



GALETECH
ENERGY SERVICES

Islandmore Wind Farm

Environmental Impact Assessment
Report

Annex 5.3: Habitat Management
Plan

Islandmore Wind Farm Limited

Contents

1.1	Introduction	1
1.2	Desk Assessment Methodology	1
1.2.1	Catchment Data	2
1.2.2	LiDAR Analysis	2
1.3	Data Analysis Results	3
1.4	Discussion	9
1.4.1	Designated Site Consideration	9
1.4.2	LiDAR Analysis	9
1.5	HMP Area Design	10
1.6	Compensation Measures for Peatland	11
1.6.1	Drain Management	12
1.6.2	Perimeter Bunding	14
1.6.3	Cell Bunding	15
1.6.4	Contour Bunding	16
1.6.5	Forest-to-Bog Restoration	20
1.6.6	Re-vegetating Bare Peat	24
1.6.7	Scrub Removal	26
1.6.8	Cessation of Turf Cutting & Disturbance Events	27
1.6.9	Prevention of Uncontrolled Burning	28
1.7	Compensation Measures for Other Species and Habitats	28
1.7.1	Marsh Fritillary Habitat Management	28
1.7.2	Hedgerow Replanting	32
1.7.3	Bog Woodland Replanting	35
1.8	Monitoring	36
1.8.1	Monitoring of Water Retention Measures	36
1.8.2	Vegetation Monitoring	36
1.8.3	Monitoring Marsh Fritillary	37
1.8.4	Monitoring Hedgerow and Bog Woodland Replanting	38
1.9	Conclusion	38

1.1 INTRODUCTION

Islandmore Wind Farm Limited has commissioned Galettech Energy Services (GES) to manage the preparation of an Environmental Impact Assessment Report (EIAR) for the Islandmore Wind Farm ('the project') in County Roscommon. APEM Group Woodrow has been commissioned by GES to prepare a Habitat Management Plan (HMP) for lands within the planning application boundary ('the site') to accompany **Chapter 5** (Biodiversity) of the Environmental Impact Assessment Report (EIAR). A summary of the baseline data gathered across the site can be found in at **Annex 5.2**.

This HMP report provides a summary of the proposed compensation measures to be implemented during the construction and operation phases of the project, as well as ongoing monitoring throughout the lifetime of the project. The compensation measures have been designed to offset the identified residual effects on ecological features of County Importance and Local (Higher) Importance.

The HMP proposes a suite of peatland restoration measures to compensate for the direct loss of Fossitt (2000) habitats (PB4) Cutover bog and (PB2) Upland blanket bog across the site. Light Detection and Ranging (LiDAR) data analysis was carried out in combination with field survey of habitats, to inform the peatland restoration measures within the HMP areas. The peatland restoration actions prescribed for the management of peatland habitats include: -

- Drain management;
- Marginal, cell and contour bunding;
- Forest-to-bog restoration;
- Bare peat revegetation;
- Scrub removal;
- Cessation of turf cutting & disturbance events; and,
- Prevention of uncontrolled burning.

Compensation measures prescribed to offset the direct loss of marsh fritillary habitat on (PB4) Cutover bog consists of:-

- Marsh fritillary habitat management.

The compensation measures prescribed to offset the removal of (WL1) Hedgerows across the site consist of:-

- Hedgerow replanting.

Monitoring is an essential component of implementing compensation measures. The results of monitoring can be used to determine whether compensation measures have been implemented effectively; whether remedial actions are necessary; and if so whether measures remain sufficient and appropriate to achieve the specified aims, or if further measures might be necessary to ensure targets are met. A programme of ecological monitoring to gauge the effectiveness of the proposed compensation measures is also included in the HMP.

1.2 DESK ASSESSMENT METHODOLOGY

During habitat surveys, restoration opportunities were identified and this site knowledge has been supplemented through additional desk assessment activities.

1.2.1 CATCHMENT DATA

To enable the prioritisation of peatland restoration, existing GIS data was reviewed to identify potential hydrological connectivity of the site with European designated sites (NPWS, 2026) of nature conservation importance (**Figure 1**). Known watercourses running within or close to the site were identified where these flow towards Special Areas of Conservation (SAC) or Special Protection Areas (SPA). Water Framework Directive (WFD) catchment data (EPA, n.d.) was also reviewed to identify where the site lies within wider catchment areas (**Figure 2**).

1.2.2 LiDAR ANALYSIS

Best practice guidance on peatland restoration recommends the use of high-resolution topographic datasets, such as LiDAR, to identify appropriate locations for restoration measures (Mackin *et al.*, 2017, Burnham *et al.*, 2024).

LiDAR digital terrain model (DTM) data has been acquired from a third party to inform the design of the HMP. The DTM data was provided at a resolution of 1m and included a 2km area around the centre of the site (E562090, N799024). The data is projected in Irish Transverse Mercator (IRENET95). Geographic Information System (GIS) software has been used to process the DTM data utilising the following suite of tools:-

- Grass 8 / Raster / r.watershed;
- SAGA Next Gen/ Terrain Analysis/ Fill Sinks (Wang & Liu);
- Crayfish / Conversions / SAGA flow to GRB;
- Raster terrain analysis/ Slope; and,
- Raster conversion / polygonise.

Hydrological processing tools were used to determine the hydrology of the site, and identify artificial drainage and modifications to the natural hydrological regime, including:-

- Flow accumulation (**Figure 3**);
- Naturalised overland flow pathways (**Figure 4**);
- Sub-catchments (**Figure 5**); and,
- Slope (**Figure 6**).

