National Parks & Wildlife Service

Tóchar Midlands Wetland Restoration Scheme

Annaghmore Lough Fen (Offaly)

NFS site No. 107009

pNHA

Fen Restoration Plan

August 2026

Tóchar
Athchóirlú Bogach Lár na Tíre
Midlands Wetland Restoration

ARUP

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Government of Ireland

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An tSeirbhís Páirceanna Náisiúnta agus Fiadhúlra
National Parks and Wildlife Service

Fen Restoration Plan

Annaghmore Lough Fen (Offaly) (107009)

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Arup

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Executive Summary

Annaghmore Lough Fen (Offaly) is situated on the Laois-Offaly Co. border approximately 10 km south-west of Tullamore and is designated as a proposed Natural Heritage Area (pNHA) for fen and bog habitats within the site. Key habitats include 7230 Alkaline fens, 7140 Transition mires, 7210 *Cladium* fens, 91D0 Bog woodland and 91E0 Alluvial forest, all of which are listed under Annex I of the EU Habitats Directive.

The Clodiagh River passes through the eastern area of the site, with a small lake within the centre of the site. Historical mapping indicates a substantial reduction in open water extent, with the lake originally covering the majority of the site. Arterial drainage along the Clodiagh River (deepening and widening of the channel) have led to the development of the fen habitat.

Satellite imagery shows an acceleration in the rate of peat extraction throughout the years south of the site in the general pNHA area and associated drainage adjacent to the site, which may have also altered local hydrological conditions.

This Fen Restoration Plan was developed to set out proposals for the restoration of associated fen habitats to contribute to their favourable conservation condition.

This is a site-level plan that will be subject to refinement prior to implementation of restoration actions in each subsite. The assessment primarily considers the following pressures that may be impacting on the hydrological function and/or favourable condition of the fen habitat:

- Drainage
- Scrub encroachment
- Changes to water quality, e.g. nutrient enrichment
- Poaching
- Over or under grazing
- Peat extraction southwest of the site

This assessment was developed using a desktop assessment of previous studies of Annaghmore Lough Fen commissioned by National Parks and Wildlife Services including the surveys carried out in 2022 as part of the National Fen Survey (Brophy et al., In prep.). Detailed aerial imagery and topographic datasets were then used to map all drainage features within the site. Hydrological and ecological field surveys were undertaken to collect additional information to validate the findings from desktop assessment and inform the selection of suitable restoration actions, considering the conditions found on site and possible constraints.

Drainage features, water quality and ecology were assessed, and recommendations made for suitable restoration actions (Figure 1-2:). A prioritisation exercise has been completed to identify restoration measures that should be targeted first in progressing the implementation of these restoration requirements. Consultation with stakeholders, and further site

investigations, will be the next key steps required to refine this assessment prior to proceeding to the implementation phase(s). The key measures proposed by this assessment are:

On-site Measures:

- Implementation of conservation grazing with suitable stocking levels and timings
- Installation of piezometers along the R. Clodiagh corridor to determine if the river is dewatering the fen. Appropriate measures will be determined based on this monitoring but could include localised management of the river water levels, review of any on-going drainage maintenance measures and interception of groundwater flow paths to the river with longitudinal groundwater flow cut offs.
- Fencing off access to the lake by cattle and the installation of alternative watering systems e.g. water troughs

Off-site Measures:

- Management of nutrient enrichment: Participation in the NPWS Farm Plan Scheme is recommended for landowners within the wider hydrological contribution area (both surface water runoff and any potential groundwater recharge areas associated with the surrounding esker aquifer) to support nutrient reduction and achievement of conservation objectives.

Annex I Quality Habitat - Annaghmore Lough Fen (Offaly) pNHA

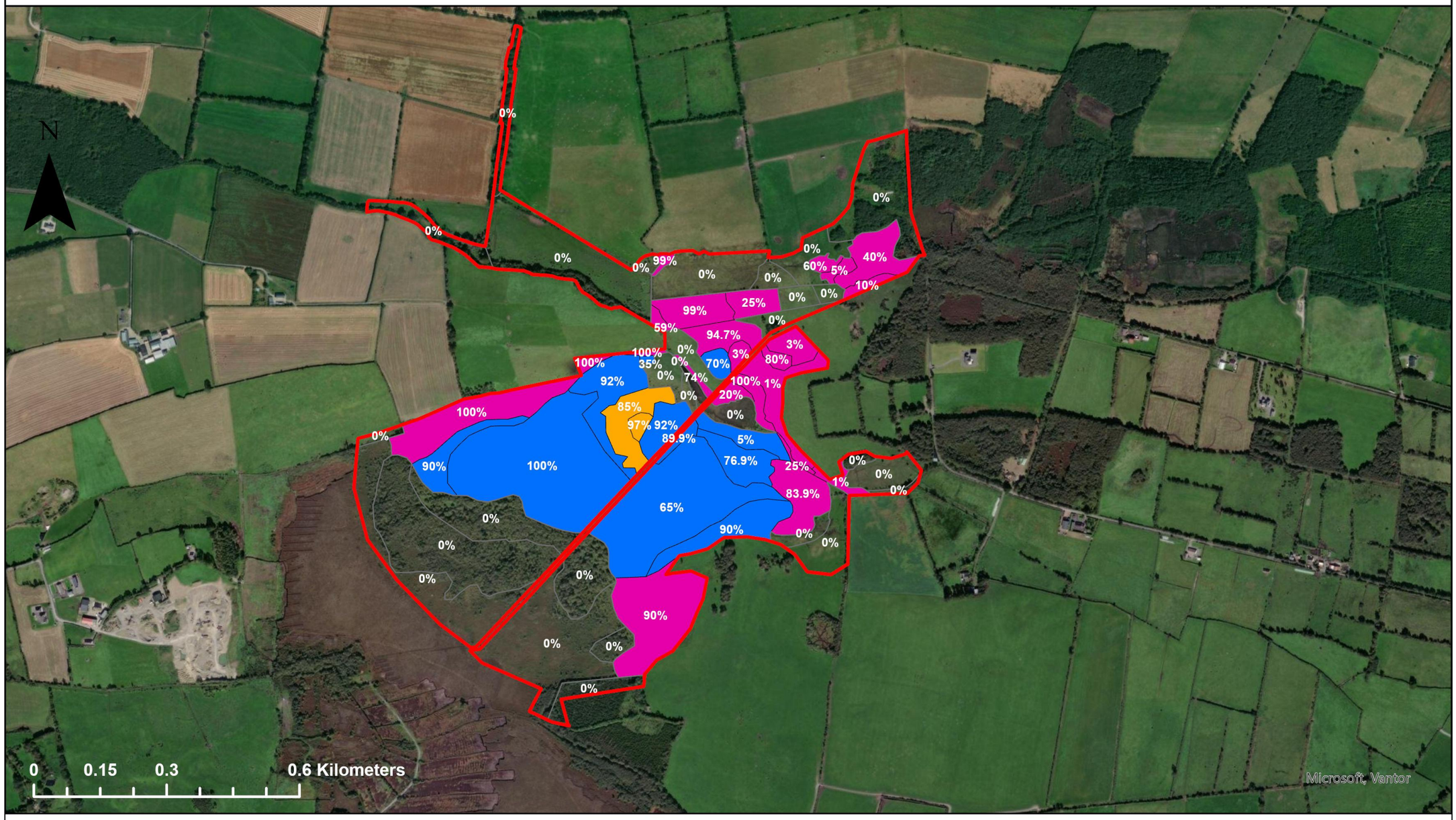


Figure 1-1: Annex I quality habitats recorded and mapped as part of the 2023 National Fen Survey. Note the % value indicates the % cover of the dominant Annex I quality habitat recorded in the polygon

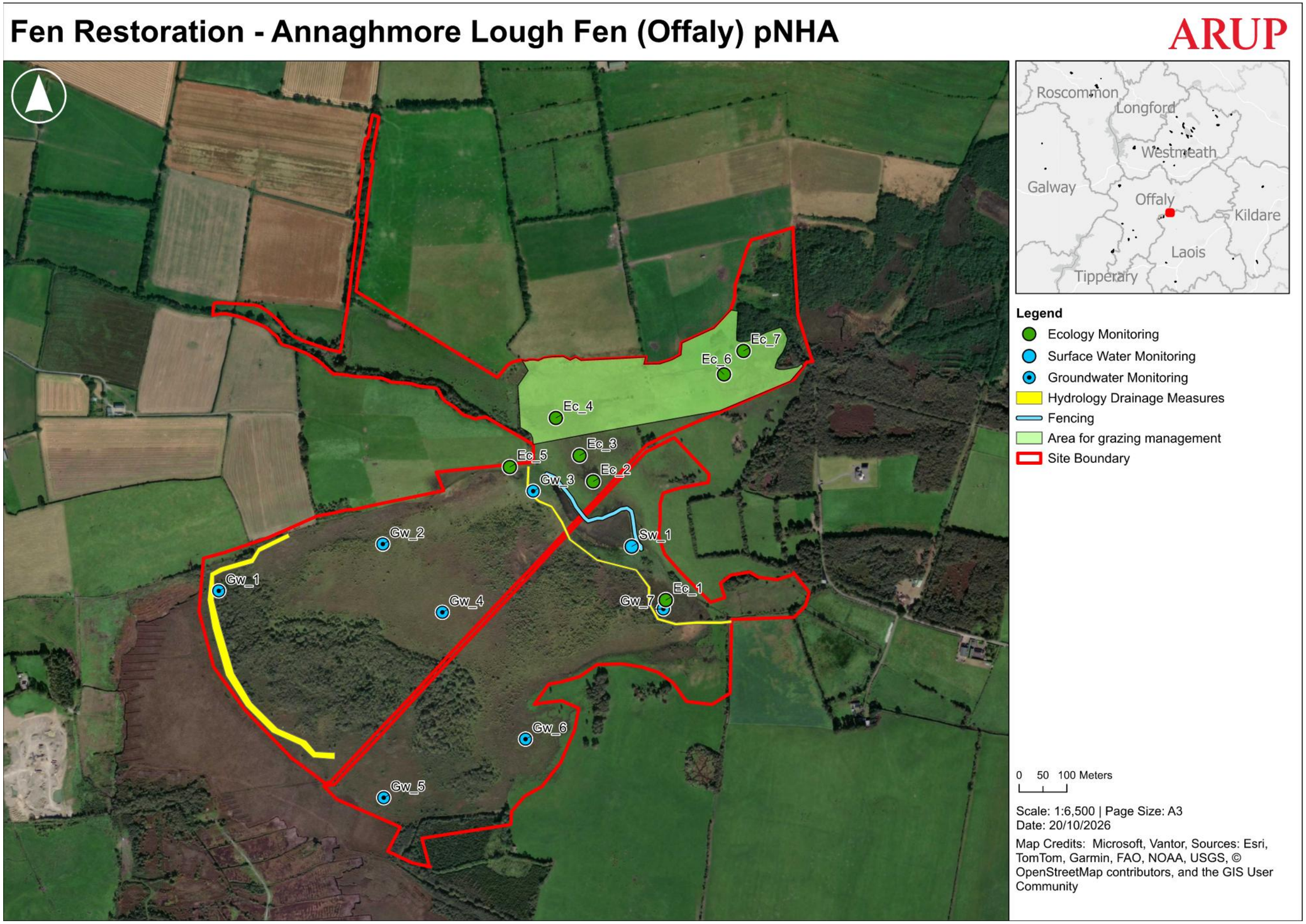


Figure 1-2: Restoration and monitoring map

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Acknowledgements

This Restoration Action Plan was prepared following consultation with a broad range of groups and individuals involved in peatland restoration, local residents and stakeholders through several workshops.

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Tóchar Wetlands is a wetlands restoration project, co-funded by the Government of Ireland and the European Union through the EU Just Transition Fund Programme. It is managed by the National Parks and Wildlife Service, of the Department of Housing, Local Government and Heritage.

1 Introduction

1.1 Purpose of this Fen Restoration Plan

This Fen Restoration Plan (FRP) report was developed by Arup on behalf of National Parks and Wildlife Service (NPWS) to set out proposals for restoration of Annex I[1] quality 7140 Transition mires and quaking bog (hereafter referred to as 7140 Transition mires), 7210 Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* (hereafter referred to as 7210 *Cladium* fens) and 7230 Alkaline fens habitats within the site which contributes to the favourable conservation condition of the fen habitat.

Annaghmore Lough Fen (Offaly) is a proposed Natural Heritage Area (pNHA) (000413) situated on the Laois-Offaly Co. border, approximately 10 km south-west of Tullamore, designated for supporting fen and bog habitat. A section of the pNHA was surveyed as part of the National Fen Survey (NFS) (Brophy et al, In prep) and corresponds to the boundary of this project. The NFS covered a total area of 77.24 ha and is dominated by fen habitat although several other associated peatland habitats are also present. The total extent of 7140 Transition mires at Annaghmore Lough Fen is 18.31 ha, the extent of 7210 *Cladium* fens is 0.5 ha and the extent of 7230 Alkaline fens is 11.16 ha (Brophy et al, In prep). Other Annex I quality habitats present within the site include 91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) (hereafter referred to as 91E0 Alluvial forests).

The main aim of the restoration actions proposed as part of this assessment is to maintain or improve the quality of existing areas of fen or improve the hydrological conditions that will allow an expansion of the measurable area of fen. However, in some areas, it must be recognised that restoration to increase areas of existing fen will not be possible due to unsuitable hydrological conditions, and the objective may simply be to ensure no further deterioration.

Although the focus of the restoration plan is on fen habitat, it is anticipated that restoration actions will also benefit the wider network of wetland habitats within the site, including Annex I quality habitat 91E0 Alluvial forests alongside a mosaic of wetland Fossitt-level habitats within Annaghmore Lough Fen, which were mapped during previous NFS (Brophy et al., In prep.).

The implementation of the actions proposed within this FRP report may also provide wider improvements to biodiversity, reduce carbon emissions and improve water quality all of which may be demonstrable under eventual post implementation monitoring.

[1] Each habitat and species type protected under the EU Habitats Directive (Council Directive 92/43/EEC of 21 May 1992) is given a unique numeric code so that all. Member States use the same reference in legislation, reporting and monitoring. Each habitat and species code is an index in the Annex lists with codes grouped by habitat family.

1.2 Wider benefits of peatland restoration

Fens are vital habitats due to their rich biodiversity, supporting a wide array of flora and fauna, many of which are rare or endangered. They act as natural water filters, purifying water by trapping pollutants and sediments, thus enhancing water quality downstream. Additionally, fens store significant amounts of carbon in their peat soils, contributing to climate change mitigation by reducing atmospheric carbon dioxide levels. Their ability to absorb and gradually release water helps regulate water flow and minimise flood risks. Beyond their ecological importance, fens hold cultural, historical, and recreational value, offering opportunities for education, research, and outdoor activities. Although some fens in Ireland are not protected as Special Areas of Conservation (SACs) or Natural Heritage Areas (NHAs), they remain crucial for biodiversity and climate resilience.

Peatland drainage and extraction transform a natural peatland which acts as a modest carbon sink into a carbon source (Waddington & McNeil, 2002; Alm *et al*. 2007; Wilson *et al*. 2015). The EPA- funded Carbon Restore Project (Wilson *et al*. 2012) found that rewetting of drained peatlands can lead to restoration of functional peatland, such as the return of typical plant and animal species, which in turn may lead to the restoration of peat-formation and the C-sink function.

The primary pressures affecting the condition of fen habitats at Annaghmore Lough Fen relate to nutrient inputs and the management of grazing practices. Implementation of the Fen Restoration Plan will address these pressures through measures aimed at monitoring hydrology, reducing nutrient enrichment and establishing appropriate grazing management, thereby improving the condition and ecological functioning of the fen habitats. Improvements in habitat condition may also support the peat-forming and carbon storage functions of the fen over the longer term.

The restoration of fen habitat at Annaghmore Lough Fen is likely to lead to improved water quality. Well-functioning fen habitat reduces the risk of dissolved organic carbon passing into water courses and has been shown to attenuate the speed at which water moves downstream thereby reducing flood risk.

1.3 Key pressures on Fens

The overarching (National) key pressures and threats to Annex I fen habitats were identified in the latest Status of EU Protected Habitats and Species in Ireland (Article 17 report) (NPWS 2025). Key pressures and threats directly relevant to the Annex I quality fen habitats at Annaghmore Lough Fen are shown below in Table 1-1. The level of impact of each pressure at a national level may not align with the level of impact at Annaghmore Lough Fen, as each site is subject to different levels of cumulative pressure from varying sources. The overall conservation status is assigned as Bad for 7140 Transition mires, Bad for 7210 *Cladium* fens and Bad for 7230 Alkaline fens in the Article 17 report.

Table 1-1: National pressures to Annex I fen habitats

Habitat	Importance	Pressure
7140 Transition mires	High	PA22 Drainage for use as agricultural land PL02 Drainage (mixed or unknown drivers)
	Medium	PA17 Agricultural activities generating pollution to surface or ground waters (including marine) PI03 Problematic native species
	Low	PA07 Intensive grazing or overgrazing by livestock PC05 Peat extraction
7210 *Cladium* fens	High	PL02 Drainage (mixed or unknown drivers)
	Low	PA07 Intensive grazing or overgrazing by livestock
7230 Alkaline fens	High	PA07 Intensive grazing or overgrazing by livestock PA22 Drainage for use as agricultural land
	Medium	PA01 Conversion into agricultural land (excluding drainage and burning) PL02 Drainage (mixed or unknown drivers) to surface or ground waters
	Low	PA17 Agricultural activities generating pollution to surface or ground waters (including marine) PI03 Problematic native species

1.4 Legislative Context

There is a comprehensive system of legislation, both domestic and international, which aims to protect biodiversity at a landscape, habitat and species level in Ireland. This legislation exists within, and independently of, the planning process.

In Ireland, the most important pieces of legislation underpinning biodiversity and conservation are:

- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, hereafter referred to as the Habitats Directive.
- Regulation (EU) 2024/1991 of the European Parliament and of the Council of June 2024 on nature restoration and amending Regulation (EU) 2022/869.

- Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds, hereafter referred to as the Birds Directive.
- European Communities (Birds and Natural Habitats) Regulations, 2011 (S.I. No. 477 of 2011), as amended, hereafter referred to as the Birds and Habitats Regulations.
- Wildlife Acts 1976 to 2017, hereafter referred to as the Wildlife Acts; and
- Flora (Protection) Order, 2015 (S.I. No. 356 of 2015).

According to the EU Habitats Directive (92/43/EEC) and the EU Birds Directive (79/409/EEC), Member States are required to establish a Natura 2000 network of sites of highest biodiversity importance for rare and threatened habitats and species across the EU. In Ireland, the Natura 2000 network of European sites includes SACs and Special Protection Areas (SPAs).

The EU Nature Restoration Regulation aims to restore damaged ecosystems and improve biodiversity with particular focus on capturing and storing carbon and reducing the impact of natural disasters. Specific targets include improving and re-establishing biodiverse habitats on a large scale and bringing back species populations by improving and enlarging their habitats. EU countries are required to submit National Restoration Plans to the European Commission showing how they will deliver on the targets and monitor their progress. Member States are required to implement restoration measures for specific habitats and species, including marine ecosystems, forests, wetlands, and pollinators.

Ireland is required to manage water resources in an integrated way under the Water Framework Directive (WFD, 2000/60/EC) and the European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003). Member States are required to submit River Basin Management Plans to the European Commission showing how they will protect and improve the water environment. Restoring surface and groundwater bodies to the equivalent of 'good status' or better and to protect water from any further deterioration requires collaboration at a local and national level. Implementing the WFD supports the achievement of site-specific conservation objectives for fen habitats, contributing to their favourable conservation status.

1.5 Outline of this FRP document

- Section 2 of this FRP report outlines details of Annaghmore Lough Fen and the conservation objectives for 7140 Transition mires, 7210 *Cladium* fens and 7230 Alkaline fens habitats.
- Section 3 outlines the findings from the land and water desktop and site monitoring surveys that were carried out to inform the development of these FRP.
- Section 4 outlines the findings from the ecological desktop and site monitoring surveys that were carried out to inform the development of these FRP.
- Section 5 provides a summary of the key pressures identified by this FRP report that are impacting on fen.

- Section 6 outlines the key restoration measures proposed by this FRP.
- Section 7 outlines additional considerations to inform the development of the FRP.
- Section 8 outlines key players in the FRP, summarises restoration actions proposed, habitats that will benefit and further steps required to prepare for implementation.

Restoration actions proposed by this FRP assessment were mapped in GIS format and delivered to NPWS in accordance with NPWS data standards. This includes detailed mapping of the key pressures addressed by this assessment, detailed mapping of proposed restoration actions, ecological survey results and referenced sensitivity areas. GIS Shapefiles which accompany this report include all relevant data on referenced species.

2 Site Overview

2.1 Annaghmore Lough Fen (Offaly) pNHA

The pNHA extends beyond the Tóchar project boundary and includes a substantial area of bog habitat outside the project area. Unless otherwise stated, habitat descriptions presented herein relate solely to habitats occurring within the Tóchar project boundary, hereafter referred to as the 'site'.

The Clodiagh River flows through the site and a small lake remains within the centre of the site. Historical mapping indicates that the extent of open water has reduced substantially over time, with the former lake now reduced to an area of approximately 0.90 ha. The site has also been influenced by historical drainage and peat extraction activities in the surrounding landscape. Aerial imagery indicates a substantial expansion of peat extraction activities within the raised bog southwest of the site since the mid-1990s, with the currently extracted area extending to approximately 75 ha. Iron-rich flushes were recorded during the National Fen Survey (Brophy et al., in prep.), indicating localised groundwater influence within parts of the fen.

The site contains valuable fen habitat including areas of Annex I quality 7140 Transition mires, 7210 *Cladium* fens and 7230 Alkaline fens alongside Annex I quality 91D0 Bog woodland and 91E0 Alluvial forests. The area of 91D0 Bog woodland within the site is a small percentage of a larger area of WN7 Bog woodland habitat and as such does not appear as a distinct area in the relevant Annex I quality habitat figure in Figure 1-1.

Additional habitats recorded within the site include improved agricultural grassland and a range of semi-natural and wetland habitats including wet grassland, wet willow-alder-ash woodland, bog woodland, dry and calcareous neutral grasslands, dry-humid acid grassland, reed and large sedge swamps, marsh, and mesotrophic lakes. Fen habitat in the north of the site is predominately 7230 Alkaline fens, while in the south 7140 Transition mires dominates.

The site is part of the wider Annaghmore Lough Fen (Offaly) pNHA which has been proposed for fen and bog habitat.. The surrounding landscape is predominantly agricultural, and the site is grazed by cattle. Grazing pressure varies across the site, being appropriate in some areas and insufficient in others, resulting in rank vegetation and an increased risk of scrub encroachment. Localised poaching has also occurred around the lake and outflow where livestock access surface water for drinking.

Multiple drains occur within the northern and eastern parts of the site. Altitude at the site ranges from 81 m to 90 m and the site is generally flat. Detailed topographical information is found in Section 3.1.3. Figure 2-1 outlines the location and extent of Annaghmore Lough Fen (Offaly) pNHA.

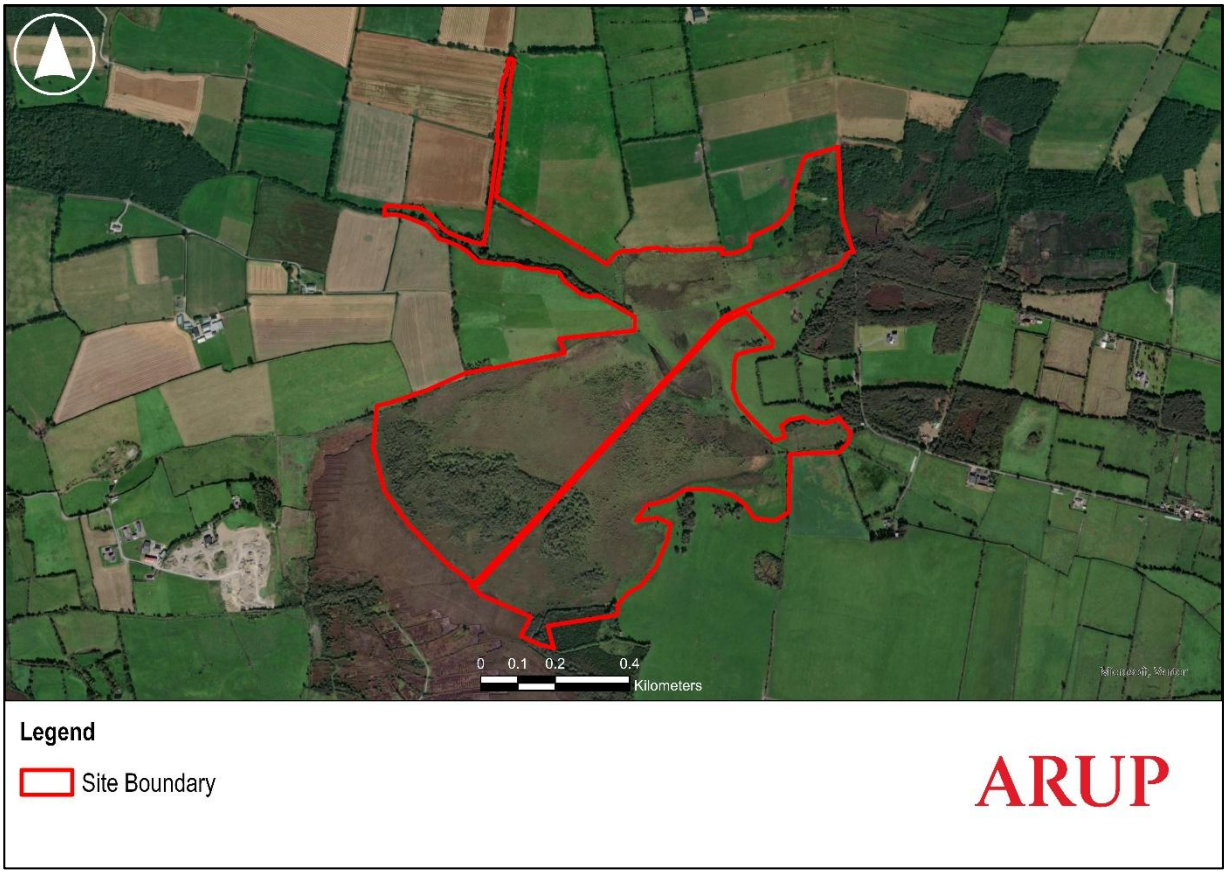


Figure 2-1: Site Location Map

The pNHA is located within the 25A: Lower Shannon Catchment and is primarily drained by tributaries of the Clodiagh (Tullamore) River. For the purposes of the Water Framework Directive, most of the pNHA is located within the CLODIAGH[TULLAMORE]_SC_010 sub-catchment. There is a sub basin divide south of the site. The sub-basin located southwest of the site is the BALLYNACARRIG_010.

2.1.1 Fen Condition Assessment

Annaghmore Lough Fen was surveyed as part of the NFS from the 8th to the 10th of June 2023 (Brophy et al, In prep). During these surveys, the pressures outlined in Table 2-1 were identified:

Table 2-1: Assessment of impacts of pressures on 7140 Transition mires, 7210 *Cladium* fens and 7230 Alkaline fens at Annaghmore Lough Fen

Pressure Code	Pressure [sub-category]	Influence
PA08	Extensive grazing or under grazing by livestock. Under grazing was noted in the northern section of the site, which has facilitated scrub encroachment.	Negative

Pressure Code	Pressure [sub-category]	Influence
	Poaching was recorded adjacent to the lake. This is a result of repeated access to the lake by cattle for drinking water (due to an absence of watering troughs) rather than being due to overstocking.	
PL02	Drainage. Drainage ditches were recorded in the north and east of the site.	Negative
PA22	Drainage. Drainage ditches were recorded in the north and east of the site.	Negative
PA01	Conversion into agricultural land (excluding drainage and burning) Much of the agricultural land within the site consists of reclaimed peatland, including recently reclaimed land. This was noted during the NFS as a pressure on 7230 Alkaline fens and 7140 Transition mires.	Negative
PA17	Agricultural activities generating pollution to surface or ground waters (including marine). Extensive algal deposition was noted within the lake and inflow and outflow, indicating pollution.	Negative
PI03	Problematic native species. Scrub encroachment was noted as a pressure on Annex I quality fen habitat within the site.	Negative
PM02	Flooding This was noted as a pressure regarding 7230 Alkaline fens in particular.	Negative

The results of a field evaluation (2026) of the above pressures to inform the restoration planning process is detailed in Section 5 of this report.

