rather than conventional. Costs associated with implementation will vary depending on the ground preparation and machinery requirements.

Cover crops are typically associated with soil health improvements and subsequent improved cash-crop yields, which has the ability to make land more profitable. Following cover crop growth, cash crops may require less fertiliser usage.

Additional costs may be associated with planning and consultation requirements.

**Equipment and Materials**

The following is a list of equipment and materials that are typically required in the implementation of cover crops.

- **Equipment**
  - Tractor
  - Seed spreader/broadcast or drill
  - Soil lifter and roller—for ground preparation
  - Compost roller—an option to reduce bulkiness at the end of the cover crop cycle

- **Materials**
  - Seed mix
  - Herbicides—for targeted treatment of noxious weeds

**Notes**

This Design Specification Sheet is to be used in conjunction with the High Flood Mitigation Measures High Flood Management Fund Handbook website [https://catchmentbasedapproach.org/higher-flood-management-fund-handbook](https://catchmentbasedapproach.org/higher-flood-management-fund-handbook).

**Further Reading**

For further information on cover crops refer to the following sections within the References (REFS.X) specification sheet:

- General—reference 2
- Measure Specific—LM02.3: Cover Crops—references 1, 2, 3, 4, 5, 6 and 7
- Consents and Permissions—reference 14

**Equipment and Materials**

- Seed spreader/broadcast or drill
- Soil lifter and roller—for ground preparation
- Compost roller—an option to reduce bulkiness at the end of the cover crop cycle

**Notes**

This Design Specification Sheet is to be used in conjunction with the High Flood Mitigation Measures High Flood Management Fund Handbook website [https://catchmentbasedapproach.org/higher-flood-management-fund-handbook](https://catchmentbasedapproach.org/higher-flood-management-fund-handbook).

**Further Reading**

For further information on cover crops refer to the following sections within the References (REFS.X) specification sheet:

- General—reference 2
- Measure Specific—LM02.3: Cover Crops—references 1, 2, 3, 4, 5, 6 and 7
- Consents and Permissions—reference 14

**Equipment and Materials**

- Seed spreader/broadcast or drill
- Soil lifter and roller—for ground preparation
- Compost roller—an option to reduce bulkiness at the end of the cover crop cycle

**Consents and Permissions**

Consents and permissions are unlikely to be needed for the establishment of cover crops.

**Health and Safety Considerations**

The Construction (Design and Management) Regulations (CDM) 2015 provide a helpful reference for identifying the risks and responsibilities for people involved in the design and construction process and what is expected of them, the designer and the contractor. Considerations include, but are not limited to, location of services and public utilities, risk assessments, health and safety at work, training of employees, environmental/site management plans shall be produced and assessed at all times. Ensure all construction staff are fit for work, appropriately trained, and have access to appropriate PPE and on-site welfare. Considerations include, but are not limited to, access to appropriate PPE and on-site welfare.

**Operation/Maintenance**

Post-construction activities will also need to be considered in project planning to ensure that specified inspection and maintenance requirements can be undertaken safely. As with the construction phase, inspections of the constructed works should be conducted by appropriately trained and experienced individuals. During operation ensure that any interface with the public are appropriately controlled and maintained.

**Adkins**

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**Notes**

This information provided is NOT an exhaustive list but includes guidance on common requirements for the measure. For further information and personal checking, please make contact with the Catchment Advisor and we will arrange in according the specific requirements for the measure.

**Further Reading**

For further information on cover crops refer to the following sections within the References (REFS.X) specification sheet:

- General—reference 2
- Measure Specific—LM02.3: Cover Crops—references 1, 2, 3, 4, 5, 6 and 7
- Consents and Permissions—reference 14
Purpose of Measure

Overland leaky barriers are discrete low wood features that are strategically located and fixed on a floodplain or along preferential flow routes to intercept and temporarily store water. They are primarily designed to operate during out of bank events or following heavy rainfall in areas that experience overland flow. The barrier acts to slow and temporarily store overland flow by roughening the ground surface, which can also facilitate the management of sediment laden runoff.

They can be used in both lowland and upland areas and are well suited to woodland settings, where their inclusion can act to enhance local biodiversity and improve woodland condition. Woodland settings also provide local sources of materials for ease of construction.

Design Parameters

Overland leaky barriers are typically constructed from lengths of large wood (tree trunk bunks) generated from tree felling (normally 300–600 mm in diameter). The height and length of the feature may be increased through the use of multiple lengths (Figure 2 and Figure 3) or through incorporation of composite materials such as brushwood or small logs (Figure 4). The barrier height is determined by the flood height, floodplain strip and width of the flow route. Barriers are not to be installed immediately upstream or adjacent to a structure typically within 30 m e.g. a bridge, culvert or outfall, so as to reduce the risk to assets should wood become mobilised.

Since wood is a natural material there may be some gapping between the feature and the ground surface. If the gapping is too large, a layer of smaller branches and brushwood should be added. Packing with smaller branches and brushwood to manage porosity and improve connectivity with the ground level is advised.

Some minor adjustments may be required to the design height and the configuration of the component parts of a barrier should observations during a flood event identify the need to improve the storage potential of the barrier or series of barriers.

Introduction

Overland leaky barriers typically have a 5–10 year design life at optimum functionality without the need for significant construction

A lot to medium level of maintenance is required for overland leaky barriers. Maintenance shall include bi-annual checks for filler and woody material that has been intercepted by the barrier. Additional checks shall also occur following each significant overland flood/floodplain inundation event, to ensure that the barrier is still firmly fixed and that no woodconstruction materials have been dislodged or mobilised. If intercepted by the barrier should be removed and any damaged filling replaced if there is risk of mobilisation. Some minor adjustments may be required to the design height and the configuration of the component parts of a barrier should observations during a flood event identify the need to improve the storage potential of the barrier or series of barriers.

Equipment and Materials

The following is a list of equipment and materials that are typically required for construction of an overland leaky barrier—

Equipment:

• Dragger and operator—for manoeuvring of large wood

• Winches/hoists/hoists—for manoeuvring and positioning of wood over 25 kg

• Fence post driven—for driving fixing stakes

• Fencing tools—to secure the barrier

• Chainsaw—fall trees and yield wood material

Materials:

• Large wood—for main structural component

• Fixing stakes—to secure the barrier in place

• Wire and staples—to attach barrier to fixings

• Small branches/brushwood—to pack feature

Cost

The construction of an overland leaky barrier, including equipment, materials and build time, is typically between £200 and £150 per metre length of barrier. Therefore, a 3 metre long overland leaky barrier may cost in the region of £600 to £450, depending on the ease of access, specific equipment required and proximity of materials. If multiple overland leaky barriers are constructed, the cost per feature is likely to increase because the overheads of construction will be spread across multiple features.

The above cost estimates cover a ‘fair weather’ construction. If construction is undertaken in a particularly difficult location or planned for a time of year when weather may be inclement a contingency should be added. In addition, the above estimates do not take account of potential costs for tree felling and tree felling licenses from Natural England. Survey may be required to confirm the presence or absence of protected species in the local area, which, if found, may require protected species mitigation licenses from Natural England.

Further Reading

For further information on overland leaky barriers refer to the following sections within the References (REFS.X) specification sheet:

General—reference 5

Measure Specific—FR01.1: Overland Leaky Barrier—no specific references

Consults and Permissions—references 1, 2, 3, 6, 10, 13, and 14

Notes

This Design Specification Sheet is to be used in conjunction with the project or planning application. The reference to the NHF Manual 5158157/7.9.2.1/DG/FR01.1 and TRA/01.1 should be amended.