1.3 DATA ANALYSIS RESULTS

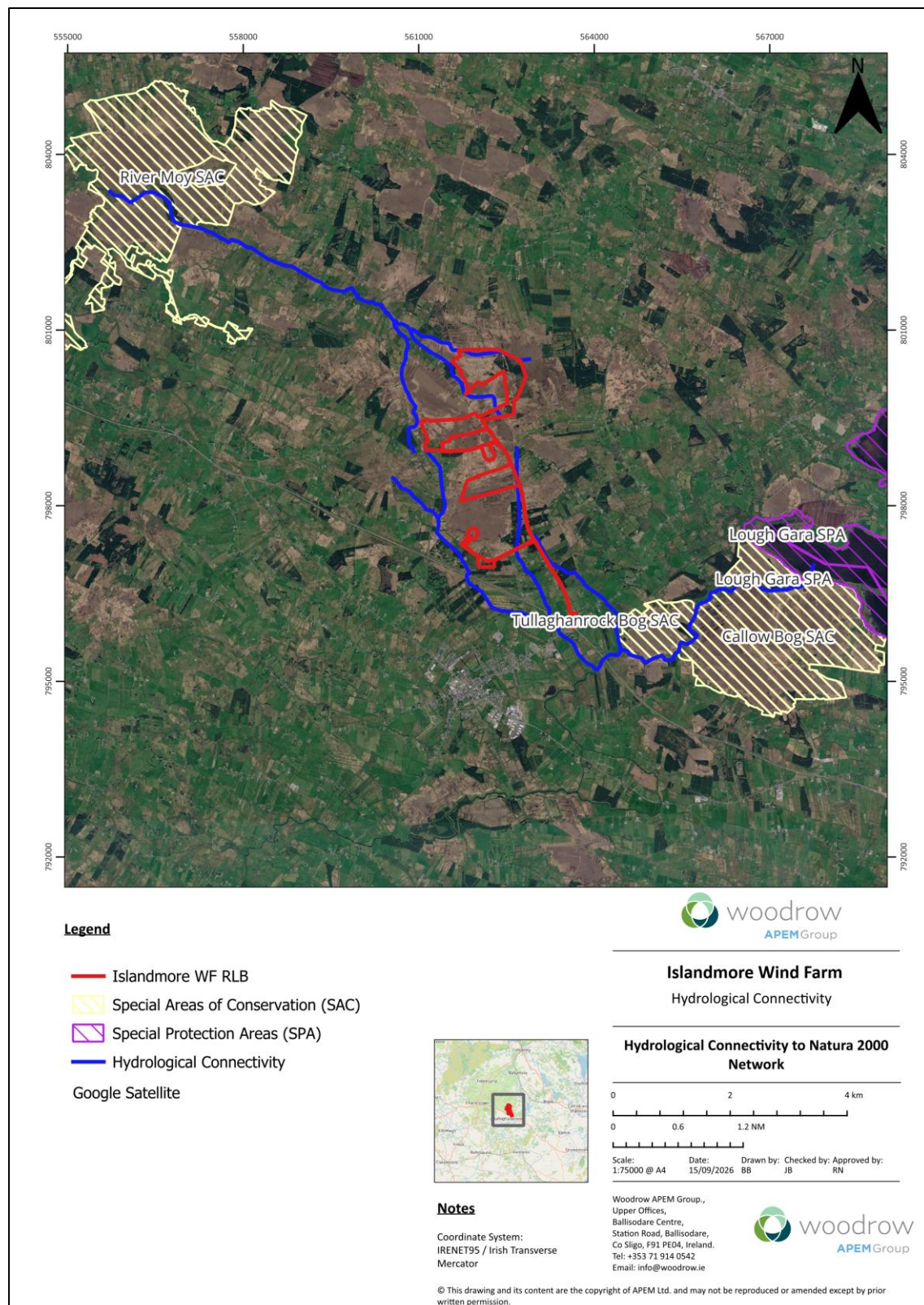


Figure 1: Hydrological connectivity between the site and the Natura 2000 Network

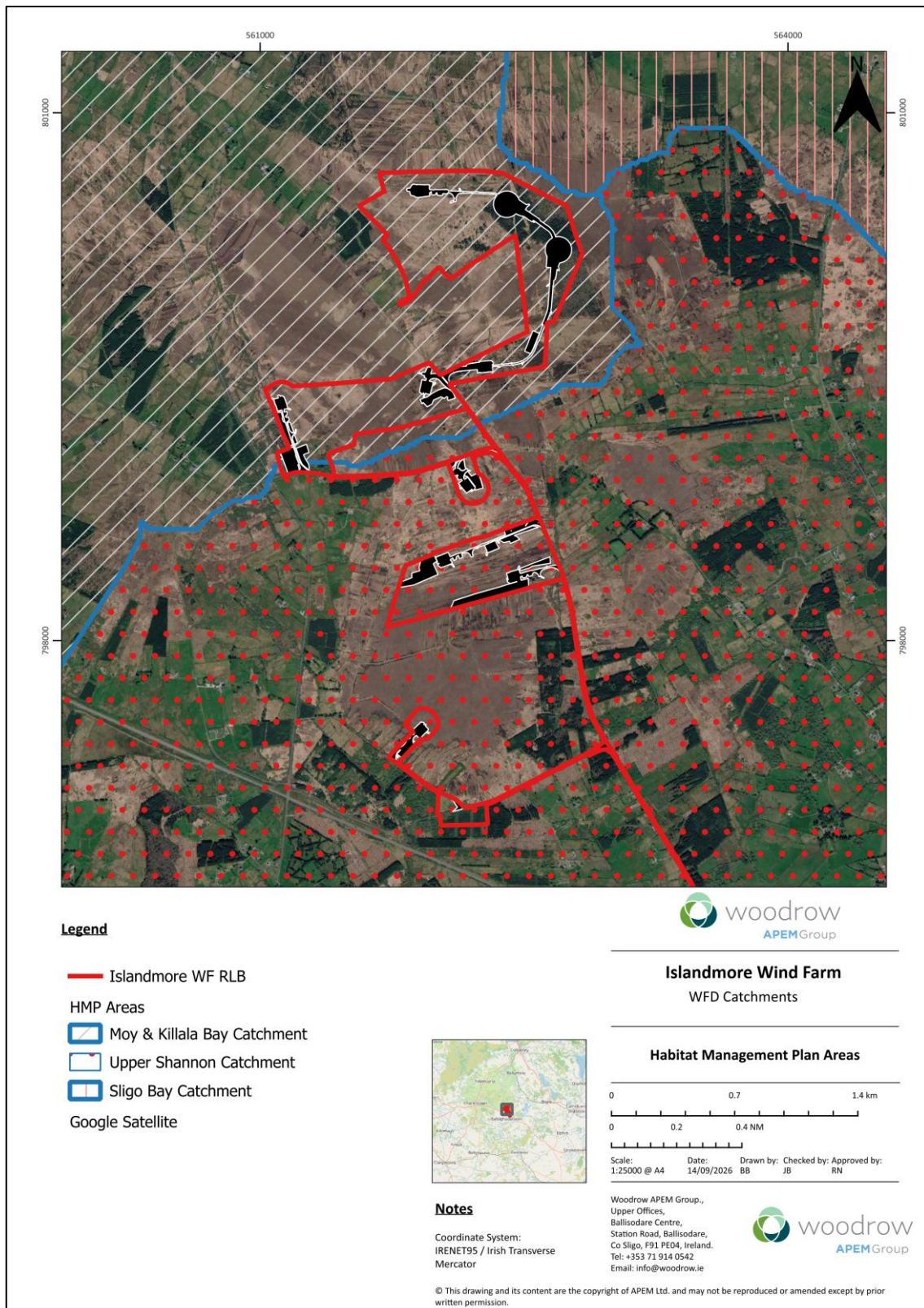


Figure 2: Water Framework Directive Catchments

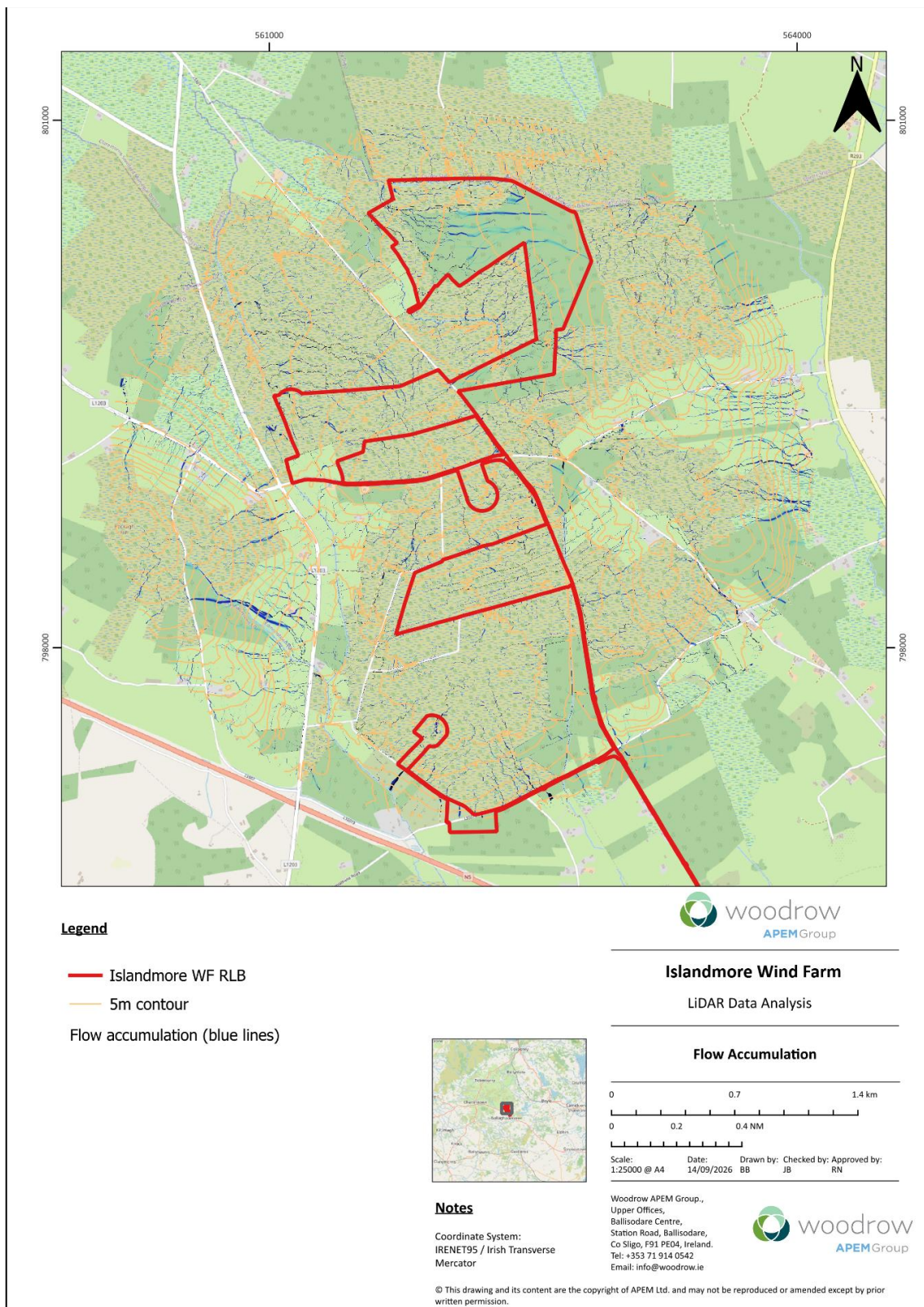


Figure 3: Surface Flow Accumulation Pathways

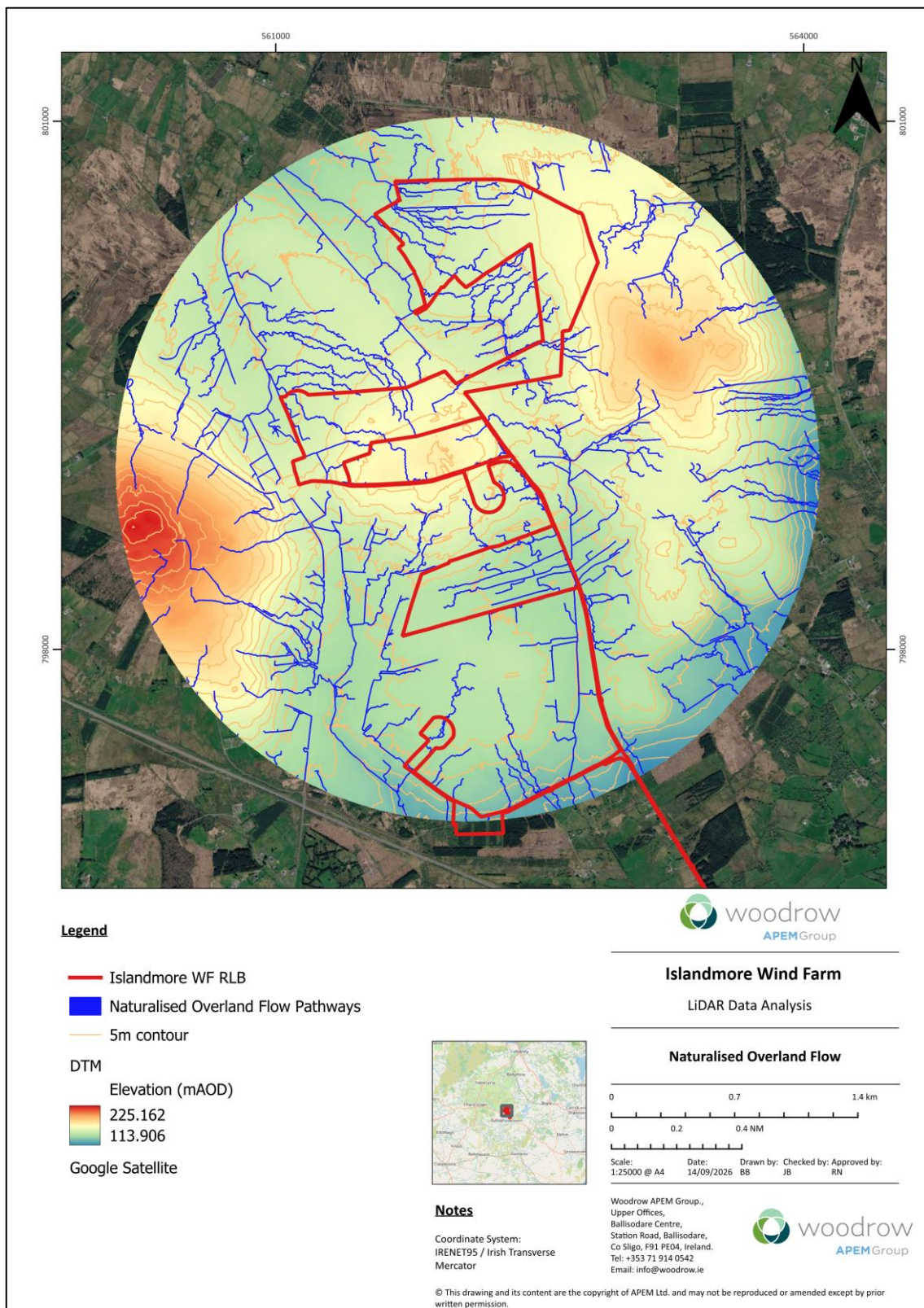


Figure 4: Naturalised Overland Flow Pathways

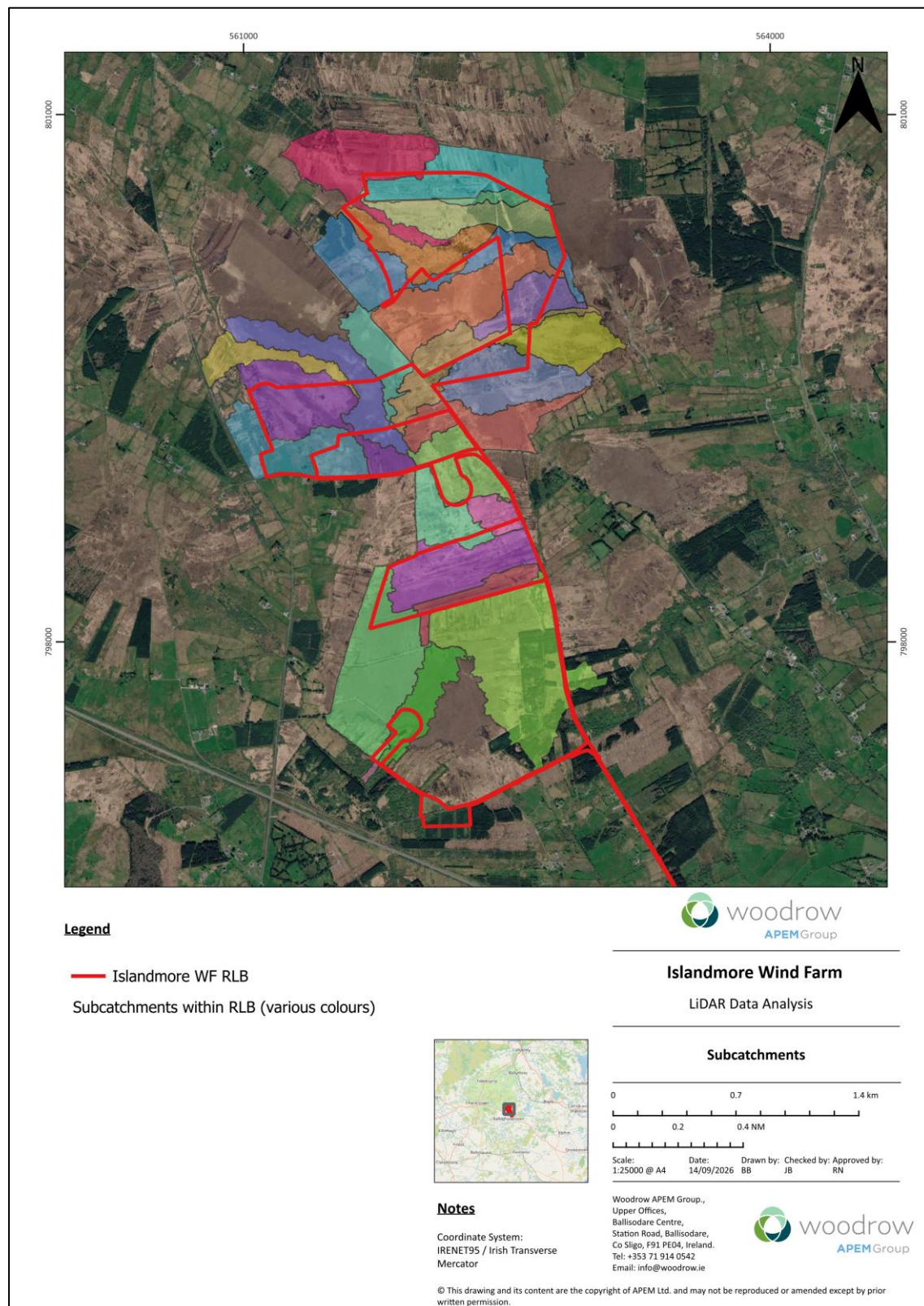


Figure 5: Sub-catchments

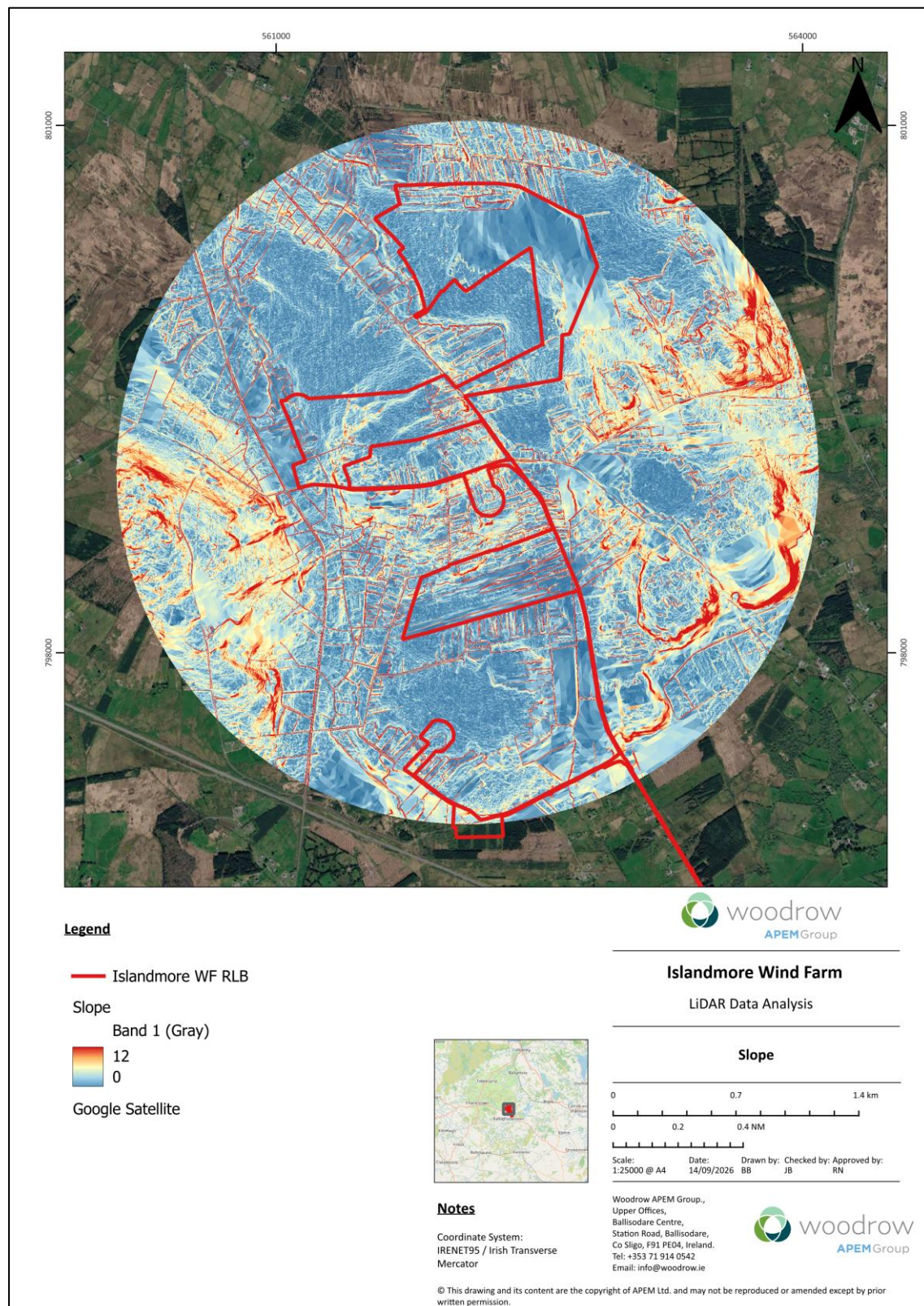


Figure 6: Slope

1.4 DISCUSSION

1.4.1 DESIGNATED SITE CONSIDERATION

1.4.1.1 Hydrological Connectivity

The watercourses within the project site discharge into the Owengarve River to the north which is hydrologically linked to the River Moy Special Area of Conservation (SAC) (**Figure 1**). The River Moy SAC designation includes the Annex II species qualifying features: white-clawed crayfish (*Austropotamobius pallipes*), sea lamprey (*Petromyzon marinus*), brook lamprey (*Lampetra planeri*), salmon (*Salmo salar*) and otter (*Lutra lutra*).

To the south, the project is hydrologically linked to Tullaghanrock Bog SAC, Callow Bog SAC and Lough Gara SPA via the Lung River. These watercourses are within the current range and distribution for white-clawed crayfish and brook lamprey according to Article 17 reporting (NPWS, 2019).

Water Framework Directive (WFD) catchment data (EPA, n.d.) was reviewed to identify where the site lies within wider catchment areas. **Figure 2** shows that the northern part of the site lies within the Moy and Killala Bay catchment (WFD catchment id 34), while the southern part of the site lies within the Upper Shannon catchment (WFD catchment id 26B).

1.4.2 LiDAR ANALYSIS

1.4.2.1 Flow Accumulation

Flow accumulation mapping produced by the kinematic wave method shows how many cells within the DTM are connected based on relative elevations. The benefits of flow accumulation mapping include a visual representation of where surface flows are most concentrated.

Concentrated flow accumulation can be noted towards the northern extent of the site, particularly associated with the (WD4) Conifer plantation. Flows are highly concentrated in the southern extent of the site; run-off from the (PB2) Upland blanket bog is draining directly into the Lung River. This represents a key flow pathway for the loss of water from the discharging (PB2) Upland blanket bog.

The natural hydrological regime of the (PB4) Cutover bog habitats throughout the site has been significantly modified, particularly near T1, T6, T8 and T9. Turf cutting and the associated excavation of drains within peatland systems facilitates lowering of the local water table by establishing and intensifying the formation of preferential pathways for flow routing. This is evidenced through the artificially straight drainage channels which can be seen where peat extraction is at its most intensive (**Figure 3**).

In general, flows are less concentrated elsewhere within the site as the terrain is relatively flat, with fewer defined pathways for the conveyance of surface runoff; hence, runoff rates are reduced, and water is retained for longer.

1.4.2.2 Naturalised Overland Flow Pathways

Naturalised overland flow pathways (**Figure 4**) illustrate the preferential flow routes of surface water runoff across the landscape. They are generally associated with

watercourses and natural topographic depressions. Artificial drainage channels can intercept and alter naturalised overland flow pathways by redirecting flow and increasing flow capacity. For peatland restoration, water retention efforts should be prioritised at these locations to reduce runoff rates and encourage the retention of saturated soil conditions.

1.4.2.3 Sub-Catchments

The sub-catchments within the site have been assessed to determine which are linked to the Owengarve River and Lung River (**Figure 5**), as hydrological connectivity between each of these watercourses and the Natura 2000 Network has been established (see **Section 5.4.1**). The selected sub-catchments have been used to identify and prioritise areas for peatland restoration to protect these downstream receptors. As such, works should be prioritised within the sub-catchments near T1, T6 – T10.