The results of the conservation status assessment of Annex I quality fen habitat at Annaghmore Lough Fen carried out as part of the NFS is summarised in Table 2-2.

Table 2-2: Conservation Status Assessment of 7140 Transition mires, 7210 *Cladium* fens and 7230 Alkaline fens at Annaghmore Lough Fen

Overall Conservation Status Assessment					
Annex I quality habitat	**Area**	**Structure & Functions**	**Future Prospects**	**Overall Conservation Status**	**Rationale**
7140 Transition mires	Favourable	Unfavourable-bad	Unfavourable-bad	Unfavourable-Bad	Ongoing pressures continue to threaten the future prospects and the structure and functions of this habitat.
7210 *Cladium* fens	Unfavourable-bad	Unfavourable-bad	Unfavourable-bad	Unfavourable-bad	Ongoing pressures continue to threaten the area, future prospects and structure and functions of this habitat.
7230 Alkaline fens	Unfavourable-bad	Unfavourable-bad	Unfavourable-bad	Unfavourable-bad	Ongoing pressures continue to threaten the area, future prospects and structure and functions of this habitat.

3 Land and Water

3.1 Desktop Study

3.1.1 Meteorological Conditions

Understanding long-term meteorological patterns is key for informing effective fen restoration planning, particularly with respect to hydrological dynamics. To support this, historical precipitation data over the past 40 years from the closest Met Éireann weather station, Clonaslee Waterworks II (approximately 4 km southeast of the site), was reviewed to assess seasonal variability in rainfall at the site and surrounding areas (Met Éireann, 2025).

At this station, monthly and daily rainfall data was available from 1985 to 2025. The minimum and maximum mean monthly rainfall collected in that station over the past 40 years were 18 mm in September and 283.1 mm in October respectively. Two datasets are presented: (1) average monthly precipitation (mm), incorporating a 40-year period to show seasonal distribution patterns (Figure 3-1) and (2) total annual precipitation (mm) for each year within the 40-year record (Figure 3-2), to identify longitudinal trends. This information is important to assess water availability and to evaluate the feasibility and sustainability of restoration actions aimed at restoring or maintaining suitable hydrological conditions.

The average monthly rainfall is highest in the winter months (October to January) and lowest in late spring to early summer (April to June). Minimum rainfall is lowest in late spring and early autumn, particularly in May and September, while the maximum monthly rainfall shows considerable variability throughout the year, with notable peaks in February, June, October and December (Figure 3-1).

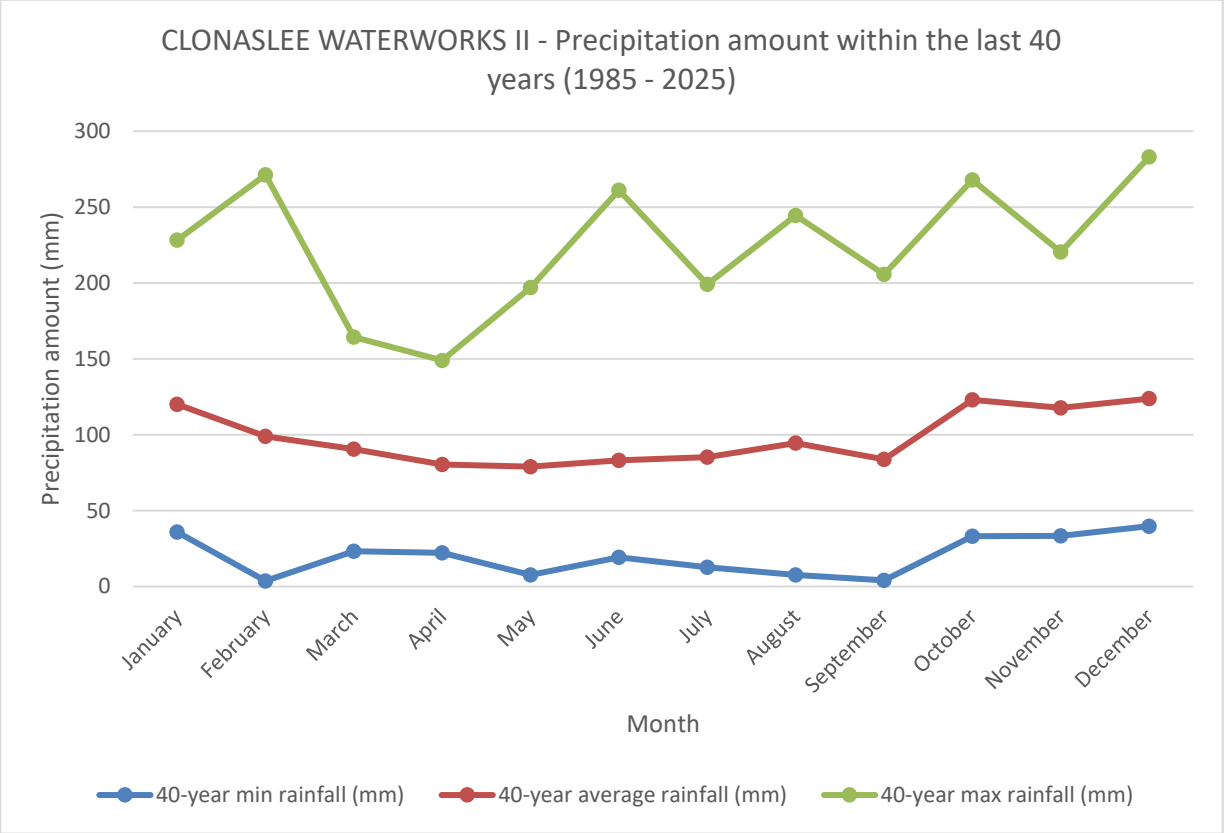


Figure 3-1: 40-year minimum, average and maximum monthly rainfall in Clonaslee Waterworks II (Met Éireann, 2026)

Total annual precipitation also varies between years, indicating inter-annual variability that is relevant when considering baseline hydrological conditions and the application of the restoration measures under both wetter and drier climate conditions (Figure 3-2). In particular, maximum precipitation surged to nearly 1451 mm in 2014 and minimum precipitation was circa 789 mm in 1985.

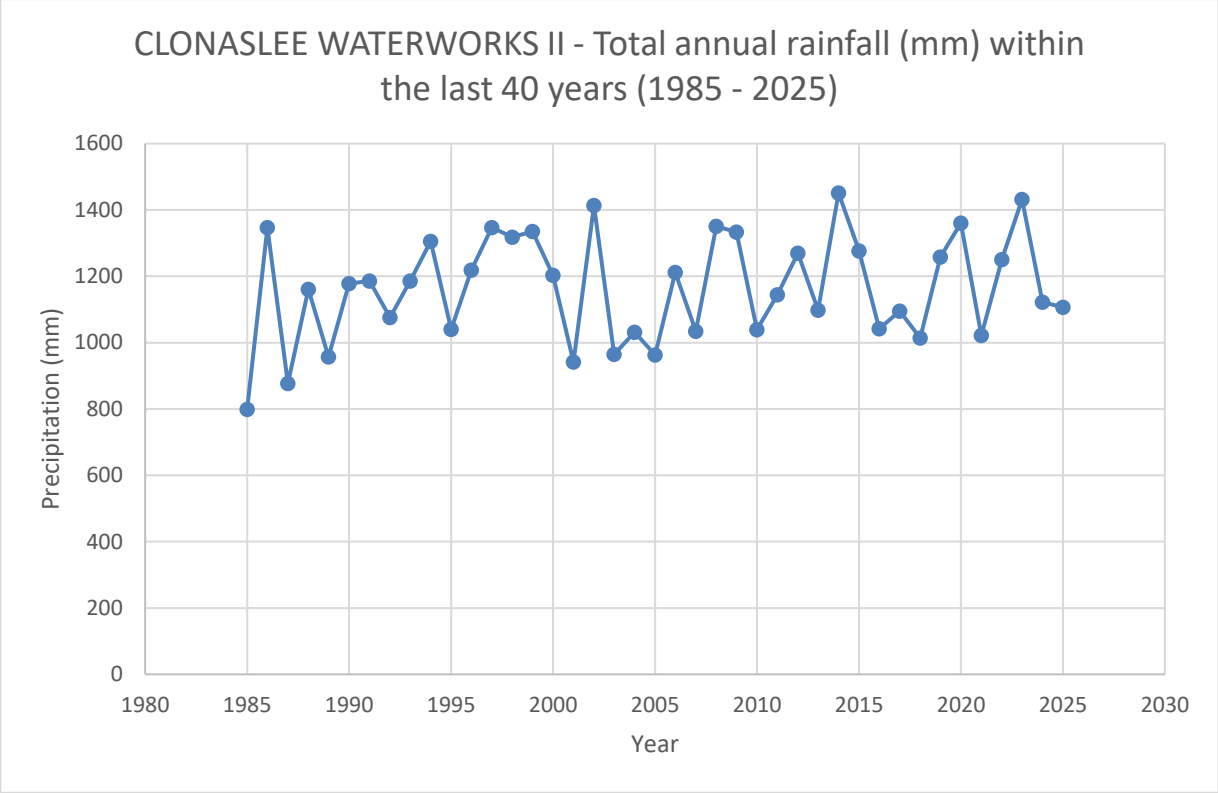


Figure 3-2: Clonaslee Waterworks II weather Station – Total annual precipitation within the last 40 years (1985-2025) (Met Éireann, 2026)

3.1.2 Hydrogeological Setting

The hydrogeological information gathered for the Annaghmore Lough Fen (Offaly) pNHA was extracted from the Geological Survey Ireland (GSI) website. Most of the site is underlain by the Ballysteen Formation, characterised by dark muddy limestone and shale. The northwestern limit of the site underlain by Waulsortian Limestones which is characterised by massive, unbedded lime-mudstone. The Waulsortian Limestone typically exhibits higher groundwater transmissivity than the Ballysteen Formation and may provide important groundwater inputs to the fen, supported by the presence of iron-rich groundwater flushes detailed in the NFS (Brophy et al., In prep.). The bedrock geology of the site is presented in Figure 3-3.

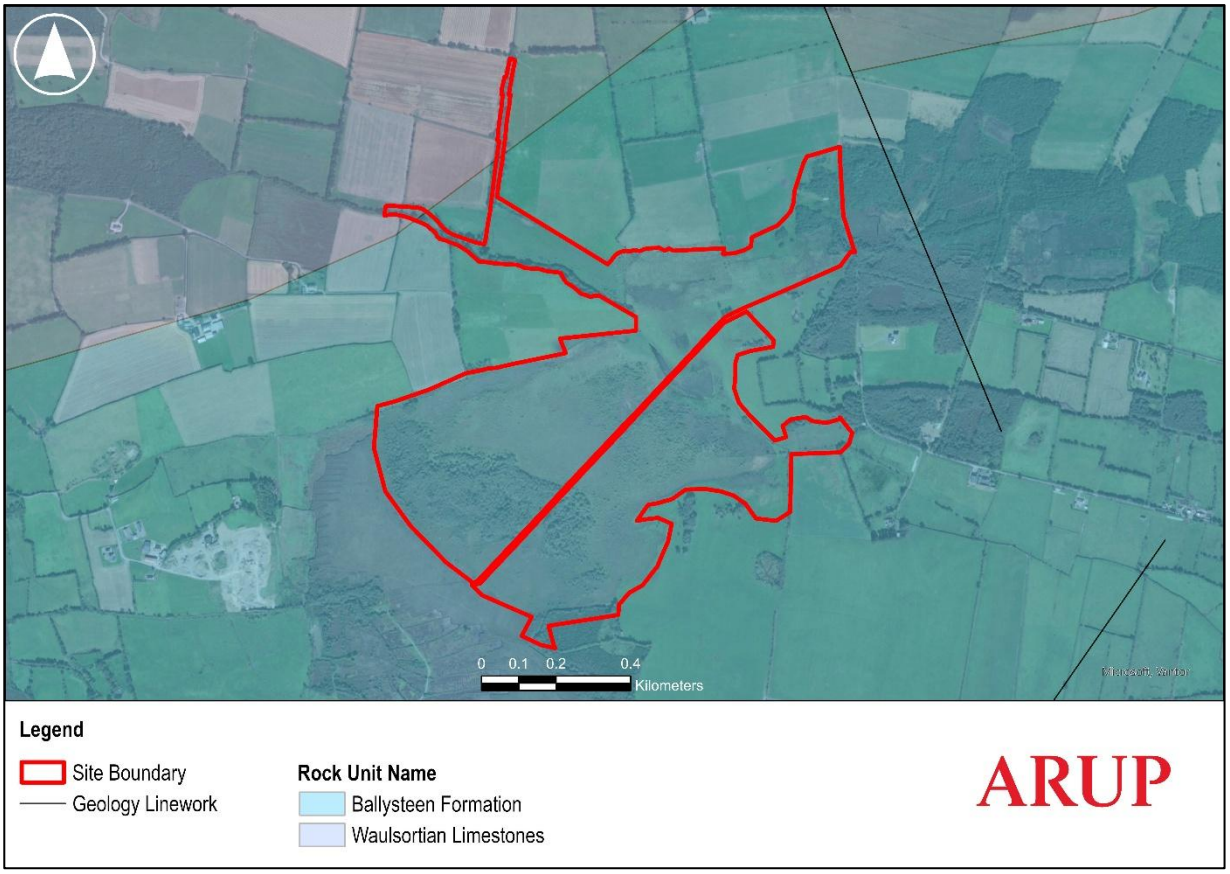


Figure 3-3: Bedrock Geology of Annaghmore Lough Fen (Offaly) pNHA

The area is underlain by a Locally Important bedrock aquifer which is moderately productive only in local zones (LI). Most of the flow in this type of aquifer is in the upper 15 m, in the zone that consists of a weathered layer and connected fracture zone below. A Locally important gravel aquifer (Lg) is also present in the southwest region of the site. The esker-derived sand and gravel deposits have a greater capacity to store and transmit groundwater than the surrounding peat deposits and may therefore act as preferential groundwater flow pathways within the site. The aquifer classification underlaying the site is presented in Figure 3-4.

The groundwater body which underlies Annaghmore Lough Fen (Offaly) pNHA is Geashill (IE_SH_G_103). This ground waterbody is at 'good' status and 'not at risk' of not achieving its WFD objectives.

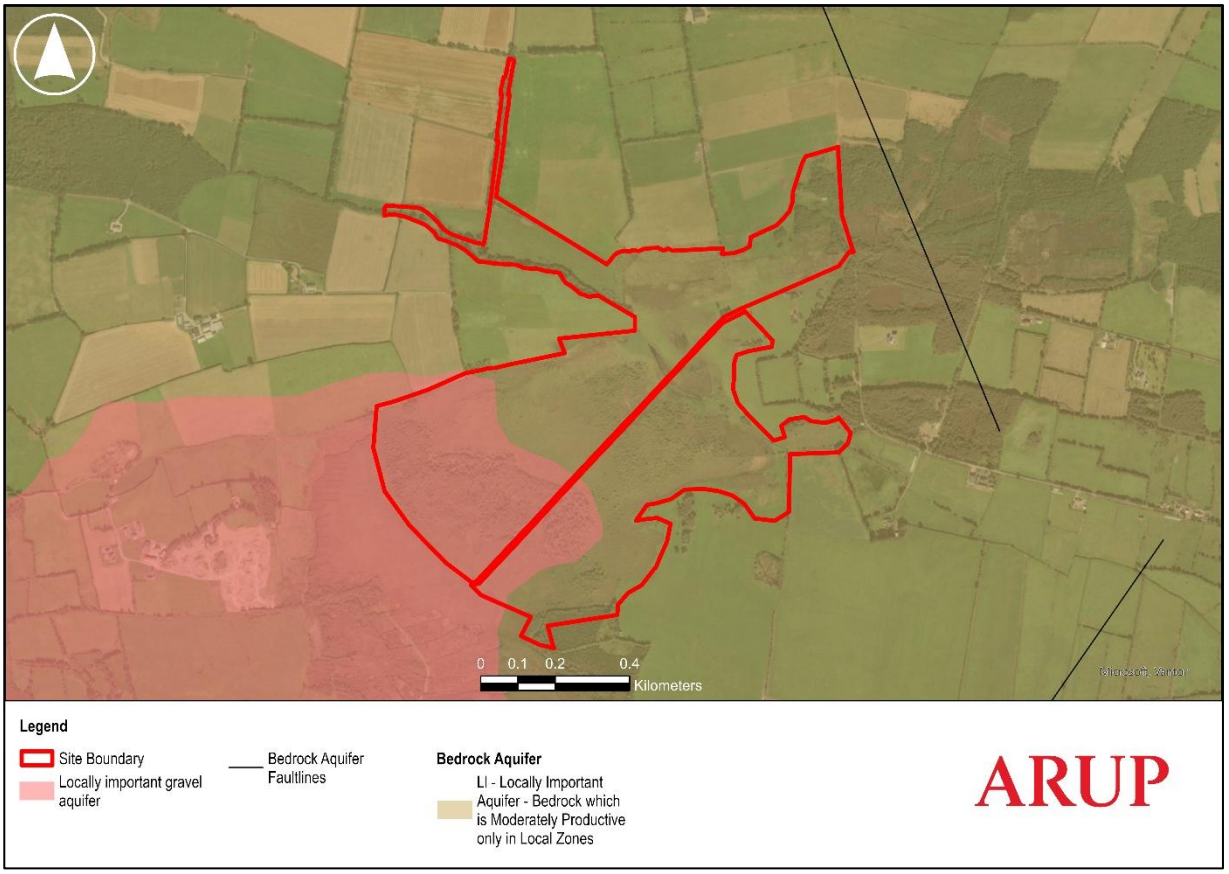


Figure 3-4: Aquifer classification of Annaghmore Lough Fen (Offaly) pNHA

Quaternary sediments within the site boundary comprise largely of fen peat, with a small area of cut over raised peat in the eastern extent of the site. To the west and southwest of the site, there are gravels derived from limestones, while till derived from limestone is located to the west, north and east. The gravel deposits are more permeable than the surrounding peat and till and therefore have a greater capacity to store and transmit groundwater. The subsoil type underlaying the site is presented in Figure 3-5.

Soil type in Annaghmore Lough Fen observed during the Scoping Study and Pilot Survey of Fens included peat with depths ranging from 14 cm to greater than 310 cm. The Teagasc soils map notes that soil types within the site are mostly fen peat (95.3%) and cut peat (4.2%) with smaller areas in the site of shallow well (west) (0.2%) and poorly (north and east) drained mineral soil (0.1%).

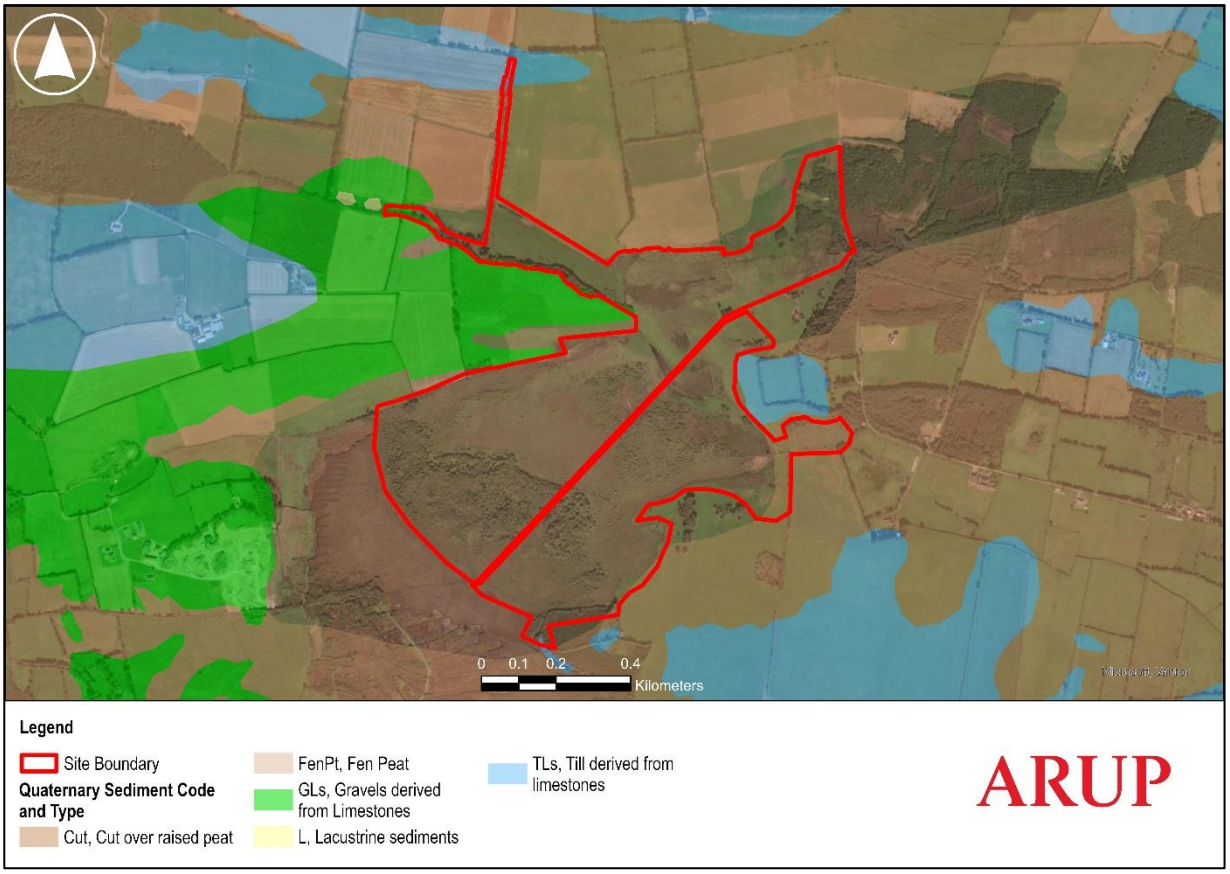


Figure 3-5: Sub-soil type underlying Annaghmore Lough Fen (Offaly) pNHA (Source: GSI Quaternary map)

Groundwater vulnerability ranges from low in peat-covered areas to high in areas underlain by gravel. This pattern is reflected by the recharge rates, reflecting the influence of subsoil type on the water infiltration. These recharge rates are higher in the gravels to the east of the site (151-500 mm/year), and lower in the peat within the site (1 to 50 mm/year). The groundwater vulnerability and groundwater recharge for the site are presented respectively in Figure 3-6 and Figure 3-7.

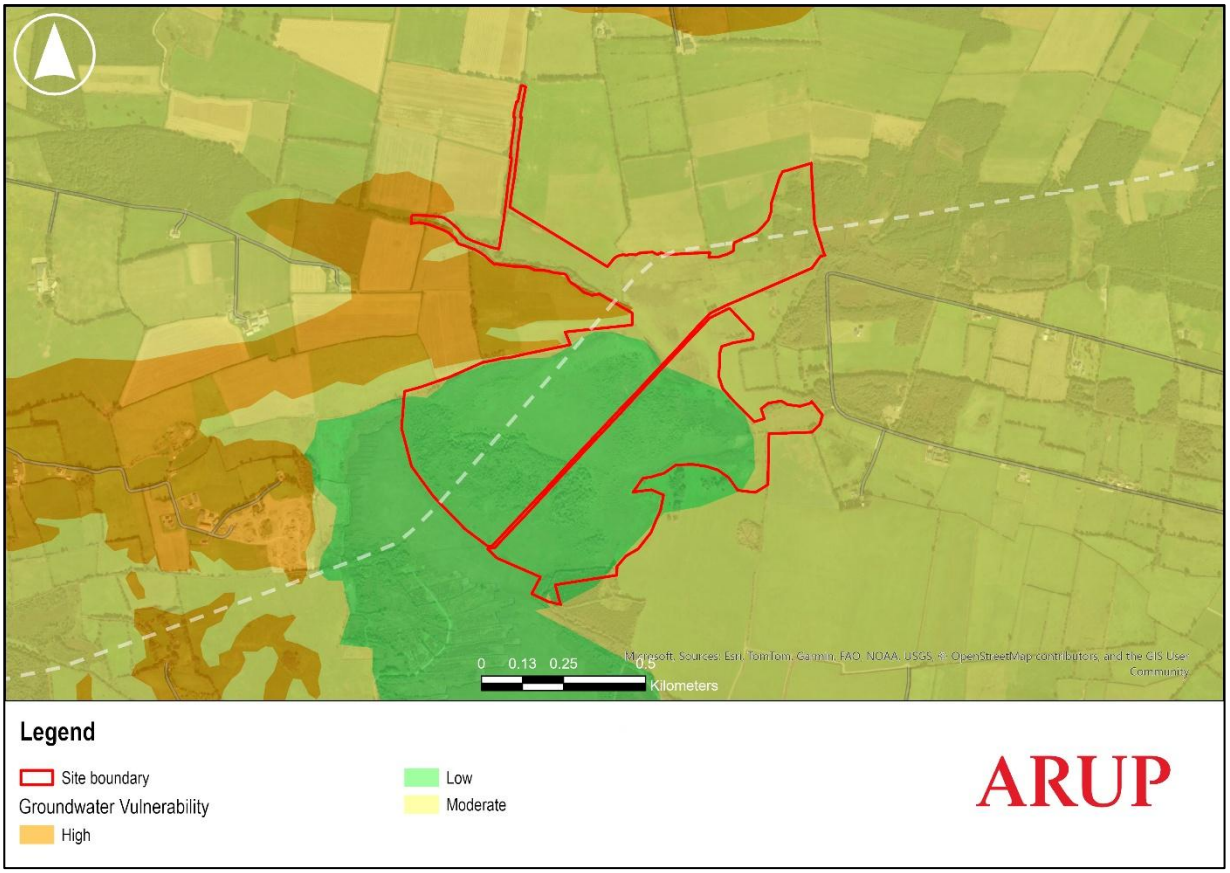


Figure 3-6: Groundwater vulnerability map for Annaghmore Lough Fen (Offaly) pNHA (Source: GSI)

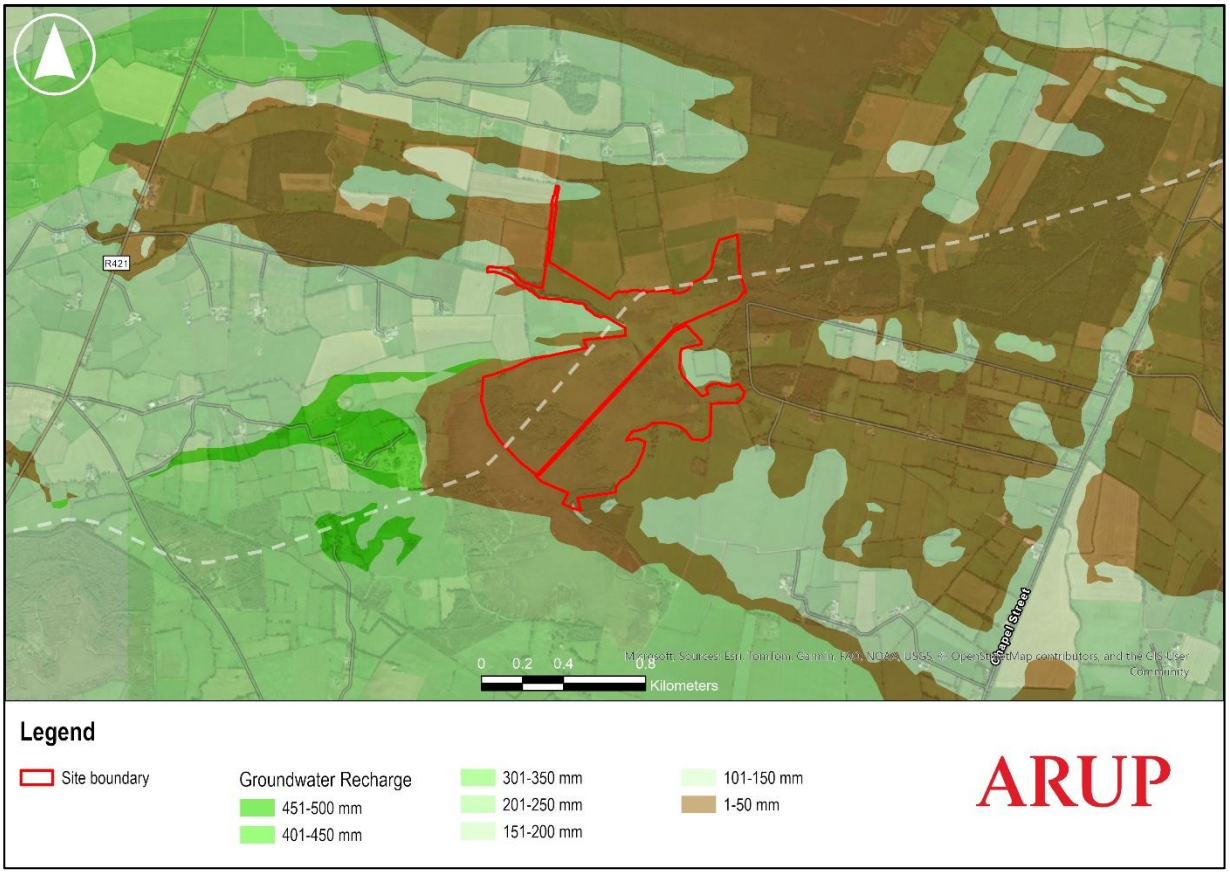


Figure 3-7: Groundwater recharge map for Annaghmore Lough Fen (Offaly) pNHA (Source: GSI)

3.1.3 Topographic and Surface Water Drainage

The site is located within the 25A: Lower Shannon WFD Catchment and lies predominantly within Clodiagh [Tullamore]_SC_010 WFD sub catchment (Figure 3-8). The Clodiagh River passes through the site, draining south-east before turning north towards the River Brosna and ultimately the River Shannon. The Clodiagh River is a WFD River waterbody classed as good ecological status and not at risk of failing to achieve its WFD objectives.

