

National Parks & Wildlife Service

Flughany Bog SAC (Site code 000497)



Raised Bog Restoration Plan (Report)

Version 2

October 2022

Contents

1	INTRODUCTION	1
1.1	PURPOSE OF THE RESTORATION PLAN.....	1
1.2	FLUGHANY BOG SAC	1
1.3	SITE-SPECIFIC CONSERVATION OBJECTIVES	2
2	RESTORATION MEASURES AT FLUGHANY BOG SAC	2
2.1	INTRODUCTION	2
2.2	BLOCKING OF HIGH BOG DRAINS	3
2.3	BLOCKING OF DRAINS ON CUTOVER BOG	4
2.4	CONTOUR BUNDING	5
2.5	CELL BUNDING	6
2.6	GENERAL SITE MANAGEMENT	7
3	DRAINAGE MANAGEMENT PLAN	8
4	COMMUNITY BENEFITS	8
5	RESTORATION PLAN IMPLEMENTATION	9
5.1	PREPARATORY	9
5.2	PROGRESS TO DATE	10
5.2.1	<i>Hydrological characterisation</i>	<i>10</i>
5.2.2	<i>Review of restoration proposed measures in line with best practice at time of implementation</i>	<i>10</i>
5.2.3	<i>Detailed ecological surveys</i>	<i>10</i>
5.2.4	<i>Landownership Investigations.....</i>	<i>11</i>
5.2.5	<i>Stakeholder consultation and community engagement</i>	<i>11</i>
5.2.6	<i>Compensation/land acquisition</i>	<i>11</i>
5.2.7	<i>Appropriate Assessment Screening</i>	<i>12</i>
5.2.8	<i>Compilation of tender/construction documents and Health & Safety file</i>	<i>12</i>
5.2.9	<i>Surveying setting/out of the Works</i>	<i>12</i>
5.2.10	<i>Implementation of restoration measures</i>	<i>13</i>
5.2.11	<i>Post-Works inspections and preparation of as built survey information.....</i>	<i>14</i>
5.2.12	<i>Update of restoration plan to outline Works completed and remaining Works required in future.</i>	<i>14</i>
6	REFERENCES	17
7	GLOSSARY & ACRONYMS	18

Maps:

Map 1 - Flughany Bog SAC Boundary	15
Map 2 - Flughany Bog SAC Restoration Zones	16

1 Introduction

1.1 Purpose of the Restoration Plan

This restoration plan has been developed by National Parks and Wildlife Service (NPWS) of the Department of Housing, Local Government and Heritage to set out proposals for restoration of raised bog and associated habitats at Flughany Bog Special Area of Conservation (SAC) (000497). This plan identifies technically feasible restoration measures for the various zones of the bog including the high bog, cutover bog and surrounding margins and provides details of progress on implementation of the restoration plan.

The restoration measures set out will enable nature conservation targets for Active Raised Bog (ARB) at this SAC to be met. Although the focus of the restoration plan is on ARB habitat, it is anticipated that restoration measures will also benefit other peatland habitats and can contribute to socio-economic benefits for the local community, improvements to biodiversity and reduced carbon emissions. Monitoring of this restoration plan will be undertaken to ensure that the intended restoration measures are successfully contributing to the achievement of the site-specific targets for ARB at Flughany Bog SAC.

Action 1.1: Develop restoration plan further in partnership with stakeholders.

This restoration plan will be developed further in conjunction with stakeholders to ensure that restoration is carried out in such a way that the conservation requirements of the site can be met, whilst minimising any impacts on adjacent land and maximising benefits to the local community. The plan will develop and change over time through input from stakeholders and **will be considered a living document**. The primary aim of this restoration plan is to ensure site-specific conservation objectives for Flughany Bog SAC can be met.

Section 2 of the restoration plan sets out the restoration measures that have been proposed for Flughany Bog SAC. Section 3 outlines how a drainage management plan for Flughany Bog has been developed to support the implementation of this restoration plan. Section 4 describes potential for community benefits to be explored through the plan and Section 5 outlines progress with implementation of the plan.

Map 1 outlines the location and extent of Flughany Bog SAC. Map 2 illustrates the restoration measures that have been implemented to date as well as any proposed/outstanding restoration measures to be implemented at Flughany Bog.

This document provides an outline of the restoration plan but is supported by detailed datasets that are available on the NPWS Restoration Maps Viewer. This map viewer provides NPWS with an up-to-date view of all restoration plan details and supporting information including status of landowner investigations, landowner consent, progress with construction and details of proposed and remaining restoration measures.

1.2 Flughany Bog SAC

Flughany Bog is an example of a western raised bog, located 10km south-east of Tobercurry. It is one of a series of small to medium-sized raised bogs which occur along the border between counties Mayo and Sligo. The SAC includes the raised bog, known as Flughany Bog and surrounding areas which include cutover bog, scrub, wet grassland, and improved grassland. Flughany is comprised of two lobes which are separated by a ridge of mineral material. The bog displays some features of blanket bog morphology, such as the absence of a distinct dome.

The SAC has been selected for three Annex I habitats. These are:

- [7110] Active raised bogs*

- [7120] Degraded raised bogs still capable of natural regeneration
- [7150] Depressions on peat substrates of the *Rhynchosporion*

*Priority habitats

This draft plan has been developed to address restoration measures for these peatland habitats.

At Flughany, the structure of the bog is partially damaged mainly due to the effects of peat extraction along the margins of the high bog area. This peat cutting, which has continued until recently, has lowered the water levels and has resulted in a species-poor flora, which has a low Sphagnum cover, over a substantial part of the surface. Flughany Bog, whilst small, is a good example of a relatively intact raised bog. The site is also of note as it occurs close to the north-western limit of raised bog formation in Ireland. Overall, the site displays a good diversity of the flora and fauna that is typical of raised bog habitats.

1.3 Site-specific conservation objectives

Detailed site-specific conservation objectives (SSCOs) aim to define the favourable conservation condition of a habitat or species at site level. The maintenance of habitats and species within sites at favourable condition will contribute to the maintenance of favourable conservation status of those habitats and species at a national level.

A conservation objective has been set for Flughany Bog SAC for ARB habitat using attributes and targets based on parameters set out in the Habitats Directive. In summary, one of the key targets is to restore the area of ARB to 23.6 ha. The area of ARB was reported as 11.4 ha during the latest monitoring survey (2012) and it has been determined that there is potential for 9.2 ha of Degraded Raised Bog (DRB) to be restored to ARB on the high bog following restoration measures. There is also long-term potential for 3 ha of bog peat-forming habitats (BPFH) to develop if restoration measures are undertaken on cutover areas. Several targets have been set for other attributes relating to the quality and condition of ARB habitat, including a target to restore adequate transitional areas to support/protect the active raised bog and the ecosystem services it provides. The restoration measures proposed by this restoration plan aim to achieve these targets. Further information on the SSCO's can be found in the Flughany Bog SAC conservation objectives document (NPWS, 2015a) and the conservation objectives supporting document – raised bog habitats (NPWS, 2015b).

2 Restoration measures at Flughany Bog SAC

2.1 Introduction

Hydrological processes are key drivers of raised bog ecology, as raised bogs are predominately fed by precipitation. For ARB to develop or be maintained, mean water levels need to be near or at the bog's surface for most of the year. Seasonal fluctuations should not exceed 20cm below ground surface, and water levels in the peat should be within 10cm of the surface, except for very short periods of time (Kelly & Schouten 2002). Gentle slopes that limit intermittent lateral losses of water (through surface run-off) and encourage sustained water-logging are the most favourable to achieve these conditions. These conditions may be maintained on steeper slopes in areas of focused flow (flushes) (Mackin et al., 2017a; Regan et al., 2020). However, it will not be possible to raise the water level to high enough levels across the entire high bog surface, particularly approaching marginal areas, to enable ARB to develop. Even in high bog areas that do not have potential for ARB to form, water levels should be raised as necessary to support habitat for the areas where ARB can occur.