Compensatory restoration measures in these sub-catchments will likely improve water quality in the downstream receiving waterbodies by slowing flows, stabilising baseflows and reducing the sediment load. Within the selected sub-catchments, restoration measures should be carried out working upslope to downslope.

1.4.2.4 Slope

Low slope gradient is advised for implementation of peatland restoration measures, to reduce the risk of peat instability (Mills and Rushton, 2023). Peat dams are usually only effective on a shallow slope ($<12^\circ$) (NatureScot, 2019). Slope analysis, based on the DTM data, has been undertaken to identify flat ground. In these areas, deeper peat deposits are also likely, which will tend to increase success rates of applied restoration measures.

The site is a good candidate for peatland restoration with extensive areas of relatively shallow slope of ($<6^\circ$) (**Figure 6: Slope**). Within the peatland habitats, steep linear features ($>12^\circ$) detected typically represent the vertical faces of peat cuttings across the (PB4) Cutover bog.

1.5 HMP AREA DESIGN

A peatland enhancement ratio of 1:2 has been adopted as a project-specific biodiversity enhancement measure. While no fixed compensation ratio is prescribed in Irish peatland policy or guidance, peatland restoration associated with wind energy developments is commonly determined through site-specific HMPs and restoration opportunities.

In order to provide compensation for the residual effects of the project on peatland habitats, a compensation order of 1:2 (lost: restored) is proposed, i.e. 1ha loss of peatland will result in measures to protect or restore 2ha of peatland.

HMP Catchment Area	Available Area (all habitats)	Area of habitat impacted by the Project	Area of important ecological features impacted by the project
Moy and Killala Bay Catchment	107.09ha	13.68ha	PB2 Upland blanket bog – 2.59ha PB4 Cutover bog – 4.51ha GS3 Dry-humid acid grassland – 1.02ha WS1 Scrub – 0.33ha

Upper Shannon Catchment	50.41ha	12.40ha	PB2 Upland blanket bog – 0.04ha PB4 Cutover bog – 9.44ha GS3 Dry-humid acid grassland – 1.03ha WN7 Bog woodland - <0.01ha WS1 Scrub – 0.95ha WL1 Hedgerow – 0.46km WL2 Treelines - <0.01km
Total	157.50ha	26.08ha	

Table 1: HMP Areas

1.6 COMPENSATION MEASURES FOR PEATLAND

A range of peatland restoration and protection measures have been identified that could be implemented across areas of the site. These include:-

- Drain management;
- Peat bunding (including marginal / perimeter bunding, contour bunding and cell bunding);
- Forest to bog restoration;
- Bare peat revegetation;
- Scrub control;
- Cessation of turf cutting; and,
- Wildfire control.

Compensation Measures	HMP Area	Location / Turbine No.	Timeline
Peatland Restoration			
Drain management	Moy & Killala Catchment, Upper Shannon Catchment	T1, T2, T4, T5, T6, T8, T9, T10	Construction phase
Marginal bunds	Upper Shannon Catchment	T8, T9	Construction phase
Contour bunds	Moy & Killala Catchment, Upper Shannon Catchment	T1, T2, T3, T4, T6, T8, T9, T10	Construction phase
Cell bunds	Moy & Killala Catchment, Upper Shannon Catchment	T2, T4, T5, T6, T7, T8, T9	Construction phase
Forest-to-bog restoration	Moy & Killala Catchment	T2, T3	Construction phase, operation phase
Re-vegetating bare peat	Upper Shannon Catchment	T8, T9	Construction phase
Scrub removal	Moy & Killala Catchment	T1, T2, T3, T4, T6	Construction phase
Cessation of turf cutting & disturbance events	Moy & Killala Catchment,	T1, T4, T5, T8, T9, T10	Construction phase, operation phase

	Upper Shannon Catchment		
Prevention of uncontrolled burning	Moy & Killala Catchment, Upper Shannon Catchment	T1, T2, T3, T4, T6	Construction phase, operation phase
Monitoring	Moy & Killala Catchment, Upper Shannon Catchment	T1-T10	Pre-construction, construction, and operation phase
Other Species and Habitats			
Marsh fritillary habitat enhancement	Upper Shannon Catchment	T1/ T2, T8-T10	Construction phase
Hedgerow & tree line replanting	Moy & Killala Catchment, Upper Shannon Catchment	Replant lengths lost to temporary construction for access to T6 and T10. New planting to the east of peat storage and access at T6.	Construction phase
Invasive species control	Moy & Killala Catchment, Upper Shannon Catchment	T3, T5, T10	Construction phase

Table 2: Compensation measures to be implemented across the HMP Areas.