A small area in the south-west of the site lies within the Ballynacarrig_10 sub-basin, which drains north-west to the River Brosna and then River Shannon. A detailed image of the sub basin divide southeast of the site is presented in Figure 3-9. The lower Shannon catchments drain towards the Shannon Estuary.

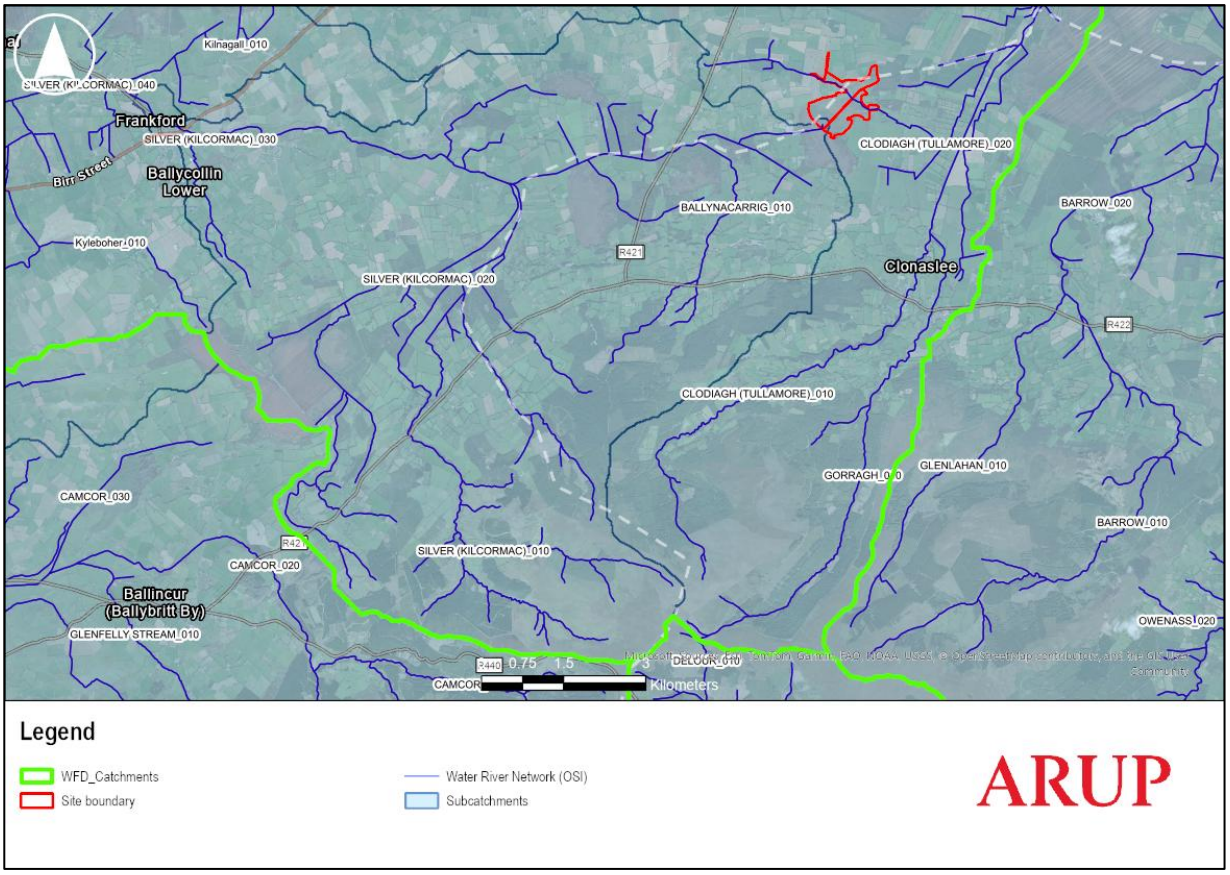


Figure 3-8: WFD Catchment and River sub catchments (EPA, 2025)

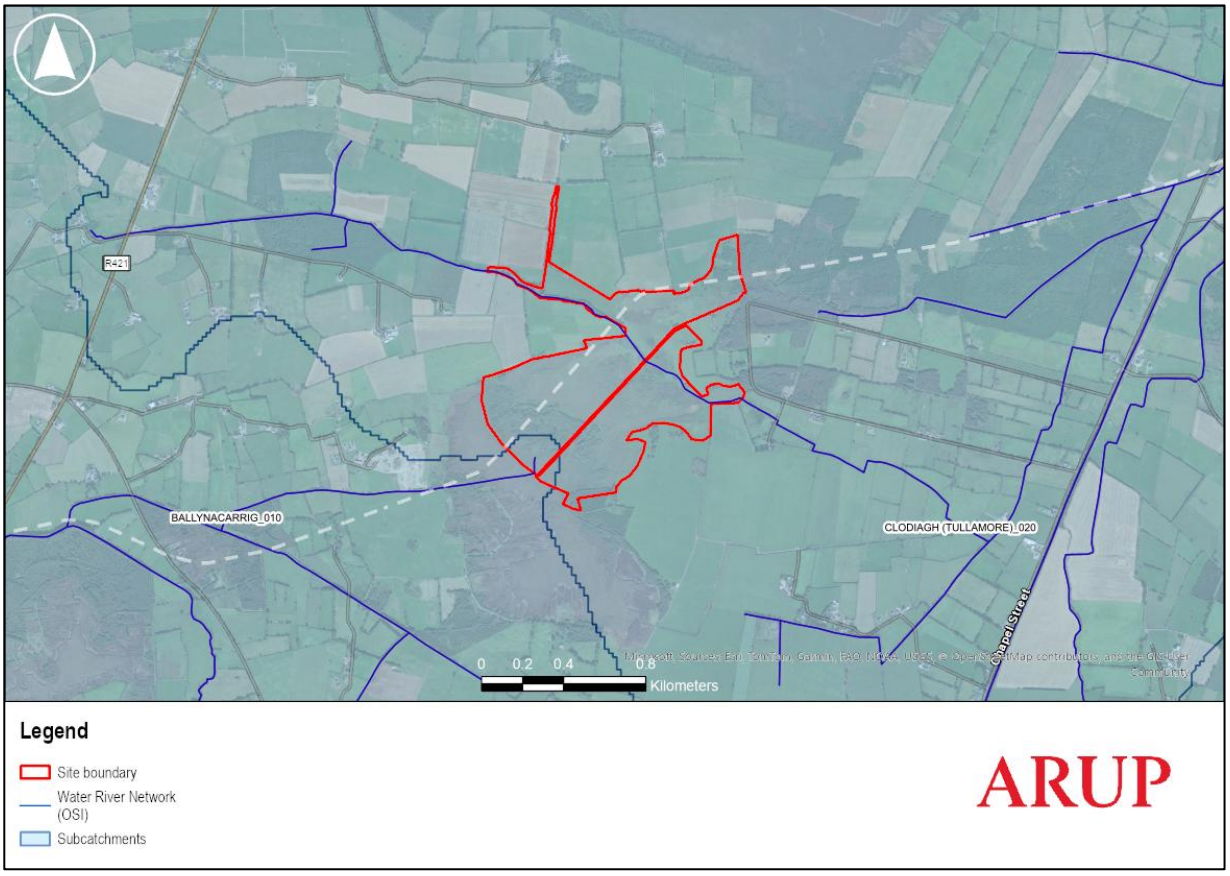


Figure 3-9: WFD River sub catchments (EPA, 2025)

The site is positioned at elevations ranging from circa 81 to 91 mOD and is relatively flat, with water flowing towards the main drain in the centre of the site. Higher ground is located at the divide between the two sub-catchments (approximately 91 mOD).

An assessment of historical hydrological mapping indicates the site contained a substantially larger area of open water than the area that is present today. Mapping from the early nineteenth century shows a large lake occupying much of the current site boundary, whereas by 2025 this waterbody was reduced to a small central lake. No wells or springs are visible within the site on historical mapping; however, the presence of a disused gravel pit was identified east of the site. Additionally, drains were identified in the southwestern boundary of the site, where peat extraction has been recorded in the past 30 years. Historical water distribution and retention within wetland is shown in Figure 3-10.

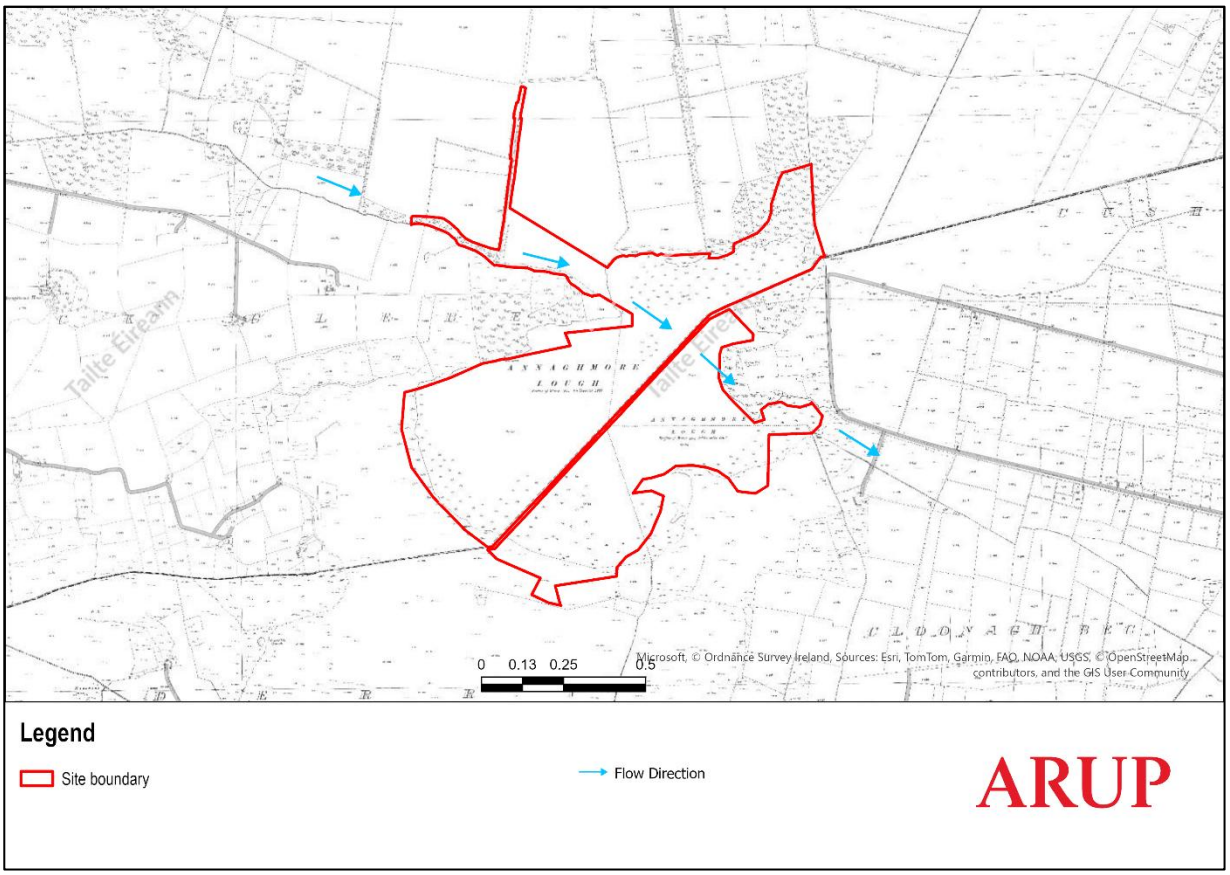


Figure 3-10: Historical water distribution and retention within wetland (Tailte Éireann Historical mapping)

The mapped Wetness Index[2] classifies most of the site area as temporarily wet, indicating alternating periods of saturation and dryness over the period of 2012 to 2018. In addition, the lake adjacent to Clodiagh River in the centre of the site is classified as permanent and temporary water and an extensive area in the southwest of the site is classified as dry. This

[2] Dataset available at 10 m resolution indicating the occurrence of water and wet surfaces over the period from 2012 to 2018.

pattern suggests a mosaic of variable soil moisture conditions, supporting intermittent wetland characteristics across the site (Figure 3-11).

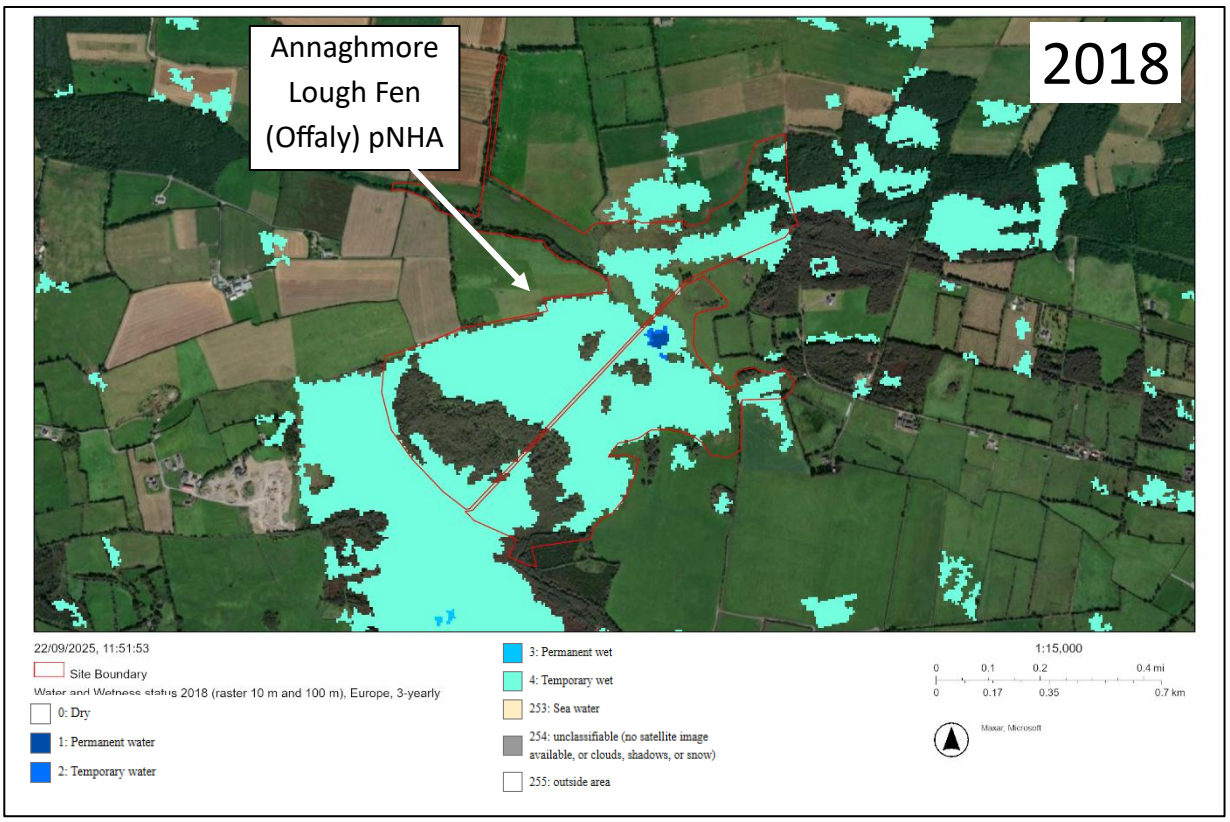


Figure 3-11: HRL Water and Wetness – 2018 of Annaghmore Lough Fen (Offaly) pNHA (Copernicus, 2025)

Total productivity mapping of Annaghmore Lough Fen (Offaly) pNHA further illustrates the site's hydrological variation. Much of the area immediately southwest of Clodiagh River is classified as having moderate productivity, typically associated with semi- degraded peatlands habitats impacted by drainage and vegetation encroachment. Productivity increases towards the southwestern site boundary, potentially reflecting altered hydrological conditions associated with historical peat extraction and drainage. Beyond the site boundary, areas of low productivity coincide with active or former peat extraction areas and are likely to reflect sparsely vegetated or exposed cutover peat surfaces. The northeast section of the site shows high productivity, which presents the characteristics of artificial drainage, agricultural use or colonisation by grasses, shrubs, or trees in a more intense manner. These indicate a disturbed peatland system (Figure 3-12).

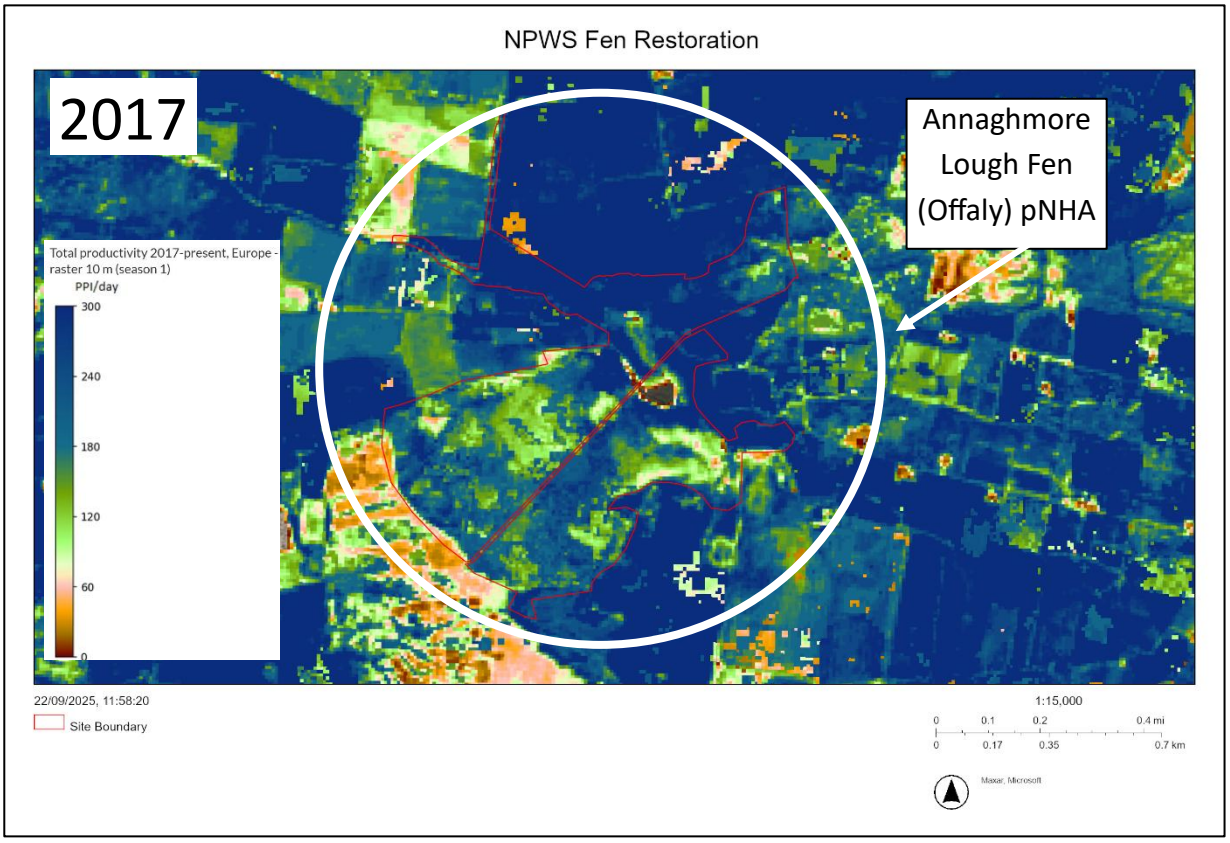


Figure 3-12: Total Productivity 2017 -present, Europe – raster 10 m (season 1) of Annaghmore Lough Fen (Offaly) pNHA (Copernicus, 2025)

Figure 3-13 and Figure 3-14 show the site photogrammetry and the Digital Terrain Model (DTM) map of Annaghmore Lough Fen (Offaly) pNHA, both generated from LiDAR imagery. The images indicate a main drain flowing through the centre of the site and connecting with a small central lake. Several smaller drains discharge into the main channel from adjacent farmland to the south and east. The main drain ranges from approximately 2.5 to 6 m in width between the western site boundary to the lake. Downstream of the lake, flow becomes dispersed across a broad shallow corridor for approximately 4 m before reconverging into a defined channel approximately 2.5 m wide. Channel depths are generally shallow (less than 0.4 m) upstream, increasing to approximately 0.8 m downstream of the confluence with the smaller drains. These drains are shown in Figure 3-15.

Topographically, the site generally slopes towards the main drain located through the centre of the site. North of the drain, the ground falls at approximately 0.40% from north to south. South of the drain, the site slopes northward at a gradient of approximately 0.15%. Elevated ground occurs both north and south of the site, reaching approximately 90 mOD and 89 mOD, respectively.

In the east-west direction, the northern portion of the site is mostly flat, with an elevation of approximately 81.5 mOD and a few localised high points, with elevations of approximately 87.5 mOD.