Design Considerations

This sheet is for design information only and is NOT to be used as a ‘fit for construction’ brief. Design specification should be prepared in accordance with the Design Patronage Policy.

Maintenance and Liability

The landowner shall be responsible for the implementation and maintenance of the works and for the upkeep and repair of the barrier. Where the site is subject to commercial or public use, the landowner or responsible person should ensure that the barrier is maintained. Further information and additional reading, see references detailed in the Further Reading section.

Equipment and Materials

The list provided within the “Equipment and Materials” section is typical for a minimum of one unit. Many additional equipment and materials will vary by design. The cost of the range of materials and equipment availability, therefore, the list should NOT be considered an exhaustive list.

Consents and Permits

The information provided is a NOF palette to be used in conjunction with the relevant local planning authority to derive an acceptable consent for the proposed works. If non-compliance with planning consents and associated requirements is found, this will result in significant delays and additional costs.

Health and Safety Considerations

The Construction (Design and Management) Regulations (CDM) 2015 provide a useful reference for identifying the risks and responsibilities for parties involved in construction and maintenance works. This includes the need to identify sites and implement effective risk assessments, develop a health and safety strategy and produce a site welfare plan that enables work to proceed safely and efficiently.

Working method statements, risk assessments, biosecurity procedures and environmental management plans shall be produced and ad- dressed at all times. Ensure all construction staff and equipment are suitably trained. As necessary, invoke non-native species presence and future management actions.
FR01.2: Flow Pathway Bund

Purpose of Measure

Storm water is often conveyed along preferential surface flow pathways during heavy rainfall events. This is often responsible for rapid water and sediment transfer to the drainage system and wider watercourse network which can contribute to flooding. The construction of bunds across overland flow pathways is aimed at attenuating and storing water at a target location. Water can be recovered for subsequent events. Where outlet features are installed, these are typically designed to drain 50% of overland flow.

Flow pathway bunds are versatile features that can be located throughout the catchment where pathways are identified. They may be temporarily stored in ponds or swales as this can increase localised overland flow. Where the feature may be susceptible to livestock poaching, fences may be constructed, as this can increase localised overland flow. Where outlet features are installed, these are typically designed to drain 50% of overland flow.

Design Parameters

Flow pathway bunds shall be strategically located to temporarily store overflow flow and designed to attenuate and store enough water to perform their function. Flow pathway bunds shall be constructed across slopes contours to intercept and store overflow flow (Figure 1). Higher bunds are typically required to intercept and store water in steeper gradient settings. Long-term stability of the bund is a principal design factor, with a well-constructed steeply sided-ovelflow providing the best balancing of minimum stall and sediment. Stable bund design can typically be achieved with slopes no steeper than 1 in 1 to the upstream and downstream face (Figure 3). Steeper slopes [Figure 5] may be maintained where earth material is scarce or available. The gentle slope is in height and constructed through the compaction of sub-soil layers approximately 15 deep at a time. Construction with dumpy allows for greater levels of compaction. Flow pathway bund water storage capacity shall typically not exceed 200 m3. A grass seed shall be established over the surface of the bund through re-seed of top soil won from site and top soil adding and mixing. Grass will increase stability and blend the measure into the landscape. Grass species should be tolerant to both dry and wet conditions e.g. smooth meadow-grass or creeping bent, and sown at a rate of 20–25 m2 per m² at the appropriate time of year (typically autumn). A biodegradable geotextile such as coir-matting can be placed over the bund surface in combination with top soil and seeding to add further stability during the grass establishment phase. Trees or shrubs shall be planted on the bund as this may mean increases of stability and an increase failure risk as the trees mature. The design shall consider the requirement for water storage control. This can be preferably achieved through the provision of a point-in-the bund that acts as a spillway, or through the incorporation of more active control measures such as outlet pipes within through the bund (Figure 4 and 5), or French drain beneath. Having control over the rate of release of water from the stored volume can be advantageous in situations where water does not discharge to ground water so storage capacity can be recovered for subsequent events. Where outlet features are installed, these are typically designed to drain 50% of stored water within a 24 hour period. End of pipe scour protection p. tipped stones may also be required to protect walls on the water pathway "downstream" of the bund. Measures to reduce structural damage to well and compaction to the surrounding land from heavy machinery shall be implemented, as this can increase localised overland flow. Where the feature may be susceptible to livestock poaching, fences may be constructed (Figure 4). Bund plan shall consider tree planting needs to avoid damaging root system immediately under and just beyond the crown.

Complementary measures—Offline storage ponds (p. Figure 3) may be constructed "upstream" of a flow pathway bund (p. Figure 1) as they can be used to provide additional storage for water intercepted by the bund. Spot generated from pond evaporation can be used to create an earth bund and reduce material disposal costs.

Maintenance Requirements

Flow pathway bunds constructed from earth typically have a 30 year design life without the need for significant maintenance. A medium level of maintenance is typically required for flow pathway bunds. Visual inspections to check for obvious signs of maintenance or any evidence of minor failures or erosion, which may include cracks or material loss shall be required and repairs undertaken where necessary. Such inspections are best undertaken following significant storm events. Occasional dilapidation and appropriate disposal of accumulated eroding bund soil so "upstream" of the bund may be required as overflow flow pathways can transport sediment, organic matter and other debris. Should pipes be included in the bund design to control water levels then check on their integrity is undertaken in addition to checking any flooding at the pipe outlet point. Seasonal grass cutting or topping is recommended to maintain vigorous growth and prevent the establishment of non-grass species on the bund.

Costs

The construction of a flow pathway bund, including equipment and materials, is typically between £50 and £150 per linear metre. Therefore, a 10 m long flow pathway bund may cost in the region of £500 to £1,500, depending on the ease of access, specific equipment required and availability. Costs at the lower end of the price range are expected where material for bund construction is generated locally e.g. through the excavation of a storage feature such as a pond or lake. If multiple flow pathway bunds are constructed the cost per bund is likely to reduce because the overheads of design and construction will be spread across multiple features. The above costs are indicative of bund construction. If construction is undertaken in a particularly difficult location or planned for a time of year when flooding may be a consideration some should be added. In addition an allowance should be made for additional fencing and maintenance needs. The costs of downstream management and maintenance per annum of construction will be spread across multiple features.

Equipment and Materials

The following is a list of equipment and materials that are typically required in the construction of a flow pathway bund. Equipment

- Tracked excavator—preferably with a toothless tilting bucket head to allow for more compact compaction
- Dumper trucks—duo site movement and tipping
- Spades—for smaller scale bund adjustments
- Hammer—for driving stakes/pins required to a geotextile

Materials

- Earthworks—for construction of bund
- Core matting—for bund stability
- Woodland stakes/pins—for securing feature and core matting
- Seeding—for vegetation development on bund
- Pipes—for outlet structure
- Gravel—for French drain
- Outlet scour protection (e.g. tipped stones)—to protect against erosion "downstream" of the measure.