1.6.1 DRAIN MANAGEMENT

The aim of drain management is to slow the discharge of water from the (PB2) Upland blanket bog and (PB4) Cutover bog, and to restore hydrological function (Mackin *et al.*, 2017). The restoration measure will be assessed as successful when a series of water-tight peat dams or water-retaining timber dams have been installed at 5-12m intervals along the identified surface drains. A '*Blanket Bog Restoration Toolkit*' has been published which details best practice guidance on water retention measures (Chico *et al.*, 2024).

The following step-by-step guide summarises the information on drain management using peat dams on drains less than 1.5m wide and 2m deep:-

- Source a low ground pressure excavator with a tilting bucket for drain management works;
- Remove the living vegetation where the dam is to be created by extracting turves c. 30cm deep;
- Store turves vegetation side up, and ideally within reaching distance of the excavator to minimise the number of passes;
- Create a key in the peat by the removal of any dry peat from the base and sides of the dam;
- Dig a borrow pit within reaching distance of the digger to minimise the number of passes;
- Excavate dark wet peat from the borrow pit and use this to create the dam itself by infilling the key. Use dark wet peat only, in order to increase the stability and longevity of the dam;

- Use the bucket of the digger to compact the peat placed into the dam as works progress;
- Continue until the dam protrudes c. 40cm above the surface of the bog and expands 40cm beyond the width of the drain;
- Re-instate the vegetation turves on top of the dam to facilitate re-growth;
- Tap the vegetation turves with the bucket of the digger to secure in place;
- Infill the borrow pit with any excavated peat which was not used during the works, such as the discarded dry peat;
- Vegetation turves can be replaced on top of the pit;
- Create peat dams at 5-12m intervals;
- Work upstream to downstream;
- Monitor the structural integrity of the peat dams regularly immediately following construction as appropriate and especially following periods of heavy rain; and,
- Repair as necessary.

The following step-by-step guide summarises the information on drain management using timber dams on drains less than 3m wide and 2m deep:-

- Source untreated timber planks approx. 25cm wide, 3.75cm thick and posts 0.5-2m long, 10cm thickness;
- Drive supporting posts about 1m apart into the base of the drain using a mallet/sledgehammer. These will be used to stabilise the dam;
- Drive the first plank straight down, upstream of the supporting posts, overlapping the sides of the drain by 50cm. Make sure to drive plank straight down to avoid creating cracks in the side of the drain. This bottom plank should be embedded into the base of the drain by 25-50cm;
- Drive the next two (or three, if necessary) planks straight down on top of the first. Fix all planks to the supporting posts. The bottom two planks should fit closely together. Gaps of approx. 1-2cm should be left between the second board and the third board (and the fourth board, if using);
- A V-notch should be cut into the middle of the top plank;
- Create a spill plate below the V-notch on the top plank to evenly distribute any overflowing water. This can be made of available stone, timber or vegetated turves;
- Create dams at 5-12m intervals;
- Work upstream to downstream.
- Monitor the structural integrity of the timber dams regularly immediately following construction as appropriate and especially following periods of heavy rain; and,
- Repair as necessary.

Catchment	Drain Length
Moy and Killala Bay Catchment	c. 2.51km
Upper Shannon Catchment	c. 3.22km

Table 3: Drain Management Opportunities

1.6.2 PERIMETER BUNDING

A perimeter or marginal bund is a barrier designed to retain water and is typically constructed along the perimeter of cutover peatlands (Mackin *et al.*, 2017). Perimeter bunds are most effective where the land is relatively flat, so that the water table can be maintained close to the surface of the cutover bog without exerting too much force on the bund wall. Optimum water levels within the bund are typically significantly less than 0.5m (Mackin *et al.*, 2017). An appropriate hydrological barrier should exist between a location where perimeter bunding is proposed and adjacent agricultural land (with the retention of existing drains on the edge of the site) (Mackin *et al.*, 2017).

The aim of a perimeter bund is to restore the hydrological function of (PB2) Upland blanket bog and (PB4) Cutover bog. The restoration measure will be assessed as successfully implemented when:-

- A water-tight bund has been constructed, which withstands heavy rainfall events;
- The growth of *Sphagnum* spp. has increased in coverage;
- The vegetation community resembles a higher quality peatland habitat; and,
- The ecological succession to scrub which often occurs on cutover bog is halted.

Best practice guidance on the creation of perimeter or marginal bunds along with case studies of their use in peatland restoration in Ireland has been issued by the National Parks and Wildlife Service (NPWS) and is summarised below (Mackin *et al.*, 2017):-

- Identify the appropriate placement of the marginal bund under the guidance of a suitably qualified peatland ecologist / hydrologist;
- Install silt traps downstream as appropriate to protect sensitive watercourses;
- Use marking flags to highlight the line along which the bund is to be constructed;
- Use a specialist wide track excavator with a 1.2m bucket to remove the surface vegetation (turves) up to a depth of c. 0.5m along the contour lines in consecutive linear strips;
- Temporarily store the turves as intact turves vegetation-side-up and if possible, within reaching distance of the excavator to minimise the number of passes necessary;
- Only use wet fibrous peat to build the bund;
- Dig a trench 0.5m in width and 1.5m in depth (if peat depths allow);
- Use a low permeability geotextile membrane to line the trench if the peat is too dry to form a watertight barrier;
- Reinstall the excavated peat into the trench and compress the peat in layers, using the back of the bucket, after each load has been deposited in place;
- Install prefabricated outlet weirs or overflow pipes as appropriate to ensure water levels do not rise above c. 0.25m within the bund area;
- Extend the bund beyond the dimensions of the trench to 1.5 m in width and <0.5m in height;

- Use highly humified peat excavated from construction areas elsewhere on site for use in bund construction;
- Re-instate vegetation (turves) on top of the bund and within the marginal drain;
- Compress to ensure good contact with the peat and to prevent peat erosion;
- 5m long finger bunds should be constructed using the same technique at approximately 25m spacing on the upslope side of the perimeter bund to prevent flow along the bund which may lead to erosion;
- Monitor the structural integrity of the bund regularly immediately following construction and especially following periods of heavy rains; and,
- Repair bund as necessary.

1.6.3 CELL BUNDING

Cell bunding is like perimeter or marginal bunding but, in these areas, a series of peat bunds are constructed to join up forming enclosed 'cells' of variable shapes and sizes on primarily on (PB4) Cutover bog. The aim is to establish peat-forming conditions within each cell by raising the water table within it close to or slightly above the ground surface (maximum depth typically 10-20 cm). This 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

NPWS have adopted the following approach to cell bunding within peatland restoration plans prepared for designated peatland sites (e.g. NPWS, 2022):-

- Probe peat at proposed cell bunding locations to ensure the presence of an adequate depth of peat in (PB4) Cutover areas;
- Identify the appropriate placement of the bunds and cell sizes (up to a maximum size of 30m x 30m);
- Use marking flags to highlight the locations where bunds are to be constructed;
- Install silt traps downstream as appropriate to protect sensitive watercourses;
- Use a specialist wide track excavator with a 1.2m bucket to remove the surface vegetation (turves) up to a depth of c. 0.5m along the bund lines in consecutive linear strips;
- Temporarily store the turves as intact turves vegetation-side-up and if possible, within reaching distance of the excavator to minimise the number of passes necessary;
- Only use wet fibrous peat to build the bund;
- Dig a trench 1.0-1.5m in depth (if peat depths allow);
- Reinstall the excavated peat into the trench and compress the peat in layers, using the back of the bucket, after each load has been deposited in place;
- Install prefabricated outlet weirs or overflow pipes as appropriate to ensure water levels do not rise above c. 0.25m within the bund area;

- Extend the bund beyond the dimensions of the trench to 1.5m in width and <0.5m in height;
- Use highly humified peat excavated from construction areas elsewhere on site for use in bund construction;
- Re-instate vegetation (turves) on top of the bund;
- Compress to ensure good contact with the peat and to prevent peat erosion;
- Monitor the structural integrity of the bund regularly immediately following construction and especially following periods of heavy rains; and,
- Repair bund as necessary.

1.6.4 CONTOUR BUNDING

Contour bunds aim 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. The key limitation 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 limited where the surface slope is steep. This method is best suited to sites with a relatively gentle slope or as a means of effectively blocking a dense network of shallow surface drains such as those created for afforestation, but where tree planting did not occur.

The aim of a contour bund is to restore the hydrological function of (PB2) Upland blanket bog and (PB4) Cutover bog. The restoration measure will be assessed as successfully implemented when:-

- The growth of *Sphagnum* spp. has increased in coverage;
- The vegetation community resembles a higher quality peatland habitat; and
- The ecological succession to scrub which often occurs on cutover bog is halted.

NPWS have adopted the following approach to contour bunding within peatland restoration plans prepared for designated peatland sites (e.g. NPWS, 2022):-

- Identify the appropriate placement of the contour bund utilising LiDAR data analysis and under the guidance of a suitably qualified peatland ecologist / hydrologist;
- Use marking flags to highlight the contour line along which the bund is to be constructed;
- Install silt traps downstream as appropriate to protect sensitive watercourses;
- Use a specialist wide track excavator with a 1.2m bucket to remove the surface vegetation (turves) up to a depth of c. 0.5m along the contour lines;
- Temporarily store the turves as intact turves vegetation-side-up and if possible, within reaching distance of the excavator to minimise the number of passes necessary;
- Only use wet fibrous peat to build the bund;
- Excavate a trench 1.5-2.0m deep;

- Re-compact peat into the trench and build a slightly raised bund 0.25-0.30m above the current ground surface;
- Reinstall the excavated peat into the trench and compress the peat in layers, using the back of the bucket, after each load has been deposited in place;
- Re-install vegetation (turves) on top of the bund and within the marginal drain;
- Compress to ensure good contact with the peat and to prevent peat erosion;
- 5m long finger bunds should be constructed using the same technique at approximately 25m spacing on the upslope side of the contour bund to prevent flow along the bund which may lead to erosion;
- Monitor the structural integrity of the bund regularly immediately following construction and especially following periods of heavy rains;
- Repair bund as necessary; and,
- 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.

In the north-east of the site, a significant extent of the (PB2) Upland blanket bog has been prepared for commercial forestry but either remains unplanted or the saplings largely failed. This is made evident by the series of ridges and furrows which remain, along with frequent self-seeded conifers and scrub. Contour bunding in these areas can be undertaken to block the ridge and furrow as well as any deeper drains to restore the bog hydrology closer to a natural state. This approach is proposed to be adopted within the site near T1–T4. Additional scrub and scattered tree removal may also be required in these areas to reset the hydrology.

Catchment	Perimeter Bunding	Cell Bunding	Contour Bunding
Moy and Killala Bay Catchment	-	c. 1.09ha	c. 5.89km
Upper Shannon Catchment	c. 0.57km	c. 2.25ha	c. 1.47km

Table 4: Potential Bunding Opportunities.