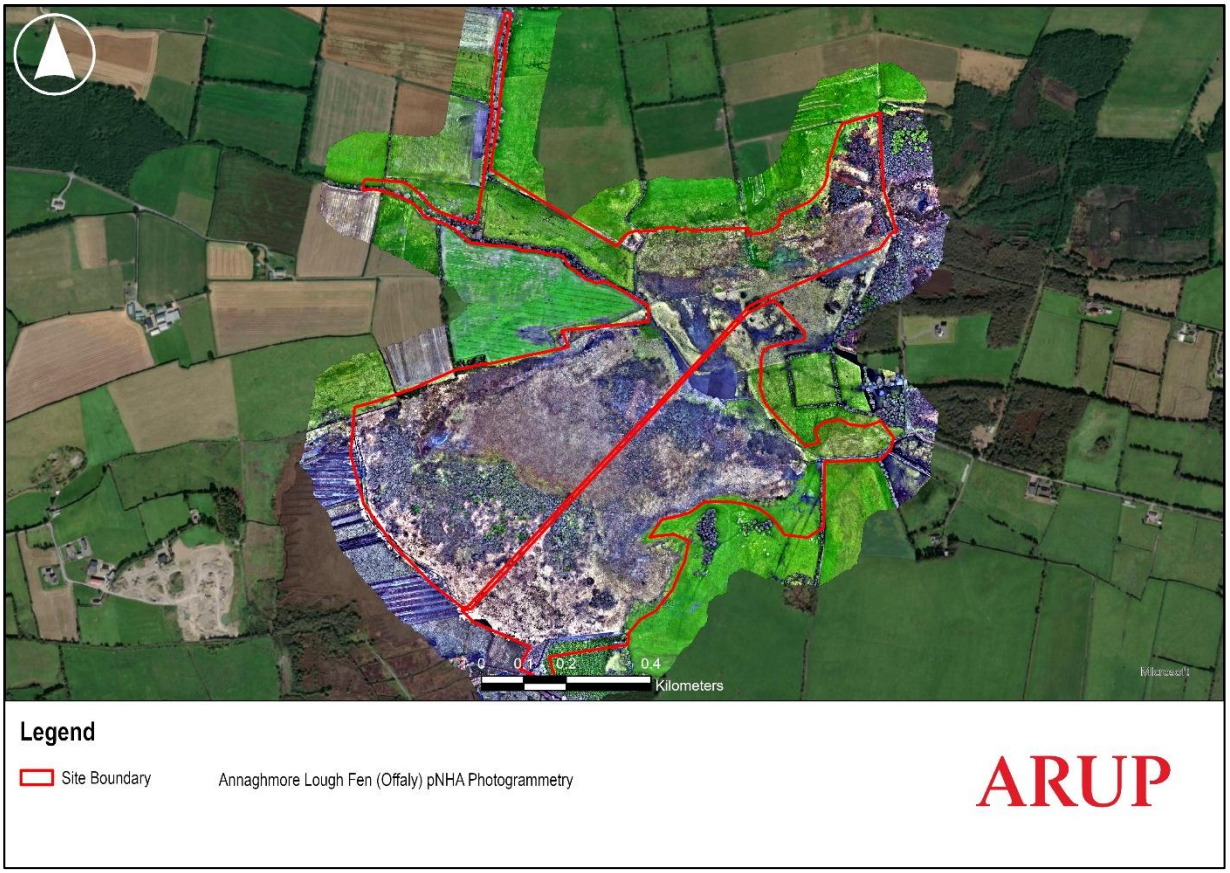


Figure 3-13: Site Photogrammetry map of Annaghmore Lough Fen (Offaly) pNHA

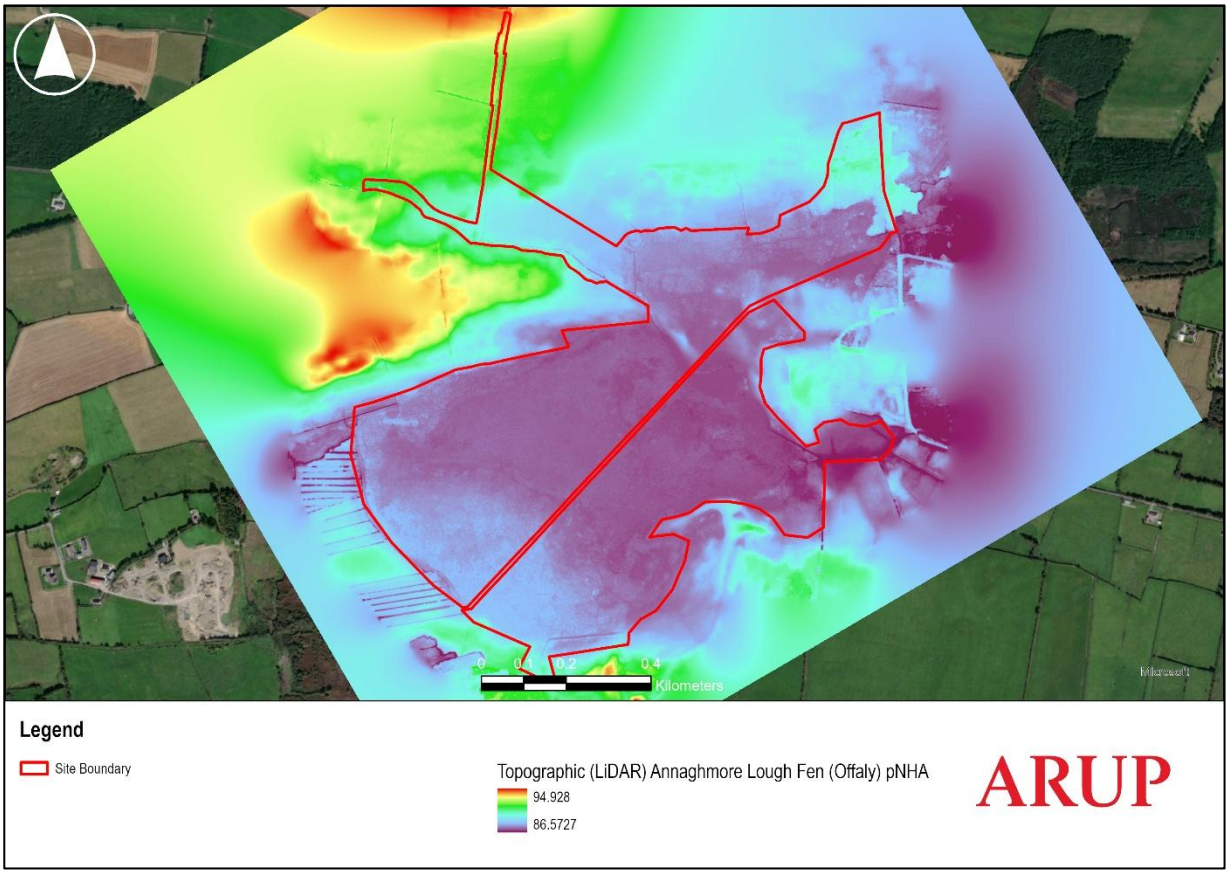


Figure 3-14: Topographic (LiDAR) map of Annaghmore Lough Fen (Offaly) pNHA

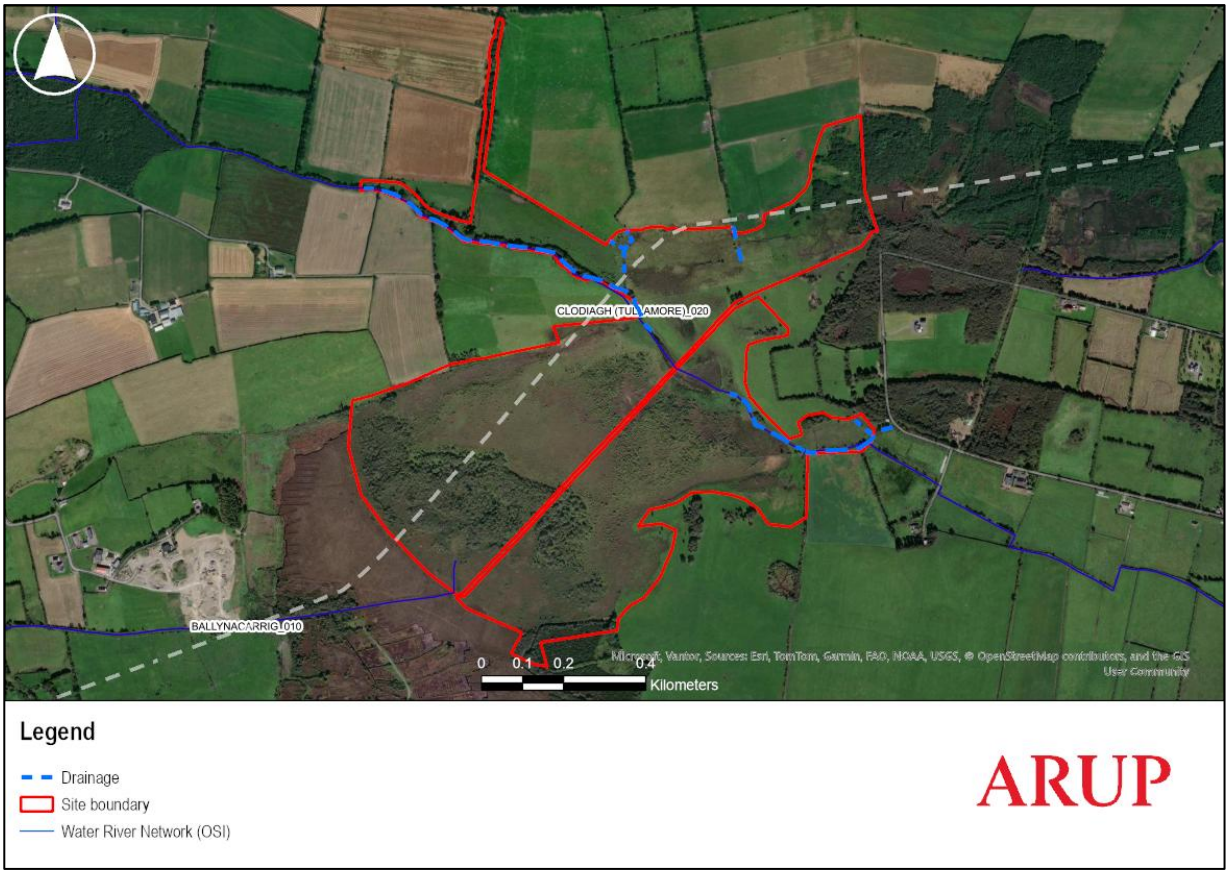


Figure 3-15: Mapped drainage network of Annaghmore Lough Fen (Offaly) pNHA

3.1.4 Land use Pressures and Water Quality

Pollution Impact Potential (PIP) maps (EPA 2025) show the highest risk areas in the landscape for losses of Nitrate and Phosphorus to waterbodies. The PIP models estimate the annual nutrient losses from agricultural land using spatial data on farm management, soil and hydrogeology.

Freely draining soils and substantial groundwater pathways are high risk for nitrate losses. PIP mapping indicates that the risk of near-surface nitrate loss is very low to the southwest of the site and low throughout most of the surrounding area. An area of high susceptibility is present along the western site boundary south of the Clodiagh River, indicating a greater potential for nitrate leaching from the soil layer (Figure 3-16). The subsurface nitrate loss map, which reflects the potential for transport via groundwater pathways, shows a similar pattern (Figure 3-17). Susceptibility is generally very low across most of the site and surrounding area, increasing to low at the western site boundary.

High risk areas for phosphorus loss typically have poorly draining soils and dominant overland flow pathways. The maps indicate that phosphorus delivery flow paths across the site range from medium to very high risk (Figure 3-18). Numerous high and very high-risk flow delivery pathways occur within the agricultural lands surrounding the site and connect to the local drainage network. In particular, PIP Rank 1 areas occur upstream of the site to the northwest, where runoff may enter the Clodiagh River and be conveyed through the site. Additional high-risk flow pathways are present within and adjacent to the site boundary, particularly south of the Clodiagh River. These results indicate that both direct runoff from adjacent land and upstream phosphorus inputs conveyed via the Clodiagh River may represent potential nutrient pressures on the fen. Flow delivery paths and PIP Ranking for Phosphorus are presented in Figure 3-18. A close-up of the flow delivery paths in the site area is presented in Figure 3-19.

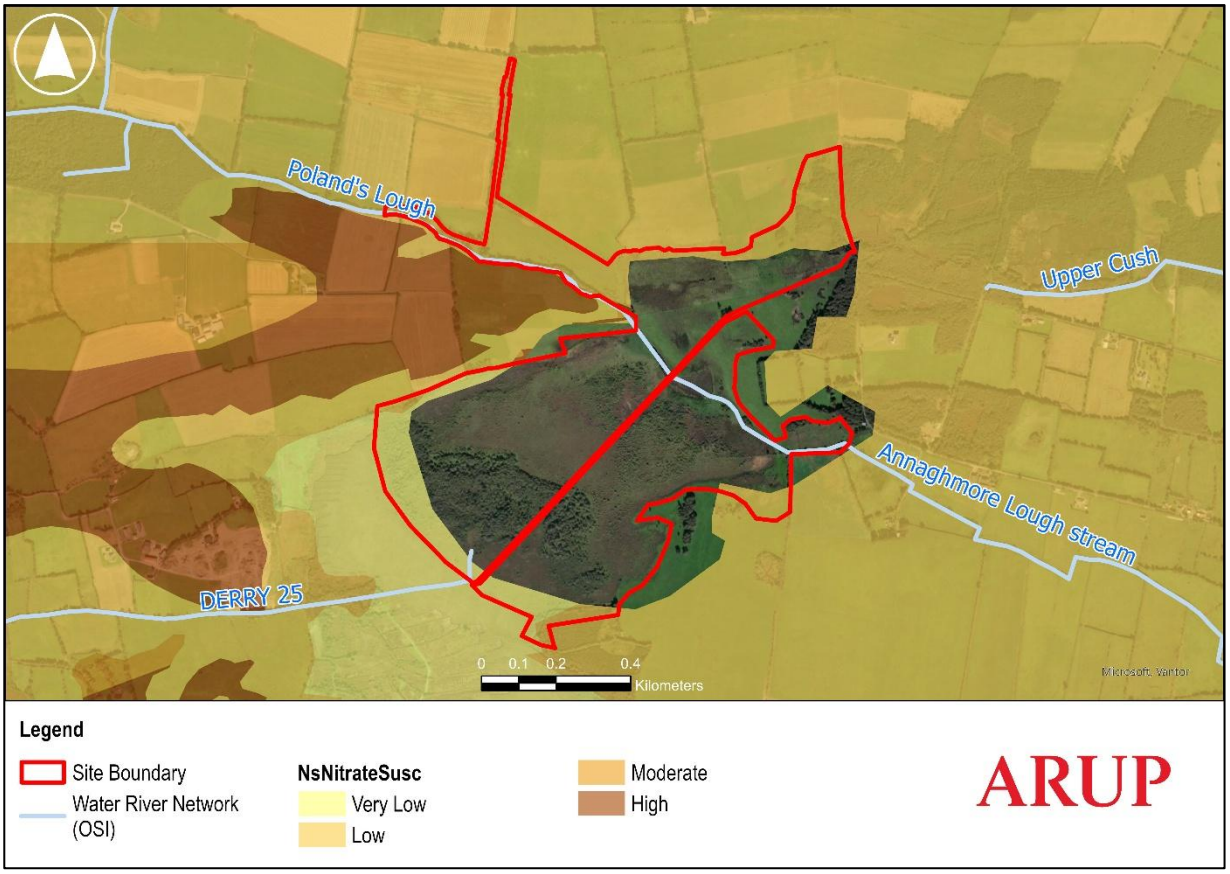


Figure 3-16: Susceptibility maps (Nitrate – near surface) of Annaghmore Lough Fen (Offaly) pNHA (EPA, 2021)

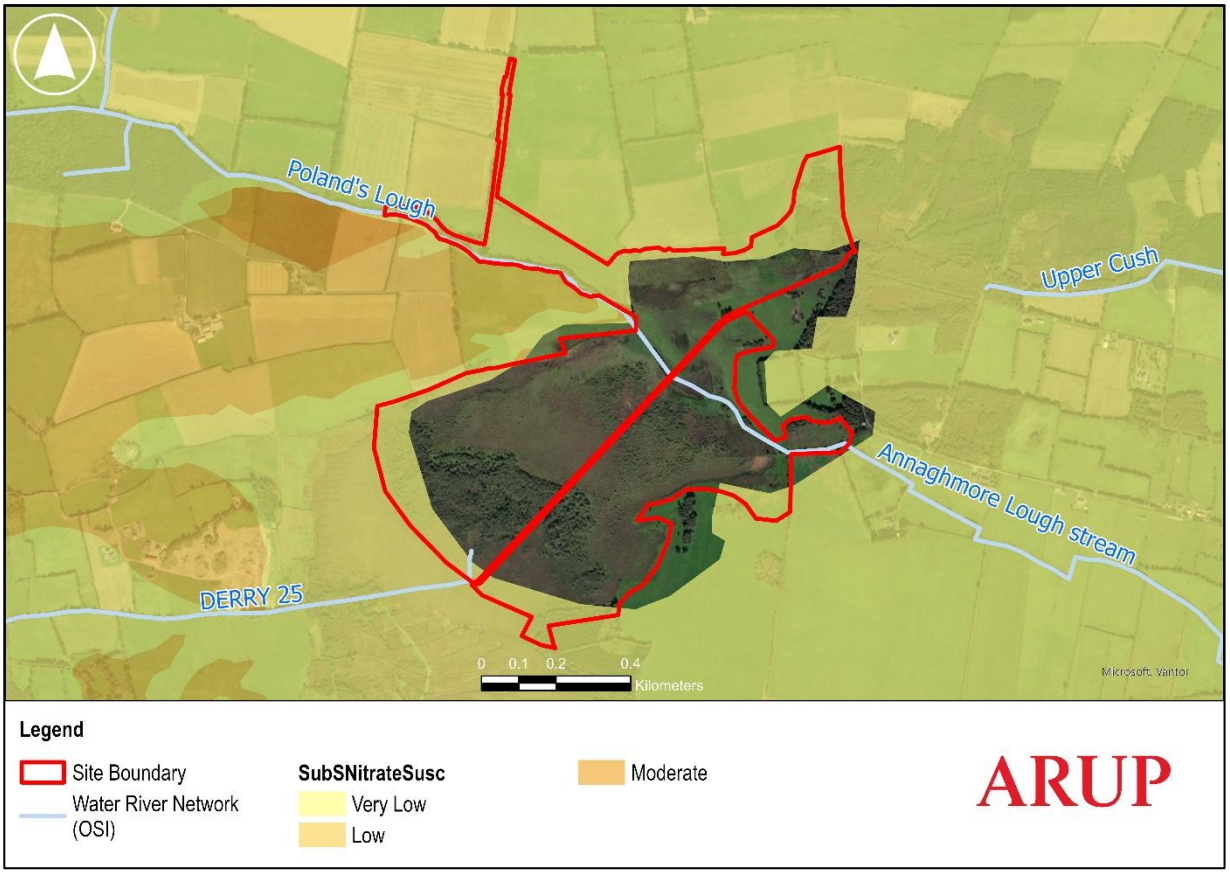


Figure 3-17: Susceptibility maps (Nitrate – sub surface) of Annaghmore Lough Fen (Offaly) pNHA (EPA, 2021)

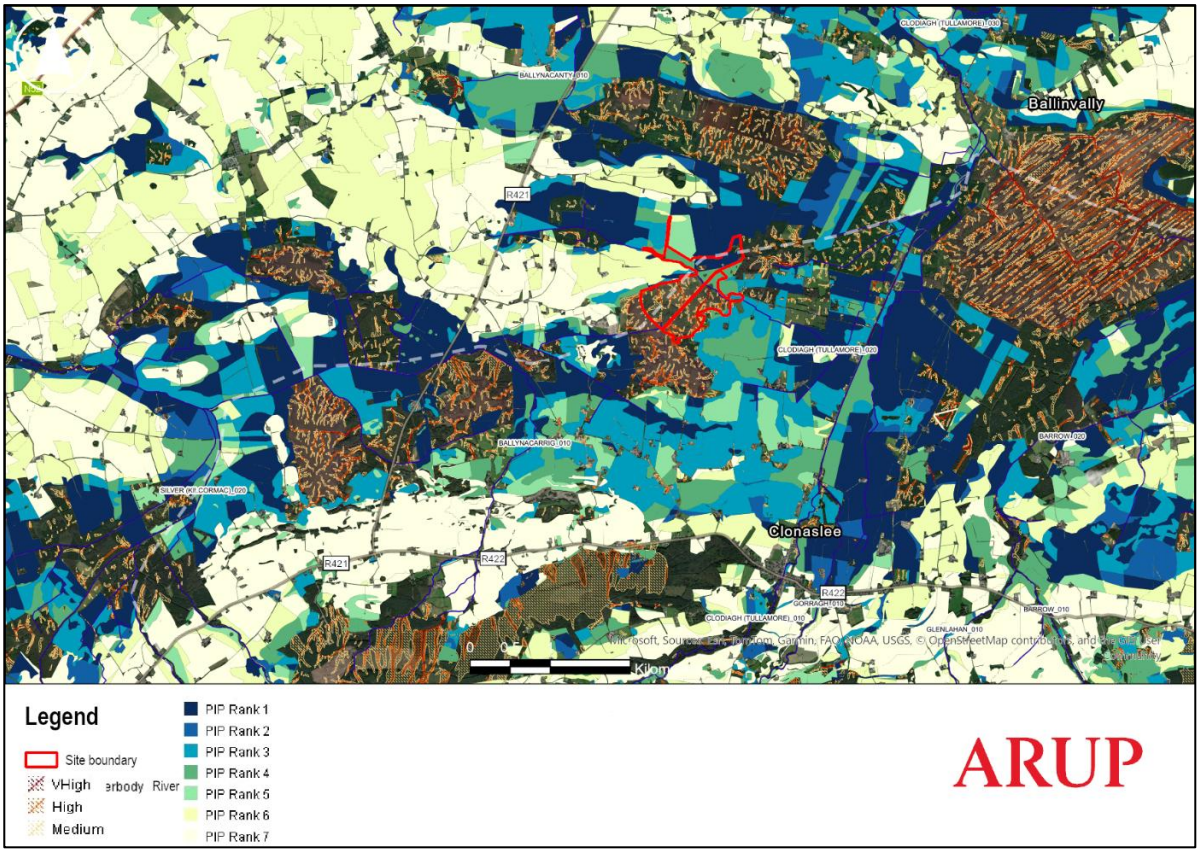


Figure 3-18: PIP maps (Phosphorus) of Annaghmore Lough Fen (Offaly) pNHA (EPA, 2021)

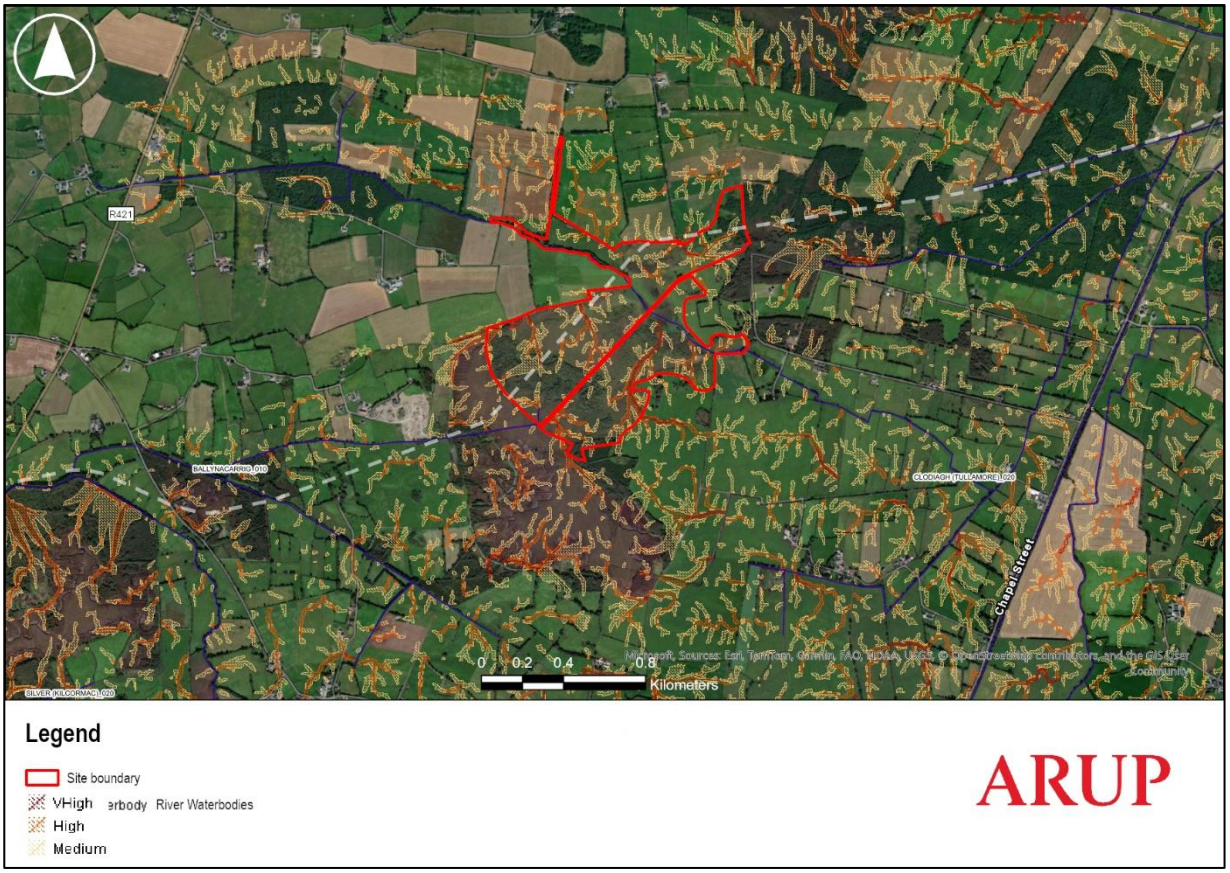


Figure 3-19: Flow delivery paths (Phosphorus) of Annaghmore Lough Fen (Offaly) pNHA (EPA, 2021)

3.2 Field Survey

In the 2023 NFS, water sampling data of electrical conductivity (EC), pH and peat depth were collected. EC values recorded ranged from 254 to 976 µS/cm, pH values ranged from 6.49 to 8.71, and peat depth ranged from 14 to 310cm (Brophy et al., In prep).

Site monitoring was undertaken in February and June 2026, focusing on developing the understanding of the water regime, pressures and implementation of restoration measures within the habitat. The site monitoring included peat depth probing, water quality monitoring and observations of water flow in the drainage network. Water quality monitoring parameters measured included electrical conductivity, pH, temperature, phosphate and nitrate.

The baseline peat depth, surface water and water quality monitoring locations for Annaghmore Lough Fen are shown in Figure 3-20 to Figure 3-22 below.

3.2.1 Peat Depth Probing and Ground Investigations

A total of 23 peat depth measurements were recorded within the site (Table 3-1). Deep peat was recorded in the northeast of the site, varying from 0.97 to 1.41 m. Along the Clodiagh River, 12 peat measurements were taken, with depths ranging from 0.05 m in the centre of the site to 0.9 m on the outflow. A further 9 measurements were recorded south of the Clodiagh River, ranging from 0.05 m along the southeastern boundary to more than 4 m in the densely vegetated central-southern part of the site (Figure 3-20).

Table 3-1: Peat depth measurements at Annaghmore Lough Fen

Location	Date of measurement	Peat depth (m)
ID 1	July 2026	0.97
ID 2	July 2026	1.41
ID 3	July 2026	0.12
ID 4	February 2026	0.08
ID 5	July 2026	0.5
ID 6	July 2026	0.45
ID 7	June 2026	0.16
ID 8	June 2026	1
ID 9	July 2026	0.05
ID 10	June 2026	0.19

Location	Date of measurement	Peat depth (m)
ID 11	June 2026	4
ID 12	June 2026	3.5
ID 13	June 2026	4
ID 14	June 2026	4
ID 15	June 2026	2.25
ID 16	June 2026	0.05
ID 17	June 2026	0.5
ID 18	June 2026	1
ID 19	February 2026	1
ID 20	February 2026	0.6
ID 21	June 2026	0.62
ID 22	July 2026	1
ID 23	February 2026	0.9

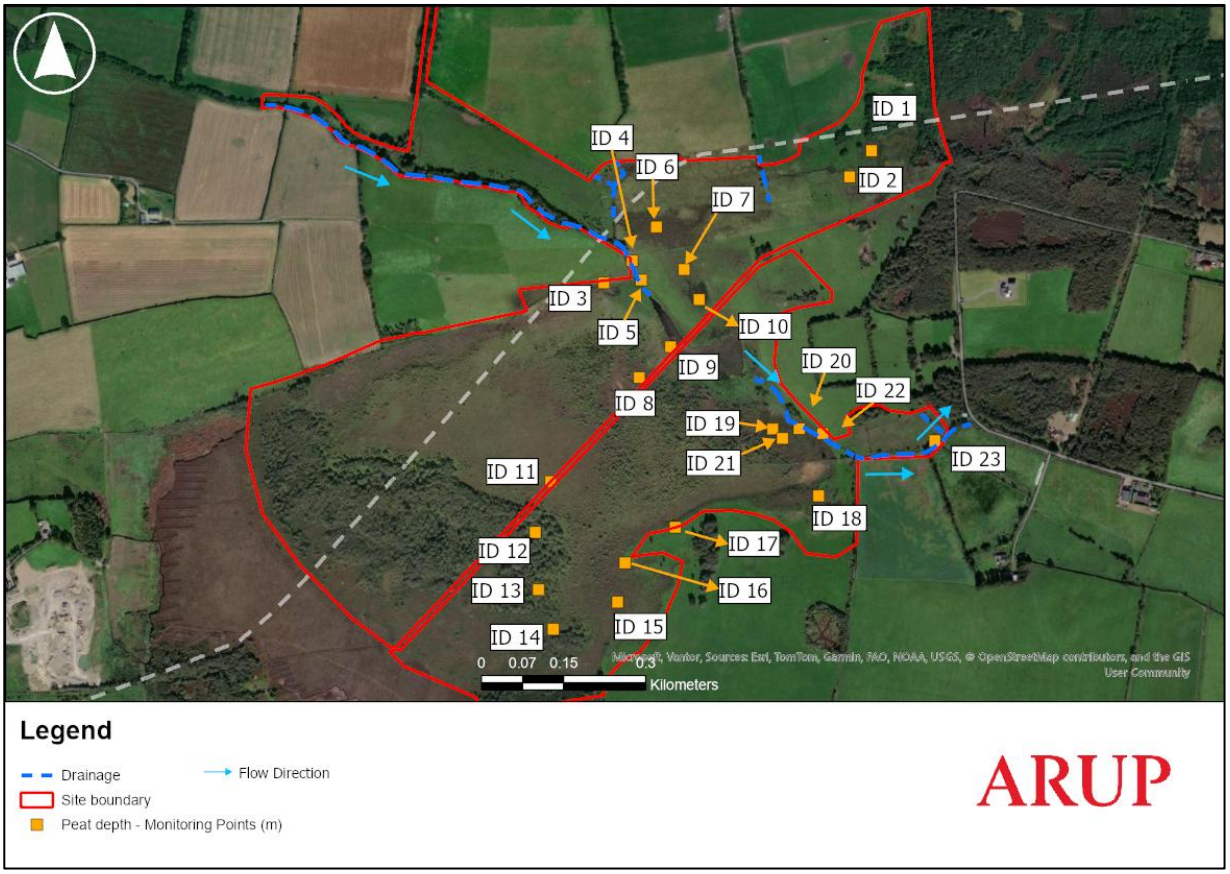


Figure 3-20: Baseline peat monitoring locations of Annaghmore Lough Fen (Offaly) pNHA

3.2.2 Groundwater Levels and Springs

No springs or groundwater seepages were identified during the site visit or on historical mapping. However, the 2022 National Fen Survey (Brophy et al., in prep.) reported widespread flushes within the 7140 Transition mires southwest of the lake and noted that this area may be supported by groundwater inputs.