Consents and Permissions

Permits may be required for flow pathway bunds, especially when these occur within a floodplain, with exact requirements depending on the bund size, storage volume and location. Advice on planning requirements should be sought from the Catchment Advisor. Large bunds in the floodplain often require planning permission accompanied by environmental reporting e.g. an Environmental Impact Assessment (EIA), flood risk statement/assessment and a waste management plan. A flood-risk activity permit from the Environment Agency will be required for works adjacent to or within a floodplain of a main river. Local authorities will advise as to avoid disruption to farm operations or other land uses.

Notes

This Design Specification Sheet is in draft in preparation with the Natural Flood Management (NFM) Pilot in South Oxfordshire. The final draft version will be posted on the National Trust’s Natural Flood Management Measures Booklet, Design Specification and Environmental Impact Assessment Website. Further information and additional reading, see references detailed in the Further ‘Reading’ section.

Health and Safety Considerations

The Construction (Design & Management) Regulations (CDM) 2015 provides a helpful reference for identifying the risks and responsibilities for people involved in the construction process. What the CDM Regulations mean is that everyone, from the design team to the people who carry out the work, should ensure that health and safety at work is available from the Health and Safety Executive publication "Managing Construction Site Health and Safety". Design— The ‘Due diligence’ assessment is required to identify the hazards and evaluate the risk that may arise from the design. Depending upon the hazard, the design management stage appropriate to control the specific risk. Considerations include, but are not limited to, location of services and the need to address the potential for accumulation of flammable and explosive materials (e.g. petrochemical). Designers should take steps to reduce the risk of harm, innovate novel approaches that reduce the risk of harm, and maintain necessary, innovate novel approaches to achieve the necessary construction. Construction—Where hazardous, risk assessments, line of sight procedures and environmentally sensitive management plans shall be produced and adopted by all in advance. Exposed construction shall be as safe as work allows, appropriately named, hold the correct licences/permits for machine operation and take action to appropriate PTS and site supervision. Operations/Maintenance— Working methods. Risk assessments, line of sight procedures and environmentally sensitive management plans shall be produced and adopted by all in advance. Exposed construction shall be as safe as work allows, appropriately named, hold the correct licences/permits for machine operation and take action to appropriate PTS and site supervision. Operations/Maintenance— Working methods. Risk assessments, line of sight procedures and environmentally sensitive management plans shall be produced and adopted by all in advance. Exposed construction shall be as safe as work allows, appropriately named, hold the correct licences/permits for machine operation and take action to appropriate PTS and site supervision.
Purpose of Measure
Offline storage ponds are designed to provide additional areas for water storage within the landscape that fill during a flood or heavy rainfall event. This acts to reduce the volume and rate at which water enters the river network. As an offline measure, the pond does not include within its design a direct connection to an existing watercourse (small ditch, stream or river) or waterbody (pond/flake), through for example, an open channel or a piped connection.

They may be constructed adjacent to a watercourse or outside of the floodplain, to intercept water moving along an overland flow route. They can be designed to permanently hold some water, or as temporary flood storage features which are dry for most of the time. Ponds, both permanent and temporary, can add considerable biodiversity value to the local area. As such, consideration should be given to the ecological design of ponds to maximise opportunities for wildlife where this does not compromise the flood management function of the measure.

Design Parameters
Offline ponds shall be designed on a site-specific basis according to factors such as land use, soil type, existing drainage, local habitats, catchment selling and future maintenance requirements. Ponds may be designed as a single feature (Figure 1 and Figure 2) or as a connected chain of ponds (Figure 3). Ponds may utilise an outlet structure or spillway to convey flow out of the pond or between individual pond features should overflow be a strong possibility. This outlet feature or spillway shall include scour protection.

Pond sizes vary, however most are between 100 – 400 m² with a depth up to 1.5 m. Size will be governed by access, availability of space, volume needed for water storage and ease of build. Where filled in pond features are present in the landscape their remnant/retain should be considered. Ideally, remnant ponds should not be excavated beyond their original size and depth profiles for historical and ecological reasons.

Pond design shall ensure safe egress in the event of entering the pond through provision of appropriate bank slopes (no steeper than 1:3). Ponds potentially accessible to the public (i.e. near to footpaths) may need further measures such as warning signs and/or exclusion fencing. Ponds can either permanently or temporarily hold water. Ponds designed to hold water throughout the year must provide additional capacity to hold storm water. Temporary ponds are typically designed to drain within a short-term period, to ensure their storage space becomes available for longer duration rainfall events over multiple days. Lining of ponds is best avoided, especially for temporary ponds as infiltration to ground is an important flood reduction feature. An assessment of the suitability of the ground to retain water should be undertaken.

Additional storage can be created through building around a pond that rises up to high-ground levels. Should bunding be undertaken (as shown in Figure 1) it must not result in more than 200 m² of additional above ground storage.

The ability for ponds to provide additional biodiversity to the local area should be considered in the design e.g. provision of variable depths, slopes and islands. Excavation of the pond will generate spoil material. Any design will need to consider how and where this material will be used. An Environmental Impact Assessment (EIA) and a waste management plan should be considered as this is the most sustainable and cost effective option. Spoil re-use opportunities will be dependent on the materials properties and potential for contaminate to be present so should be investigated as part of the design process.

Complementary measures – A complex system can be implemented. In which both offline and online storage ponds (FR02.2) can be utilised to generate flood control water. Store from pond excavation can be used to build a flow pathway bund (FR02.1) around the pond to increase storage capacity and reduce disposal costs. In channel leaky barriers (WC01.1) may also be constructed in proximity to an offline storage pond to encourage water spill from a watercourse channel for storage within the offline pond. Planting cross slope avoids & hedgerows (LM01.2) adjacent to offline storage ponds can also be beneficial to reduce the surface and further attenuate flow.

Maintenance Requirements
Offline storage ponds typically have a 10 year design life at optimum functionality, without the need for significant maintenance.

A medium level of maintenance is required for storage ponds, including regular checks for settlement build-up in the base of the pond (especially where unfenced and open to poaching) as this can reduce storage capacity and effectiveness over time. Occasional desertion and appropriate disposal of accumulated sediment may be required. This may be of higher importance in the pond design includes an outlet feature, to ensure biofilms do not occlude. Typically, maintenance is low whilst the pond feature is establishing, through vegetation growth and water filling.

Permanent storage ponds typically have a greater maintenance requirement than temporary storage ponds.

Cost
Construction of offline storage ponds is costing between £10 and £50 per m² of excavation (including equipment, materials and labour costs). However, in most cases the construction cost will be towards the lower end, assuming simplistic pond design, limited removal of soil and limited consenting requirements. There will be additional costs associated with this.

The above cost estimates therefore cover a ‘fair weather’ construction. If construction is undertaken in a particularly difficult location or planned for a time of year when weather may be inclement a contingencies should be added. In addition an allowance should be made for pre-construction activities and maintenance. The cost of design, planning and consenting before construction typically amounts to be 15% of total construction cost. A typical allowance for maintenance costs is 10% of construction cost for each year a structure is in operation. For an example of typical maintenance requirements, see the ‘Maintenance Requirements’ section.

Consents and Permissions
Consents are often required for offline storage ponds, with exacting requirements depending on the pond size, storage volume and location.

Large ponds may require planning permission from the local planning authority, with the permission request accompanied by environmental reporting e.g. Baseline Ecological Appraisal (BEA). A flood risk permit from the Environment Agency will be required for works adjacent to or in the floodplain of main river. Ponds located adjacent to or/and after the flow of an ordinary watercourses may need land drainage consents from the Land Drainage Authority (LDA) or Internal Drainage Board (IDB).