The main aim of restoration on raised bogs is to maintain or improve the quality of existing areas of ARB or improve the hydrological conditions that will allow ARB to develop in areas with suitable topographic conditions (gentle slopes and/or areas of focused flow). This requires measures to be implemented on both the high bog and cutover areas. Measures implemented on selected areas of cutover will also help to minimise the impact that drainage and cutting has had on the hydrological

integrity of the high bog and support a diversity of other transitional wetland habitats (e.g. wet woodland and fen), as well as the species they sustain. Once restored, these transitional cutover zones may provide further ecosystem services through flood attenuation and water supply maintenance and purification, increased carbon sequestration and improvements to the site's overall biodiversity value.

The main restoration measures that may be considered for improving hydrological conditions on raised bogs include:

- Drain blocking (includes drains on both high bog and the margins)
- Removal of forestry/tree clearance
- Installation of marginal dams
- High bog excavation/re-profiling
- Inoculation with *Sphagnum* species
- Bunding on high bog or cutover bog.

Further details on each of these measures can be found in Irish Wildlife Manual No. 99 'Best practice in raised bog restoration in Ireland (Mackin et al., 2017b). Additional measures may be considered in particular instances where there are specific problems that are causing damage to an SAC. The most relevant restoration measures for Flughany Bog SAC are outlined in Section 2.2 – 2.5 below.

2.2 Blocking of high bog drains

Blocking high bog drains slows the flow of water off the surface of the bog and increases the water table in the peat. Drain blocking is a proven and effective restoration measure on Irish raised bogs with minimal maintenance requirements. The approach has been demonstrated at a number of raised bogs in Ireland with very positive results evident in less than 10 years (**Figure 2.1**) as outlined by Fernandez *et al.* (2014a).

Sometimes, there are concerns from local communities living close to raised bogs that drain blocking on the high bog will result in, or exacerbate, flooding. Blocking high bog drains, in fact, slows the flow of water off the bog potentially reducing the frequency and magnitude of flood events by restoring the hydrological function of the bog. To address these concerns NPWS have developed a drainage management plan for Flughany Bog, with further details of this plan outlined within section 3.



Figure 2.1 Overgrown peat dams showing *Sphagnum* regeneration above a dam

Action 2.1: Block all high bog drains within Flughany Bog SAC.

There is an extensive network of drains on Flughany Bog. It is proposed that all remaining unblocked drains on the high bog surface are blocked with peat dams. Details of the locations of unblocked drains on the high bog can be found in Map 3.

2.3 Blocking of drains on cutover bog

Blocking of cutover drains slows the flow of water off the cutover areas and increases the water table in the surrounding peat. This can help to reduce the rate of infiltration through the high bog and can lead to conditions that allow peat to form on the cutover (**Figure 2.2**).

Drain blocking on cutover areas has been carried out at a number of raised bogs in Ireland to date resulting in the development of peat-forming vegetation on cutover areas. As with blocking of high bog drains, there are sometimes concerns from local communities living close to raised bogs that drain blocking on cutover bog will result in, or exacerbate, flooding. Blocking drains on cutover bog can slow the rate at which water is lost from the bog therefore potentially reducing the frequency and magnitude of downstream flood events. This restoration measure is primarily focused on former spread-grounds and only in very rare occasions, where it is absolutely essential, includes agricultural land. Drains in these areas will only be blocked in agreement with landowners and where there is a suitable hydrological barrier such as a functional drain to prevent impacts outside of the restoration area.



Figure 2.2 Water table at the surface of cutover bog following successful drain blocking resulting in *Sphagnum* development less than 10 years after drain blocking (this was previously an area of bare peat)

Action 2.2: Block drains on selected cutover areas within Flughany Bog SAC.

There are several cutover areas surrounding the bog where blocking of drains may reduce ongoing subsidence of the high bog. In some areas this will also lead to the development of peat forming habitats. It is proposed that these drains are blocked, primarily with peat dams, with some plastic reinforcements where necessary to prevent erosion. The required conditions are for the water table to be maintained at or close to the surface, therefore large areas of standing water or deep pools are not desired. Details of the locations on the cutover where it is proposed to block drains can be found in Map 2.

2.4 Contour bunding

Contour bunds on the high bog aims to reduce the rate of lateral flow through the upper layers of the peat. In contrast to some other bunding techniques, contour bunding is not intended as a means of impounding surface water. This method involves excavating a trench 1.5-2.0m deep, re-compacting peat into the trench and building a slightly raised bund 25-30cm above the current ground surface. In addition, these bunds have 5m long 'finger bunds' constructed using the same technique at approximately 25m spacing to prevent flow along the bund which may lead to erosion.

After 1-2 years it is anticipated that the bund will have subsided close to current ground level and therefore will not appear as a prominent feature on the bog surface.



Figure 2.3 Example of contour bund constructed at Knockacoller Bog SAC, Co. Laois

Contour bunds are most effective where there is cracking or slumping in the upper layers of the peat as the re-compacted trench assists in sealing up these cracks and slows the flow rate through the peat, supporting a higher water table behind the bund. The key issue with this technique is that the extent of the impact extending back into the bog depends on the hydraulic gradient (which is closely correlated to surface slope). As a result, the extent of impact from such bunds is likely to be extremely limited where the surface slope at the margins is steep. This method is best suited to sites with a relatively gentle slope towards the margins or as a means of effectively blocking a dense network of shallow surface drains on the high bog. Ground conditions will play an important factor in whether the bund can be constructed in such circumstances, therefore this method is most effective on drier sites where machines can operate safely and effectively.

Action 2.3: Assess the feasibility of contour bunding on the high bog at Flughany Bog SAC

Contour bunding has not been proposed for Flughany Bog SAC. The potential for this measure should be explored through the current restoration plan review process. However, it is notable that the site is a western raised bog with steeper surface slopes than Midland bogs and therefore may not be suited to this measure. Proposals should be informed by monitoring the response from this measure at other restoration sites.

2.5 Cell bunding

Cell bunding involves the creation of individual cells, consisting of a cutoff walls extending into the peat substrate and protruding above the ground surface to create a water table close to or slightly above the ground surface (maximum depth typically 10-20cm). The approach permits the interception of laterally flowing groundwater by low permeability cutoff walls, while the surface

bunds prevent lateral discharge of surface water; this also encourages recharge to the underlying water table, helping contribute to the water balance, while also maintaining an elevated water table in those areas up gradient of standing water. Due to topographic variability the depth of water will also vary significantly resulting in enhanced ecological diversity across the bunded area.

Cell bunds are typically constructed by excavating a trench 1.0-1.5m deep, recompacting the excavated peat into the trench and constructing a bund 0.5-0.6m high above the ground surface (Figure 2.3). Water level control structures (pipes or overflow weirs) are incorporated into these cells as a means to regulate water levels and evenly distribute water across the site.



Figure 2.4 Example of existing cell bund constructed at Cloncrow Bog NHA (the vegetation in this photo has developed in the 2 years since cell construction)

Action 2.4: Assess the feasibility of cell bunding at Flughany Bog SAC

Cell bunding has not yet been proposed for Flughany Bog SAC; however, there is a current ongoing review of the restoration plan to determine the potential for implementing enhanced measures. The potential for this measure should be explored. Some cutover areas have very suitable conditions to allow implementation of this measure. Proposals should be informed by monitoring the response from this measure at other restoration sites.