3.2.3 Surface Water levels

Surface water across the site drains from west to east along the main central drain. At the western boundary, water levels were low and the channel was wide, with a visible streambed, algae on the water surface and dense riparian vegetation that increased looking upstream beyond the site boundary. Drain dimensions measurements were taken during the site visits and presented in Table 3-2.

At the lake (ID 5), water was shallow around the margins and the lakebed was visible. Downstream of the lake, dispersed flow became increasingly confined to a defined channel (ID 4). Water was generally clear, with vegetation largely restricted to the channel margins. Further downstream, two trapezoidal arterial drains joined the main channel (Point 2), contributing flow from the southeast and forming a connected drainage network across the site (Figure 3-

21). At the site outlet (ID 1), the trapezoidal main drain contained clear brownish water and conveyed flow from the site to the east.

Table 3-2: Drain dimension measurements at Annaghmore Lough Fen[3]

Location	Date of measurement	Water level (m)	Drain width (m)
ID 1	February 2026	0.7	2.3
ID 2	February 2026	0.5	1
ID 3	February 2026	0.3	1
ID 4	February 2026	0.2	1.5
ID 5	February 2026	0.3	NI
ID 6	February 2026	0.15	1.5
ID 7	February 2026	0.4	4

[3] NI – Not Identified

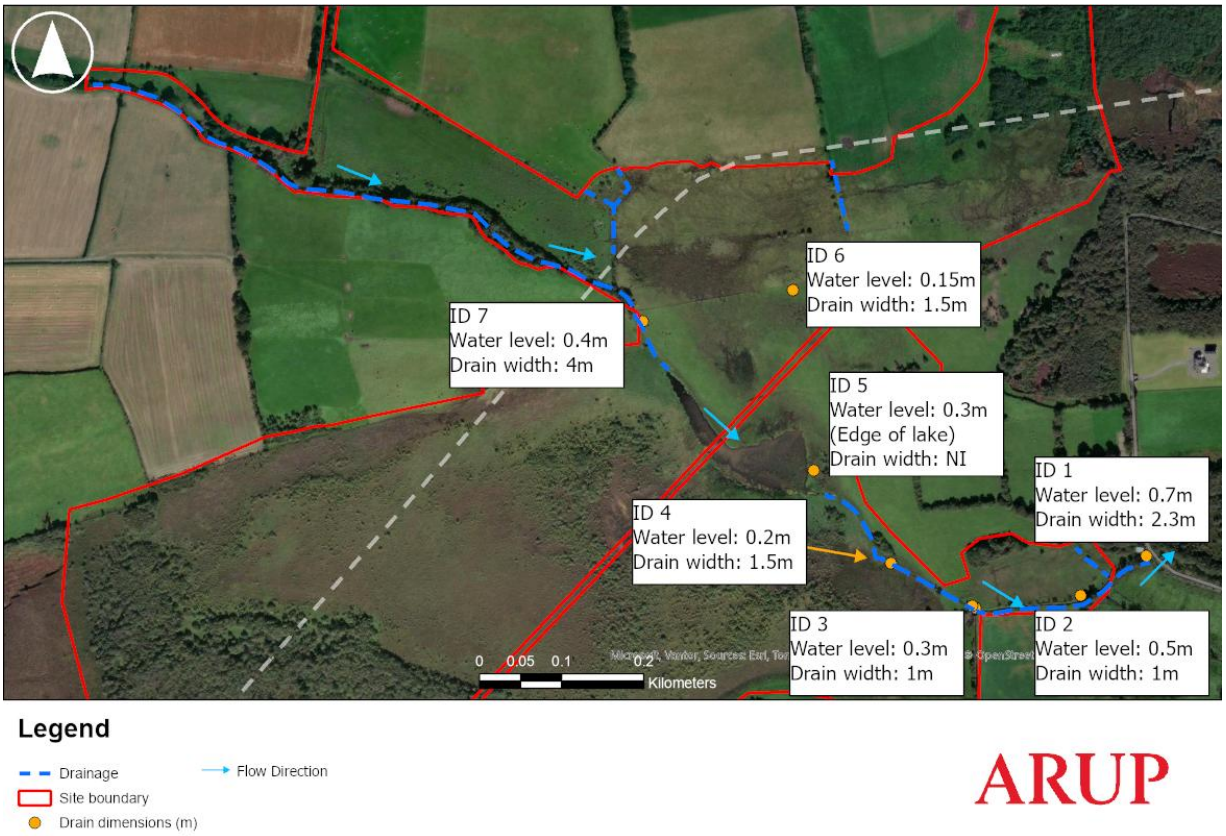


Figure 3-21: Baseline surface water monitoring locations of Annaghmore Lough Fen (Offaly) pNHA

3.2.4 Water Quality

Phosphate concentrations (PO_4) ranged from 0.02 mg/L at ID 2 to 0.44 mg/L at ID 5. With the exception of ID 2, all measured phosphate concentrations exceeded the WFD Good Status environmental quality standard of 0.035 mg/L PO_4-P (Table 3-3).

Although there is no regulatory surface water threshold for nitrate, nitrate concentrations of greater than 1.8 mg/L NO_3^- (which is the case for all measurements taken) may impact the ecological health of rivers (EPA, 2025b). Nitrate concentrations (NO_3-) varied considerably across the site, ranging from 0.8 mg/L at ID 2 to 54.4 mg/L at ID 4 (Figure 3-22). The highest nitrate concentration was recorded within the open water body, while lower concentrations were generally observed within the drainage network. Only the nitrate concentrations measured in ID 4 exceeded the regulatory European groundwater threshold of 50 mg/L NO_3^- (Directive 2006/118/EC) (Table 3-3).

Table 3-3: Water quality measurements at Annaghmore Lough Fen[4]

Location	Date of measurement	Phosphate (mg/L)	Nitrate (mg/L)	EC (µS/cm)	pH	Temperature (°C)
ID 1	February 2026	0.17	22.8	653	6.97	9.9
ID 2	February 2026	0.02	0.8	646	7.51	10.4
ID 3 – Sample 1	February 2026	0.16	1.8	675	7.65	10.2
ID 3 – Sample 2	June 2026	0.07	9.2	488	7.83	19.3
ID 4	February 2026	0.23	54.4	651	8.13	11.74
ID 5	February 2026	0.44	5.6	457	NI	13
ID 6	February 2026	0.22	13.4	717	7.56	10

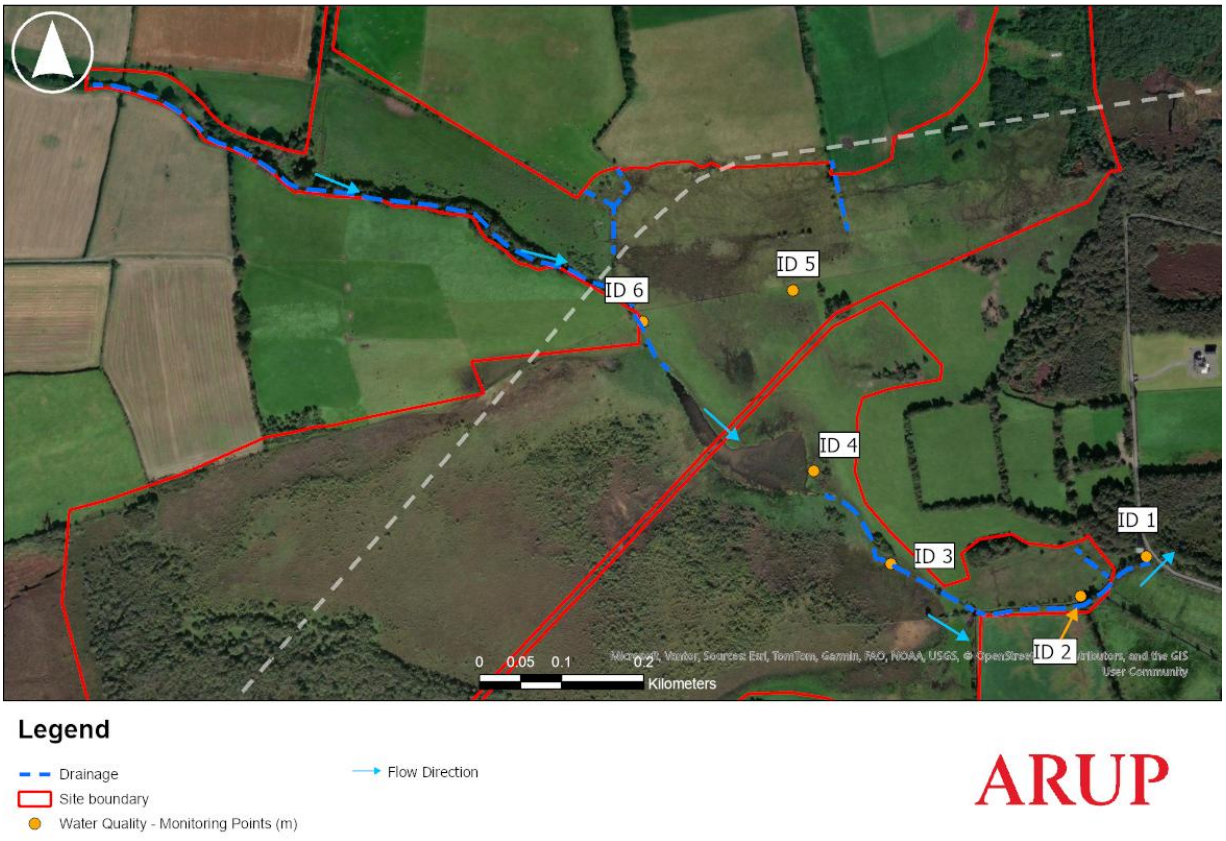


Figure 3-22: Baseline water quality monitoring locations of Annaghmore Lough Fen (Offaly) pNHA

[4] NI – Not Identified

3.3 Conceptual Site Model

Annaghmore Lough Fen (Offaly) pNHA is interpreted as a Groundwater Floodplain (WETMEC 7b) in the vicinity of the Clodiagh River, which provides the principal surface water inflow and outflow. The hydrological regime has been modified by drainage associated with peat extraction along the southwestern site boundary and may therefore locally exhibit characteristics of Groundwater-Fed Bottoms (WETMEC 9) in this area (Wheeler et al., 2009). The iron-rich flushes recorded during the National Fen Survey also indicate localised groundwater discharge, suggesting that small areas of Groundwater-Flushed Bottom (WETMEC 16b) may occur within the fen. (Wheeler et al., 2009).

The characteristics of the site are:

- There is a WFD sub-basin boundary within the site. To the east, surface water generally drains towards the Clodiagh River, while to the west, drainage flows towards the peat harvesting drains west of the site.
- Most of the site is underlain by the Ballysteen Formation, which comprises dark muddy limestone and shale. The northwestern limit of the site is underlain by the Waulsortian Limestones, characterised by massive, unbedded lime-mudstone (GSI, 2025).
- Within the site boundary, quaternary sediments are primarily fen peat and cut-over raised peat. Gravel deposits are located to the west, while till derived from limestone is present to the east (Figure 3-23) (GSI, 2025).
- The Ballysteen Formation is classified as a Locally Important Bedrock Aquifer that is Moderately productive only in Local Zones (LI). To the southwest, a Locally Important Gravel Aquifer (Lg) has a greater capacity to store and transmit groundwater than the surrounding peat deposits (GSI, 2025).
- The Clodiagh River flows through the eastern portion of the site from northwest to southeast before turning northwards and ultimately discharging to the River Brosna.
- No springs or groundwater seepages were identified during the site survey. However, the National Fen Survey reported widespread iron-rich flushes within the transition mire southwest of the lake, suggesting localised groundwater influence (Brophy et al., in prep.). The occurrence of these flushes may reflect groundwater movement through the surrounding gravel deposits and discharge where more permeable materials interface with lower permeability peat.
- The hydrological regime at the site is primarily controlled by the Clodiagh River, which provides the principal surface water inflow and outflow, together with historical drainage modifications. These include channelisation of parts of the river, reduction of Annaghmore Lough from a substantially larger waterbody to a small central lake, and drainage associated with peat extraction along the southwestern

site boundary. The site therefore functions predominantly as a topogenous fen, with water movement driven by surface water inputs and throughflow across the basin.

- Peat excavation and drainage along the western boundary have accelerated in recent years with excavations and drainage encroaching up to 50m within the redline boundary for site. It is expected that this drainage will dewater the peat along the western area of the site and potentially lead to unstable, uncontrolled slopes in that area.

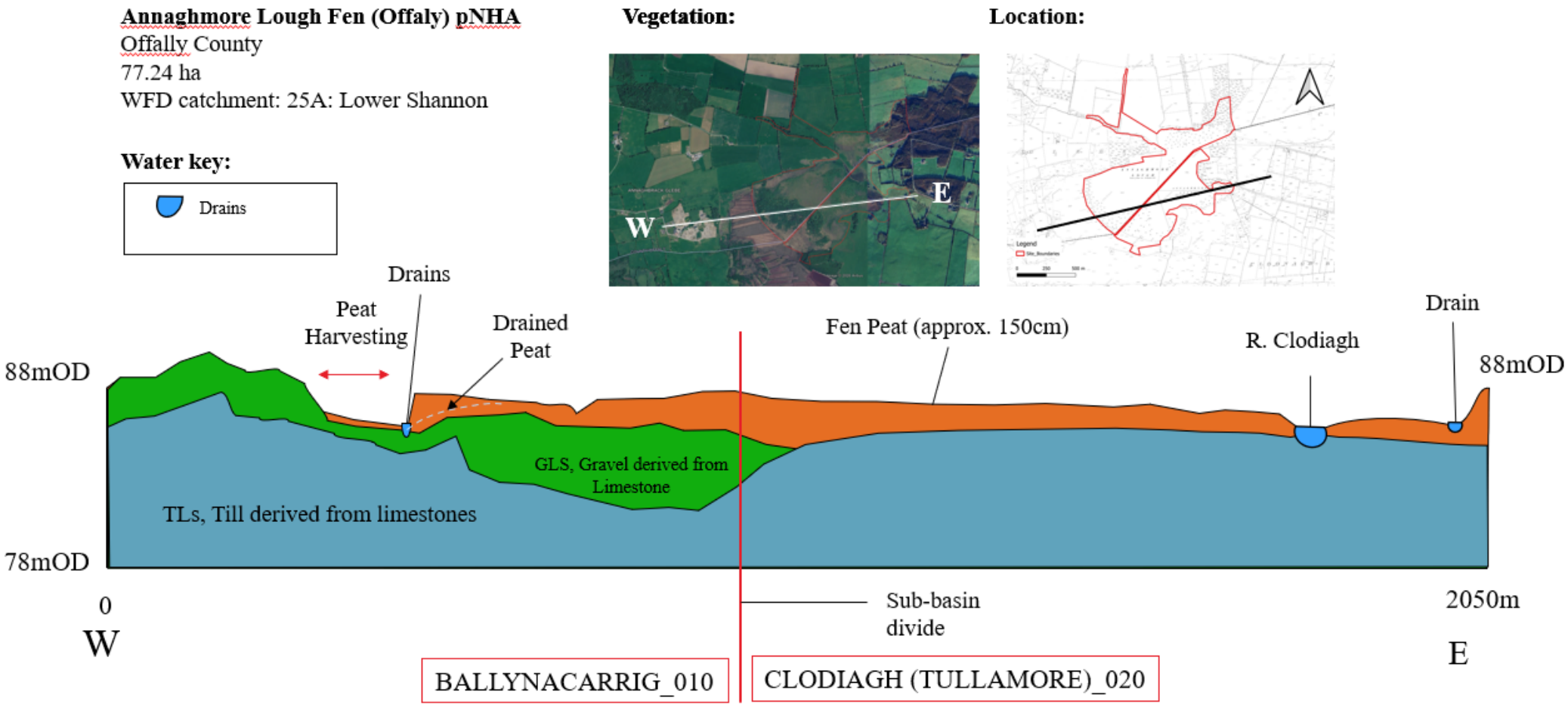


Figure 3-23: Conceptual Site Model of Annaghmore Lough Fen (Offaly) pNHA

4 Ecology

4.1 Desk Study

A review of available desktop information on the ecological baseline for Annaghmore Lough Fen was reviewed from the below information sources:

- NPWS Protected sites – Natural Heritage Areas – pNHA site Synopses archive – 000413
- NPWS Article 17 habitats distribution datasets;
- National Fen Survey (Brophy et al, In prep);
- Biodiversity Maps - National Biodiversity Data Centre (NBDC);
- World Imagery Wayback - ArcGIS;
- Plant Atlas 2020 website - Botanical Society of Britain & Ireland (BSBI);

The NFS was commissioned to develop and test a standardised methodology for assessing the conservation status of fen habitats across Ireland. As part of this study, Annaghmore Lough Fen was selected as one of the sites for field survey. Surveyed in June 2023, the survey methodology included:

- Detailed vegetation assessments using quadrats to record species composition and structure.
- Hydrological observations such as water levels and flow.
- Documentation of disturbance indicators including drainage, grazing, and invasive species.

GPS mapping and photographic records were also used to support habitat boundary delineation and condition assessment. While the primary emphasis was on habitat quality, vascular plants and bryophytes were recorded as part of the vegetation surveys, contributing to an understanding of species diversity and habitat integrity at the site.

4.1.1 Habitats

The NFS findings revealed the presence of Annex I quality 7140 Transition mires, 7210 *Cladium* fens, 7230 Alkaline fens, 91D0 Bog woodland and 91E0 Alluvial forests. The remainder of the habitats identified consists of rich fen and flush, poor fen and flush, transition mires and quaking bog, improved agricultural grassland, wet grassland, dry and calcareous neutral grasslands, dry-humid acid grassland, wet willow-alder-ash woodland, bog woodland, reed and large sedge swamps, marsh, mesotrophic lakes, and drainage ditches. A directory of Annex I and Fossitt habitat codes is provided in

Table B-1, Appendix B.

4.1.1.1 Annex Habitats

The following Annex I quality habitat was identified and mapped:

- **7230 Alkaline fens** (11.16 ha) are located across the site, though is largely absent from the centre which is instead dominated by 7140 Transition mires.
- **7210 *Cladium* fens** (0.50 ha) are located within two areas of 7230 Alkaline fens-dominated habitat in the north and south of the site, respectively.
- **7140 Transition mires** (18.31 ha) is recorded across the site but dominates the central section of the site south of the lake.
- **91D0 Bog woodland** is recorded in the south-western section of the site, where a small amount of the WN7 Bog woodland habitat present is considered to be of Annex I quality. It is a small percentage of a larger area of WN7 Bog woodland habitat and as such does not appear as a distinct area in Figure 1-1.
- **91E0 Alluvial forests** are located primarily in the centre of the site, adjacent to the lake and largely surrounded by 7140 Transition mires habitat.

It should be noted that the resulting mapping of Annex I quality habitats from the NFS survey requires suitable interrogation and interpretation as to the extent of these habitats within each polygon i.e. Annex I quality habitat mapping is represented by the habitat that has the highest percentage attributed to the polygon. Therefore, polygons could be a mosaic or only support a small percentage of Annex I quality habitat within the overall polygon area and thus must be interpreted appropriately (Figure 1-1).

4.1.1.2 Non-Annex/Fossitt habitats

Non-Annex I fen and other habitats were also recorded, with mapping based on Fossitt classification (Fossitt, 2000). Habitats recorded are detailed in Table 4-1 and Figure B-1, Appendix B.

Table 4-1: Habitat types and locations at Annaghmore Lough Fen

Habitat Type	Location	Notes
FL4 – Mesotrophic lakes	Located in the centre of the site.	This habitat consists of a central lake within the site that has undergone extensive historical drainage.
FS1 – Reed and large sedge swamps	Located in the centre of the site.	This swamp habitat is adjacent to the southern and eastern edges of the lake.
FW – Drainage ditches	Located in the northern and	These drains run across the northern and eastern sections of the site and include the

Habitat Type	Location	Notes
	eastern areas of the site.	lake inflow and outflow, which have been dredged and canalised.
GA1 - Improved agricultural grassland	Present in the eastern edge of the site.	While this habitat is restricted to the east of the site, areas of GS1, GS3 and GS4 have also been improved and are subject to agricultural activity.
GM1 – Marsh	Located in the centre of the site.	This habitat is adjacent to the northern edge of the lake.
GS1 – Dry calcareous and neutral grassland	Spread across the northern and eastern areas of the site.	This habitat is spread across multiple pockets within the site and has been utilised for agricultural activity.
GS3 – Dry-humid acid grassland	Present in the northern area of the site.	This habitat is present within an area of 7230 Alkaline fens-dominated habitat.
GS4 – Wet grassland	Spread across the northern area of the site.	This habitat has been utilised for agricultural activity.
PF1 – Rich fen and flush	Located across the site, though largely absent from the centre.	This habitat is spread across the site and contains areas of Annex I quality 7230 Alkaline fens.
PF2 – Poor fen and flush	Located in the southern area of the site.	This area has developed over the since-drained historic extent of the lake and is located in the southern area of the site adjacent to bog habitat outside of the site boundary.
PF3 – Transition mires and quaking bog	Dominant habitat in the centre of the site.	This habitat dominates the centre of the site and contains areas of Annex I quality 7140 Transition mires.
WD4 – Conifer plantation	Present in the southern area of the site.	This habitat is adjacent to areas of 7230 Alkaline fens and PF2.

Habitat Type	Location	Notes
WN6 – Wet willow-alder-ash woodland	Spread across the centre and south/south-western area of the site.	This habitat has developed over the since-drained historic extent of the lake alongside Transition mires and quaking bog habitat.
WN7 – Bog woodland	Present in the south-western area of the site.	This habitat is adjacent to patches of wet willow-alder-ash woodland and Transition mires and quaking bog and is itself close to the bog habitat present within the pNHA outside of the site boundary.

4.1.2 Species

The following subsections outline the presence of species recorded at or within the zone of influence of Annaghmore Lough Fen. This includes protected species listed under relevant legislation and conservation frameworks such as the EU Habitats and Birds Directives (Annex I, II, IV, and V), the Irish Red Lists, and the Wildlife Acts (including species protected under the Flora Protection Order). Records are limited to those from the past ten years, reflecting the most plausible timeframe for continued presence and ecological relevance to the site - excepting where invasive species have been historically recorded and there has been no indication since of their elimination.

4.1.2.1 Species within the site

The species within Table 4-2 were identified using the NBDC interactive maps service, reviewing the NFS documentation and from the ecological walkover conducted in 2026.

Table 4-2: Species records within Annaghmore Lough Fen

Common Name	Latin name	Description	Most recent record
Black bog-rush	*Schoenus nigricans*	A sedge species that grows in calcareous and base-rich fens, it is associated with 7230 Alkaline fens.	11/06/2026-14/07/2026
Bladderwort	*Utricularia* spp.	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Bog pimpernel	*Lysimachia tenella*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Bogbean	*Menyanthes trifoliata*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Bottle sedge	*Carex rostrata*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026

Common Name	Latin name	Description	Most recent record
Carnation sedge	*Carex panicea*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Common butterwort	*Pinguicula vulgaris*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Common cottongrass	*Eriophorum angustifolium*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Common marsh bedstraw	*Galium palustre*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Common reed	*Phragmites australis*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Common sedge	*Carex nigra*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Common spike-rush	*Eleocharis palustris*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Common valerian	*Valeriana officinalis*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Creeping bent	*Agrostis stolonifera*	A native Irish grass species that can encroach onto degraded fen habitats.	11/06/2026-14/07/2026
Cuckoo flower	*Cardamine pratensis*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Devil's bit scabious	*Succisa pratensis*	A native Irish plant species often found in wetland habitats. Food plant for the marsh fritillary butterfly.	11/06/2026-14/07/2026
Fen pondweed	*Potamogeton coloratus*	A native Irish aquatic plant species often found in wetland habitats	11/06/2026-14/07/2026
Flea sedge	*Carex pulicaris*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Floating sweet grass	*Glyceria fluitans*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Glaucous sedge	*Carex flacca*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Marsh grass of Parnassus	*Parnassia palustris*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Irish marsh orchid	*Dactylorhiza kerryensis*	A native Irish species of orchid found in wetland habitats.	08-10/06/2023
Jointed rush	*Juncus articulatus*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Lesser spearwort	*Ranunculus flammula*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026

Common Name	Latin name	Description	Most recent record
Marsh arrowgrass	*Triglochin palustre*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Marsh helleborine	*Epipactis palustris*	A native Irish species of orchid found in wetland habitats.	08-10/06/2023
Marsh horsetail	*Equisetum palustre*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Marsh pennywort	*Hydrocotyle vulgaris*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Marsh willowherb	*Epilobium palustre*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Purple moor-grass	*Molinia caerulea*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Round-leaved wintergreen	*Pyrola rotundifolia*	A native Irish plant species often found in wetland habitats.	08-10/06/2023
Small-fruited yellow-sedge	*Carex viridula*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Stonewort	*Chara spp.*	An aquatic plant species associated with alkaline wetland habitats.	11/06/2026-14/07/2026
Tormentil	*Potentila erecta*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Water horsetail	*Equisetum fluviatile*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Water mint	*Mentha aquatica*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Wild angelica	*Angelica sylvestris*	A native Irish plant species often found in wetland habitats.	11/06/2026-14/07/2026
Comb-moss	*Ctenidium molluscum*	A native Irish moss species indicative of calcareous habitats.	11/06/2026-14/07/2026
Fern-leaved hookmoss	*Cratoneuron filicinum*	A native Irish moss species indicative of calcareous habitats.	11/06/2026-14/07/2026
Giant spearmoss	*Calliergon giganteum*	A native Irish moss species often found in wetland habitats.	11/06/2026-14/07/2026
Intermediate hookmoss	*Scorpidium cossonii*	A native Irish species of brown moss which is an indicator of 7230 Alkaline fens habitat.	11/06/2026-14/07/2026
Lesser clubmoss	*Selaginella selaginoides*	A native Irish moss species often found in wetland habitats.	11/06/2026-14/07/2026
Maidenhair pocketmoss	*Fissidens adianthoides*	A native Irish moss species often found in wetland habitats.	11/06/2026-14/07/2026

Common Name	Latin name	Description	Most recent record
Yellow starry feathermoss	*Campylium stellatum*	A native Irish species of brown moss which is an indicator of 7230 Alkaline fens habitat.	11/06/2026-14/07/2026
Blackbird	*Turdus merula*	A native Irish bird species.	22/10/2020
Buzzard	*Buteo buteo*	A native Irish bird species.	22/10/2020
Chaffinch	*Fringilla coelebs*	A native Irish bird species.	22/10/2020
Cuckoo	*Cuculus canorus*	A native Irish bird species.	29/04/2020
Fieldfare	*Turdus pilaris*	A native Irish bird species.	11/02/2019
Golden Plover	*Pluvialis apricaria*	An Annex I species of Irish bird.	12/03/2018
Goldfinch	*Carduelis carduelis*	A native Irish bird species.	22/10/2020
Grey Heron	*Ardea cinerea*	A native Irish bird species.	12/03/2018
Hooded Crow	*Corvus cornix*	A native Irish bird species.	22/10/2020
Jay	*Garrulus glandarius*	A native Irish bird species.	22/10/2020
Lapwing	*Vanellus vanellus*	An Annex II species of Irish bird.	22/10/2020
Little Egret	*Egretta garzetta*	An Annex I species of Irish bird.	22/10/2020
Magpie	*Pica pica*	A native Irish bird species.	22/10/2020
Mallard	*Anas platyrhynchos*	An Annex II species of Irish duck.	22/10/2020
Mistle Thrush	*Turdus viscivorus*	A native Irish bird species.	22/10/2020
Mute Swan	*Cygnus olor*	A native Irish bird species.	08-10/06/2023
Raven	*Corvus corax*	A native Irish bird species.	20/01/2019
Redwing	*Turdus iliacus*	A native Irish bird species.	11/02/2019
Robin	*Erithacus rubecula*	A native Irish bird species.	22/10/2020
Shoveler	*Spatula clypeata*	An Annex II species of Irish duck.	12/03/2018
Snipe	*Gallinago gallinago*	An Annex II species of Irish bird.	08-10/06/2023
Song Thrush	*Turdus philomelos*	A native Irish bird species.	22/10/2020
Sparrowhawk	*Accipiter nisus*	A native Irish bird species.	22/10/2020
Starling	*Sturnus vulgaris*	A native Irish bird species.	22/10/2020
Stonechat	*Saxicola rubicola*	A native Irish bird species.	22/10/2020
Teal	*Anas crecca*	An Annex II species of Irish duck.	27/12/2019
Whooper Swan	*Cygnus cygnus*	An Annex I species of Irish bird.	29/12/2019
Woodpigeon	*Columba palumbus*	A native Irish bird species.	22/10/2020
Wren	*Troglodytes troglodytes*	A native Irish bird species.	22/10/2020

Common Name	Latin name	Description	Most recent record
Mountain hare	*Lepus timidus*	A native Irish mammal species.	08-10/06/2023
Smooth newt	*Lissotriton vulgaris*	A protected species of Irish amphibian.	08-10/06/2023

4.1.2.2 Species within the Zone of Influence

Table 4-3 outlines notable records of functionally linked species recorded within the 2 km distribution zone of influence around Annaghmore Lough Fen within the last ten years from the NBDC.