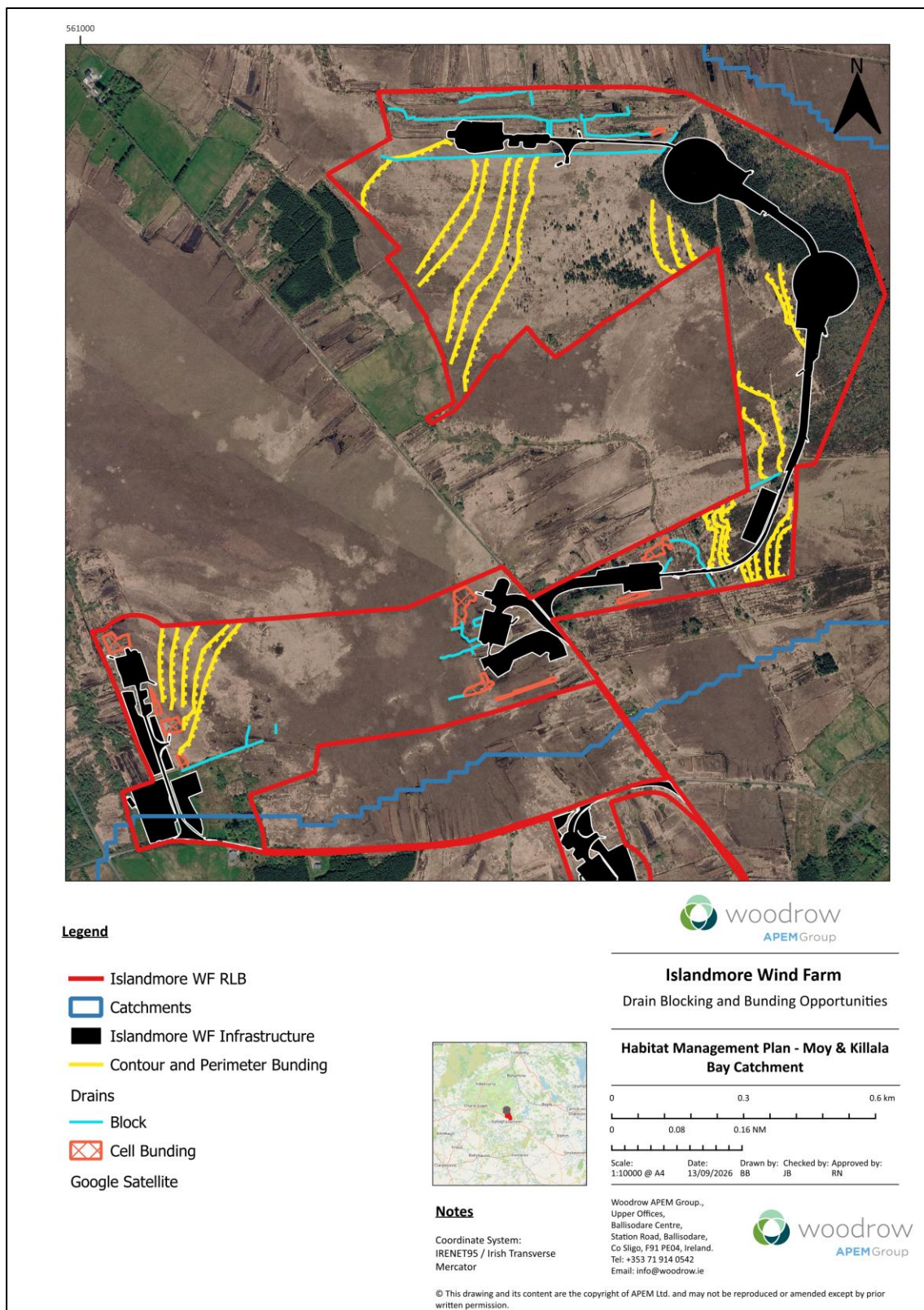


Figure 7: Drain Blocking and Bunding Opportunities Within the Moy and Killala Bay Catchment

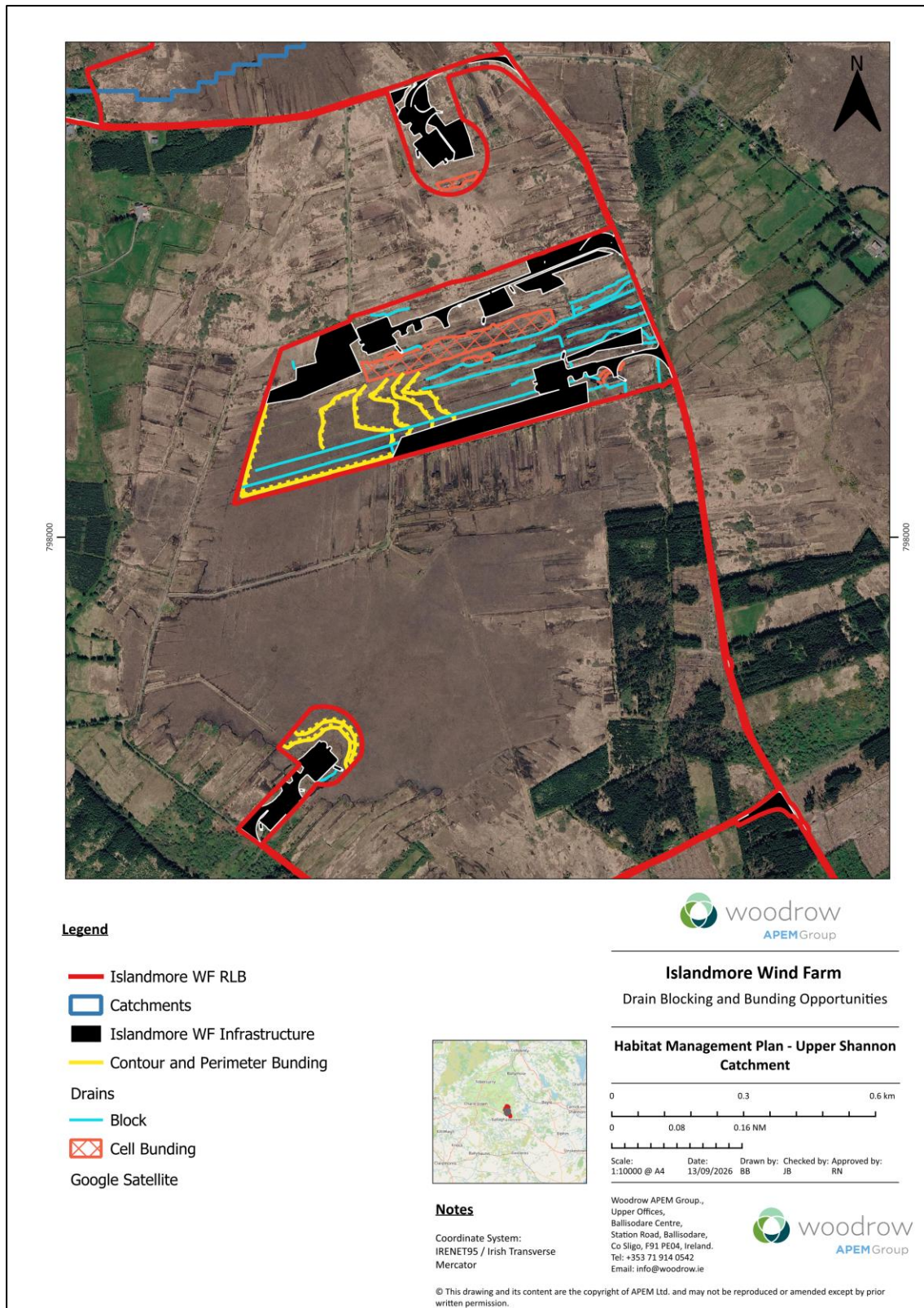


Figure 8: Drain Blocking and Bunding Opportunities Within the Upper Shannon Catchment

1.6.5 FOREST-TO-BOG RESTORATION

The suite of mitigation measures proposed for this project (see **Chapter 5**) specifies the removal of sub-sections of the (WD4) Conifer plantation in the north-east of the site, in order to create bat buffer zones around turbine locations. Small-scale forest-to-bog restoration is to be carried out within these buffer zones. The aim of the forest-to-bog restoration is to alleviate the negative ecological effects of the previous afforestation of peat soils to establish (WD4) Conifer plantation, including drainage and active tree planting. Once conifers have been removed the habitat will be restored to (PB2) Upland blanket bog. Creating and retaining these areas as open habitat will reduce the suitability for bats and the associated risk of collision and barotrauma. The restoration measure will be assessed as having been successful when:-

- The vegetative community within the bat buffer zones is restored to a peatland habitat with affinity to a recognisable IVC community;
- The furrow and ridge drainage system has been removed through ground smoothing techniques;
- A series of water-tight cell bunds has been constructed, which can withstand heavy rainfall events; and,
- The removal of self-seeded conifer saplings from the wider peatland landscape has been achieved.

The following guidelines on forest-to-bog restoration techniques have been taken from best practice guidance (NatureScot, 2025a, NatureScot, 2025b):-

- Consult with Coillte and the Forest Service to secure permission to re-designate land use;
- Undertake a targeted peat depth survey to a 20m grid sampling methodology to inform selection of methods;
- Ensure all personnel follow best-practice methodology to prevent introduction or spread of invasive species when using machinery and equipment;
- A machine de-bogging and emergency plan should be in place before work starts as sites can rewet rapidly and be unstable;
- Source specialist forestry machinery including a forwarder and harvester;
- Peatland restoration machines must be large enough to have the power to prize out the stumps but not be pulled into the peatland themselves. A toothed excavator bucket is required to prize stumps out by the root plates and break them up if necessary;
- Excavators need to have window protection (window guarding or strengthened glass) when moving woody debris and stumps around;
- Usually exceptionally wide tracks are better for the peatland work (<1.5m wide tracks can lead to too much rutting, compaction, and disturbance of peat). 1.9m wide tracks (on a 14-tonne machine) reduce ground pressure on the peat, disturb existing vegetation less, and are more stable and better suited for stump lifting with better leverage. This set up also reduces the amount of cross tracking required;

- Pre-plan access routes, and areas for re-fuelling and the storage of machinery on-site and locate these away from drains and watercourses;
- Block all outflows from existing furrows and install silt traps along collector drains;
- Create brash mats where necessary for timber and brash extraction using waste materials to further protect the surface of the bog and prevent sedimentation within these clearance areas;.
- Clear fell the buffer zones using specialist wide track machinery with a long reach to minimise tracking over sensitive habitat;
- Remove as much of the resultant brash and waste material from the areas;
- Collect and remove the brash mats once works are complete to ensure no input of nutrients into watercourses as the vegetation decays;
- Maintain as much of the existing peatland vegetation as possible;
- Ground (or surface) smoothing operations, frequently including stump flipping and cross-tracking are to be undertaken to remove the impact of forestry ridge and furrows. The technique must, however, be used in conjunction with peat dams in larger drains (described in **Section 5.6.1**) wherever peat depths allow, to ensure that water preferential pathways do not develop along the base and sides of the drains in the future;
- Stump flipping is a ground smoothing technique, which peels off the shallow root systems from the underlying peat, flipping them over, followed by compressing them upside down into the furrows with the back of the bucket (where adequate peat depth occurs). This technique can be more challenging on sites just after felling as root plates have not broken down and can remain intertwined and need breaking up mechanically;
- When stump flipping Sitka spruce (*Picea sitchensis*) root plates, peel the stump off the peat, minimising the amount of peat disturbance. Then flip them over and compress the stump into the furrow. Care is needed to flip Lodgepole pine (*Pinus contorta*) root balls, ensuring that no additional peat is excavated below the roots;
- Cross-tracking involves an excavator driving back and forth over the ground so that the whole surface gets flattened, any mulch or brash is distributed, and any stumps or woody debris do not spring back up. As the machine progresses over the flipped stumps, wide tracked machines will consolidate stumps into the peat and block any remaining furrows and drains;
- The initial pass in cross-tracking is made up and down the slope and then a second pass can be made across the slope, if required. There is sometimes low-amplitude corrugation left at the end: in the rare cases where this is aligned across the slope, rather than up and down it, it encourages retention of water on the surface and is possibly desirable;
- Use highly humified peat excavated from construction areas elsewhere on site for use in the construction of cell bunds within the buffer zone (see **Section 1.6.3**). Ensure the design of pools through cell bunding avoids channelling water around the perimeter of the buffer zone;

- The most effective time to remove any subsequent tree regeneration is to remove it within 7-years of re-wetting. Dense tree regeneration would normally indicate that the site was not re-wetted sufficiently, perhaps because the peat was cracked below the furrows, or because there is close proximity of seed sources through remaining plantations (as would be the case here). The need to carry out removal of dense conifer regeneration on forest-to-bog sites can be reduced by re-wetting the site as soon after tree felling as possible.