2.6 General site management

In addition to the proposed measures, it is important that the restoration plan contributes to improving general site management. This includes considering issues such as:

- Fire prevention and response
- Management of littering/fly-tipping

Burning of the high bog can result in significant damage to a raised bog by removing peat-forming vegetation which reduces the capacity of the peat to retain water. This causes much more rapid surface run-off and therefore can result in more widespread drying out and increased peak flows in surrounding streams. Flughany Bog SAC has been damaged on several occasions through burning.

Issues such as littering and fly-tipping are also common problems on raised bogs. Depending on the nature of the material dumped this can lead to pollution in surrounding areas.

Action 2.5: Prepare a fire prevention and control plan for Flughany Bog SAC in consultation with local stakeholders.

It is proposed that a fire prevention plan is developed for Flughany Bog SAC to identify past occurrences of fires, the likely causes and develop an effective plan to prevent fires in future as well as an appropriate response should a fire occur in the future. Issues such as fire prevention and management of littering/fly-tipping also need to be addressed as part of a wider strategy of raising public awareness on the importance of these habitats.

3 Drainage Management Plan

One issue that can cause concerns, particularly for local stakeholders, relates to whether restoration may result in increased flooding in the surrounding area. In many instances bog restoration has the opposite effect by returning more natural hydrological conditions whereby flow is attenuated and reaches the surrounding watercourses more slowly than when drains were present. This is evident at bogs such as Killyconny Bog SAC (000006) where extensive restoration has been carried out on cutover bog and there have been no adverse impacts on adjoining agricultural land.

Nonetheless, many individuals may remain unconvinced on these issues until several years after restoration has taken place. Therefore, in order to provide reassurance, an integrated drainage management plan for the bog and its surroundings has been developed as part of this restoration plan. The drainage management plan will be intended to support the conservation objectives for Flughany Bog SAC by ensuring the drainage network can be maintained without impacting on the conservation objectives. The plan assesses instances of existing impediments to the effective management of the drainage network (e.g., undersized culverts or channels) and provides recommendations in relation to remedial Works and maintenance Works going forward. Implementation of such measures will ensure that the risk of flooding will be significantly reduced.

Action 3.1: Implement the actions of a drainage management plan for Flughany Bog SAC in conjunction with local stakeholders.

Implementing the recommendations of this plan will require engagement with local stakeholders to ensure any management actions completed are carried out in line with best practice guidance.

4 Community benefits

Through consultation with the local community and other stakeholders it will be possible to develop ideas for maximising socio-economic benefits for the local community through restoration. These might include building or improving existing facilities, where appropriate (i.e., tracks, board walks, bog bridges), encouraging the creation of small tourism enterprises, promoting the benefits to human health and well-being and enhancing the value of the site as an educational resource. There are many cases where local communities, including local businesses, are actively involved in or supporting the conservation and restoration of raised bogs across the country. Examples of this are found at Abbeyleix Bog (Co. Laois), Carrownagappul Bog SAC (Co. Galway), Girley Bog Natural Heritage Area (NHA) (Co. Meath), Lodge Bog (Co. Kildare) and Scohaboy Bog NHA (Co. Tipperary).

Flughany Bog has several existing tracks and walkways that may be suitable for recreation and amenity development. Where the local community are interested in any proposals for amenity

facilities consideration should be given to bogs in the wider area and any proposed amenity facilities should be implemented in a way that does not impact the site specific conservation objectives for the site.

Apart from immediate economic benefits, the restoration of raised bogs can provide many other benefits to the wider community, such as provision of clean water, flood attenuation and water flow regulation, preservation of archaeological artefacts and other sources of historical knowledge and, not least, helping Ireland reduce its national greenhouse gas emissions and, therefore, helping to combat climate change.

Action 4.1: Optimise the community benefits of the restoration plan.

As the restoration plan is further developed and implemented, opportunities to improve the recreation and amenity value of the bog and surrounding areas and promote local initiatives, while protecting and enhancing its natural values, will be explored by and with the local community. Promoting community involvement in the long-term management of the site both during and after restoration measures are carried out, will be encouraged.

5 Restoration Plan Implementation

5.1 Preparatory

Prior to implementation of the restoration plan several preparatory actions are required before construction of restoration measures can commence. A summary of these preparatory actions is outlined below:

- Hydrological characterisation – collation of existing hydrological data, hydrological surveys, instrumentation with monitoring data (where necessary);
- Review of proposed restoration measures in line with best practice at the time of implementation (including exploring opportunities to implement enhanced measures);
- Detailed ecological surveys (primarily comprising surveys of cutover areas, but where necessary also includes high bog areas e.g., if ecotopes have not been surveyed in many years);
- Landownership Investigations (investigations into ownership, turbary rights etc.);
- Stakeholder consultation and community engagement (meeting with stakeholders to outline restoration plans and consider any concerns raised by the local community);
- Compensation/land acquisition (compensation or acquisition of lands required to implement the required restoration measures on private lands);
- Appropriate Assessment Screening;
- Compilation of tender/construction documents including preparation of health and safety file;
- Surveying and setting out of the Works;
- Implementation of restoration measures (including construction supervision and contract administration);
- Post-Works inspections and preparation of as-built survey information;
- Update of restoration plan to outline Works completed and remaining Works required in future. This includes updating status of all Works within the NPWS GIS-based data viewer.

5.2 Progress to date

There has been some recent progress made with preparatory actions ahead of implementing restoration actions at Flughany Bog SAC. A summary of progress to date is outlined below:

5.2.1 Hydrological characterisation

Status – Complete

Detailed hydrological characterisation of Flughany Bog SAC was carried out in October 2022. This comprised detailed surveys of the high bog and cutover to collect data to enable the restoration plan to be refined prior to the implementation of Phase 1 measures. This review has considered opportunities for enhanced restoration measures such as bunding on the high bog and cutover areas and found the several cutover areas to be suitable to the implementation of cell bunding. Further characterisation should be carried out to consider the potential to implement these measures.

5.2.2 Review of restoration proposed measures in line with best practice at time of implementation

Status – Ongoing

Following detailed hydrological characterisation of Flughany Bog SAC, a comprehensive review of proposed restoration measures was commenced. Cell bunding is currently being designed for the cutover areas of Flughany with limited opportunities for contour bunding on the high bog. This review is anticipated to be complete by the end of 2022 in anticipation of implementation of restoration measures in 2023.

5.2.3 Detailed ecological surveys

Status – Complete

The most recent ecotope survey on Flughany Bog SAC was completed in October 2012 which determined that at that time active raised bog (7110) covered 11.40ha (7.63%) of the high bog area. High quality Active Raised Bog comprises only 1.67ha, consisting of both central ecotope (1.44ha) and active flushes (0.23ha). Central ecotope has deep, interconnecting pools, with frequent open water, low hummocks, high hummocks, hollows and lawns. Total *Sphagnum* cover is approximately 40%. The active flush areas include a large pool/lawn with a high cover of *S. cuspidatum*, and also low hummocks. *Sphagnum* cover reaches up to 75% in places (Fernandez et al. 2014b).