Table 4-3: Species records within the Zone of Influence of Annaghmore Lough Fen

Legislative Protection	Common Name	Latin Name
Wildlife Acts	Blackbird	*Turdus merula*
Wildlife Acts	Buzzard	*Buteo buteo*
Wildlife Acts	Chaffinch	*Fringilla coelebs*
Wildlife Acts	Cuckoo	*Cuculus canorus*
Wildlife Acts	Fieldfare	*Turdus pilaris*
EU Birds Directive	Golden Plover	*Pluvialis apricaria*
Wildlife Acts	Goldfinch	*Carduelis carduelis*
Wildlife Acts	Great Spotted Woodpecker	*Dendrocopos major*
Wildlife Acts	Grey Heron	*Ardea cinerea*
EU Birds Directive	Hen Harrier	*Circus cyaneus*
Wildlife Acts	Hooded Crow	*Corvus cornix*
Wildlife Acts	Jay	*Garrulus glandarius*
EU Birds Directive	Lapwing	*Vanellus vanellus*
EU Birds Directive	Little Egret	*Egretta garzetta*
Wildlife Acts	Magpie	*Pica pica*
EU Birds Directive	Mallard	*Anas platyrhynchos*
Wildlife Acts	Mistle Thrush	*Turdus viscivorus*
Wildlife Acts	Mute Swan	*Cygnus olor*
Wildlife Acts	Raven	*Corvus corax*
Wildlife Acts	Redwing	*Turdus iliacus*
Wildlife Acts	Robin	*Erithacus rubecula*

Legislative Protection	Common Name	Latin Name
Wildlife Acts	Sand Martin	*Riparia riparia*
EU Birds Directive	Shoveler	*Spatula clypeata*
EU Birds Directive	Snipe	*Gallinago gallinago*
Wildlife Acts	Song Thrush	*Turdus philomelos*
Wildlife Acts	Sparrowhawk	*Accipiter nisus*
Wildlife Acts	Starling	*Sturnus vulgaris*
Wildlife Acts	Stonechat	*Saxicola rubicola*
EU Birds Directive	Teal	*Anas crecca*
EU Birds Directive	Whooper Swan	*Cygnus cygnus*
Wildlife Acts	Woodpigeon	*Columba palumbus*
Wildlife Acts	Wren	*Troglodytes troglodytes*
Wildlife Acts	Yellowhammer	*Emberiza citrinella*
No legislative protection	Field-rose	*Rosa arvensis*
No legislative protection	7-spot Ladybird	*Coccinella septempunctata*
No legislative protection	Meadow Brown	*Maniola jurtina*
Wildlife Acts	Hedgehog	*Erinaceus europaeus*
EU Habitats Directive	Soprano Pipistrelle	*Pipistrellus pygmaeus*

4.2 Field Survey

Following a comprehensive review of available desktop data, a targeted follow-up ecological survey was undertaken on the site on the 11th of June and the 14th of July 2026. These field surveys concentrated on key areas highlighted during the desk-based assessment, specifically those with potential for restoration activities. These locations were investigated in detail to verify and further assess ecological conditions and parameters, ensuring that any recommended restoration measures would be both appropriate and effective in the identified zones.

Two survey forms were created to collect data relevant to:

- Monitoring data; and
- Pressures and threats.

4.2.1 Monitoring Points

The targeted walkover survey was a focused assessment designed to gather site-specific data at pre-identified locations. The walkover was designed to assess ecological condition at seven pre-identified monitoring points (Monitoring Points 1, 2, 3, 4, 5, 6 and 7), selected

based on hydrological features, habitat potential, and restoration feasibility. The locations were determined through expert discussion and review of baseline data and will serve as fixed monitoring stations post-restoration.

These monitoring points now serve a dual purpose:

- Baseline characterisation of current site conditions.
- Long-term monitoring stations to assess ecological change following restoration.

The surveys focused on two key components:

- Target Notes: Qualitative observations at each monitoring point, capturing site condition, vegetation structure, hydrological features, and legacy management.
- Pressures and Threats Identification: Systematic recording of anthropogenic and natural pressures affecting each location.

The surveys confirmed the presence of Annex I quality 7140 Transition mires habitat at Monitoring Point 2 and 7230 Alkaline fens at Monitoring Points 1, 3, 4, 5 and 6. 7210 *Cladium* fens was not recorded at any Monitoring Point.

4.2.2 Pressure & Threats

This section outlines the historical and current pressures and threats affecting fen habitats at Annaghmore Lough Fen, with emphasis on Annex I quality 7140 Transition mires, 7210 *Cladium* fens and 7230 Alkaline fens habitat.

4.2.2.1 7140 Transition mires

Historical Pressures

As detailed in Table 2-2 the overall status of 7140 Transition mires habitat was assessed as Unfavourable-Bad as part of the NFS due to ongoing pressures at the time. These pressures relate to drainage, poaching and trampling, pollution arising from agricultural activity and peat extraction.

- **Drainage** was noted as an issue across the site and has been a historic pressure for a prolonged period. Much of the 7140 Transition mires habitat within the site has developed over the historic extent of Annaghmore Lough which has since been largely drained. Drainage works have continued in order to facilitate peat extraction to the south of the site and as part of land reclamation efforts for agriculture within and surrounding the site.
- **Poaching and trampling** was noted throughout the site and was recorded as a pressure for 7140 Transition mires habitat.
- **Nutrient enrichment** in the form of algal deposits was noted as a pressure for 7140 Transition mires habitat within the site.

- **Peat extraction** was noted as occurring on the bog to the west of the site, with the disturbance arising from this activity impacting 7140 Transition mires habitat within the site.

Current Observations

7140 Transition mires was recorded at Monitoring Point 2, to the north of the lake. No pressures or threats were recorded in this area.

4.2.2.2 7210 *Cladium* fens

Historical Pressures

The overall status of 7210 *Cladium* fens habitat at Annaghmore Lough Fen was assessed as Unfavourable-Bad as part of the NFS due to ongoing pressures at the time. These pressures relate to poaching and trampling, drainage, and reclamation of agricultural land.

- **Drainage** was noted as an issue across the site and has been a historic pressure for a prolonged period. Drainage works have continued in order to facilitate peat extraction to the south of the site and as part of land reclamation efforts for agriculture within and surrounding the site, in both cases occurring in relative proximity to 7210 *Cladium* fens habitat.
- **Poaching and trampling** was noted throughout the site and was recorded as a pressure for 7210 *Cladium* fens habitat.
- **Reclamation of agricultural land** has resulted in the loss of 7210 *Cladium* fens habitat.

Current Observations

7210 *Cladium* fens were not recorded at any of the seven current monitoring points; therefore, the 2026 ecological walkover does not provide direct monitoring-point evidence on current pressures affecting this habitat.

4.2.2.3 7230 Alkaline fens

Historical Pressures

The overall status of 7230 Alkaline fens habitat at Annaghmore Lough Fen was assessed as Unfavourable-Bad as part of the NFS due to ongoing pressures at the time. These pressures relate to drainage, poaching and trampling, reclamation of agricultural land, pollution arising from agricultural activity, and flooding.

- **Drainage** was noted as an issue across the site and has been a historic pressure for a prolonged period. Drainage works have continued in order to facilitate peat extraction to the south of the site and as part of land reclamation efforts for

agriculture within and surrounding the site, in both cases occurring in relative proximity to 7230 Alkaline fens habitat.

- **Poaching and trampling** was noted throughout the site and was recorded as a pressure for 7230 Alkaline fens habitat, with severe poaching and trampling noted in areas across the site.
- **Reclamation of agricultural land** has resulted in the loss of 7230 Alkaline fens habitat.
- **Nutrient enrichment** in the form of algal deposits was noted as a pressure for 7230 Alkaline fens within the site.
- **Flooding** was noted as a pressure that is impacting areas of 7230 Alkaline fens habitat within the site.

Current Observations

7230 Alkaline fens were recorded at Monitoring Points 1, 3, 4, 5 and 6. The following pressures and threats were noted during the site walkover:

- **Drainage** was noted during the walkover as a continued pressure on 7230 Alkaline fens habitat, with historical drainage and current drawdown to the lake negatively impacting 7230 Alkaline fens habitat in the north of the site.
- **Nutrient enrichment** was recorded as a continued pressure on 7230 Alkaline fens habitat in the northern part of the site due to the proximity of agricultural land. Similar impacts were observed in 7230 Alkaline fens habitat in the eastern section of the site, where algal growth was recorded within surface waters.
- **Poaching** due to inappropriate management was noted within areas of 7230 Alkaline fens habitat. Mild poaching was recorded in the north of the site while severe poaching was noted adjacent to the lake, where cattle have access for drinking.
- **Abandonment of pastoral systems** was noted as a pressure in the northern section of the site where previously grazed areas of 7230 Alkaline fens have since been abandoned, with the vegetation in this area starting to become overgrown.

4.2.3 Additional Observations

While some areas of 7230 Alkaline fens habitat are under pressure due to insufficient grazing as discussed in Section 4.2.2.3, it is important to note that the site walkover surveys indicated that suitable grazing levels are already present in other parts of the site containing 7230 Alkaline fens and 7140 Transition mires habitat within the site as shown in Figure B-2, Appendix B.

While 7140 Transition mires was recorded at Monitoring Point 2 in the northern section of the site and no pressures or threats were recorded, this is not reflective of the condition of 7140 Transition mires habitat within the site. The majority of the 7140 Transition mires habitat within the site is located further south of the lake in the central part of the site where historic

pressures such as disturbance from peat extraction are expected to have persisted. However, no monitoring points were placed in this area as restoration efforts are focused in the northern area of the site as described in Section 6.4, where implementable measures as part of the Tóchar project were deemed the most appropriate.

7210 *Cladium* fen was recorded as a mosaic (covering ~25%) with 7230 Alkaline fens at Monitoring Point 6. Based on the pressures recorded at this Monitoring Point, this habitat is likely suffering from the same pressures and proposed restoration measures would be beneficial to both fen habitat types.

4.3 Site Conservation Priority Matrix for Annaghmore Lough Fen

The restoration actions proposed (Table 4-4) for the Annex I quality 7140 Transition mires, 7210 *Cladium* fens and 7230 Alkaline fens habitats are expected to deliver broader ecological benefits beyond their target habitat types. If these measures are successfully implemented and sustained, they may positively influence associated features such as European priority species, nationally important species, and locally significant habitats and species. In such cases, the additional restoration interventions outlined for these other features may become unnecessary or only partially required. However, to validate and understand the extent of these mutual benefits, ongoing post-restoration monitoring will be essential. This will ensure that improvements are not limited to Annex I quality habitat alone but will also extend to the wider ecological network within and around the site

Table 4-4: site Conservation Priority Matrix for Annaghmore Lough Fen

Level	Feature Type	Feature Name	Extent/ Population	Pressure/threat	Restoration Measure on-site	Restoration Measure off-site
1	Annex I quality habitat	7230 Alkaline fens	11.16ha	Drainage Under grazing Poaching Nutrient enrichment	Vegetation monitoring Conservation grazing Removal of access to lake and installation of alternative livestock watering	Engage with upstream landowners to manage nutrient input
		7210 *Cladium* fens	0.50ha	None identified – historical pressures include: Drainage Poaching and trampling Nutrient enrichment Peat extraction	Vegetation monitoring Conservation grazing	Engage with upstream landowners to manage nutrient input
		7140 Transition mires	18.31ha	None identified – historical pressures include: Drainage Poaching and trampling Reclamation of agricultural land	Vegetation monitoring	Engage with upstream landowners to manage nutrient input
		91D0 Bog woodland	Not assessed as part of NFS	None identified		

Level	Feature Type	Feature Name	Extent/ Population	Pressure/threat	Restoration Measure on-site	Restoration Measure off-site
		91E0 Alluvial forests	Not assessed as part of NFS	None identified		
4	Nationally important species	See Table 4-2 and Table 4-3	See Table 4-2 and Table 4-3			
5	Habitats and species of local interest	FL4 – Mesotrophic lakes	See Table 4-1	Drainage Under grazing Poaching Nutrient enrichment	Vegetation monitoring Conservation grazing Removal of access to lake and installation of alternative livestock watering	Engage with upstream landowners to manage nutrient input
		FS1 – Reed and large sedge swamps				
		GM1 – Marsh				
		GS1 – Dry calcareous and neutral grassland				
		GS3 – Dry-humid acid grassland				
		GS4 – Wet grassland				
		PF1 – Rich fen and flush				
		PF2 – Poor fen and flush				
		PF3 – Transition mires and quaking bog				
		WN6 – Wet willow-alder-ash woodland				
		WN7 – Bog woodland				

4.4 Impact Assessment Notes

Restoration actions proposed for Annaghmore Lough Fen aim to improve the ecological condition of sensitive fen habitats, including the Annex I quality 7140 Transition mires, 7210 *Cladium* fens and 7230 Alkaline fens habitats present on site. These actions are designed to support favourable ecological condition and enhance habitat resilience. However, potential impacts, both direct and indirect, must be carefully assessed to ensure compliance with Article 6(3) of the Habitats Directive.

Potential Impacts

- **Habitat loss** – low risk - Restoration actions (i.e. reintroducing conservation grazing, fencing off the lake from access by cattle) are designed to enhance existing habitats rather than remove them. While temporary disturbance will likely occur, it is not anticipated that this would result in habitat loss.
- **Habitat degradation** – moderate risk - Potential degradation could occur if restoration measures are poorly implemented or monitored. This could occur where continued ecological and hydrological monitoring is undertaken without due care.
- **Species disturbance** – very low risk – It is not expected that the proposed restoration actions will result in any significant disturbance to species. Works will be timed appropriately to avoid disturbing breeding or wintering bird species within the site, and these works will be carried out appropriately so as to avoid disturbing the site's population of smooth newt (*Lissotrition vulgaris*).
- **Accidental pollution release** – very low risk - No chemical inputs are proposed. However, machinery use (if any) could pose a risk of fuel/oil leaks. This is mitigated by avoiding machinery in sensitive areas and using hand tools where possible.
- **Introduction and/or spread of invasive non-native species** – moderate risk - Restoration activities (e.g. soil disturbance, water movement) could facilitate dispersal of invasive species. Monitoring and biosecurity protocols will be embedded into the site plan to avoid such risks.

4.5 Good Practice Recommendations

Several good practice measures are recommended based on the requirement for compliance with legislation but also the occurrence of sensitive receptors and possible pathways for negative effects during preparation for or implementation of restoration actions. These are summarised in Table 4-5 below and should be taken as generally applicable in the planning of FRP.

Consultation with relevant NPWS staff should be undertaken prior to implementation to obtain more recent or up to date information on the locations of sensitive receptors, and buffers revised accordingly. Any further requirements outlined by NPWS at pre implementation stage should also be adhered to.

Table 4-5: Good Practice Recommendations

Receptor	Measure
Ground nesting birds	No vegetation clearance or activity which might contravene Section 40 of the Wildlife Act (consolidated) should be undertaken.
Invasive Alien Species (IAS)	All vehicles should undergo steam cleaning before site entry. Identified buffers on IAS should be avoided during site preparation and restoration implementation.
Protection of European sites	Any required mitigation measures to avoid potentially adverse effects on European sites in proximity with an identified potential source-pathway-receptor and should be incorporated into an Environmental Management Plan or Checklist of Environmental Commitments. Implementation should be overseen by a suitably qualified ecologist.
Protection of Sensitive Habitats	High sensitivity habitats should be protected from long term damage by the use of low-pressure vehicles. Extensive repeated tracking over fen habitat or any other identified priority habitat should be avoided. The storage locations of any materials should avoid high & medium sensitivity habitats.

5 Key Pressures – Field Validation and Evaluation

The FRP considers pressures on Annaghmore Lough Fen through an initial desktop assessment of existing information on the site (including previous NPWS commissioned surveys), assessment of land, water and topographic data and aerial imagery, followed by field surveys to characterise and confirm key pressures mapped through desktop assessment. Consultation with NPWS Regional Staff was also undertaken, including a visit with the Conservation Ranger for the area to inform identification of pressures.

The NFS undertook a site evaluation and ranking which determined the conservation value of the site. This evaluation considered 15 criteria as outlined which included naturalness, non-recreatability, potential value, typicality, educational value, size, diversity, fen value, rarity of species, rarity of habitats, viability, recorded history, management needs, intrinsic appeal and expert opinion. These criteria then informed the conservation status assessment (structure & functions) which are detailed in Section 2.1.1

The conservation status assessment results for Annaghmore Lough Fen are summarised in Table 2-2.

5.1 Field surveys of key pressures

Following completion of desktop mapping of key pressure, field surveys were carried out by personnel to verify the findings of the desktop assessment and characterise conditions of the pressures to inform selection of appropriate restoration actions required. The site surveys are discussed in Sections 3.2 and 4.2. These surveys aimed to capture information on the land and water environment such as drainage features, peat depth and water quality and the ecology.

As part of the ecology monitoring surveys, pressures and threats associated with the monitoring point were recorded. A summary is provided within Section 5.2.

5.2 Key Pressures

An overview of the key pressures identified on site, following desktop review and site visits are summarised in this section.

5.2.1 Flora and Fauna Pressures

The key pressures affecting the ecological receptors of Annaghmore Lough Fen have been identified through a review of historical information and data captured during the 2026 ecological walkover, including the assessment of condition and identification of pressures and threats. These pressures are ranked below based on their relative intensity, spatial extent, and ecological impact. The drainage network within the Site is shown in Figure 3-15 while the remaining pressures are shown below in Figure 5-1.

- **Abandonment of grazing and abandonment of agricultural management** - A lack of grazing in areas of 7230 Alkaline fens habitat in the north of the site is leading to the

development of rank vegetation, causing shifts in species composition and a decline in characteristic fen community vegetation. This abandonment of grazing, alongside the historical drainage pressure, will also facilitate scrub encroachment over time without sufficient grazing to prevent it. Encroachment by fast growing non-fen species and woody species leads to shading, litter accumulation, and altered microclimatic and hydrological conditions, resulting in a decline in open fen communities. Alongside the impacts on Annex I quality 7230 Alkaline fens, this pressure is also negatively impacting the wider mosaic of wetland habitats in this northern section of the site which includes 7210 *Cladium* fens.

- **Poaching** – Due to the absence of watering troughs or other watering systems, cattle within the site use the lake for drinking. As a result of this, the adjacent area of 7230 Alkaline fens habitat that is being used to access the lake has been damaged by severe poaching. Severe poaching can negatively impact fen habitats by creating areas of bare peat that become susceptible to erosion as well as by negatively altering both habitat hydrology at a micro level and species composition, causing an overall decline in characteristic fen community vegetation.

- **Nutrient enrichment (Eutrophication)** - Nutrient enrichment is identified as a locally and spatially variable pressure, with data collected during the 2026 ecological walkover indicating clearer evidence at some Monitoring Points (Monitoring Points 1 and 4) where algal growth and other indications of nutrient inputs were recorded. In the context of surrounding land use, it is considered likely that adjacent agricultural land contributes to diffuse nutrient inputs via surface and/or groundwater pathways. Elevated nutrient availability leads to competitive dominance of fast-growing species, resulting in reduced species richness and the loss of characteristic fen vegetation. This pressure affects Annex I quality 7230 Alkaline fens habitat within the site and is also negatively impacting the wider mosaic of wetland habitats within the site.

- **Drainage** - Drainage has been identified as both a historical and ongoing pressure at Annaghmore Lough Fen. While its intensity varies spatially, it represents a significant but spatially variable pressure, particularly affecting parts of the site where historical drainage and local drainage schemes have altered hydrological conditions. Drainage lowers water tables, disrupts groundwater-fed systems, and reduces the extent of saturated conditions required for fen habitats. This results in shifts in species composition, reduced peat formation, and increased susceptibility to secondary pressures such as scrub development and nutrient enrichment. This pressure currently affects Annex I quality 7230 Alkaline fens and is also negatively impacting the wider mosaic of wetland habitats within the site. Hydrological restoration measures, as described in Section 6.2, are expected to contribute to the re-establishment of appropriate water regimes and a recovery of ecological function for these habitats.

All identified pressures and threats have been fully considered within the FRP to guide appropriate remediation. The proposed suite of restoration measures, encompassing

both hydrological and vegetation interventions, is designed to maintain and improve the condition of Annex I quality habitats present within Annaghmore Lough Fen, while delivering co-benefits to associated non-Annex habitats and protected species. The prioritisation of pressures was informed by a review of historical data (including the NFS) and detailed observations recorded at monitoring points during this project. These measures, supported by ongoing vegetation and hydrological monitoring, will ensure that habitat structure and function are preserved, threats are addressed promptly, and the ecological integrity of the site is safeguarded into the future.

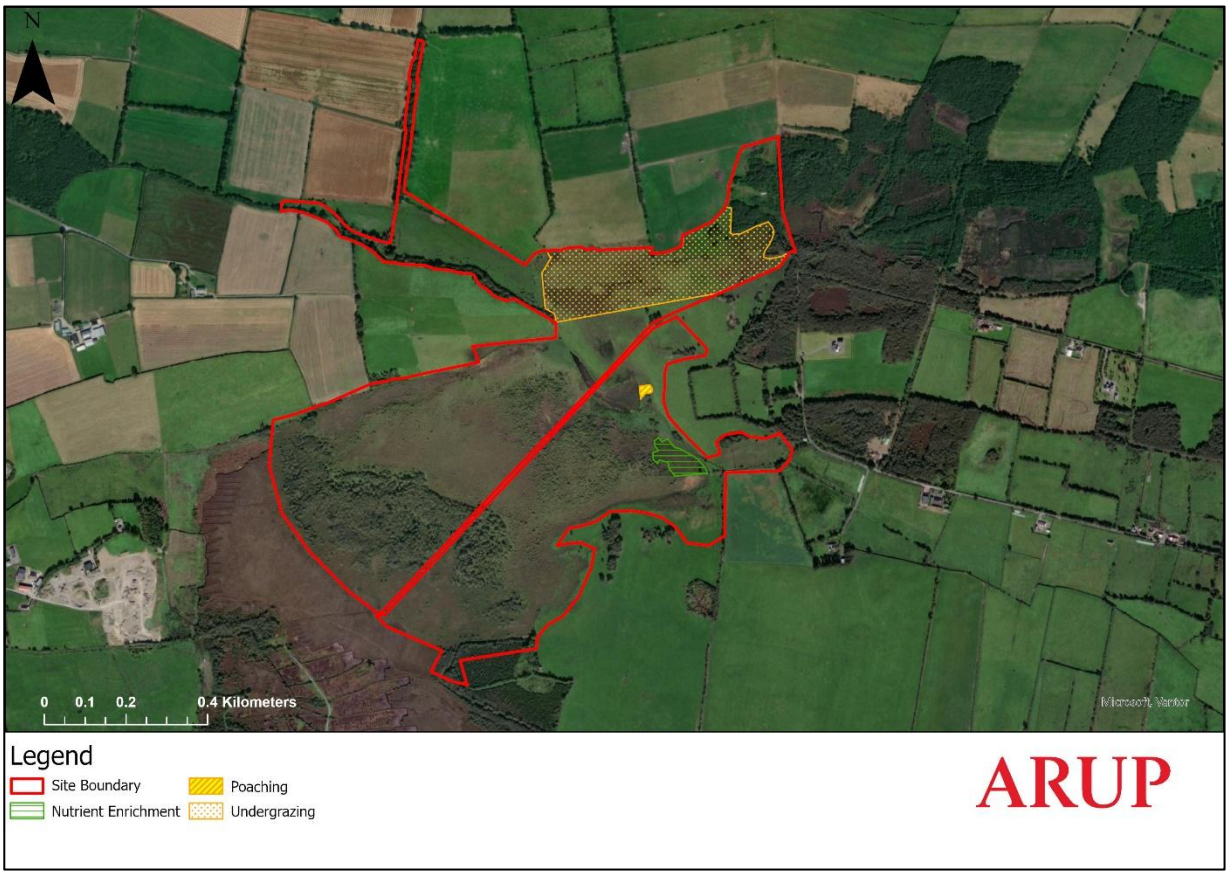


Figure 5-1: Flora & Fauna Pressures mapped within Annaghmore Lough Fen (Offaly) pNHA

5.2.2 Fen Hydrology Pressures

The hydrology of Annaghmore Lough Fen has been modified by historical drainage and peat extraction activities in the surrounding landscape. Historical mapping indicates a substantial reduction in the extent of open water within the site, while aerial imagery shows significant expansion of peat extraction within the raised bog southwest of the fen. The Clodiagh River and deep drainage associated with the peat extraction may be influencing the groundwater table through drawdown, placing pressure on the groundwater-dependent fen habitats.

5.2.3 Fen Nutrient Pressures

Water quality monitoring and EPA datasets indicate that nutrient enrichment represents a potential pressure on the fen. Elevated phosphate concentrations were recorded at several monitoring locations, while PIP mapping identified areas of elevated phosphorus delivery risk both within the upstream catchment and adjacent to the site. Nutrient inputs are likely to arise from a combination of agricultural runoff, livestock access to surface waters, and wider catchment nutrient sources transmitted through surface water and, potentially, groundwater pathways.

6 Restoration Measures

6.1 Introduction

The restoration actions proposed by the Fen Restoration Plan will help to maintain or improve the quality of existing areas of fens and improve the conditions that will allow an expansion of the area of fen. In some areas it must be recognised that restoration to fen habitat will not be possible, and the objective may simply be to improve the habitat condition.

Selection of the most appropriate restoration action depends on a range of factors including peat depth, hydrological conditions (flow rates, existing and expected flow paths after restoration), substrate type, existing ecological conditions, potential ecological constraints and practicality of access for machinery.

Each of the factors was considered based on a combination of desktop analysis combined with site-specific field surveys to select the most appropriate restoration technique to address each pressure considered by the FRP. The restoration measures proposed are outlined in Section 6.2 to Section 6.4, with detailed mapping of proposed measures illustrated in the maps provided in Appendix C.

6.2 Hydrology Measures

6.2.1 On-site Hydrology Measures

The site forms part of an established watercourse and is connected to an arterial drainage network. Consequently, the primary hydrological measures are expected to focus on reducing nutrient inputs and improving water quality within the fen rather than substantially altering existing surface water flow pathways.