Pre-regulatory assessments will need to be considered in project planning to ensure that specific inspection and maintenance requirements can be undertaken safely. As with the construction phase, inspections and maintenance can be undertaken by trained individuals. During operation ensure that any interfaces with the public are appropriately controlled and monitored.

Further Reading
For further information on offline storage ponds refer to the following sections within the References (REFS.X) specification sheet:

- Measure Specific—FR02.1: Offline Storage Pond—reference 1
- Consents and Permissions—reference 8, 7, 8, 9, 10, 11, 13 and 14

Notes
This Design Specification Sheet is to be read in conjunction with the Natural Flood Management Fund Handbook for Terms & Conditions governing participation in the NFM Fund (https://catchmentbasedapproach.org/learn/HE) and the NFM Fund Handbook for Terms & Conditions governing participation in the NFM Fund (https://www.naturalfloodmanagementframework.org.uk).

Cost
Costs are based on available information from a range of sources relating to the measure. Costs should therefore be treated as a guide only. For further information please refer to the Natural Flood Management Fund Handbook for Terms & Conditions governing participation in the NFM Fund (© Atkins Ltd) or reference 1.

Health and Safety Considerations
The Construction (Design and Management) Regulations (CDM) 2015 provide a helpful reference for identifying the roles and responsibilities for people involved in the design and construction of measures associated with this measure during its design life. Refer to the Natural Flood Management Fund Handbook for Terms & Conditions governing participation in the NFM Fund (© Atkins Ltd) or reference 1.

Health and Safety Considerations
The Construction (Design and Management) Regulations (CDM) 2015 provide a helpful reference for identifying the roles and responsibilities for people involved in the design and construction of measures associated with this measure during its design life. Refer to the Natural Flood Management Fund Handbook for Terms & Conditions governing participation in the NFM Fund (© Atkins Ltd) or reference 1.

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Purpose of Measure

Online storage ponds are water storage measures that are hydraulically connected to a watercourse via ditches (Figure 1), pipes, or within the watercourse channel itself (Figure 2). Online storage ponds are designed to slow the flow of water and store additional water during and initially after a storm event.

Online storage ponds can be designed to permanently hold water, or as temporary flood storage features which are dry for some of the time. Ponds, both permanent and temporary, can add considerable benefits to the local area. As such, consideration should be given to the ecological design of the pond to maximise opportunities for wildlife where this does not compromise the flood management function of the measure.

Design Parameters

Online ponds shall be designed on a site-specific basis according to factors such as land use, soil type, existing drainage, local habitats, catchment setting and future maintenance requirements. Ponds may be designed as a single feature (Figure 2) or as a connected chain of ponds (Figure 3). Ponds often require an outlet structure (spillway) to convey flow out of the pond or between individual pond features should overtopping or drying of the stream system be a strong possibility. This outlet feature or spillway may include scour protection, such as a gravel apron (Figure 1) or rip-rap armour spillway (boulders materialising). It is important to consider the pond size and layout and review Figure 2 and Figure 3 to understand the components of a pond and the consideration required. Ponds vary, however, are most commonly between 100 - 400 m² with a depth up to 1.5 m. Size will be governed by access, available space, volume required for water storage and ease of build, as well as watercourse character such as width, flow velocity and bank height. Ponds of greater dimensions and storage capacity are possible, however, in all instances the pond will need to be designed by a suitably qualified professional

Ponds potentially accessible to the public (i.e. near to footpaths) may need further measures such as warning signs and/or erosion fencing. It may also be possible to create additional flood storage within the pond by building bunds—however the bund and associated outlet structure must not prohibit passage of fish or result in more than 200 m² of additional above ground storage. Ponds can either permanently or temporarily hold water. Ponds designed to hold water throughout the year may promote additional capacity to hold storm water. Most online ponds will hold some water throughout the year, to act as an NFM feature they must be built to provide temporary additional flood storage i.e. not be permanently full. The flood storage component of a pond’s capacity needs to drain down within 48 hours to provide storage for subsequent rainfall events. Lining of ponds is best avoided as infiltration to ground is an important flood reduction feature. However, if the local ground water infiltration to the pond is not optimal (likely of too much or too little filling) a pond liner may be required.

Excavation of the pond will generate spoil material. Any design will need to consider how and where this material will be managed. The preference should always be local re-use e.g. for local agricultural benefit, as this is often the most sustainable and cost effective option. Spposed re-use opportunities will be dependent on the material’s properties and potential for contaminants to be present—both should be investigated as part of the design process.

A key multiple benefit of ponds is additional biodiversity. In particular, ponds with shallow side slopes and varied depths generate habitat complexity. Re-seeding of banks or islands with native species may be required to support vegetation re-growth and bank stability.

Complementary measures—A complex system can be implemented, in both which online and offline storage ponds (FR01.1) can be connected to manage flood water. In-channel boundary features (WC01.1) may be constructed in proximity to an online storage pond to encourage water splash from a watercourse channel for storage within the pond, before entry back to the watercourse. Spill generated from pond excavation can be used to create a flow pathway bund (FR01.2) in adjacent land to allow surfactant overflow before entering the watercourse or online storage pond.

Maintenance Requirements

Online storage ponds typically have a 10 year design life at optimum functionality without the need for significant maintenance. A medium to high level of maintenance is required for storage ponds, including regular checks for sediment build-up on the base of the pond (especially where unfenced and open to poaching) as this can reduce storage capacity and effectiveness over time. Occasional dredging and appropriate disposal of accumulated sediment may be required. This may be of higher importance if the pond design includes an outlet feature, to ensure blockages do not occur and fish passage is not impaired. Any spillways or other outlet structures e.g. pipes, may also need checking routinely, to check for signs of erosion and removal of any blockages that may be preventing water drainage back into the watercourse.

Permanent storage ponds typically have a greater maintenance requirement than temporary storage ponds.

Cost

Construction of online storage ponds is based on £10 and £50 per m² of excavation (including equipment, materials and labour costs). However, in most cases the construction cost will be towards the lower end, assuming simplistic pond design, limited removal/dredging of soil and limited consenting requirements. Higher costs may be observed where ponds are adjacent to main rivers (due to consenting requirements) and where more complex designs (including outlet structure requirements) are used. There will be additional costs associated with any requirements to spread or remove spoil.

The above cost estimates cover a basic water management solution. If construction is undertaken in a public/park area, as a flood alleviation measure or in a difficult location or planned for a time of year where weather may be inclement a contingency should be added. In addition an allowance should be made for pre-construction activities and maintenance. The cost of design, planning and consenting, and construction can be 60% of construction cost. A typical allowance for maintenance costs is 10% of construction cost for each year a structure is in operation. For an example of typical maintenance requirements, see the “Maintenance Requirements” section.