Two further areas to the southwest of T2 in an area of generally failed afforestation but with local abundance of conifers will also be considered for forest to bog restoration to (PB2) Upland blanket bog habitat subject to site conditions at the time of construction.

Location	Habitat	Area (ha)
Turbine 2	Conifer clearance – swept area	1.09 ha
Turbine 2	Open habitat – swept area	0.09 ha
Turbine 2	Conifer clearance – additional area	0.20 ha
Turbine 3	Conifer clearance – swept area	1.07 ha
Turbine 3	Open habitat – swept area	0.08 ha
Southwest of Turbine 2	Areas of dense conifers in areas of generally failed afforestation.	1.34 ha
Southwest of Turbine 2	Areas of dense conifers in areas of generally failed afforestation.	0.46 ha

Table 5: Forest to Bog Restoration Opportunities

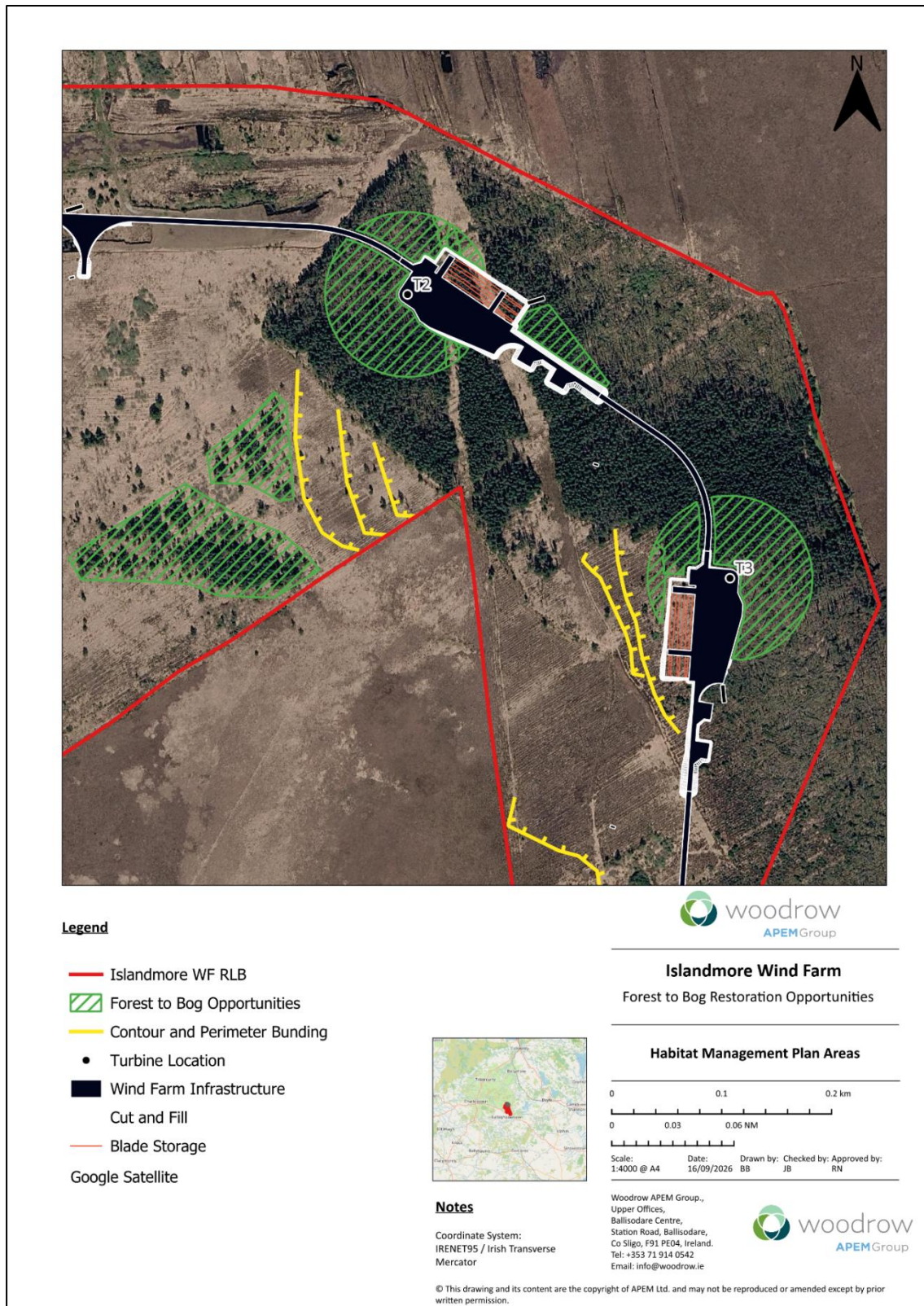


Figure 9: Forest to Bog Restoration Opportunities

1.6.6 RE-VEGETATING BARE PEAT

Large expanses of bare peat associated with on-going mechanised turf extraction were noted within the site. Re-establishing vegetation over the bare peat will protect the peat soils and the stored carbon. Techniques proposed are based on good practice from Scotland (NatureScot, 2025c; NatureScot, 2025d). As the locations of these are expected to change over time depending on the location of turf extraction, it is not possible to define the specific location of these works at the present time. Re-vegetation will only be undertaken in areas where turf cutting has ceased (see **Section 5.6.8**).

The restoration measure will be considered successful when:-

- Bare peat coverage is reduced within the relevant HMP works areas within 5-years; and,
- The vegetation turves which were translocated have become established within the bare peat area.

1.6.6.1 Surface Flow Barriers

Best practice requires water flow over the bare peat to be dealt with first. Even on flat surfaces, surface water movement can still be high and therefore it is crucial to manage water flow across an area for bare peat. Surface bunds are <50 cm high and typically span a wide feature (such as a bare peat area) to slow and break up the flow of water. Bunds can catch a lot of sediment which reduces peat loss and facilitates revegetation, enabling the creation of new peat-forming habitats.

Surface bunds can be made from a range of materials such as turves/peat, coir logs, wood (untreated round wood, untreated sawn wood), filled geo-textile sacks, heather bales and mineral.

The following method on the use of coir rolls in bare peat restoration has been taken from best practice guidance (Chico *et al.*, 2024; NatureScot, 2025d):-

- Position the coir logs against the overland flow pathways;
- Create a gentle 'U' shape with each coir log;
- Use a mallet to fix the coir log in place using wooden pegs;
- Secure large 3m coir logs with c. 8 large wooden pegs (c. 50cm), and smaller 1-2m coir logs with c. 6 pegs; and,
- Repeat to create a series of coir logs intercepting flows across the bare peat.

1.6.6.2 Mulching

Mulch needs a good donor site, with heather (*Calluna vulgaris*) and good mix of cottongrass (*Eriophorum* spp.) and mosses. Although the donor site must be cut low (to get mosses), care should be taken not to expose the peat surface. Ensure donor sites contain mosses and plant species that can establish at the restoration sites – e.g., bog-mosses (*Sphagnum* spp.) need to be the appropriate species. Where possible, donor material will be sourced from areas of (PB2) Upland blanket bog within the infrastructure footprint that are to be removed during construction (NatureScot, 2025d).

Ensure mulch has the correct structure, as this can be just as important if creating a protective layer, as the seed content. Mulch that is too mossy is less effective; it ideally needs a good proportion of heather fragments. Mulches ultimately need a good balance of plants and structure. Avoid collecting too much dead matter (donor sites therefore need to have a short sward height).

Mulch should be collected and applied as soon as feasible to ensure it is still viable. Autumn is the best time to cut mulch from donor site because the seed source will be present. Mulch application must be thick (3.5-5 cm at 330-695 bags per hectare).

Consider weather at time of application. Mulch should not be applied in a dry period as it can blow away. Frost heave can also have a big impact on mulch. The best season for applying mulch can be spring after snow melt, but bird breeding season limitations and the storage issues if cut in autumn can present problems.

Ensure mulch is applied to areas that will not be flooded by other interventions that are changing water levels on site. Deal with any reprofiling or bunding interventions first, before mulch applications.

This technique may in certain circumstances benefit from the application of lime and fertiliser, to increase surface pH and encourage plants to establish. The amount and concentration of chemical should be low and exhausted quickly to ensure appropriate species colonise. Any application of fertiliser or liming should be based on the assessment of an experienced peatland restoration ecologist.

1.6.6.3 Translocation of Vegetated Turves

Where vegetation must be removed for construction activities, these could potentially be used to revegetate bare peat nearby after ensuring that the receptor location has suitable peat substrate and hydrological conditions.

Large turves should be removed from the donor location retaining the vegetation and upper peat layers as turves, often to 0.5m thick. Turves should be kept moist and handled carefully to minimise damage.

Surface bunds or dams may be needed to stop whole turves slipping (as well as managing water movement). Do not hold back too much water or the turves may float, move, and not help vegetation establish.

Turves are laid closely together to maximise vegetation continuity. Gaps may be infilled with Sphagnum fragments, plugs, or donor material. Turves should be placed gently and as close together as possible, gently tamping them down and together.

Turf translocation methodology adapted from Anderson (2003):-

- Identification of suitable receptor locations where the revegetation of bare ground is required and the hydrological and vegetation structure are similar to the donor location;
- The best period for translocation is the autumn / early winter under 'normal' weather conditions;
- Prepare receptor area prior to translocation. if you're moving a 200 mm deep bog turf, you would typically excavate a ~200 mm deep pocket in the receptor area and place the turf so the original vegetation surface is level with adjacent ground;

- Use an excavator to take as large a turf as is practically possible to reduce edge effects and increase the chances of transferring terrestrial and soil invertebrates;
- Retention of 200-300 mm of root zone/soil beneath each turf. Depth to be determined by rooting depth on site;
- Immediately transfer to receptor location and place into prepared location using an excavator;
- Close-fitting placement of turves onto prepared ground. Gaps between turves should be tightly closed and watered/wetted if conditions are dry. Surface finished flush with surrounding ground; and
- The water table should be maintained within approximately 10 cm of the surface throughout the growing season.

1.6.7 SCRUB REMOVAL

Scrub can have a negative impact on the integrity of peatland sites as it can outcompete peatland vegetation and have a drying effect on the supporting peat (NatureScot, 2025e). Scrub removal on peatland habitats should only be considered in conjunction with water retention measures, otherwise scrub control measures are likely to be temporary and ineffective. The need for this should be assessed on a site-by-site basis during the pre-construction surveys and agreed with the appointed Ecological Clerk of Works (ECoW).

The aim of scrub removal is to interrupt the ecological succession to scrub which often occurs on peatland habitats when the hydrology of the site has been negatively impacted. The scrub removal as a restoration measure will be considered a success when:-

- The cover of scrub does not continue to increase;
- The scrub cover within the re-wetted areas is reduced to a level below standard minimum mapping units (400m²); and,
- The understory of the scrub has recovered to a peatland habitat with affinity to a recognisable IVC community.

The following guidelines on scrub clearance within peatland habitats have been taken from best practice guidance (NatureScot, 2025e):-

- Carry out scrub removal outside of the bird nesting season (March-August inclusive);
- Survey scrub before removal to identify any potential use by protected mammals;
- Cut scrub close to ground level;
- Use handheld machinery when working on primary bog and as appropriate elsewhere;
- Use a mechanical flail on cutover bog as appropriate and where access allows;
- Remove birch seedlings located on the primary bog (to the east of T6) by hand pulling or using handheld equipment (such as brush cutters), as appropriate;

- Treat larger broadleaved saplings (>1.5cm diameter at breast height) using a non-drip weed wipe, wiping (not spraying) stumps with glyphosate to prevent re-growth; and,
- Remove all felled material from the bog habitats.