A cutover habitat survey in accordance with Irish Wildlife Manual No. 128 'The Habitats of Cutover Raised Bog' (Smith & Crowley, 2020) has not yet been carried out. However, this is scheduled to take place in late 2022/early 2023 in advance of implementation of restoration measures. This survey involves detailed mapping of the various vegetation communities occurring on the cutover bog and also classifies these in terms of sensitivity to damage from restoration activities. This mapping together with ecotope mapping of the high bog ensures the restoration plan takes into account the existing sensitive habitats present on site to minimize potential impacts and also establishes a baseline status that can be used to monitor the results of measures.

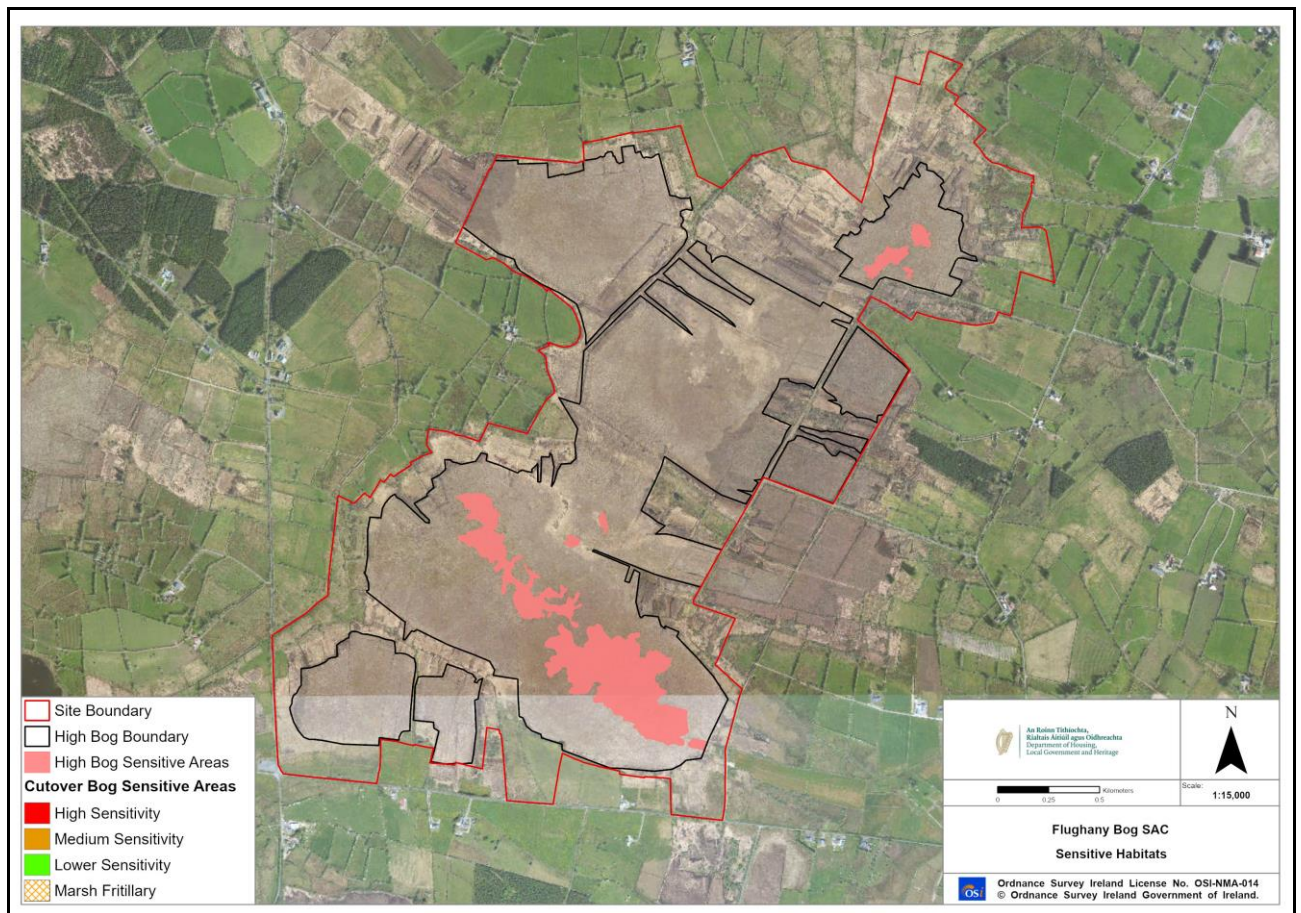


Figure 5.1 Sensitive habitats mapped at Flughany Bog SAC

5.2.4 Landownership Investigations

Status – Ongoing

Landownership investigations have commenced at Flughany Bog SAC. These have identified that there are significant areas of private and unregistered land, with only small pockets of land in State ownership. In addition, there are some areas where private individuals hold turbary rights. These investigations are currently ongoing and will identify individuals to be consulted at the next stage in the restoration plan implementation process.

5.2.5 Stakeholder consultation and community engagement

Status – Ongoing

Stakeholder consultation and community engagement has recently commenced at Flughany Bog SAC. This has included meeting with some private individuals owning the freehold or having a turbary right at the bog and other state bodies.

5.2.6 Compensation/land acquisition

Status – Ongoing

Compensation will be offered to qualifying landowners and turbary right holders within the bog as and when these individuals have been identified.

5.2.7 Appropriate Assessment Screening

Status – Not commenced

An Appropriate Assessment Screening report has not yet been prepared to consider the potential for significant effects on any European Sites from the implementation of the restoration plan at Flughany Bog SAC as the final restoration design has not been completed. However, since the bog has been selected as a Special Area of Conservation for the presence of raised bog habitats, the proposal to allow restoration measures to take place in Flughany Bog SAC **is directly connected with and necessary to the management of this site as a European site**. The proposed restoration measures are essential to support the reestablishment of appropriate hydrological conditions within the SAC to enable nature conservation targets for Active Raised Bog (ARB) at this SAC to be met.

However, following a precautionary approach and to inform a risk assessment, screening for Appropriate Assessment will be undertaken to assess, in view of best scientific knowledge and in view of the conservation objectives of those European sites considered, whether or not the project, individually or in combination with other plans or projects, is likely to have a significant effect on any European site.

5.2.8 Compilation of tender/construction documents and Health & Safety file

Status – Not commenced

A work package comprising details of restoration measures will be compiled together with detailed specifications for the proposed measures when restoration plan design is updated, and landowner permissions are in place. In addition, a health and safety file will be compiled to ensure the Works could be carried out in accordance with the Safety, Health and Welfare at Work (Construction) Regulations. Generally, this work involves the following activities:

- Identify hazards arising from the design of the various schemes.
- Eliminate these hazards, or where not practicable to do so, reduce the risk of these hazards.

5.2.9 Surveying setting/out of the Works

Status – Not commenced

The surveying and staking out of drains and dams can be difficult due to the nature of the bog environment. Vegetation and soft ground conditions can make identification of features and surveying of same difficult and potentially dangerous. The setting out of the Works is generally done using bamboo stakes to mark the locations of the restoration measures that are to be constructed such as the dams or bunds. Setting out Works has not yet commenced at Flughany Bog as this depends on the final work package compiled. This activity provides an additional opportunity to review the restoration measures in detail on the ground and where necessary minor modifications can be made (e.g., adjusting the placement of particular dams due to dense vegetation coverage or alignment of bunds due to ground conditions). This ensure that the risk of damage to the raised bog is minimized as inadequate planning can increase the risk of machines entering unsuitable areas.



Figure 5.2 – Example of setting out dams on an area of high bog

5.2.10 Implementation of restoration measures

Status – Not commenced

None of the restoration Works at Flughany Bog have been completed to date. The plan currently proposes construction of 1,540 dams; however, proposals for limited contour bunding and extensive cell bunding are currently being developed. In addition, there is a block of coniferous forestry to be felled from the high bog and cutover.