Environmental and Materials

The following is a list of equipment and materials that are typically required in the construction of an online storage pond:

Equipment:

- Tracked excavator—preferably with a toothless lifting bucket head to minimise soil disturbance
- Tracked dumpers—for spoil movement and tipping
- Lowes—should off site spoil disposal be required
- Water pumps—for dewatering excavations

Materials

- Outlet screen protection—to prevent against erosion downstream of the measure
- Pond liner (sheeting/laying)—should the pond be required to permanently hold water and infiltration to ground undertaken
- Seeding/soil—materialising to facilitate vegetation re-establishment in working area

Notes

This Design Specification Sheet is to be read in parallel with the Natural Flood Management Fund Handbook for flood risk and the following sections of the Fund Handbook for Terms & Conditions governing participation in the Fund

Maintenance and Liability

The landowner shall be responsible for the implementation and maintenance of the online storage pond. Ponds are only eligible for participation in the Fund if they have source protection, such as a gravel apron (Figure 1) or rip-rap armour spillway (boulders materialising). The landowner will be responsible for all costs, including the cost of setting up the pond, the cost of its maintenance, and the cost of any repairs, and must also maintain the pond. The landowner will also be responsible for ensuring that the pond is not compromised by the flood management function of the measure.

Equipment and Materials

The list provided within the “Equipment and Materials” section is typical of the materials that may be used where ponds are site specific and where more complex designs (including outlet structures) are required. For standard ponding scenarios, the risk characteristics and material availability, therefore, the list should NOT be considered exhaustive.

Consents and Permissions

The information provided is NOT exhaustive but includes guidance on common requirements for the measure. For further consenting and geographical location specific requirements, please contact your local planning authority and/or Environment Agency. The landowner shall be responsible for identifying the roles and responsibilities for design, funding and implementation. The landowner shall be responsible for ensuring that they have access to appropriate PPE and on-site training. A Waste Management Plan and Exemption Agreement or Licence may be required for management of spoil generated by excavating a pond.

Consents will be required for online storage ponds, with exact requirements depending on the pond size, volume and location.

Large ponds may require planning permission from the local planning authority, with the permission request accompanied by evidence of a feasibility study. Dependent upon the design, planning permission may include a detailed risk assessment to identify whether the pond will need to be deemed an “infiltration pond” or a “detention pond”. Therefore, consideration of planning requirements is necessary. Environmental Impact Assessment (EIA) and a waste management plan and Exemption Agreement or Licence may be required for management of spoil generated by excavating a pond.

Further Reading

For further information on online storage ponds refer to the following sections within the References (REFS) specification sheet:

General references 2, 3 and 7

Measure Specific—FR02.2 Online Storage Pond—see specific references for “FR02.1. Offline Storage Pond” Consent and Permissions—references 6, 7, 8, 9, 10, 11, 13 and 14

FR02.2: Online Storage Pond Pond

Figure 3. Online storage pond with adjacent tree planting as part of the Everglades NFM scheme (© Everglades Fish Trust)

Figure 2. An online storage pond within the channel, complete with rip-rap armour spillway (© Newcastle University)

Figure 1. Online storage pond features at Almondsbury Farm, complete with an armoured spillway (© Atkins Ltd)

Figure 2. An online storage pond within the channel, complete with a rip-rap armoured spillway (© Newcastle University)

Figure 3. Online storage pond with adjacent tree planting as part of the Everglades NFM scheme (© Everglades Fish Trust)

Figure 2. An online storage pond within the channel, complete with rip-rap armoured spillway (© Newcastle University)

Figure 1. Online storage pond features at Almondsbury Farm, complete with an armoured spillway (© Atkins Ltd)

Figure 2. An online storage pond within the channel, complete with a rip-rap armoured spillway (© Newcastle University)

Figure 3. Online storage pond with adjacent tree planting as part of the Everglades NFM scheme (© Everglades Fish Trust)
FR02.3: Swales

Purpose of Measure

Swales are artificial linear depressions/ shallow channels that act to capture, temporarily store and occasionally redirect overland flow and may be particularly effective when positioned in proximity to impermeable surfaces such as farm yards or tracks, or other surfaces that promote overland flow.

Vegetated swales increase roughness that slows the flow within the channel, which may be important should the swale be acting to direct water towards a storage area. Through attenuating and storing water, swales can promote water infiltration into the soil and can work to settle out pollutants and sediment, reducing the transfer of these to the drainage network and downstream watercourses. Swales can add biodiversity value through the provision of habitats in the local area. Through the attenuation and settling of sediment and pollutants, local water quality may also be improved through the creation of swales.

Therefore, consideration should be given to the ecological design of ponds to maximise opportunities for wildlife where this does not compromise the flood management function of the measure.

Design Parameters

Swales are best targeted at improving/ improved grassland or arable margins and should be designed to take into account existing land use and access requirements. Land characteristics such as slope and contours must be considered to ensure the swale can capture and attenuate overland water flow, by constructing along contours so as not to create preferential flow pathways to watercourses.

Swales are typically appropriate for sloping fields (not steeper than 1:8) where they follow existing contours. The likely rate of runoff from the land must be considered to ensure the swale is of sufficient length, depth, width and orientation to intercept and provide effective storage. Swales shall have bank slopes not steeper than 1:3 to provide stability, aid in maintenance and allow for safe access. Swale bay widths typically range from 1 m to 3 m (Figure 2), with a maximum depth to width ratio of 1.5. Depths of swales typically as the slope and size of land producing runoff increases.

Excavation of the swale will generate spoil material. Any design will need to consider how and where this material will be managed. The preferences should always be local re-use as this is often the most sustainable and cost effective option. Spot re-use opportunities will be dependent on the material's properties and potential for contamination to be present—both should be investigated as part of the design process. A simple option is to use the spoil on the downslope of the swale to slightly raise ground levels (nominally 300—400 mm) to provide additional storage capacity (Figure 3).

Lining of swales is not required as infiltration is an important flood reduction feature of the measure. Swales shall not be designed to direct flow towards the local drainage/watercourse network without attenuation. They can be designed as isolated features or to drain/ connect to other NFM storage measures such as off-line ponds (FR02.1). Connecting storage areas with swales can act to ensure the swale function is maintained for longer periods during rainfall events. Consideration will be required to the erosional potential of water moving to storage area with appropriate erosion protection provided. Following construction the swale shall be left to revegetate naturally where possible. It is recommended that turf be stripped from the working area prior to excavation and translocated to areas of bare ground created by the works, such as an low level downslope bund. Re-weathering with an appropriate grass mix can also be used to encourage vegetation development, which can further promote infiltration and run-off control. Swales potentially accessible to the public or livestock may need further measures such as exclusion fencing (Figure 3) and/or crossing provision.

Complementary measures—Material generated from swale excavation can be used to create other connected measures such as free path/ primary bunds (FR02.1.2), which will act to reduce material disposal costs. Cross-slope woodland & hedgerows (LMH.2) may be planted downslope of a swale to enhance infiltration and interrupt overland flow (Figure 2). Off-line storage ponds (FR02.2) can be hydraulically connected to swales and used to store water attenuated by the swale.

Maintenance Requirements

Swales typically have a 70 year design life at optimum functionality without the need for significant maintenance. A low level of maintenance is required for swales, typically on an annual basis, including the removal of debris, which may reduce storage capacity, as well as vegetation management (cutting/controlled grazing) and removal of nuisance weeds that may have become established.

Where swales are connected to storage areas, these may need routine checks for signs of erosion and/or the removal of any blockages. If appropriate to the drainage network, maintenance shall be also be required to ensure the signs of erosion within the swale and along downstream bund. Should any signs of failure or excessive erosion be observed, repairs will be required. Any fencing, crossing structures/ infrastructures of way will also be maintained.

Cost

Construction of swales is typically costed between £20 and £70 per linear metre, including equipment, materials and labour costs. In most examples, the construction figure will be towards the lower end of this estimate, assuming the spoil disposal for the measure can be managed on site. Off-site spoil disposal would be considerably more expensive.