1.6.8 CESSATION OF TURF CUTTING & DISTURBANCE EVENTS

The Cessation of Turf Cutting Restoration Scheme has been established by the Department of Housing, Local Government and Heritage (NPWS, 2025). The scheme aims to purchase turbary rights from local communities, relocating turf cutting activities to less environmentally sensitive areas, and providing compensation to those participating (Fernandez *et al.*, 2014). These initiatives have shown positive results, with data indicating a decline in peat cutting activity within the 53 no. Special Areas of Conservation (SACs) (Fernandez *et al.*, 2014). Due to the success, the scheme was expanded to include 36 no. Natural Heritage Areas (NHAs), and new applicants were welcomed in 2024 (DHLGH, 2024).

A summary of the application process for participating in the scheme is provided below, along with details of the financial compensation currently provided to successful applicants (DHLGH, 2024). The following steps serve as a template for a local scheme aimed at reducing turf cutting within the HMP lands for the lifetime of the project:-

- Complete an application form to include:-
 - Proof of identity.
 - Proof of title of the turbary plot within the Species Habitat Management Area (SHMA).
 - A map of the turbary plot.
 - The bog plot number and townland.
 - Land registry folio number and Property Registration Authority.
 - The name of the entity which originally granted turbary rights.
 - The name of the individual from whom the Right of Turbary was inherited.
 - Evidence of turf cutting on the plot within the last 5 years.
 - A letter of consent from the landowner (if different to the applicant).
- Agree to site visits from surveyors to assess the suitability of the land for inclusion in the scheme.
- Agree to the cessation of turf cutting within the plot for the duration of the scheme.
- Agree to the cessation of disturbance activities within the plot for the duration of the scheme, including the use of heavy machinery, footing and drying turf, and the creation of bare peat through vegetation removal.
- Submit the complete application form to the identified land agent representing the scheme.
- Consent to restoration measures to improve the habitat condition as recommended.

- Successful applicants will receive an annual payment (details to be agreed at a later date) for the length of the agreement.

The aim of the proposed restoration measure to cease turf cutting within the site is to halt the overall loss of loss of (PB4) Cutover bog and (PB2) Upland blanket bog habitat within the site. This restoration measure will be considered successful when there has been no notable evidence of turf extraction within the HMP areas included in the scheme for at least a period of 5-years, with assurance that no further turbarry will be carried out for the lifetime of the project.

1.6.9 PREVENTION OF UNCONTROLLED BURNING

Fire damage to peatland habitats was noted within the site during surveys, particularly in the north. The fire damage was evident from standing deadwood in the (WD4) Conifer plantation, as well as more subtle signs, such as the surface of the peat being hard underfoot, and a diminished bryophyte layer.

Fire breaks within peatland habitats need to be >6m wide to reliably stop a fire under controlled burning (DAFM, 2012). It is recommended that fire breaks are installed as a fail-safe within HMP areas which were target noted as being severely impacted by fire.

This step-by-step guidance proposes landowners uphold a commitment to the cessation of burning activities on peatland habitats within the HMP Areas for the lifetime of the project:-

- Assess the suitability of the land for the creation of a fire break along the perimeter of the peatland habitat;
- Remove shrubs, dwarf shrubs, and long grasses within a 6 m strip using a strimmer or other handheld machinery;
- Repeat vegetation removal as necessary to maintain a strip free from highly flammable vegetation;
- Participating landowners must commit to the cessation of burning activities on peatland habitats for the lifetime of the project; and,
- Participants will receive an annual payment (details to be agreed at a later date) for the length of the agreement.

The aim of the restoration measure is to prevent the use of fire as a land management method within the (PB2) Upland blanket bog habitats within the site. This restoration measure will be considered successful when there has been no notable evidence of fire within the HMP Areas for at least a period of 5-years and continuing for the lifetime of the project.

1.7 COMPENSATION MEASURES FOR OTHER SPECIES AND HABITATS

1.7.1 MARSH FRITILLARY HABITAT MANAGEMENT

Proposed compensation measures for the direct loss of marsh fritillary (*Euphydryas aurinia*) habitat involve land management actions on an adjoining parcel of suitable habitat. The aim of these land management actions is to increase habitat quality for the species by achieving a 'good condition' score for the land parcel (NBDC, n.d.). This compensation measure will be considered successful when the identified marsh fritillary habitat within the HMP Area has:-

- Three or more well-developed devil's-bit scabious (*Succisa pratensis*) plants per square metre, across more than 20% of the habitat; and,
- An average sward height between 12-25cm.

The following information is adapted from best practice guidance on habitat management for marsh fritillary (Phelan *et al.*, 2021):

- Conduct scrub removal for marsh fritillary habitat management over the autumn and winter months (September-February);
- Remove 90-95% cover of tall scrub (> 1.5 m) (see Section 5.6.7);
 - Retain low invading scrub (< 0.5 m) to maintain sward structure;
 - Do not use fertilisers or agricultural lime within the land parcel;
- Remove non-native conifer species;
- Conservation grazing techniques are the most effective measure for maintaining optimum sward height and structure for marsh fritillary;
 - Select one head of cattle to graze per hectare (1 LU/ha) for less than three months of the year (DAERA, 2017);
 - Limit grazing to summer months (May-July);
 - Do not bring salt licks or supplementary feed to the area;
 - Install drinking troughs as necessary along the access track to limit negative impacts from trampling and nutrient enrichment to areas not supporting devil's-bit scabious (*Succisa pratensis*);
 - Check herd regularly and assess the height of the sward; and,
 - Remove herd if sward height is <8cm, or if there are sustained periods of heavy rainfall.

An additional potential supplementary measure subject to pre-construction surveys identifying a need would be the translocation of turves featuring abundant devil's-bit scabious from near T10. Mature devil's-bit scabious plants can take several years to develop from seed, whereas turf transfer immediately transfers established plants, seed bank, soil fungi, etc.

The ECoW should undertake an assessment for the abundance of devil's-bit scabious and the presence of marsh fritillary webs prior to work. Translocation from T10 should be to bare peat areas requiring revegetation near T8, T9 or T10.

Turf translocation methodology adapted from Anderson (2003) would be similar to that described in **Section 1.6.6.3**:

- The ECoW or other appointed Ecologist should identify any areas near T10 that are due to be lost to construction with abundant devil's-bit scabious (and Marsh Fritillary webs depending on timing of translocation);
- Identification of suitable receptor locations near T8, T9 or T10 where the revegetation of bare ground is required and the hydrological and vegetation structure are similar to the donor location;
- The best period for translocation is the autumn / early winter under 'normal' weather conditions;

- Prepare receptor area prior to translocation. if you're moving a 200 mm deep bog turf, you would typically excavate a ~200 mm deep pocket in the receptor area and place the turf so the original vegetation surface is level with adjacent ground;
- Use an excavator to take as large a turf as is practically possible to reduce edge effects and increase the chances of transferring terrestrial and soil invertebrates;
- Retention of 100-300 mm of root zone/soil beneath each turf. Depth to be determined by rooting depth on site;
- Place turves on a flatbed trailer or flat-based dump truck if translocated to near T8 or T9;
- Immediately transfer to receptor location and place into prepared location using an excavator;
- Close-fitting placement of turves onto prepared ground. Gaps between turves should be tightly closed and watered/wetted if conditions are dry. Surface finished flush with surrounding ground; and
- The water table should be maintained equivalent to the donor location. where blanket bog vegetation is translocated, maintain water table within approximately 10 cm of the surface throughout the growing season.

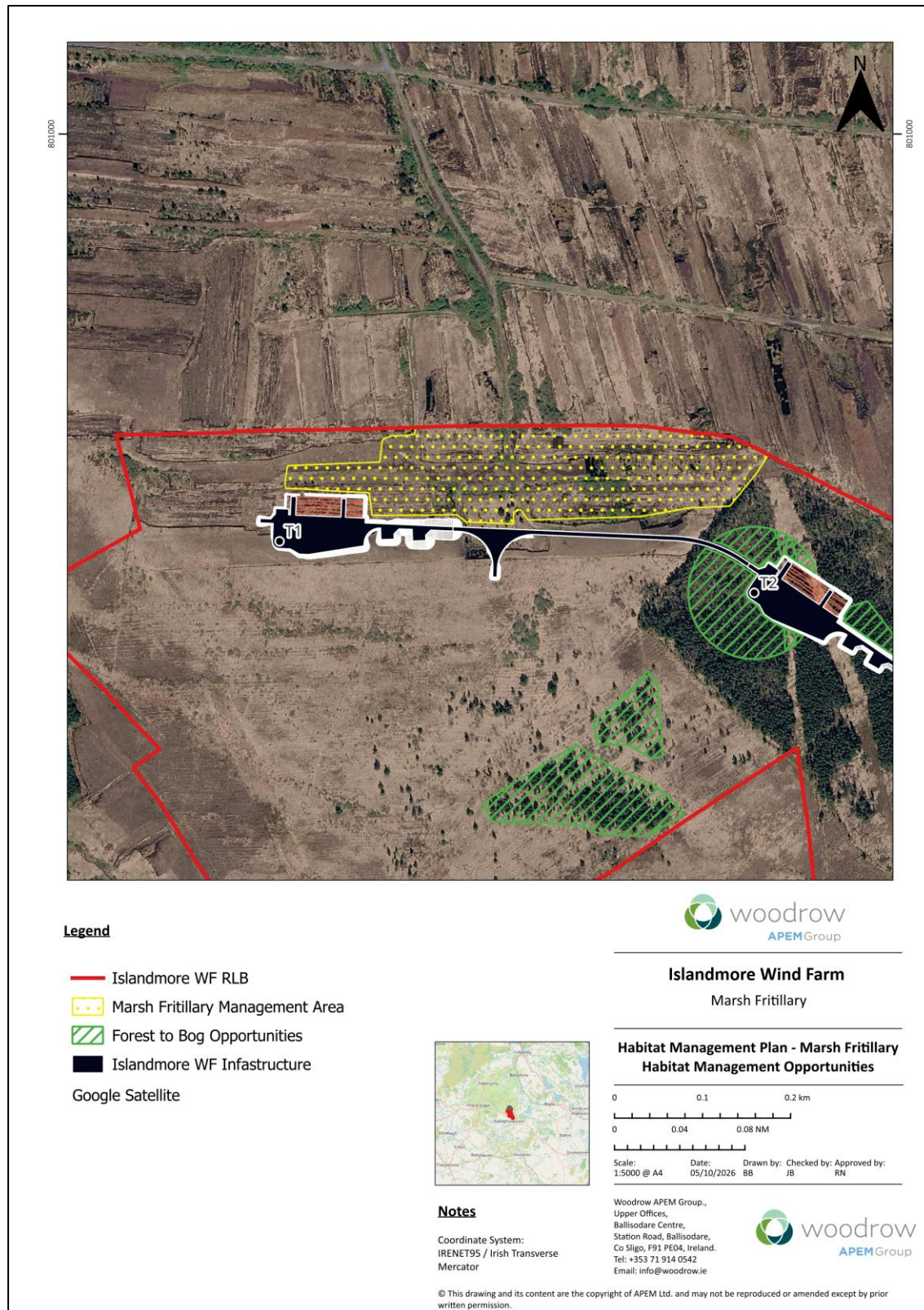


Figure 10: Potential Marsh Fritillary Habitat Restoration Area Near T1

1.7.2 HEDGEROW REPLANTING

Locations for hedgerow planting include the location of lengths lost to temporary construction works (once completed) associated with the access to T6 and T10 (**Figure 11**). Potential new planting in the grasslands to the east of the peat storage and access to T6. These areas amount to approximately 460m of WL1 Hedgerow loss, as well as 5m of WL2 Treelines, and should be accounted for with up to 700m of WL1 new native planting / native enhancement of existing hedgerows.