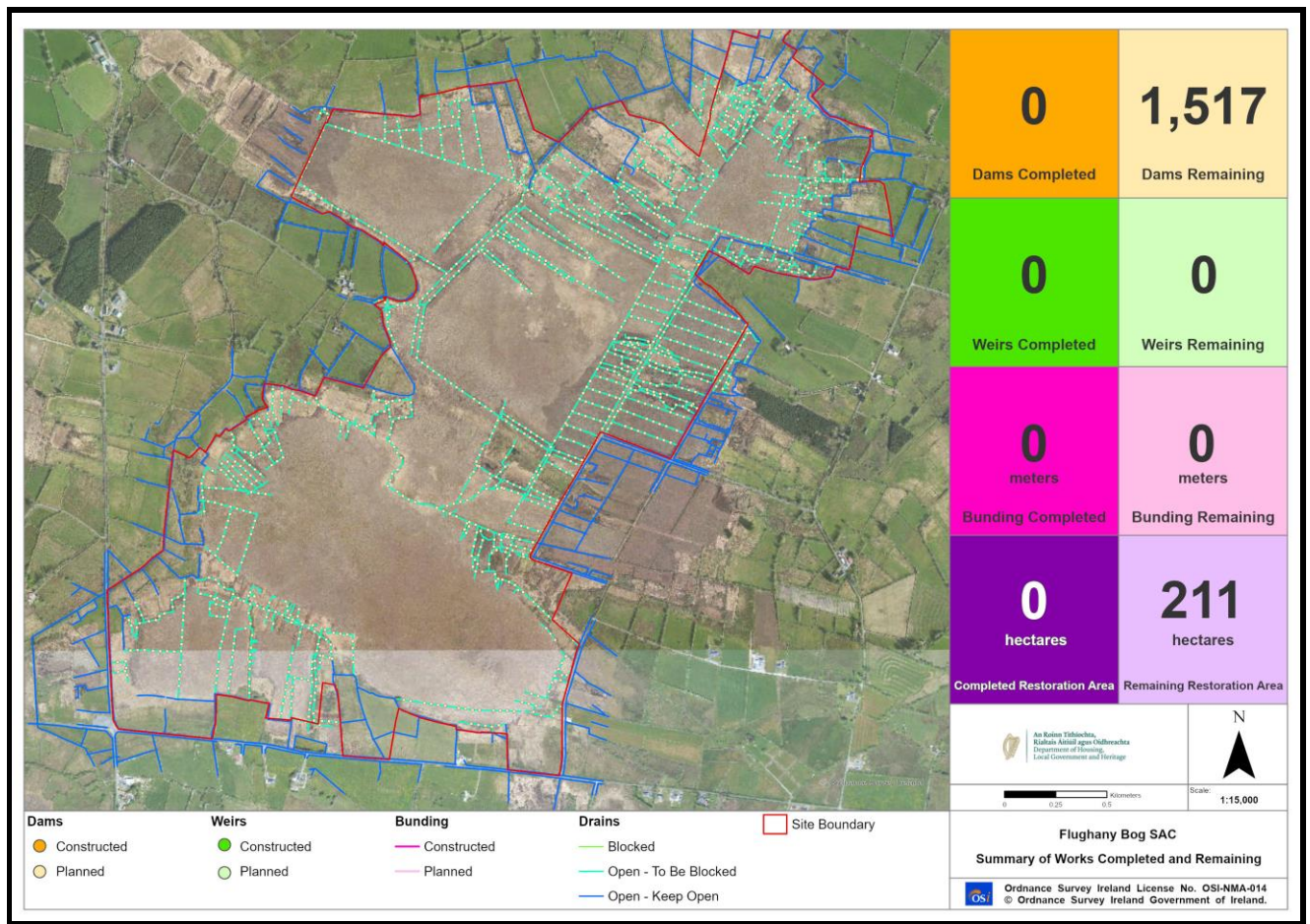


Figure 5.3 Summary of Works completed to date and Works remaining

5.2.11 Post-Works inspections and preparation of as built survey information.

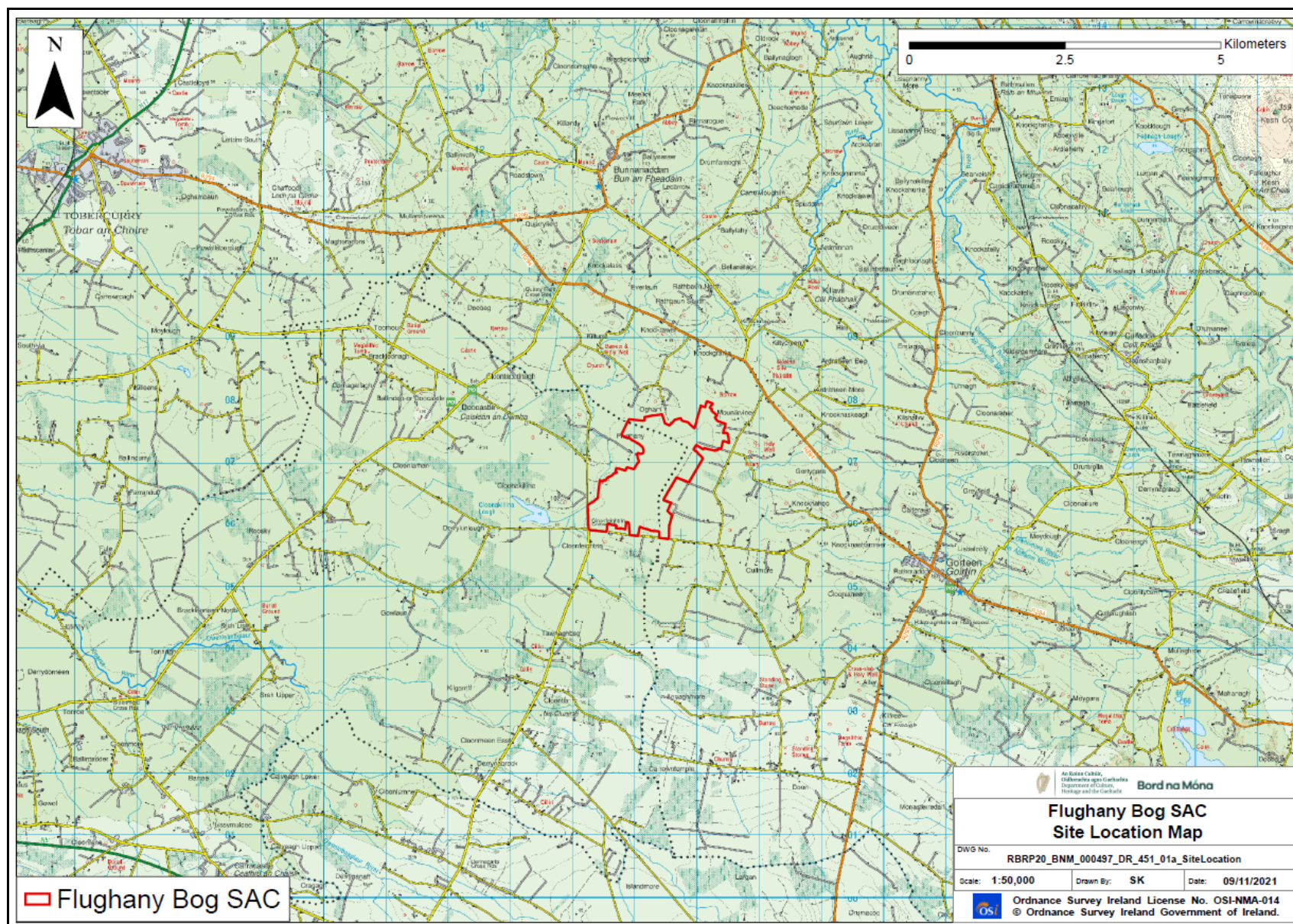
Status – Not commenced

No post work inspections have been carried out as restoration measures have not yet begun on this site. These inspections will include detailed aerial surveys of the bog to collect high-resolution ortho-imagery and oblique images to ensure a detailed as-built drawing can be prepared.