Where swales are connected to storage areas, these may need routine checks for signs of erosion and/or the removal of any blockages. If appropriate to the drainage network, maintenance shall be also be required to ensure the signs of erosion within the swale and along downstream bund. Should any signs of failure or excessive erosion be observed, repairs will be required. Any fencing, crossing structures/ infrastructures of way will also be maintained.

Further Reading

For further information on swales refer to the following sections within the References (REFS.3): specification sheet

General—reference 2, 9, 10 and 11

Consen’s Specific—FR02.3: Swales—references 1, 2, 3, 4, 5

Consents and Permisssions—references 6, 7, 9, 10, 11 and 14

Notes

This Design Specification Sheet is to be read in conjunction with the Natural Flood Management Measures Booklet, Design Specification (IDB). For further information and additional reading, see references detailed in the ‘Further Reading’ section.

Design Considerations

This sheet is for design information only and is NOT to be used as a ‘fit for construction’ package. When specific design parameters are required these should be established.

Maintenance and Liability

The landowner shall be responsible for the implementation and maintenance of the measures and their land shall be liable for any costs, including the cost of restoration of the land should the measure be removed, if required. Further details of the ‘Flood Fund Handbook for Teen & Conditions governing participation in the Fund’ are available from the Catchment Advisor (© Atkins Ltd) (REFS.X)

Cost

Costs are based on available information from a range of sources relating to the measure. Costs should therefore be treated as a guide only. For further information about the additional reading, see references detailed in the ‘Further Reading’ section.

Conents and Permissions

The information provided in a NFM an exhaustive list but includes guidance on common requirements for the measure. For further consenting and permission details please make contact with the Catchment Advisor on common requirements for the measure. For further consenting and

Health and Safety Considerations

The Construction (Design and Management) Regulations (CDM) 2015 provide a helpful reference for identifying the roles and responsibilities for people involved in the NFM construction process and what checks, tests and inspections are required to ensure health and safety.”

Design

A joint site assessment is required to identify the hazards and evaluate the risk that may arise from the design. Dependent upon the hazard, the design must allow provision be made to reduce or remove the risk. Considerations include, but are not limited to, location of services and public rights of way, flood risk, accessibility for machinery, ways in which the design can reduce the risk of injury, vegetation, wildlife, native- non-native species presence and future maintenance

Construction

Working method references, risk assessments, hierarchy procedures and environment management plans shall be produced and ad

Operation/Maintenance

Post-construction strategies will also need to be considered in project planning to ensure that specific inspection and maintenance requirements are included in the future operational management of the measure.

Akins

The Hub

Almondbury

Bristol, BS32 4RZ

Highways England

NFM Pilot

Project title

Highways England

Drawing title

FR02.3: Swales

Scale

Drawing no.

Date

Client

Design

Review

A3

15/10/20

5158157/7.9.2.1/DG/FR02.3

16/03/21

IPM

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18/12/20

Bristol, BS32 4RZ

Atkins

Aztec West

Figure 1. Cross-slope swales constructed along land contours to reduce overland flow to the road network (© Atkins Ltd)

Figure 2. Recently constructed cross-slope swale at field edge with free-piping, as part of the Evelooke NFM scheme (© Dean Gucca-Tucker)

Figure 3. Recently constructed cross-slope swale prior to vegetation establishment (© West Country Rivers Trust)
In-channel Leaky Barriers are designed to intercept and slow the flow of water within a permanently or intermittently flowing watercourse. Water is held back behind the barrier and may be encouraged onto the floodplain, where it can be stored within complementary natural food management measures, or allowed to naturally drain back to the watercourse after the flood levels recede. Leaky barriers typically only become active during high flow events, with low flows not being affected by the structure. Leaky barriers are most suited to small watercourses that have been historically stream lined, re-aligned and in locations where storage will not cause a risk to people/property, structures or existing landuse.

In-channel leaky barriers have multiple benefits, including improvements to water quality, reduction of sediment transfer and enhanced local biodiversity through increased flow variation and the provision of more habitats supporting fish, plants and invertebrates around the woody features.

**Design Parameters**

In-channel leaky barriers shall be designed on a site-specific basis depending on watercourse width, banks height and flow conditions, along with location within the catchment and adjacent land-use. In-channel leaky barriers are typically designed for smaller channels, not greater than 3 m in width. Installation in channels larger than 3 m is possible, but these would need to be informed by a more detailed design approach. In upland areas, woody bundles may be a more applicable measure (see WC02).

In-channel leaky barriers are typically constructed from large wood (normally 300 mm diameter) and/or large branches as the key construction material, with smaller branches and boulders intended to manage permits (Figure 1 and Figure 2). Positioning of the barrier shall be perpendicular to the water flow. The length of the large wood foundations shall not be less than 1.5 times the channel width to provide barrier stability, and shall be secured by, or within boulders/packing on tank top. The number of timbers and exact method of securing will be specific and based on factors such as the size of the wood, likely mobilisation of channel and floodplain roughness and risk to downstream assets.

Leaky barriers shall be installed individually, or in series where effectiveness may be increased. The spacing between barriers will be determined by the channel height overtopping range, but is typically 5 to 10 times channel width. Barriers are not to be installed immediately upstream of a structure e.g. a bridge, culvert or outfall, so as to reduce the risk to assets should wood become mobilised. The following rule shall apply in relation to the permitted distance of installation from a structure: no barrier shall be installed within a distance that is less than 3 times the channel width, as measured at the location of the barrier.

The height placement of leaky barriers will depend on the channel depth as normal base flows shall be allowed to pass under freely, ensuring the barriers only become active at sloping the flow during the rising peak of flow events (Figure 3 and Figure 4). So as to reduce velocities.

**Equipment**

Construction of in-channel leaky barriers is costed between £500 and £2,000 per barrier, including costs for equipment, materials and time. Despite this large range, costs may typically be at the lower end of this scale, with higher costs coming with increased complexity of construction. Smaller, more simple features in accessible areas will generally cost £500. In structurally less complex designs, installation within secondary areas (e.g. slow flowing, white water channels) may not be possible due to the inherent risk of construction.

In-channel leaky barriers are constructed using materials that have been selected to ensure that materials are not degraded or washed away in flood events. The use of woody materials, or materials that are found on site, is encouraged to reduce costs and improve community ownership.

**Equipment and Materials**

The following is a list of equipment and materials that are typically required for construction of an in-channel leaky barrier.

**Equipment**

- Digger and operator—for manoeuvring large wood and excavation of bankslot trenches if required
- Wheelbarrow/hoop—that for manoeuvring and positioning of wood over 25 kg
- Spades—for digging of slot trenches
- Fence post driver—for driving fence stakes

**Fencing tools** to secure the barrier
- Chain—with to tie logs and yield woody material

**Materials**

- Large woodlogs/plants—for main structural component
- Fitting stakes—to secure the barrier in place
- Wire and staples—to attach barriers to fittings
- Small branches/brushwood—to pack feature

**Transport**

- To move the barrier into the construction

**Further Reading**

For further information on offline storage ponds refer to the following sections within the References (REFS.X) specification sheet

General—All general references

Measure Specific—WC01:1—In-channel Leaky Barrier—references 1, 2 and 3

Consents and Permanence—references 1, 2, 3, 6, 10, 11, 13 and 14

**Consents and Permissions**

Works within a watercourse will require consents from relevant authorities. Should the barrier be constructed in a main river channel, then a flood risk activity environmental permit or proof of exemption from the Environment Agency will be required. In-channel leaky barriers constructed in ordinary watercourses will require flood defence consents from either the Local Flood Authority (GLA) or the Internal Drainage Board (IDB).