However, it is possible that localised water table drawdown may be occurring adjacent to the Clodiagh River and along the southwestern boundary of the site, where peat extraction activities south of the site have altered the surrounding hydrological regime. To assess whether drawdown is occurring, a network of piezometers and continuous water level loggers is proposed within the fen, adjacent to the river corridor, and along the southwestern site boundary. Monitoring should be undertaken over a sufficient period to capture seasonal variations in groundwater and surface water levels and to establish the degree of hydraulic connectivity between the river, surrounding peatland and adjacent peat extraction areas.

Should monitoring identify a sustained hydraulic gradient directed from the fen towards the river corridor or peat extraction areas, resulting in persistent lowering of fen water levels, the need for hydrological restoration measures should be evaluated. The nature and location of the drawdown should be used to inform the most appropriate restoration response. If localised drawdown is shown to be associated with discrete drainage features along the southwestern site boundary, targeted drain management measures may be considered to reduce water loss. Alternatively, if monitoring indicates that groundwater is being lost laterally from the fen towards the Clodiagh River corridor or adjacent peat extraction areas, longitudinal

groundwater cut-offs, such installation of low-impact plastic piling, may be more appropriate. If monitoring demonstrates that fen water levels remain stable and no significant hydraulic gradients are present, no further hydrological intervention may be required.

However, the Clodiagh River is an established watercourse and forms an integral part of the site's hydrology. Any restoration measures should therefore be informed by the monitoring results and assessed through detailed hydrological design prior to implementation. Longitudinal groundwater cut offs such as plastic sheet piles through the peat along the river corridor are likely to be preferred as these do not impact the river's water level or create localised impoundments and barriers to fish.

6.2.2 Off-site Hydrology Measures

No off-site hydrology measures are proposed as part of this FRP.

6.3 Nutrient Measures

The primary aim of the nutrient measures is to maintain appropriate water quality, particularly nutrient levels, to support the natural structure and functioning of the habitats. For water quality the target is to maintain, or where necessary restore, appropriate water quality, particularly pH and nutrient levels, to support the natural structure and functioning of fen habitat.

6.3.1 On-site Nutrient Measures

The installation of fencing along the northern bank of the Clodiagh River, together with the provision of alternative livestock watering arrangements (e.g. pumps and troughs) will contribute to on-site nutrient management by restricting direct cattle access to the river corridor, including the lake and adjacent fen habitats. The effectiveness of these measures should be evaluated through continued water quality monitoring within the Clodiagh River and associated drainage network (see Figure 6-1 and Appendix C for proposed locations). Water quality monitoring includes measuring nutrients (nitrate and phosphate), electrical conductivity and pH to assess changes in nutrient inputs and water quality over time and inform any follow-up maintenance or refinement of the restoration measures where required.

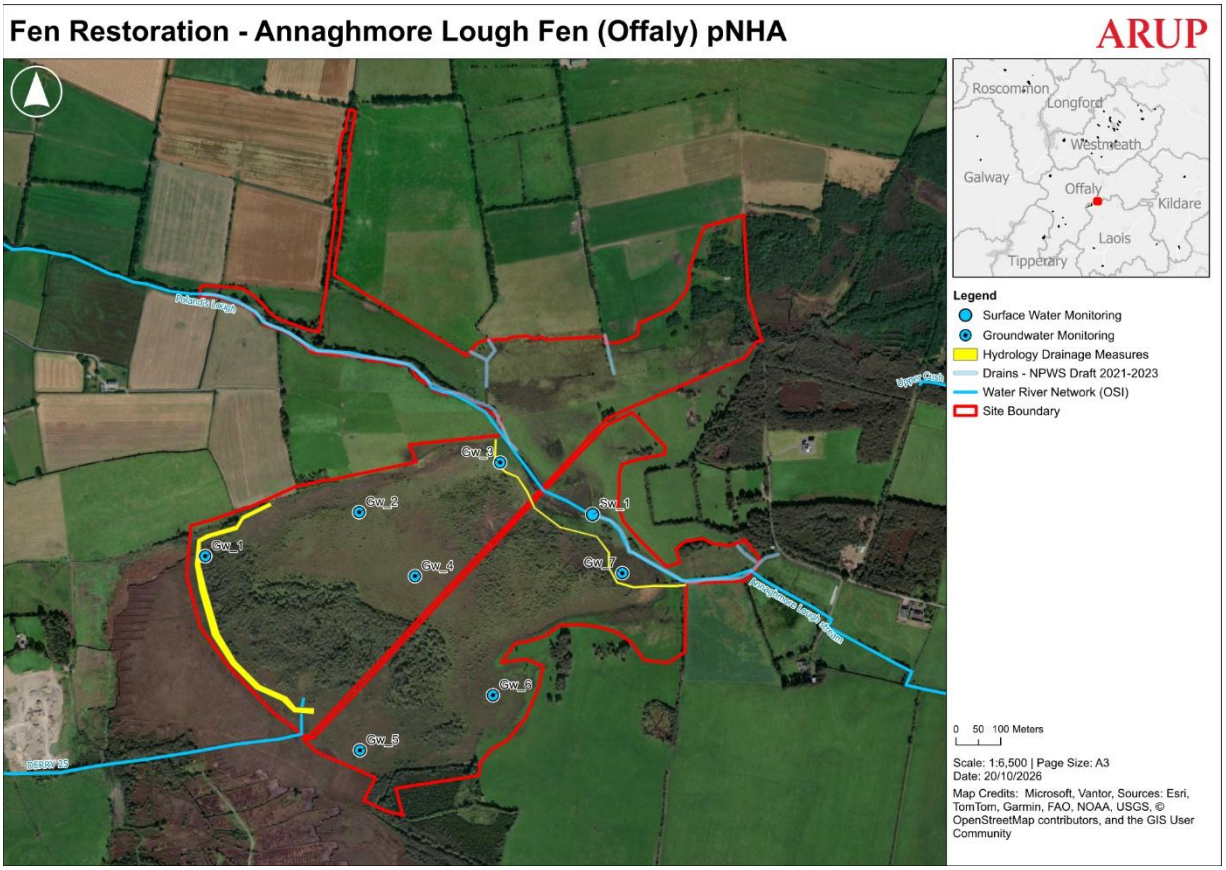


Figure 6-1: Proposed surface and ground water level and water quality management measures and monitoring for Annaghmore Lough Fen (Offaly) pNHA

6.3.2 Off-site Nutrient Measures

Water quality monitoring and Pollution Impact Potential (PIP) mapping, nitrate susceptibility mapping and hydrogeological datasets indicate that nutrient enrichment poses a risk at Annaghmore Lough Fen (Offaly) pNHA. Potential nutrient inputs may be delivered via both surface water runoff pathways and groundwater flow pathways. Surface water pathways are indicated by elevated phosphorus delivery risk identified in the PIP mapping, while groundwater pathways may be associated with the limestone bedrock aquifer and the gravel deposits and Locally Important Gravel Aquifer (Lg) present to the southwest of the site.

While a detailed hydrogeological investigation would be required to determine the precise groundwater catchment, the presence of a gravel aquifer, elevated nitrate susceptibility mapping and evidence of groundwater influence within the fen suggest that nutrient source areas may extend beyond the immediate site boundary and surface water catchment.

It is therefore recommended that agricultural landowners within areas hydrologically connected to the fen are prioritised for participation in the NPWS Farm Plan Scheme. Particular attention should be given to lands identified as having elevated phosphorus delivery risk in the PIP mapping, including areas upstream of the site and adjacent agricultural lands where runoff may enter the Clodiagh River. Consideration should also be given to agricultural lands located

within areas of elevated groundwater vulnerability and overlying the gravel aquifer to the southwest of the site, where land management practices may have the potential to influence groundwater quality.

The NPWS Farm Plan Scheme provides a mechanism for identifying and implementing site-specific land management measures that reduce nutrient losses while supporting the conservation objectives of the pNHA. Continued participation in the scheme, together with engagement of landowners within the wider hydrological contribution area, is therefore recommended to support the restoration objectives of the site.

6.4 Vegetation Measures

6.4.1 On-site Vegetation Measures

Proposed measures to address poaching and the abandonment of grazing and agricultural management include the following on-site measures which are described in order of priority in Table 6-1 and shown visually in Figure 6-2.

Table 6-1: On site Vegetation Measures proposed for Annaghmore Lough Fen

Priority	Measure	Description	Responsibility
1	Conservation grazing	Following discussions with relevant landowners, the implementation of a conservation grazing regime with appropriate stocking levels, dosing and grazing timing is recommended in the areas highlighted in Figure 6-2. The purpose of this is both to reduce poaching and to control/reduce the pressures of rank vegetation and scrub encroachment with regard to 7230 Alkaline fens habitats, while increasing the level of biodiversity within the site. It is important to note that in other areas of the site the grazing levels are already sufficient, as highlighted in Figure B-2, Appendix B. The reintroduction of appropriate grazing is the principal restoration measure for the site, addressing the influences of both poaching and grazing absence recorded across several monitoring points in the northern section of the site. Grazing will aim to reduce sward dominance by species such as *Molinia caerulea* and *Phragmites australis*, improve	NPWS (post-Tóchar)

Priority	Measure	Description	Responsibility
		structural diversity, and maintain open fen conditions. Vegetation monitoring will inform an assessment of the success of grazing implementation in the prevention of scrub encroachment and inform further adaptive management which may result in spatial targeting of scrub control. Stocking the pastures with an appropriate cattle breed (e.g. Droimeann cows) limited to summer grazing (e.g. July/Early August to October) will reduce the impact of poaching.	
2	Removal of access to the lake by cattle and installation of alternative watering solution	Following discussion with relevant landowners, it is recommended that watering troughs or other watering systems are installed and that the lake and associated inflow and outflow are fenced off as shown in Figure 6-2. This will provide cattle with an alternative water source and remove the severe poaching that was recorded within the site. Adaptive management is recommended whereby should the vegetation require grazing again in the future, this area may be opened up for restricted portions of the year.	NPWS (post-Tóchar)
3	Vegetation monitoring	Monitoring points have been proposed which overlap with (where suitable) the existing NFS points. The purpose of these points is to monitor species composition within the habitat. This serves to monitor any vegetation change and inform future restoration measures. Monitoring will be used to directly inform adaptive management, including the spatial targeting and intensity of grazing and scrub management, based on observed changes in sward structure, species composition and evidence of recovery or further degradation.	Tóchar & NPWS (post-Tóchar)

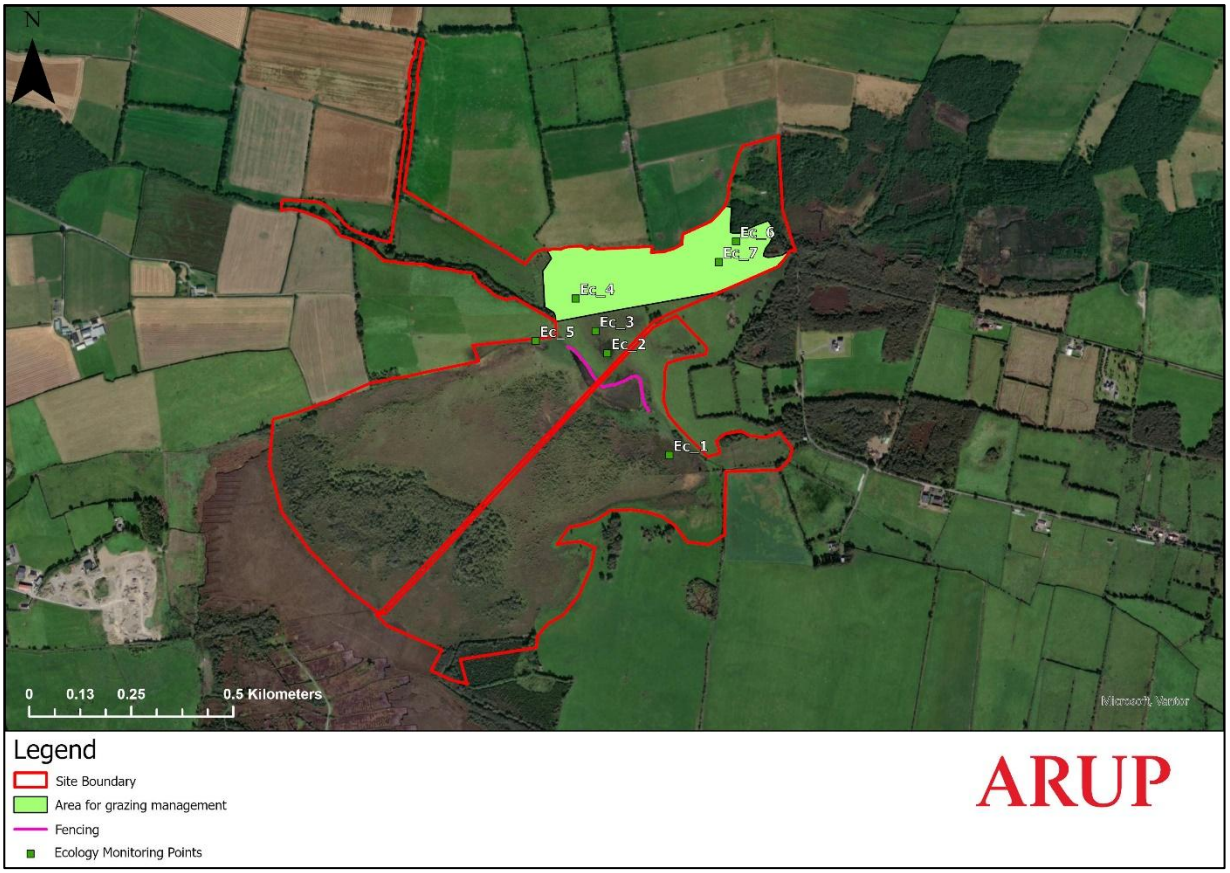


Figure 6-2: Proposed vegetation management measures and monitoring for Annaghmore Lough Fen

6.4.2 Off-site Vegetation Measures

No off-site vegetation measures are proposed as part of this FRP.

7 Additional Considerations

7.1 Drainage Management Plan

Arterial Drainage Schemes were carried out under the Arterial Drainage Act, 1945 to improve land for agriculture and to mitigate flooding. Rivers, lakes weirs and bridges were modified to enhance conveyance, embankments were built to control the movement of flood water and various other work was carried out under Part II of the Arterial Drainage Act, 1945. The purpose of the schemes was to improve land for agriculture, to ensure that the 3 – year flood was retained in bank this was achieved by lowering water levels during the growing season to reduce waterlogging on the land beside watercourses known as callows. Flood protection in the benefiting lands was increased as a result of the Arterial Drainage Schemes.

The Brosna (Westmeath, Offaly and Laois) was the first scheme, which commenced in 1947. The last schemes were completed in the 1990s. Arterial Drainage schemes cover approximately 20% of the country, typically the flattest areas. The OPW is required to maintain Arterial

Drainage schemes under sections 37 and 38 of the Arterial Drainage Act, 1945. The Act was amended on a number of occasions, e.g. to transpose EU Regulations and Directives such as the EIA, SEA, and Habitats Directives and the Aarhus Convention.

The Annaghmore Lough Fen (Offaly) pNHA is part of an Arterial Drainage Area managed by OPW. There is an Arterial Drainage Scheme channel northeast of the site (C8(17A) - Brosna East). The maintenance and function of the channel and the impact of future drainage plans on the fen and the impact of the proposed restoration measures on the objectives of the drainage district is OPW's responsibility.

The preliminary drainage management plan for Annaghmore Lough Fen (Offaly) pNHA is presented in Appendix D.

7.2 Peat Stability Assessment

Restoration activities have the potential to introduce additional risk of peat stability issues. The combination of additional loading (e.g. when excavators are used) and a higher water table has the potential to increase risk. At present, no specific guidance is available in Ireland detailing how peat stability risks should be managed in restoration projects.

Undertaking detailed geotechnical assessments is beyond the scope of the FRP. However, preliminary peat stability analysis was undertaken to inform the level of assessment required prior to the implementation of restoration actions. This includes a review of the landslide susceptibility map and historic landslide events produced by the Geological Survey of Ireland (GSI). The GSI landslide susceptibility map provides a preliminary indication of the susceptibility of a landslide based on several contributing factors, including where previous landslides have occurred and what caused them (slope, soil type and the impact of the flow of water in an area).

The proposed approach to peat stability is a tiered approach that aims to filter out low risk sites that can proceed with limited ground investigation, followed by more complex sites that require a more detailed quantitative assessment. Where risks cannot be excluded following these steps it may be necessary to progress to more detailed geotechnical studies.

The GSI landslide susceptibility map (Figure 7-1) indicates that Annaghmore Lough Fen lies entirely within an area of low landslide susceptibility. Areas of Moderately High and High susceptibility occur approximately 2 km north of the site, while there are disperse areas with moderately high vulnerability located approximately 3 km south of the site.

Despite the generally low susceptibility rating, areas of steep peat exposure associated with historic peat excavation along the western site boundary may present a greater localised risk of instability. If monitoring results demonstrate drawdown and indicate that restoration measures are to be implemented in this area, a site-specific peat stability assessment by a suitably qualified geotechnical specialist should be undertaken in advance to confirm the level of risk and identify any mitigation requirements. Depending on the findings of this assessment, measures may include modification of restoration methods, restrictions on machine access, or

regrading of steep peat faces to an angle of approximately 35° to improve long-term stability (WaterLANDS, 2024).

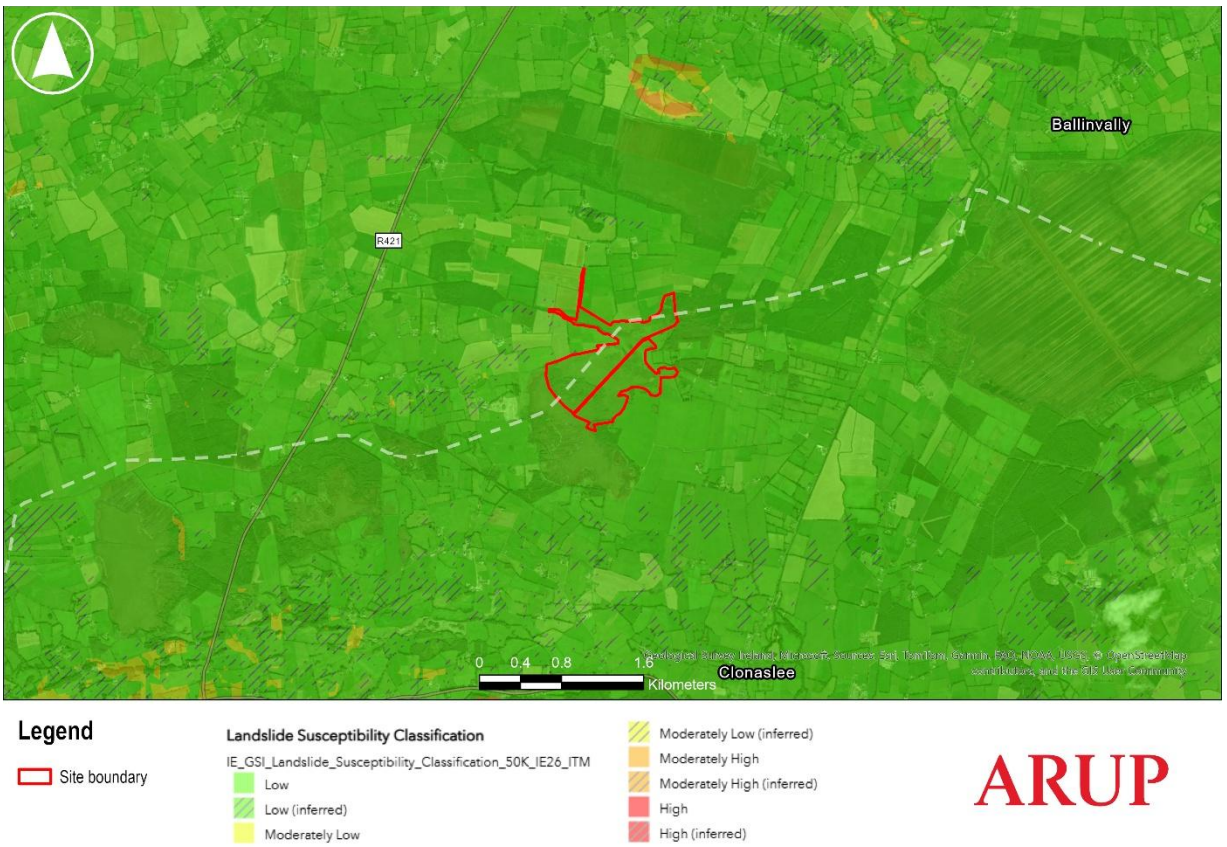


Figure 7-1: Geological Survey of Ireland Landslide Susceptibility mapping for Annaghmore Lough Fen (Offaly) pNHA

7.3 Archaeology

The site includes the Annaghmore Lough Fen (Offaly) pNHA (site code 107009). A desktop constraint assessment was conducted using the National Monuments Service (NMS) Historic Environment Viewer to evaluate the site boundary and immediate surrounding buffer zones against the statutory Record of Monuments and Places (RMP) and the Sites and Monuments Record (SMR).

The assessment confirmed that there are no recorded archaeological monuments, protected heritage features, or statutory "zones of notification" overlapping with or situated within a relevant proximity to the proposed restoration footprint.

Consequently, statutory requirements under the National Monuments Acts are determined to be not applicable to this project as follows:

- Section 12 Notification: Not required, as no works will take place at, or in the immediate vicinity of, an RMP-listed site.
- Section 14 Consent / Licensing: Not required, as the project does not impact any designated National Monument or site subject to a Preservation Order.

Proactive Risk Mitigation (Chance Finds Protocol)
While no recorded features exist, the waterlogged and anaerobic conditions of fen environments possess a high potential for preserving previously unrecorded organic archaeological materials (e.g., wooden trackways, ancient implements, or environmental deposits).

To ensure complete compliance with the spirit of the National Monuments Acts, a standard "Chance Finds" Protocol will be maintained throughout the duration of the restoration works. In the highly unlikely event that any sub-surface archaeological features or artefacts are exposed during ground disturbance or rewetting activities, works in the immediate area will cease immediately, and the National Monuments Service and the National Museum of Ireland will be notified within the statutory 72-hour window.

It should be noted that, within 1 km of the Annaghmore Lough Fen (Offaly), two records are listed in the Archaeological Survey of Ireland datasets (Figure 7-2 and Figure 7-3):

- NIAH Ref. 4096 (Country House): Located approximately 500 m north of the site.
- SMR Ref. OF014-069 (Bastion-type Fortification): Located to the west of the site. The feature is not visible at ground level and was identified from aerial photography as a rectangular earthwork with a possible corner tower.

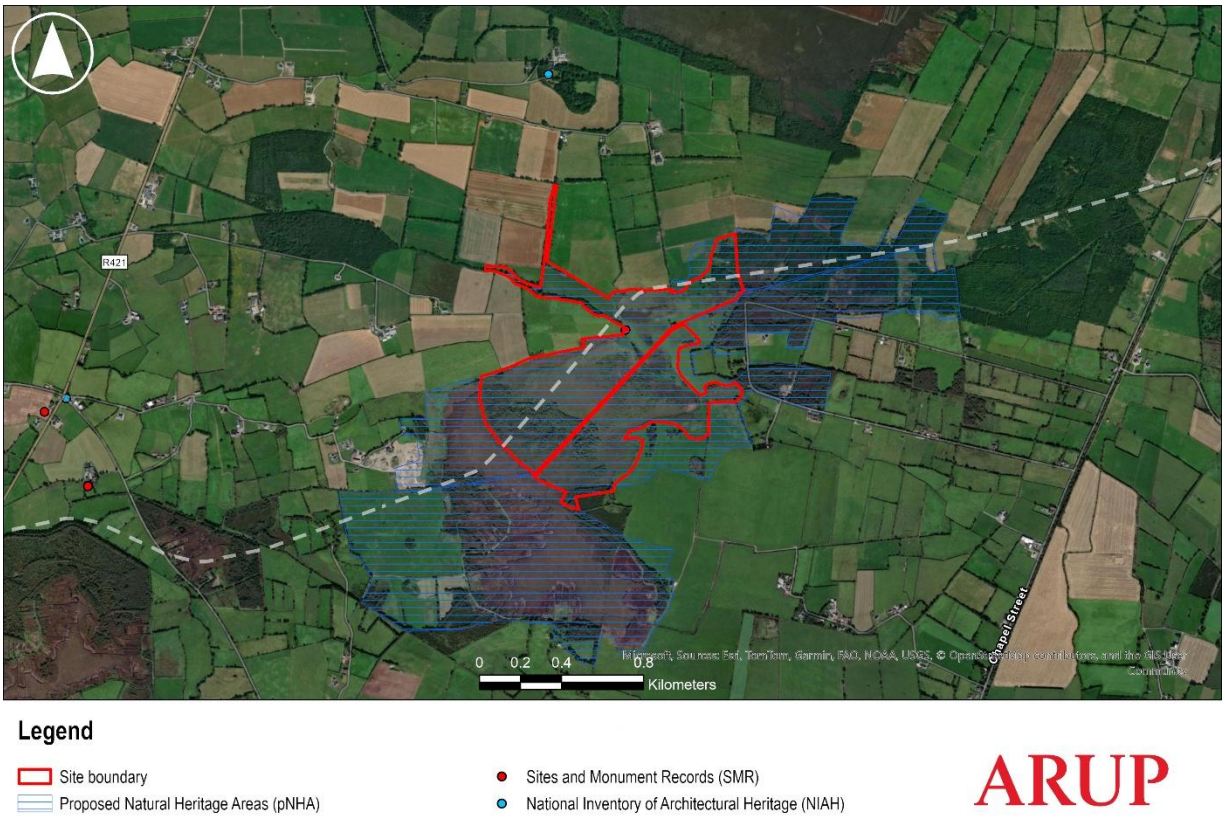


Figure 7-2: Archaeological sites for Annaghmore Lough Fen (Offaly) pNHA (NMS, 2025)

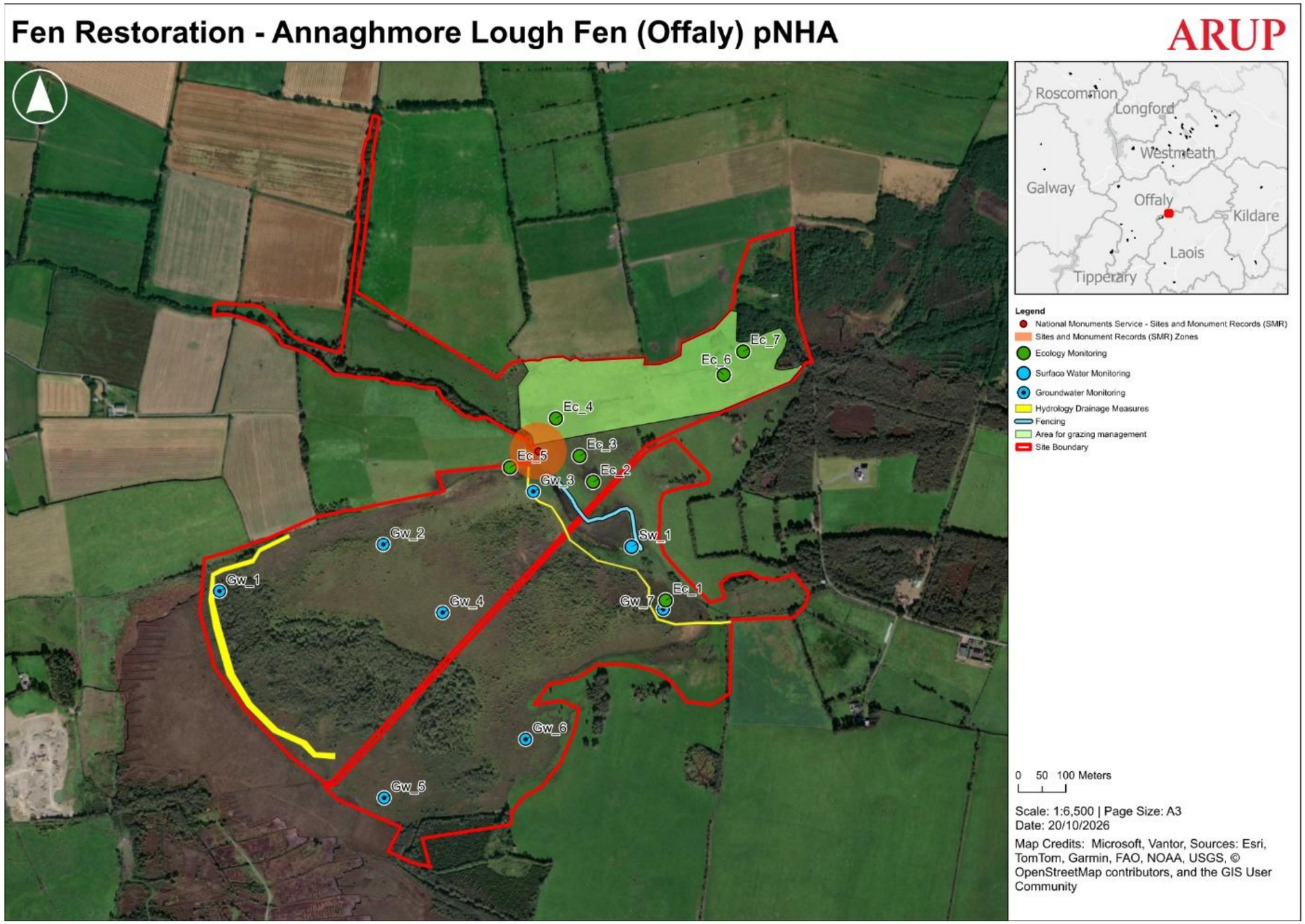


Figure 7-3: Restoration measures and archaeological sites for Annaghmore Lough Fen (Offaly) pNHA (NMS, 2025)

8 Summary of Fen Restoration Plan Actions

Prior to proceeding with the implementation of the restoration measures outlined in the FRP, consultation with landowners and key stakeholders with an interest in the site is essential (Table 8-1). While this FRP identifies the key pressures and actions to be implemented, consultation with landowners and stakeholders may identify the need to amend or alter restoration actions. There may also be opportunities to provide additional benefits to the wider community. Consultation with local NPWS staff will be crucial to informing implementation planning.