Best practice guidance on establishing and maintaining hedgerows was consulted (Teagasc, 2022; 2024). The following steps will be adopted during planting to maximise successful establishment of new hedgerows and treelines:-

- Undertake planting in the appropriate season (October to March);
- Do not undertake planting following periods of heavy rain or periods of frost;
- Use 2-year-old bare root stock (i.e. whips);
- Source a diversity of appropriate species so that no one species makes up more than 70% of the total number of plants;
- Plants will be protected from drying out by keeping plants in a bag until needed;
- Areas for hedgerow laying will be marked out using wire or twine (area of c. 1.5m in width);
- Cultivate a 1.5m strip to prepare the ground to be planted and reduce competition from weeds;
- Planting will be performed to the appropriate depth, with stems exposed and roots buried;
- Establish stockproof hedgerows by planting five native shrubs per meter in a double staggered row;
- Plant one native-species tree every c. 50m along the stockproof hedge;
- Mark the tree and leave to mature unmanaged without being pruned or topped, in order to enhance hedgerow structure;
- Tree guards will be used to protect tree saplings from herbivory and/or mechanical damage and ensure establishment success;
- Deposit organic mulch (e.g. wood chip, straw) around all plants to control the growth of competing vegetation;
- Erect a fence c. 1 m from the newly established hedgerows to protect saplings from livestock and reposition fence as hedge expands;
- Strim around the hedgerow during the first and second year to ensure the new plants are not outcompeted by weeds. Do not strim the saplings;
- Do not use herbicide to control weeds but, if necessary, a non-drip weed wipe can be used by a suitably qualified contractor to control invasive species (see **Chapter 5**);
- Prune stockproof hedges c. 10cm above ground level after planting [except for tree saplings and holly (*Ilex aquifolium*) saplings];

- Hand prune new hedges during winter (years 1-3) to encourage dense basal growth by cutting saplings back to c. 30cm of current year's growth;
- Side trim hedgerows using a circular saw between September and February, once hedgerows have established. Do not top stockproof hedges;
- Water new hedgerows during periods of drought throughout the first year to assist with establishment; and,
- Replace failed or dead plants every winter.

The DAFM has released an approved hedgerow species list for stockproof hedges, namely, hawthorn (*Crataegus monogyna*), blackthorn (*Prunus spinosa*), dog rose (*Rosa canina*), guelder rose (*Viburnum opulus*), hazel (*Corylus avellana*) and holly (Teagasc, 2017). In addition, European gorse (*Ulex europaeus*) and spindle (*Euonymus europaeus*) can be selected for added biodiversity (Teagasc 2010). A hedge must have at least three species and no one species should dominate.

Suitable native species to use as trees within a stockproof hedge include; alder (*Alnus glutinosa*), downy birch (*Betula pubescens*), silver birch (*B. pendula*), crab apple (*Malus sylvestris*), elder (*Sambucus nigra*), pedunculate oak (*Quercus robur*), sessile oak (*Q. petraea*), rowan (*Sorbus aucuparia*), bird cherry (*Prunus padus*) and wild cherry (*Prunus avium*) (Teagasc, 2010).

The aim of this compensation measure is to increase the cover of hedgerows across the HMP Areas. The measure will be considered successfully implemented when:-

- The newly laid hedgerows have been established;
- The required length of hedgerow has been established and maintained to ensure that, after five years, the new hedgerow still meets the compensation requirements;
- A selection of native species have been sourced so that there are at least three species per hedgerow; and,
- One tree species is located every c. 50m and it is allowed to mature without trimming.



Figure 11: Potential Hedgerow Recreation and Creation Near T6 and T10

1.7.3 BOG WOODLAND REPLANTING

On previously afforested peat soil areas close to the L-5501, on the east side of the road between T4 and T5, some of the areas cleared of conifers beyond the infrastructure footprint could be used to establish native woodland.

Fencing an area to exclude herbivores and allowing natural regeneration has many advantages over planting (e.g. the conservation of the local genetic biodiversity, lower site inputs and disturbance, reduced pressure on limited planting stock). However, it is difficult to predict whether or not natural regeneration will occur on a given site within the available timeframe (Department of Agriculture, Food and the Marine, 2015).

Planting as a method of establishment should therefore be undertaken. Downy birch is the usual dominant canopy species, while other subordinate tree and shrub species can include holly, rowan, oak (*Quercus* spp.) and willows (Fossitt, 2000). The planting mixture should be made up of these species, with downy birch comprising over 50% of the planting mixture.

The following guidelines on native woodland establishment techniques have been taken from best practice guidance (Department of Agriculture, Food and the Marine, 2015):-

- Planting should occur over an area of at least 45m², with tree spacing of 2.0 m x 1.5 m is required (giving a planting density of equivalent to 3,300 trees / ha). These specifications are aimed at promoting rapid establishment and the development of a vibrant emerging canopy in those areas planted;
- In order to promote the conservation of genetic biodiversity, all planting material used under Native Woodland Establishment must be: (i) derived from suitable seed sources from within Ireland; and (ii) fully traceable from seed collection to the planting site;
- Ground preparation is largely limited to pit planting, auger planting, shallow ripping, scrap mounding or inverted mounding;
- Fertiliser application while not be undertaken;
- The control of competing vegetation such as grasses, herbaceous plants, brambles, bracken, etc. is critical for the rapid establishment and growth of young trees and shrubs. Inadequate vegetation management will result in mortality, loss of growth and vigour, and the need for further inputs subsequently (e.g. beating up);
- Non-herbicide control (trampling, mulches, mats, etc.) is preferred on small sites and in highly sensitive areas (e.g. aquatic buffer zones). Otherwise, targeted herbicide application represents the most practical, effective and economical method of vegetation management;
- Pre- and post-planting herbicide application must be kept to the minimum required to ensure success and should be used in combination with other methods to control competing vegetation, e.g. the use of larger planting stock. Post-planting application should be carried out using a knapsack sprayer, with the aim of maintaining a 1-metre wide control area around the base of each tree until they are free of competing vegetation;
- Planting sites must be fully protected from the time of planting from grazing. All existing fences and boundaries must be to a standard which excludes domestic stock and protects the emerging woodland. Consider providing

access for desirable mammals, e.g. a badger gate positioned where the fenceline crosses an established track;

- Tree guards for protection against rabbit, hare and deer browsing should be used where appropriate, e.g. small sites, single or group planting within aquatic buffer zones. As well as protecting against grazing, tree guards also highlight the location of individual trees, for follow-up maintenance; and,
- All protective measures should be inspected on a regular basis, with maintenance carried out, as required.

1.8 MONITORING

The conservation measures will be monitored on an on-going basis and the results of the monitoring will be reported to the client and competent authority at appropriate intervals (Year 1, 3, 5, 10 and then for repeated 5-year increments for the lifetime of the project).

1.8.1 MONITORING OF WATER RETENTION MEASURES

The monitoring of the structural integrity of the water retention measures will be carried out by a suitably qualified contractor, such as a peatland ecologist, hydrologist or engineer. The structural integrity of these embankments and dams must meet a high standard throughout the lifetime of the project in order to protect downstream sites from adverse effects. The monitoring of the structural integrity of water retention measures is relevant for:-

- Drain management; and,
- Bunds – perimeter/marginal, cell and contour.

The monitoring should take the form of a walkover survey along all blocked drains and bunding lines. Signs of slumping or collapse, and erosion because of water movement or mammal trampling should be recorded using GPS. The accessibility of the failing point should be considered to determine whether an excavator can access the location or if remediation works need to be carried out by hand.

1.8.2 VEGETATION MONITORING

A suitably qualified ecologist can assess the effects of peatland restoration measures on the vegetation composition of the site:-

- Conduct walkover surveys to assess the wider condition of the relevant HMP work areas;
- Establish locations appropriate for fixed point photography to monitor the visual impact of restoration measures over time;
- Establish permanent 4m² quadrats (generally 2m x 2m) within HMP works areas where the restoration measures were implemented;
- Continue to use quadrat locations established during the collection of baseline data where possible;
- Record species presence and abundance within each quadrat;
- Classify habitats to IVC communities;
- Conduct Annex I assessments of habitats present;

- Record the presence of non-native species;
- Record the presence of scrub and map significant changes as appropriate following the implementation of restoration measures;
- Record any significant expanses of bare peat and map significant changes as appropriate following the implementation of restoration measures;
- Record any other identified threats to the habitat condition;
- Report on other significant changes to species assemblage and abundance; and,
- Adjust recommendations regarding restoration measures as appropriate, in the light of monitoring results.

This method for assessing and recording ecological data can also be used to monitor the effects of all proposed restoration measures on the peatland vegetation communities across the HMP Areas.

1.8.3 MONITORING MARSH FRITILLARY

Marsh fritillary larval web searches and habitat condition assessments will be conducted within the HMP works area identified for habitat management for the target species.

1.8.3.1 Larval Web Surveys

Surveyors will follow the methods for larval web surveys as laid out in best practice guidance, which have been summarised here (NBDC, n.d.):-

- Conduct surveys during the optimum survey season (late August-early September) when webs are most conspicuous;
- Survey during favourable weather conditions;
- Do not schedule surveys following a period of heavy rainfall;
- Map the extent of the potential supporting habitat;
- Walk one 100m transect per hectare, which covers a representative sample of the habitat;
- Record the route;
- Search 1m either side of transect;
- Record and photograph the location of any larval webs;
- Note any moribund larvae surrounded by the white cocoons of the parasitic wasp *Cotesia* spp;
- Adjust the mapped boundary of the suitable habitat as required; and,
- Record the number of larval webs identified per 100m transect.

1.8.3.2 Habitat Condition Assessments

Habitat condition assessments will take place preceding and following significant scrub removal within the relevant HMP Areas (NBDC, n.d.):-

- Conduct surveys during the flowering period for devil's-bit scabious (*Succisa pratensis*) from mid-August to mid-October;

- Conduct a structured walk (zig-zag) to sample a representative area of the habitat;
- Stop every 10m to fill out the habitat condition assessment sheet;
- Aim to complete c. 20 no. monitoring stops per hectare;
- Record vegetation height, abundance of devil's-bit scabious, vegetation structure, and evidence of grazing; and,
- Provide an estimate the cover (%) of tall (>0.5m) scrub for the entire habitat.

1.8.4 MONITORING HEDGEROW AND BOG WOODLAND REPLANTING

Best practice guidance on monitoring hedgerows will be followed in order to assess the status of the newly established hedgerows and the small area of bog woodland, and make recommendations on management (Foulkes *et al.*, 2013). The following method summarises the guidance on the Hedgerows Appraisal System:-

- Conduct walkover and inspection surveys to monitor the establishment rate of re-instated hedgerows;
- Map failed saplings and any resulting gaps in the hedgerow planting;
- Identify threats to the establishment of the hedgerow, such as browsing pressure, over management etc.;
- Assess the condition of the hedgerow by scoring the following criteria:-
 - Species diversity;
 - Ground flora;
 - Construction and associated features;
 - Habitat connectivity;
 - Landscape significance;
 - Structural variables;
 - Continuity; and,
 - Negative indicators.

1.9 CONCLUSION

The results from site surveys and the desk assessment including LiDAR analysis have been applied to identify appropriate areas for the implementation of water retention measures. The objective of this management is to restore the peatland hydrology closer to a natural state. The works include:-

- Drain management;
- Marginal bunds;
- Cell bunding; and,
- Contour bunds.

Further to these restoration measures opportunities exist to restore bog habitats on the site, including:

- Forest-to-bog restoration; and

- Bare peat re-vegetation.

Actions are also available to protect existing bog habitats, including:

- Scrub removal;
- Cessation of turf cutting and disturbance events; and,
- Prevention of uncontrolled burning.

When implemented effectively, these management actions would be expected to yield significant positive effects on the existing (PB2) Upland blanket bog and (PB4) Cutover bog within the HMP Areas.

Compensation measures selected to address the direct loss of other habitats within the site include:-

- Marsh fritillary habitat management;
- Hedgerow replanting; and,
- Scrub and woodland creation.

A comprehensive guide to monitoring and reporting requirements has also been provided and establishes a commitment to submit post-construction compliance monitoring reports to the client and competent authority at appropriate intervals (Year 1, 3, 5, 10 and then for repeated 5-year increments for the lifetime of the project).

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