Should trees need to be felled locally for the construction of an in-channel leaky barrier, a tree-felling licence may be required from the Forestry Commission or the relevant local authority.

Surveys may be required to confirm the presence or absence of protected species in the local area, which if found, may require protected species mitigation measures from Natural England.

**Notes**

This Design Specification sheet is to be read in conjunction with the Design Specifications and relevant REFUS.X (Openreach) Design Specification 2015, for full design parameters, details and an example design.

For further information or specific enquiries with regards to this specification, these should be directed to the Design team.

**Maintenance and Liability**

The landowner shall be responsible for the installation and maintenance of any leaky barriers or other measures for controlling in-channel flows. Any costs for such measures will be covered by the landowner.

**Environment**

The benefits of this measure include the ability to control/contain in-channel flows; and possibly improving the quality of water through increased flow variation, while also improving local biodiversity.

**Equipment and Materials**

The list provided within the ‘Equipment and Materials’ section is typical for the measure flow. Equipment and materials usage will vary for design site characteristics and material availability, therefore, this list should not be taken as equipment costs.

**Health and Safety Considerations**

The Construction (Design and Management) Regulations (CDM) 2015 provide a helpful reference for identifying the risks and responsibilities for implemented measures and facilitate a risk assessment route to provide a safe and healthy environment. Safety and health in the workplace is the responsibility of all employers and employees. Employers must provide a safe and healthy workplace and employees must cooperate with employers to maintain a safe and healthy workplace.

**Design**

A risk assessment is required to identify the hazards and evaluate the risks that may arise from the design. Dependent upon the design, the design should ensure objectives such as minimising or removing the risk. Considerations include, but are not limited to, location of services and access, including the need to access, safety, accessibility for machinery, water flows and transport of materials. The design should also consider potential impacts from other land uses or other businesses.

**Construction**

Working method statements, risk assessments, management procedures and environmental management plans shall be provided and addressed to the construction phase, prior to the start of all work, accordingly trained. hold the correct licence/patents for machine operation and have all the correct permits and site welfare.

**Operation/Maintenance**

Regular inspections will also need to be considered in project planning to ensure that specified inspection and maintenance requirements are covered on site. Maintenance should be carried out on a regular basis, to ensure that the construction phase, and any subsequent benefits.

**Client**

Highways England

**Project title**

Highways England NFM Pilot Project

**Drawing title**

WC01.1: In-channel Leaky Barriers

**File name**

51581577.0 2 TDWC01.1 3 (2.0)
**Figure 4.** Example conceptual design for headwater channel woody bundles (© Atkins Ltd).

**Consents and Permits**

As headwater channel woody bundles are targeted at temporarily (ephemeral) flowing channels/gullies in the upper catchment, it is considered unlikely that they will require planning consent or environmental impact assessment or be subject to the requirements of the Marine (Conservation) Regulations 2019. However, they may be subject to the terms of the relevant local authority’s regulations as to their permitted use and as such will require flood defence consents from the Local Flood Authority (LFA) and Internal Drainage Board (IDB). To avoid any risk of damage to natural habitats, invasive non-native species and future maintenance difficulties, the landowner shall be responsible for the implementation and maintenance of the NFM measures on their land and will hold the liability for said consents and permissions. Costs should therefore be treated as a guide only. For further information and additional reading, see references detailed in the Further Reading section.

**Notes**

This Design Specification Sheet is to be read in conjunction with the Defra NATURA 2000 NFM Pilot Project Design Guidelines (CD 5069/558-FM) website: [https://www.farmersnaturefund.org.uk](https://www.farmersnaturefund.org.uk).

**Equipment and Materials**

The following is a list of equipment and materials that are typically required for construction of a headwater channel woody bundle.

**Equipment:**
- Winches/strops/hoists — for manoeuvring and positioning of woody bundles
- Fence post driver/hedge hammer — for driving fixing stakes
- Fencing tools — to secure the bundle
- Chainme — to fell trees and yield woody material

**Materials:**
- Large wood/bundles — for main structural component
- Fixing stakes — to secure the bundle in place
- Wire and staples — to attach bundles to fixings

**Further Reading**

For further information on headwater channel woody bundles refer to the following sections within the References (REFS3X) specification sheet:
- General reference 7
- Measure Specific — WC01.2: Headwater Channel Woody Bundles — no specific references

**Consorts and Permissions**

The information provided is NOT an exhaustive list but includes guidance on common requirements for the measure. For further consulting and consent-related advice, please contact the Catchment Advisor on common requirements for the measure. For further consenting and permitting advice, please make contact with the Environment Agency or the relevant local authority.

**Health and Safety Considerations**

The Construction (Design and Management) Regulations (CDM) 2015 provide a helpful reference for identifying the risks and responsibilities for people involved in the design and construction process and what is needed to manage those risks and responsibilities. Relevant CDM core documents can be accessed from the Health and Safety Executive (HSE) website.

**Maintenance and Liabilities**

The landowner shall be responsible for the implementation and maintenance of the NFM measure on their land and will hold the liability for said consents and permissions. For further information and additional reading, see references detailed in the Further Reading section.

**Equipment and Materials**

The list provided within the ‘Equipment and Materials’ section is for the measure type. Equipment and materials required may vary by design, scale characteristics and material availability, therefore, the list should NOT be taken as exhaustive.

**Consents and Permits**

This sheet is for design information only and is NOT to be used as a final design specification. Where specific design parameters are specified in the measure, these shall be specified. Further information and additional reading, see references detailed in the Further Reading section.

**Equipment and Materials**

The list provided within the ‘Equipment and Materials’ section is for the measure type. Equipment and materials required may vary by design, scale characteristics and material availability, therefore, the list should NOT be taken as exhaustive.

**Cost**

The cost of design, planning and consenting before construction should be treated as a guide only. For further information and additional reading, see references detailed in the Further Reading section.

**Further Reading**

For further information on headwater channel woody bundles refer to the following sections within the References (REFS3X) specification sheet:
- General reference 7
- Measure Specific — WC01.2: Headwater Channel Woody Bundles — no specific references

**Consorts and Permissions**

The information provided is NOT an exhaustive list but includes guidance on common requirements for the measure. Further consulting and consent-related advice, please contact the Catchment Advisor on common requirements for the measure. For further consenting and permitting advice, please make contact with the Environment Agency or the relevant local authority.

**Health and Safety Considerations**

The Construction (Design and Management) Regulations (CDM) 2015 provide a helpful reference for identifying the risks and responsibilities for people involved in the design and construction process and what is needed to manage those risks and responsibilities. Relevant CDM core documents can be accessed from the Health and Safety Executive (HSE) website.

**Maintenance and Liabilities**

The landowner shall be responsible for the implementation and maintenance of the NFM measure on their land and will hold the liability for said consents and permissions. For further information and additional reading, see references detailed in the Further Reading section.

**Equipment and Materials**

The list provided within the ‘Equipment and Materials’ section is for the measure type. Equipment and materials required may vary by design, scale characteristics and material availability, therefore, the list should NOT be taken as exhaustive.