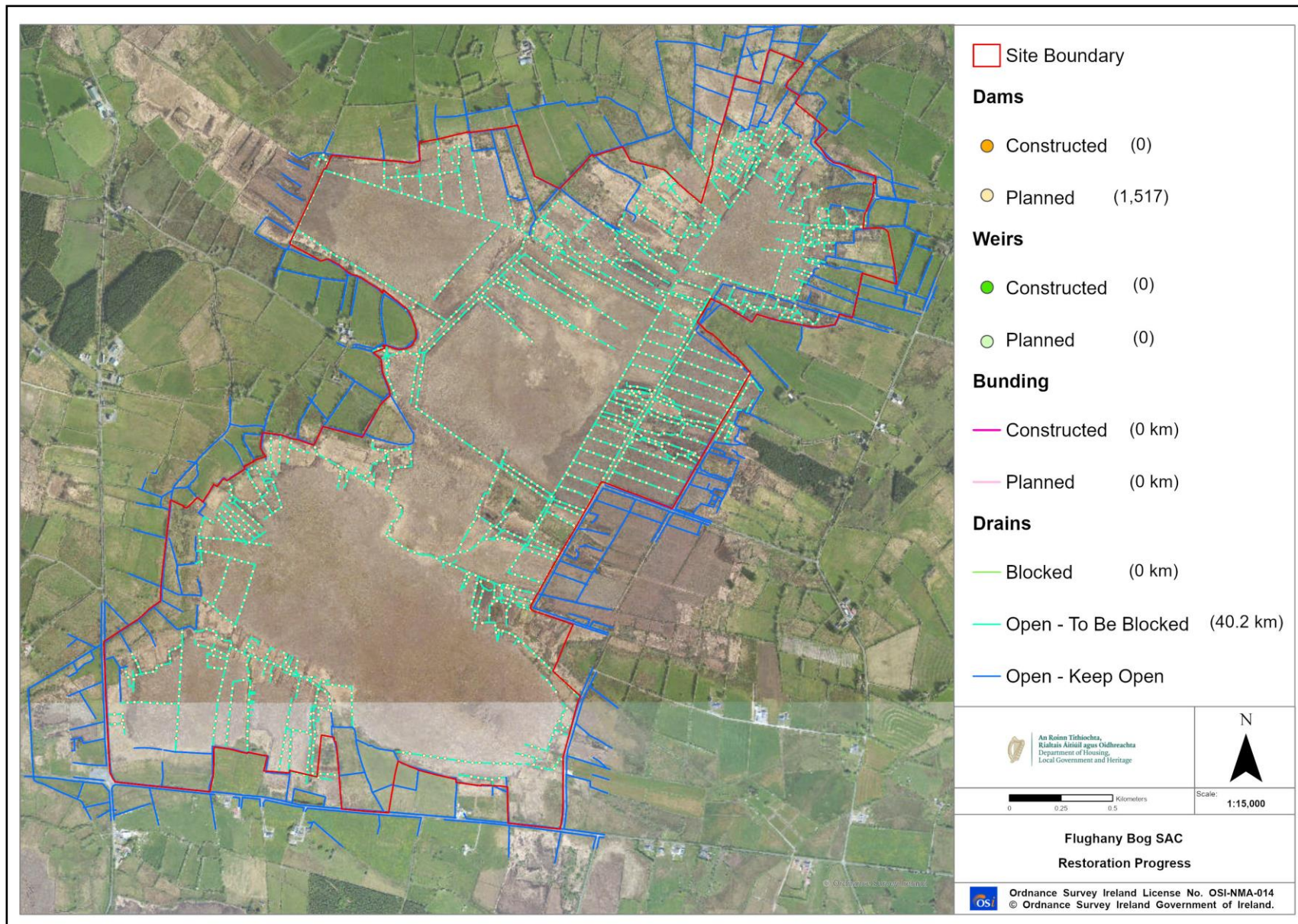
5.2.12 Update of restoration plan to outline Works completed and remaining Works required in future.

Status – Ongoing

The restoration plan is currently being updated to include for the construction of enhanced measures such as cell bunding and contour bunding. It is proposed that c. 1,540 dams to be installed along with significant lengths of contour bunding. It is anticipated that these Works will commence in 2023 when consent from landowners is received. As this restoration plan is a live document, the restoration measures will be reviewed on an ongoing basis as experience and best-practice evolves nationally and internationally.



Map 1 - Flughany Bog SAC Boundary



Map 2 - Flughany Bog SAC Restoration Proposals

6 References

- Fernandez, F., Connolly K., Crowley W., Denyer J., Duff K. & Smith G. (2014a) Raised bog monitoring and assessment survey 2013. Irish Wildlife Manuals, No. 81. National Parks and Wildlife Service, Department of Arts, Heritage and Gaeltacht, Dublin, Ireland.
- Fernandez, F., Connolly K., Crowley W., Denyer J., Duff K. & Smith G. (2014b) Raised bog monitoring and assessment survey 2013. Irish Wildlife Manuals, No. 81. Flughany Bog SAC: Site Report. National Parks and Wildlife Service, Department of Arts, Heritage and Gaeltacht, Dublin, Ireland.
- Fossitt, J. (2000) A Guide to Habitats in Ireland. The Heritage Council, Ireland.
- Kelly, L. & Schouten, M.G.C. (2002) Vegetation. In: Schouten, M.G.C. (ed.), Conservation and restoration of raised bogs: geological, hydrological and ecological Studies. Dúchas – The Heritage Service of the Department of the Environment and Local Government, Ireland; Staatsbosbeheer, the Netherlands; Geological Survey of Ireland, Dublin. pp. 110-169.
- Mackin, F., Barr, A., Rath, P., Eakin, M., Ryan, J., Jeffrey, R. & Fernandez Valverde, F. (2017a) Best practice in raised bog restoration in Ireland. *Irish Wildlife Manuals*, No. 99. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland.
- Mackin, F., Flynn, R., Barr, A & Fernandez-Valverde, F. (2017b) Use of geographical information system-based hydrological modelling for development of a raised bog conservation and restoration programme. *Ecological Engineering*, 106(Part A); pp. 242-252.
- NPWS (2015a) Flughany Bog SAC (site code 000497) Conservation objectives. National Parks and Wildlife Service, Ireland. (http://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO000497.pdf)
- NPWS (2015b) Flughany Bog SAC (site code 000497) Conservation objectives supporting document - raised bog habitats. National Parks and Wildlife Service, Ireland. ([http://www.npws.ie/sites/default/files/publications/pdf/Flughany%20Bog%20SAC%20\(000497\)%20Conservation%20objectives%20supporting%20document%20-%20Raised%20Bog%20habitats%20\[Version%201\].pdf](http://www.npws.ie/sites/default/files/publications/pdf/Flughany%20Bog%20SAC%20(000497)%20Conservation%20objectives%20supporting%20document%20-%20Raised%20Bog%20habitats%20[Version%201].pdf))
- Regan, S., Swenson, M., O'Connor, M. & Gill, L. (2020). Ecohydrology, Greenhouse Gas Dynamics and Restoration Guidelines for Degraded Raised Bogs. A report prepared for the Environmental Protection Agency, Ireland.
- Smith, G.F. & Crowley, W. (2020) The habitats of cutover raised bog. Irish Wildlife Manuals, No. 128. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland.

7 Glossary & Acronyms

ACTIVE RAISED BOG (ARB)	Areas of uncut raised bog where the conditions are right for peat to continue to form, and where species of plants and animals typical to intact bogs can thrive. ARB is listed as a priority habitat in Annex I of the Habitats Directive.
ANNEX I	Annex I of the EU Habitats Directive lists natural habitats types of Community interest whose conservation requires the designation of SACs.
ANNEX II	Annex II of the EU Habitats Directive lists animal and plant species of Community interest whose conservation requires the designation of SACs.
BIODIVERSITY	A general term used to describe all aspects of biological diversity including the number of species present in a given environment, the genetic diversity present within a species and the number of different ecosystems present within a given environment.
BOG WOODLAND	Woodland formed on a wet peaty substrate, with permanently high groundwater level. The water is poor in nutrients (ombrotrophic) and the ground surface has high cover of bog moss species, with active peat accumulation taking place. Bog Woodland is listed as a priority habitat in Annex I of the Habitats Directive. It differs from dry woodland on bog where peat accumulation is not taking place.
BUNDING	An impervious embankment of material (peat or other) that provides a barrier to retain water behind it.
CARBON SEQUESTRATION	The capture and long-term storage of atmospheric carbon dioxide, including that accumulated by a bog or fen.
CATCHMENT	An area of land contributing water that drains to a defined point. The term river catchment refers to the area of land that drains into a particular river system and is synonymous with the term drainage basin or watershed.
CUTOVER	Areas of bog that have been previously cut (by hand or by mechanical means), although not down to the underlying inorganic substrate. Cutover areas normally consist of a mosaic of cut areas, face banks, pools, drainage ditches, uncut areas of peat, scrub, grassland etc.
DEGRADED RAISED BOG (DRB)	The area of high, uncut bog which has been damaged by human activities but which could be restored to active raised bog again through restoration measures within a period of 30 years. It is listed in Annex I of the Habitats Directive.
ECOLOGY	The study of the interactions between organisms, and their physical, chemical and biological environment.
ECOSYSTEM SERVICES	Humankind benefits from a multitude of resources and processes that are supplied by ecosystems. Collectively, these benefits are

	known as ecosystem services and include products like clean drinking water and processes such as the decomposition of wastes.
EROSION	The processes whereby the materials of the earth's crust are dissolved, or worn away and simultaneously moved from one place to another by natural processes which include weathering, solution, corrosion and transportation.
EVAPOTRANSPIRATION	Water loss to the atmosphere from soil and other surfaces (evaporation) and vegetation (transpiration).
FACEBANK	Areas at the edge of the high bog where peat cutting has taken place. This is an ecotope that is highly degraded and absent of typical <i>Sphagnum</i> species.
FAUNA	Animal life.
FAVOURABLE CONSERVATION CONDITION	This is the condition of a habitat or species considered to be favourable at site level. Favourable conservation condition is defined by site-specific conservation objectives (SSCOs). The maintenance of habitats and species within sites at favourable condition will contribute to the maintenance of favourable conservation status of those habitats and species at a national level.
FAVOURABLE CONSERVATION STATUS	According to the Habitats Directive the conservation status of a natural habitat will be taken as "favourable" when: its natural range and areas it covers within that range are stable or increasing, and the specific structure and functions which are necessary for its long term maintenance exist and are likely to continue to exist for the foreseeable future, and the conservation status of its typical species is favourable.
FLORA	Plant life.
FLOW ATTENUATION	Slowing flow of water out of an area. This is a common method for reducing risk of flood in urban areas whereby diversion channels store water in attenuation ponds. Intact peatlands typically offer natural flow attenuation through slowing flow as a result of higher storage capacity and increased hydraulic roughness, while degraded peatlands are much less effective at attenuating flow as the peat is dried out encouraging overland flow.
HABITAT	Refers to the environment defined by specific abiotic and biotic factors, in which a species lives at any stage of its biological cycle. In general terms it is a species' home.
HABITATS DIRECTIVE	Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.
HEAD	Hydrological term which is a measure of the height to which water can raise itself above an arbitrary given level or datum.
HIGH BOG	The area of bog which has not previously been cut.

HYDROLOGICAL PROCESSES	The movement of water through a catchment area including freshwater and seawater inputs, water level changes and drainage mechanisms which are all influenced by the underlying geology.
LAGG	A term used to describe the natural habitat that occurs in the transitional zone between the bog and the mineral soil around a raised bog. Few intact lagg zones remain around raised bogs in Ireland as they are typically the first location to be damaged by drainage.
LIDAR	A remote sensing technology that measures vertical surface elevation by illuminating a target with a laser and analysing the reflected light usually obtained using a low-flying aeroplane. This provides detailed information on the surface elevations across an area.
LIFE	An EU financial instrument supporting environmental and nature conservation projects throughout the EU.
MARGINAL DRAIN	Drains on the margins of a raised bog typically on cutover for the purpose of draining spread-grounds to facilitate turf-cutting.
MICROTOPOGRAPHY	Variations in elevation at a relatively small scale. Generally the higher points are no more than a metre higher than the low points, and only a couple of metres across. On a high bog this consists of hummocks, hollows, pools, flats and lawns.
MINEROTROPHIC	Refers to soils and vegetation whose water supply comes mainly from streams or springs. This water has flowed over or through rocks or other minerals, often acquiring dissolved chemicals which raise the nutrient levels and reduce the acidity.
NATURAL HERITAGE AREA (NHA)	These are conservation areas designated for protection under The Wildlife (Amendment) Act 2000. NHAs are considered important for the habitats present or which holds species of plants and animals whose habitat needs protection.
NPWS	National Parks and Wildlife Service.
OMBROTROPHIC	Refers to a type of peatland that receives all of its water and nutrient from precipitation falling directly on its surface.
PIEZOMETER	A piezometer is a device used to measure head. In the case of groundwater a piezometer will provide head at a given point.
PEAT-FORMING HABITAT	These are habitats where peat is actively forming. It includes typical ombrotrophic raised bog vegetation as well as lagg or fen vegetation that indicate that peat is actively forming.
PRIORITY HABITAT	A subset of the habitats listed in Annex I of the EU Habitats Directive. These consist of habitats which are in danger of disappearance and whose natural range mainly falls within the territory of the European Union. These habitats are of the highest conservation status and require measures to ensure that their favourable conservation status is maintained.

RAISED BOG	Rain-fed peatland ecosystems that develop primarily in areas with topographic depressions, where drainage may be impeded by a high groundwater table, or by low permeability of the underlying substrata such as clay. Peat accumulation, over time, elevates the ground surface above surrounding areas to form a raised dome.
RESTORATION ZONE	A specified area within a site where restoration measures have been proposed. Restoration zones have been defined for each raised bog SAC based on factors including hydrological conditions, existing and expected habitats following restoration. This allows restoration measures for each raised bog SAC to be split into manageable units.
SITE-SPECIFIC CONSERVATION OBJECTIVE	A site-specific conservation objective aims to define the favourable conservation condition of a habitat or species at site level. The maintenance of habitats and species within sites at favourable condition will contribute to the maintenance of favourable conservation status of those habitats and species at a national level.
SPECIAL AREA OF CONSERVATION	Area designated for the conservation of habitats and/or species under the Habitats Directive.
SPREAD-GROUNDS	Area where turf is spread after cutting to dry out, typically drained cutover bog or agricultural areas adjacent to the high bog.
STATUTORY NATURE RESERVE	A Statutory Nature Reserve is an area of nature conservation interest that has been designated by Ministerial Order under the Wildlife Act, 1976.
SUBSIDENCE	Term referring to the sinking of land resulting from natural activity or human activity. Within peat subsidence occurs due to loss of water for example as a result of drainage.
TILL	Geological term referring to unsorted material deposited by glacial ice and showing no stratification. It is often referred to as boulder clay.
TOPOGRAPHY	The arrangement of the physical features of an area.