**Consents and Permits**

This sheet is for design information only and is NOT to be used as a final design specification. Where specific design parameters are specified in the measure, these shall be specified. Further information and additional reading, see references detailed in the Further Reading section.

**Equipment and Materials**

The list provided within the ‘Equipment and Materials’ section is for the measure type. Equipment and materials required may vary by design, scale characteristics and material availability, therefore, the list should NOT be taken as exhaustive.
Moorland and peatland landscapes can be highly responsive to rainfall events especially where they exhibit artificial grip and gully drainage channels. The rapid drainage from moorland areas can contribute to high flow rates and flooding in downstream watercourses. Moorland grip and gully blocking involves the construction of small in-channel structures to hold and slow down maintaining storage for subsequent events. Where dams are likely to be overtopped, or designed to be "leaky" through pipe installation, then scour protection is typically required to prevent erosion and undercutting of the downstream side of the dam. Scour protection may be in the form of rock or coir matting to overlay the peat and provide protection. Where multiple dams are being installed (Figure 1 and Figure 4), a top-to-bottom principle approach can be taken ensuring the base of the upstream dam is at least level with the top of the downstream dam to prevent over-topping on to bare peat soil. This may not be required if leaky dams are constructed. However, as the gradient of gully or peat increases, dams shall be constructed in smaller intervals to reduce erosion in each section.

The use of existing peat is not feasible, alternative approaches shall be considered such as the use of wooden drop boards (Figure 2) or stone check dams (Figure 3). Should stone or wooden dams be required, consideration must be given to the material origin and additional costs associated with procurement and transport to site. Any vehicular/machinery access that is required to undertake the work must be planned and must avoid damaging peatland, moorland habitats and associated species. For existing peatland the dam shall be constructed within the design process (as highlighted by the peatland classification and National Peat Map).

Maintenance Requirements
Moorland grip and gully blocking using peat dams typically has a 5-10 year design life at optimum functionality without the need for significant maintenance. A low level of maintenance is typically required for moorland grip and gully blocking. Maintenance may include the checking of vegetation establishment and its encroachment where necessary, regular inspection and maintenance activities shall only be undertaken by appropriately trained individuals. During operation ensure that any interfaces with the people involved in the design and construction process and what is required to identify the hazards and evaluate the risk. Considerations include, but are not limited to, location of services and public rights of way, Health and Safety Executive (HSE) guidance, Water Framework Directive (WFD) requirements and impact on the environment. Decision-making, innovative non-native species presence and future maintenance needs.

Equipment and Materials
The following is a list of equipment and materials that are typically required in the construction of a peat dam.

- Pipes—for "leaky" dams if designed to pass-through flow
- Outlet scour protection—e.g. rock or coir matting to protect against erosion of the peat downstream of the dam
- Seeding/planting—to facilitate vegetation re-establishment in working area

Notes

Cost
Costs are based on available information from a range of sources relating to the measure. Costs should therefore be treated as a guide only. For further information on the "leaky" blocking methods see Figure 4. A full design should be undertaken to ensure that the design is appropriate for the local conditions and the design for the project is appropriate for the site.

Health and Safety Considerations
The Construction (Design and Management) Regulations (CDM) 2015 provides a helpful reference for identifying the risks and responsibilities for people involved in the design and construction process for what is referred to as "leaky" blocking. The Health and Safety Executive (HSE) guidance and Health and Safety legislation is available from the Health and Safety Executive (HSE) guidance.

Client
Highways England

Project title
Highways England NFM Pilot

Consents and Permissions
Large areas of moorland are designated as open access land and therefore any works may require Public Rights of Way and Open Access consents from the County Council or relevant local authorities. If any works are being completed that may impact public right of way or the people using it, then additional consents and safety plans may be required.

Further Reading
Further information on moorland grip and gully blocking refer to the following sections within the References (REFS.X) specification sheet:

Measure Specific—WC01.3: Moorland Grip and Gully Blocking—references 1, 2, 3, 4 and 5
Consents and Permissions—references 9 and 14
### Purpose of Measure
(Detail the design intent and application of the flood reduction measure)

#### Design Parameters
(Detail the location of the measure, its key design parameters (e.g. size and volume), material requirements and the management of constraints and opportunities through the design process)

#### Maintenance Requirements
(Detail how the feature will be maintained e.g. what activities will be needed to ensure the measure continues to meet its designed purpose)

#### Cost
(Include a summary of costs for the measure — separated into pre-construction activities (e.g. design and planning), construction activities (e.g. equipment, materials and labour) and post construction activities (e.g. maintenance and monitoring))

#### Equipment and Materials
(List out separately equipment and materials required to construct the measure)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add details and additional bullets as required</td>
<td>Add details and additional bullets as required</td>
</tr>
</tbody>
</table>

#### Further Reading
(Add any additional sources detailing further information about the measure)

For a list of general sources available, please see the “Further Reading” section in the main handbook.

#### Consents and Permissions
(Detail consents and permissions that are likely to be required to construct the measure)

For a list of potential consents and permissions required, please see the “Consents and Permissions” section in the main handbook.

#### Health and Safety Considerations
Include for the following phases: Design, Construction and Maintenance (see design sheets for detailed measures for more information)

- Health and Safety Considerations

### Notes
Include name of originator/organisation responsible for production of this alternative ideas specification sheet

In order to complete this sheet, an electronic version may be required.

Include any notes here relating to the measure, noting that this sheet is NOT be used as a “fit for construction” final design specification and therefore may contain only draft designs.

Notes can include details on, but not limited to the costs, equipment and materials, and consents and permissions (see design sheets for detailed measures for more information):

#### Atkins
The Hub
500 Park Avenue
Aztec West
Almondsbury
Bristol, BS32 4RZ

#### Client
Highways England

#### Project Title
Highways England NFM Pilot

#### Drawing title
LI01.X: measure name

#### Notes
Include name of originator/organisation responsible for production of this alternative ideas specification sheet

In order to complete this sheet, an electronic version may be required.

Include any notes here relating to the measure, noting that this sheet is NOT be used as a “fit for construction” final design specification and therefore may contain only draft designs.

Notes can include details on, but not limited to the costs, equipment and materials, and consents and permissions (see design sheets for detailed measures for more information):

#### Health and Safety Considerations
Include for the following phases: Design, Construction and Maintenance (see design sheets for detailed measures for more information)

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Notes can include details on, but not limited to the costs, equipment and materials, and consents and permissions (see design sheets for detailed measures for more information):

#### Health and Safety Considerations
Include for the following phases: Design, Construction and Maintenance (see design sheets for detailed measures for more information)
NFM Fund Website
You can find everything you need to make an application to the NFM Fund on our website

https://catchmentbasedapproach.org/learn/he-nfm-fund

In particular, the website hosts links to the following key items:

- NFM Measures Booklet giving an overview of the measures that can be implemented using the Fund
- Design Specification Catalogue detailing how to design, implement and maintain measures
- Application Page to the Fund: https://highwaysengland.naturebid.org.uk
- Step by step guide to making an application
- Terms and Conditions of the Fund

NFM Fund Helpline
If you need any assistance preparing or making an application to the NFM Fund please contact your local Catchment Advisor. Alternatively you can contact us on:

Telephone: (01332) 225901

Email: NFMadvice@atkinsglobal.com