Appendix A
Specific Restoration Measures for Flughany Bog SAC

Guide to specific restoration measures for Flughany Bog SAC

Detailed information in relation to proposed restoration measures for Flughany Bog SAC is set out in this Appendix. Table A.1 outlines the various categories used within the restoration plan and provides information as a guide to reading the detailed restoration plan that follows this table. In summary, restoration measures have been determined for individual restoration zones. Map 2 can be used to identify the various restoration zones on the bog and detailed information relevant to each restoration zone can be found in the detailed restoration plan that follows Table A.1.

Table A.1 Categories within the detailed restoration plan

Heading	Description/Explanation
Restoration zone	Restoration zones have been mapped both on and around the margins of the bog. Restoration zones are outlined for the entire site on Map 2, which allows identification of restoration zones of interest. Detailed information for each restoration zone is subsequently presented in the detailed restoration plan that follows this table.
Townlands	Lists all townlands that the restoration zone intersects to assist with identifying particular restoration zones that may be of interest.
Priority	<p>Three levels of restoration priority have been identified, these are:</p> <p>Priority 1</p> <p>Priority 1 measures are those that are required immediately to prevent further loss of ARB from the high bog or have the potential to result in an increase of ARB on the high bog. This typically includes measures taking place directly on the high bog but in some cases also includes measures in the margins of the bog e.g. where a deep drain is having a significant impact on the high bog.</p> <p>Priority 2</p> <p>Priority 2 measures are those that are primarily intended to increase the area of peat-forming habitats on cutover areas. This includes both ombrotrophic dominated vegetation (bog) and more minerotrophic vegetation (lagg). Typically, priority 2 measures may also have benefits in reducing on-going subsidence on the high bog. This is because raising the water table in the margins next to the high bog may reduce the hydraulic gradient between the high bog and the peat substrate. Although positive impacts may only be minor it will contribute to reducing on-going losses of ARB in the long-term.</p> <p>Priority 3</p> <p>Priority 3 measures are those that are unlikely to have significant benefits for the high bog or lead to the creation of peat-forming vegetation in cutover areas, but may have potential for wider ecosystem services benefits. This includes improvements to biodiversity, reducing carbon losses, flow</p>

Heading	Description/Explanation
	regulation and water supply maintenance and purification. These measures may have minor benefits in reducing the hydraulic gradient between the high bog and peat substrate, which could reduce on-going losses of ARB in the long-term.
Justification for measures	This category is linked to the priority heading as it explains the main reason for the proposed restoration measures within each restoration zone. For example, for priority 1 measures this will indicate whether the measures are expected to increase the area of ARB on the high bog or if the measure is required to reduce the loss of ARB.
Area of DRB (ha)	This is the area of DRB that is expected to be restored to ARB following restoration measures. This figure is based on hydrological modelling of the topographic conditions on the raised bog surface using LiDAR data.
Potential area of peat-forming habitats (ha)	<p>This is the area of actively peat-forming vegetation that may develop if restoration measures are carried out. On the high bog this figure corresponds to the area of Degraded Raised Bog (DRB) habitat and has been determined through hydrological modelling. This modelling identifies areas of the high bog surface that appear to have suitable hydrological conditions for the development of ARB.</p> <p>On cutover bog this figure refers to the area of peat-forming habitat (PFH). However, PFH may be influenced by rainwater or bog water leading to the development of Bog PFH or may have a minerotrophic influence from groundwater leading to the development of lagg PFH.</p> <p>These areas have been determined by identifying the locations on cutover that appear to have suitable hydrological conditions for peat to begin to accumulate. It is expected that development of this habitat on cutover bog will take a much longer time than ARB on the high bog surface and will generally be confined to smaller areas. It will also be of a much lower quality than ARB on the high bog surface and lack distinct indicators of high quality habitat including species diversity and micro-topography for some time after restoration.</p>
Measures proposed	This is a brief description of the proposed restoration measures for that restoration zone. There may be several restoration measures proposed within one zone.
Are restoration measures likely to benefit the high bog?	This outlines whether the proposed restoration measures are likely to be beneficial to the condition of the high bog. This is linked to the justification for measures as it provides further detail as to how the proposed restoration measures will contribute to improving conditions or reducing the rate of deterioration on the high bog.

Heading	Description/Explanation
	<p>For Priority 1 measures such as drain blocking on the high bog, this will very clearly have benefits for the high bog by slowing the rate of run-off from the bog surface. Priority 1 measures such as blocking deep cutover drains close to an area of ARB on the high bog will reduce the rate of water loss from the high bog and lower the risk of subsidence. For Priority 2 and priority 3 measures there may be potential for minor benefits in terms of reducing the gradient between the water table in the high bog and the water table in the cutover, which may contribute to reducing on-going losses of ARB in the long-term.</p>
Current habitat	<p>This section sets out the existing habitat within each restoration zone, using the Fossitt (2000) habitat classification system. These habitats have been determined at a high level based on interpretation using aerial imagery. In many cases it is not possible to map a single habitat and more often a mosaic of habitats exists. This information may be useful in giving an indication of the type of habitat that could develop in the future.</p>
Co-dependency	<p>This section details whether there is a direct link between restoration options in two different zones. This is important as in some cases measures cannot take place in one restoration zone without impacting another restoration zone.</p>
Measures Summary	<p>Peat dams required</p> <p>This is the estimated number of peat dams required to block drains, estimated by assessing the gradient of drains using LiDAR data. As drain-blocking is the main restoration measure employed, the number of peat dams required is critical for the success of the restoration measures for each site. This allows for a relatively accurate estimate of the cost of restoration.</p> <p>Plastic dams required</p> <p>This is the estimated number of plastic dams required to block drains, estimated by assessing the gradient of drains using LiDAR data. Plastic reinforcement has also been proposed for some locations where flow is likely to result in erosion of peat dams.</p> <p>Plastic dams are typically a more expensive option than peat dams due to the cost of material and labour required to install.</p> <p>Plastic dams can also be useful in partially blocking drains by bringing the water level in a drain up to a specified level. This can be useful for drains where complete blocking would result in unacceptable impacts on adjacent land, but partial blocking will assist in reducing the gradient between the water table in the high bog and the water table in the margins.</p> <p>Establishing the number of plastic dams required is important as this may be a significant part of the cost of restoration if a</p>

Heading	Description/Explanation
	<p>high number of plastic dams are required.</p> <p>Forestry area to clear (ha)</p> <p>This is the area of forestry within each zone proposed for felling.</p> <p>Length marginal dam (m)</p> <p>This is the length of marginal dams proposed within each zone.</p> <p>No. weirs/outlets</p> <p>This is the number of weirs or outlets required to control water levels within each zone. Typically these are required where marginal dams have been proposed.</p> <p>Length infill drains (m)</p> <p>If there are proposals to infill drains this is the length of drains that have been identified as requiring infilling.</p>