Table 8-1: Role players in fen restoration plan

Measures	Stakeholder	Description
On-site	Landowners	Parts of Annaghmore Lough Fen are under Commonage ownership by private individuals
	OPW	Management of Arterial Drainage
	National Monuments Service	Management of archaeological sites
Off-site	OPW	Management of Arterial Drainage
	Landowners & farmers	Engagement for uptake of catchment measures.
	National Monuments Service	Management of archaeological sites
Capacity building	NPWS	NPWS engaging in community education and events

This section provides the summary of the Fen Restoration Plan Actions for Annaghmore Lough Fen (Table 8-2).

Table 8-2: Implementation plan for Annaghmore Lough Fen (Offaly) pNHA Fen Restoration

	Activity	Location	Monitoring/ implementation indicator	Timeframe	Key role player			Possible funding source
					National	Regional/ Local	Other	
1	**Required preliminary actions**							
1.1	**Screening for Appropriate Assessment report.**							
	N/A							
1.2	**Drainage management plan**							
	Consultation with OPW on the drainage management plan is required to ensure compliance with legislation and local authority objectives.	sitewide	Drainage management plan	Pre-restoration	NPWS OPW		Arup	Within Tóchar project scope
1.3	**Archaeological assessment**							
	Consultation with Offaly Council on the archaeology is required to ensure compliance with legislation and local authority objectives.	sitewide	Archaeological assessment report	Pre-restoration	NPWS	Offaly Co. Co	Arup	Within Tóchar project scope
2	**Enabling Works**							
2.1	**Pre-restoration Works Surveys**							

	Activity	Location	Monitoring/ implementation indicator	Timeframe	Key role player			Possible funding source
					National	Regional/ Local	Other	
	Pre-site walkover with Ecologist/Ecological Clerk of Works (ECoW) to ensure proposed measures are appropriate and whether alterations are required.	sitewide	ECoW report	Pre-restoration			Arup	Within Tóchar project scope
2.2	**Implementation of Mitigation Measures**							
	Ecological Impact Assessment Considerations – identification of necessary mitigation measures. Such measures may include, but are not limited to, the utilisation of hand machinery to avoid impact on sensitive habitats	sitewide	ECoW report	Pre-restoration			Arup	Within Tóchar project scope
2.3	**Breeding Bird Considerations**							
	Prior to restoration works, where any restoration measures are identified to have the potential to interfere with breeding birds e.g. scrub removal, these works shall occur outside the breeding bird season (1 March – 31 August inclusive).	sitewide	ECoW report	Pre-restoration			Arup	Within Tóchar project scope
2.4	**Good Practice Recommendations and CEMP**							
	Good Practice Recommendations – Includes, but not limited to, avoidance of sensitive ecological receptors, pollution prevention procedures, biosecurity measures etc. The preparation and provision of a Construction Environmental Management Plan (CEMP).	sitewide	ECoW report	Pre-restoration			Arup/ Contractor	Within Tóchar project scope
3	**On-site Restoration measures**							

	Activity	Location	Monitoring/ implementation indicator	Timeframe	Key role player			Possible funding source
					National	Regional/ Local	Other	
3.1	**Hydrology measures**							
	Install a network of piezometers and water level loggers within the fen, adjacent to the Clodiagh River corridor, and along the southwestern site boundary to determine whether water table drawdown is occurring. Monitoring results will determine whether hydrological restoration measures are required and to inform the design of any future interventions.	River corridor and southwestern site boundary	site installation records	Monitoring in 2026 to inform restoration	NPWS	Laois County Council	Arup / Contractor	Within Tóchar project scope
3.2	**Nutrient measures**							
	Restrict access to lake and channel Installation of fences and provision of alternative livestock watering arrangements (e.g. pumps and troughs) will contribute to on-site nutrient management by restricting access and eliminating the need of cattle access to the lake and channel as well as reducing the impact of poaching.	Along the lake and main drain	site installation records	Restoration in 2026	NPWS	Laois County Council	Arup / Contractor	Within Tóchar project scope
3.3	**Vegetation measures**							

	Activity	Location	Monitoring/ implementation indicator	Timeframe	Key role player			Possible funding source
					National	Regional/ Local	Other	
	1. Conservation grazing.	7230 Alkaline fens	Regular monitoring of vegetation to review the stocking density and suitability of grazers	Seasonal grazing regime	NPWS working with landowner			NPWS Farm Plan Scheme
4	**Off-site Restoration measures**							
4.1	**Nutrient measures**							
	Catchment nutrient management Prioritise engagement with landowners participating in the NPWS Farm Plan Scheme within areas that are potentially hydrologically connected to the fen. Particular focus should be given to lands identified as having elevated phosphorus delivery risk in the PIP mapping, upstream agricultural areas connected to the Clodiagh River, and agricultural lands located within areas of elevated groundwater vulnerability where nutrient losses may influence water quality within the fen.	Hydrologically connected lands surrounding the pNHA	Uptake of measures by landowners / farmers	Long-term	NPWS, LAWPRO		Landowners	NPWS Farm Plan Scheme
5	**Monitoring progress**							
5.1	**Hydrology monitoring**							

	Activity	Location	Monitoring/ implementation indicator	Timeframe	Key role player			Possible funding source
					National	Regional/ Local	Other	
	Surface and groundwater monitoring will be undertaken at key locations within the site (as described above) to assess hydrological conditions, identify any water table drawdown, and evaluate the effectiveness of implemented management measures.	Various locations across site	Water level	Long-term	NPWS	Laois County Council		Within Tóchar project scope
5.2	**Nutrient monitoring**							
	Ongoing monitoring of habitats, drainage channels and springs for water quality parameters is proposed within the fen.	Various locations within the site	Nutrients (Nitrate and phosphate), electrical conductivity and pH	Long-term	NPWS	Laois County Council		Within Tóchar project scope
5.3	**Vegetation monitoring**							
	Vegetation monitoring will be undertaken at key locations within the site to track changes in vegetation communities and inform any follow-up maintenance or refinement of the restoration measures where required.	Various locations within the site	Habitat condition	Long-term	NPWS			Within Tóchar project scope
6	**Capacity building and training**							
	Public meeting: To engage stakeholders on developments and results from the restoration measures.			Long-term	NPWS			NPWS

	Activity	Location	Monitoring/ implementation indicator	Timeframe	Key role player			Possible funding source
					National	Regional/ Local	Other	
	Farmer training: Training such as that provided by the Farming for Water EIP will provide farmers with knowledge of alternative and habitat sensitive measures			Long-term	NPWS/ Farming for Water EIP / LAWPRO / Teagasc			Farming for Water EIP / other similar

8.1 Habitats Benefiting from Implementation of Restoration Actions

7230 Alkaline fens and 7210 *Cladium* fens

The proposed restoration measures will benefit 7230 Alkaline fens (and areas of 7210 *Cladium* fen) by addressing key pressures including grazing absence, poaching and nutrient enrichment. The implementation of conservation grazing, in combination with the removal of access to the watercourse within the site, will improve sward structure, reduce the dominance of coarse species and maintain open, species-rich fen conditions. These measures will support the restoration of habitat structure and function and contribute to ensuring the favourable condition of this habitat.

7140 Transition mires

The proposed restoration measures will benefit 7140 Transition mires by maintaining open, wet conditions and preventing succession. Conservation grazing will control vegetation structure and limit scrub encroachment, while management of upstream nutrient inputs will reduce the pressure of eutrophication on this habitat. These measures will help sustain the characteristic species composition of the habitat and maintain its ecological integrity over the long term.

91D0 Bog woodland

The proposed restoration measures will benefit 91D0 Bog woodland through the retention of bog woodland areas as part of the wider site mosaic. While active intervention within these areas will be limited, the management of surrounding fen habitats will ensure that woodland expansion does not adversely affect adjacent Annex I quality fen habitats. Maintaining these areas will support their role in hydrological buffering and nutrient interception, contributing to overall site resilience.

91E0 Alluvial forests

The proposed restoration measures will benefit 91E0 Alluvial forests through the retention of wet woodland areas as part of the wider site mosaic. While active intervention within these areas will be limited, the management of surrounding fen habitats will ensure that woodland expansion does not adversely affect adjacent Annex I quality fen habitats. Maintaining these areas will support their role in hydrological buffering and nutrient interception, contributing to overall site resilience.

Non-Annex Habitats/ Fossitt classified habitats

A range of non-Annex habitats within the site, including FL4 Mesotrophic lakes, FS1 Reed and large sedge swamps, GM1 Marsh, GS1 Dry calcareous and neutral grassland, GS3 Dry-humid acid grassland, GS4 Wet grassland, PF1 Rich fen and flush, PF2 Poor fen and flush, PF3 Transition mires and quaking bog, WN6 Wet willow-alder-ash woodland and WN7 Bog woodland, will also benefit from the implementation of the proposed restoration measures. These habitats are

functionally connected to the Annex I quality fen system and form part of the wider ecological mosaic. Measures such as conservation grazing and the management of nutrient inputs will improve habitat condition and structural diversity across these areas, while supporting habitat connectivity and overall ecological stability within the site.

8.2 Species Benefiting from Implementation of Restoration Actions

It is expected that the species described in Table 4-2 and Table 4-3 will also benefit from the proposed restoration measures, particularly the smooth newt, which has been recorded on site and is associated with the mosaic of wetland and aquatic habitat present at Annaghmore Lough. Measures such as conservation grazing and the management of nutrient inputs will enhance habitat quality across the site which will in turn benefit the species which utilise them, thus contributing to the overall ecological stability of the site.

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Appendix A – Non-Technical Summary

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan Non-Technical Summary			
Site Name	Annaghmore Lough Fen (Offaly)	**NFS site no.**	107009
County	Laois-Offaly Co. border	**Designations**	pNHA
Fen habitats present (area)	7140 Transition mires (18.31ha), 7210 *Cladium* fens (0.5ha) and 7230 Alkaline (11.16ha)	**Species of note**	*Cladium mariscus* and *Caricion davallianae*

Site Description

Annaghmore Lough Fen (Offaly) is situated on the Laois-Offaly Co. border approximately 10 km south-west of Tullamore and was designated as a proposed Natural Heritage Area (pNHA) for fen and bog habitats within the site. Key habitats include 7230 Alkaline fens, 7140 Transition mires, 7210 Cladium fens, 91D0 Bog woodland and 91E0 Alluvial forest, all of which are listed under Annex I of the EU Habitats Directive.

The Clodiagh River passes through the site, with a small lake within the centre of the site. Historical mapping indicates a substantial reduction in open water extent. Satellite imagery shows an acceleration in the rate of peat extraction throughout the years south of the site in the general pNHA area and associated drainage adjacent to the site, which may have also altered local hydrological conditions.

Conceptual Site Model (CSM)

Annaghmore Lough Fen (Offaly) pNHA comprises a groundwater-dependent fen system influenced by both groundwater and surface water inputs. The site generally slopes towards the main drain located through the centre of the site. Within the site boundary, quaternary sediments are primarily fen peat and cut-over raised peat. Gravel deposits are located to the west, while till derived from limestone is present to the east. No springs or groundwater seepages were identified during the site survey. However, the National Fen Survey reported widespread iron-rich flushes within the transition mire southwest of the lake, suggesting localised groundwater influence (Brophy et al., in prep.). The occurrence of these flushes may reflect groundwater movement through the surrounding gravel deposits and discharge where more permeable materials interface with lower permeability peat. The hydrological regime at the site is primarily controlled by the Clodiagh River, which provides the principal surface water inflow and outflow, together with historical drainage modifications. These include channelisation of parts of the river, reduction of Annaghmore Lough from a substantially larger waterbody to a small central lake, and drainage associated with peat extraction along the southwestern site boundary. It is possible that the site is experiencing hydrological drawdown, likely associated with the peat extraction activities. The CSM is presented in Figure 2.

Key Pressures

Hydrology Pressures	Historical drainage and peat extraction activities - historical mapping indicates a substantial reduction in the extent of open water within the site, while aerial imagery shows significant expansion of peat extraction within the raised bog southwest of the fen. The Clodiagh River and deep drainage associated with

	the peat extraction may be influencing the groundwater table through drawdown, placing pressure on the groundwater-dependent fen habitats.
Nutrient Pressures	Water quality monitoring and EPA datasets indicate that nutrient enrichment represents a potential pressure on the fen. Elevated phosphate concentrations were recorded at several monitoring locations, while PIP mapping identified areas of elevated phosphorus delivery risk both within the upstream catchment and adjacent to the site. Nutrient inputs are likely to arise from a combination of agricultural runoff, livestock access to surface waters, and wider catchment nutrient sources transmitted through surface water and, potentially, groundwater pathways.
Ecology Pressures	Abandonment of grazing and abandonment of agricultural management, poaching, nutrient enrichment (eutrophication) and drainage are resulting in reduced peat formation, increased susceptibility to secondary pressures such as scrub development and nutrient enrichment, the development of rank vegetation, causing shifts in species composition and a decline in characteristic fen community vegetation.
Objective of Restoration Plan	
The objective of the Annaghmore Lough Fen (Offaly) Fen Restoration Plan is to maintain or improve the quality of existing areas of fens and improve the conditions that will allow an expansion of the area of fen. In some areas it must be recognised that restoration to fen habitat will not be possible or preferable, and the objective is to improve the habitat condition.	
Restoration Measures	
Hydrology Measures	**On-Site Measures:** Assess the occurrence of water table drawdown adjacent to the Clodiagh River and along the southwestern boundary of the site with the aid a network of piezometers and continuous water level loggers. In case water table drawdown is confirmed targeted drain management or installation of low-impact plastic piling is recommended.
Nutrient Measures	**On-Site Measures:** Installation of fencing along the northern bank of the Clodiagh River, together with the provision of alternative livestock watering arrangements (e.g. pumps and troughs) to restrict direct cattle access to the river corridor, including the lake and adjacent fen habitats. **Off-Site Measures:** Employ catchment nutrient management measures through landowner engagement.

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan Non-Technical Summary	
Ecology Measures	**On-Site Measures:** Conservation grazing, removal of access to the lake by cattle and installation of alternative watering solution and vegetation monitoring**.**
Monitoring Progress	
Hydrology Monitoring	Groundwater and surface water monitoring within the fen
Nutrient Monitoring	Ongoing monitoring of habitats and drainage channels for water quality parameters within the fen
Ecology Monitoring	Habitat condition assessments to track restoration progress.
More information	
Fen Restoration Plan Report (provide url) Tóchar website: https://www.tocharwetlands.ie/fen-restoration/	

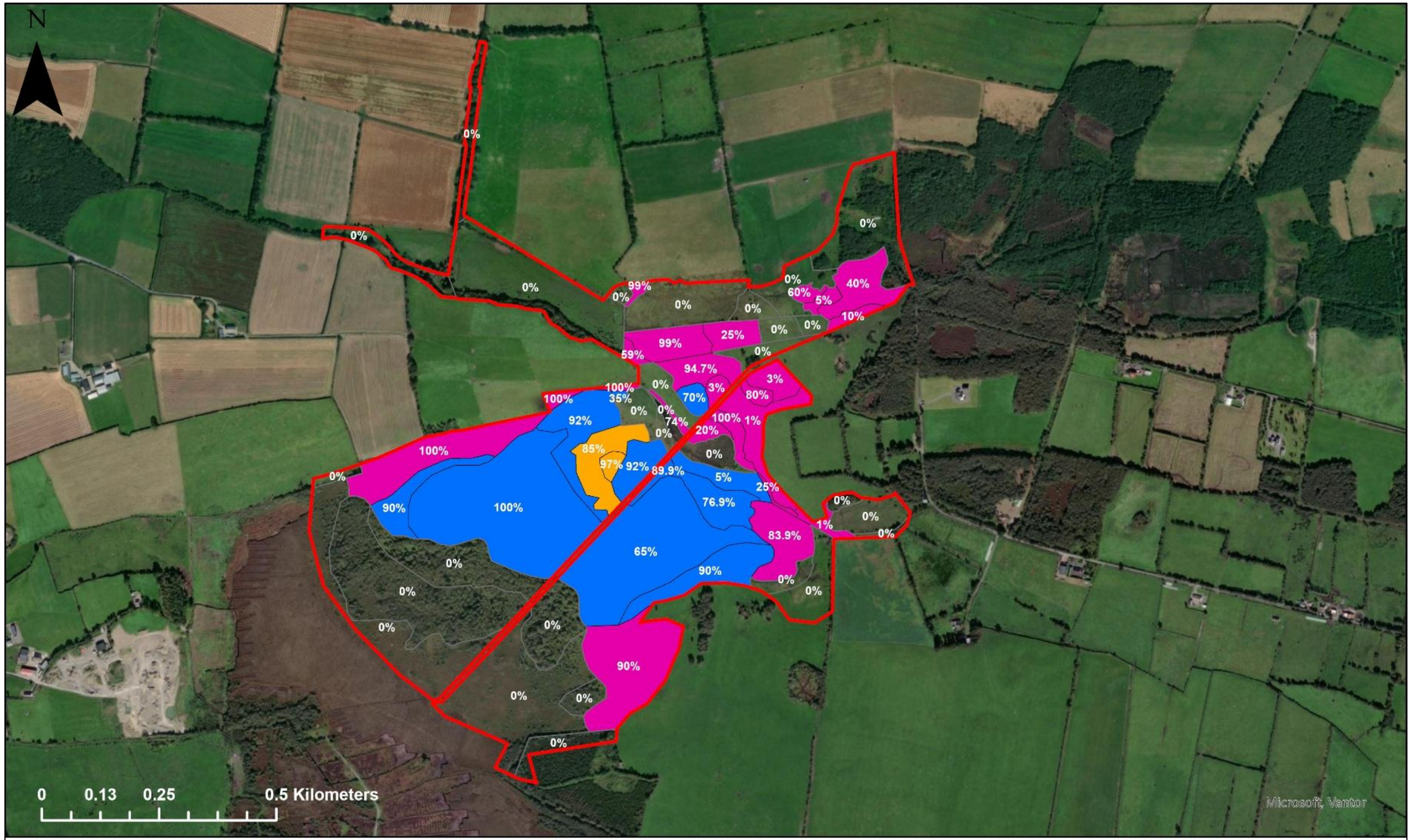
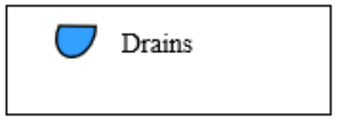


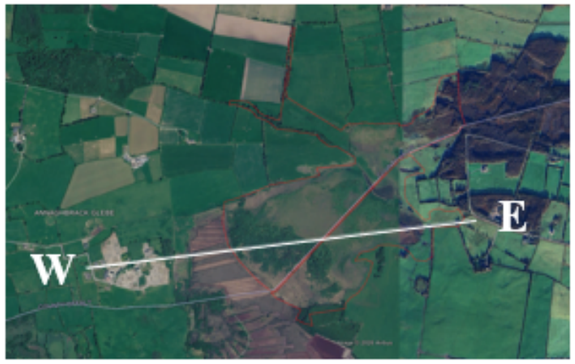
Figure 1: Site Habitat Map

Annaghmore Lough Fen (Offaly) pNHA
Offaly County
77.24 ha
WFD catchment: 25A: Lower Shannon

Water key:



Vegetation:



Location:



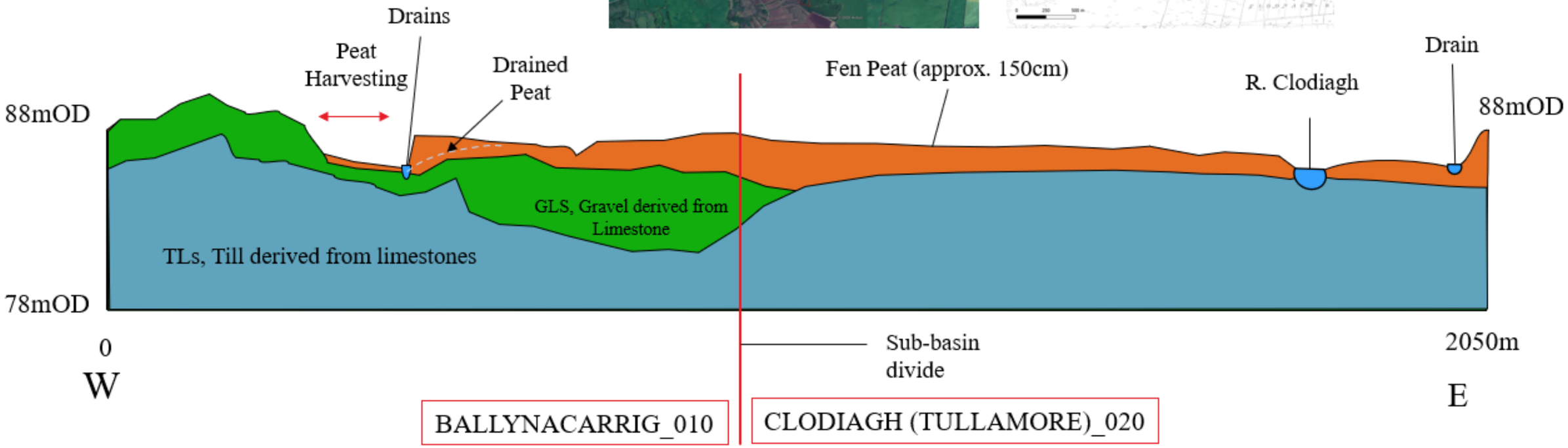


Figure 2: Conceptual Site Model

Appendix B – Ecological Survey Maps

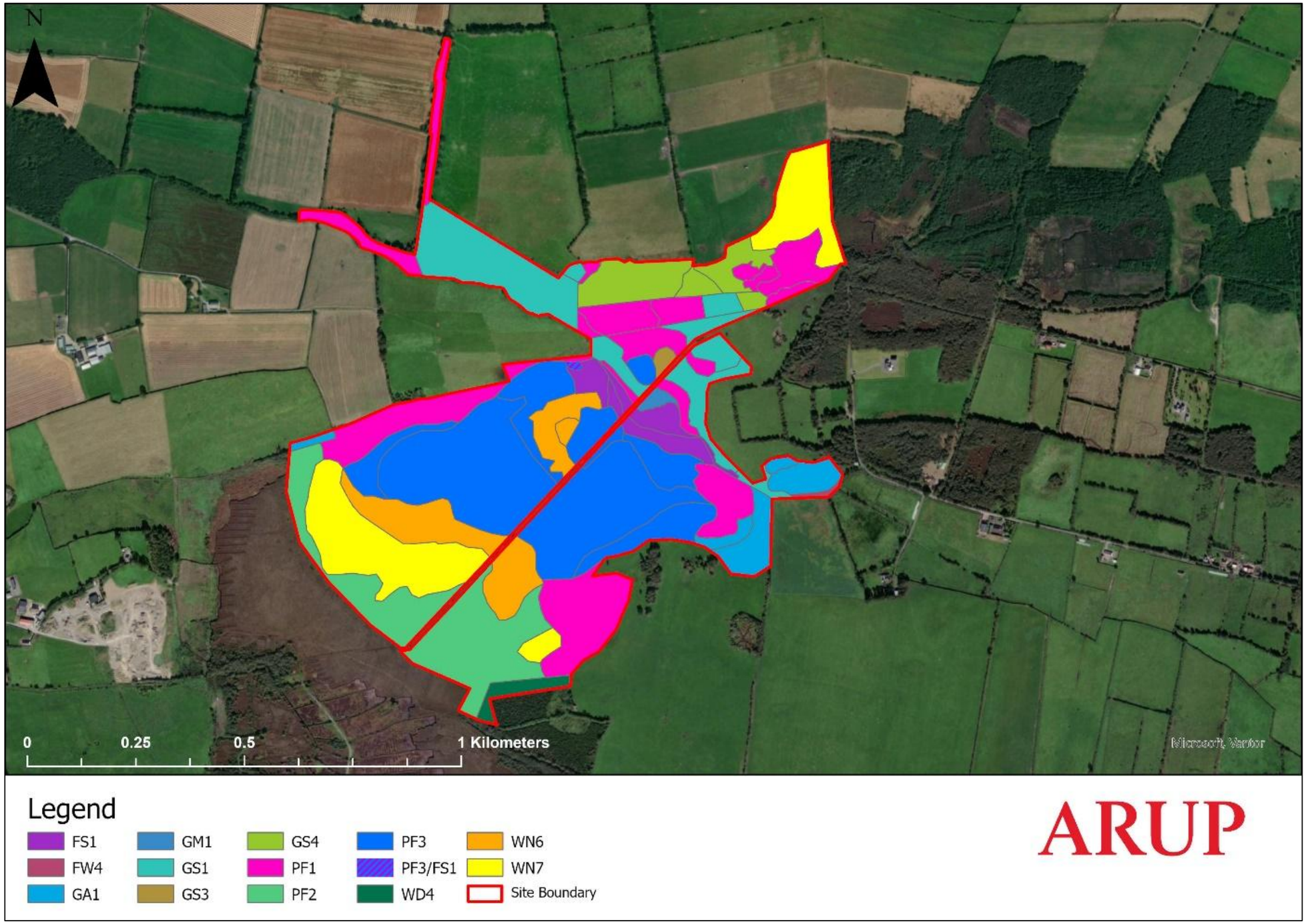


Figure B-1 Habitats recorded during the 2023 NFS and classified according to the Fossitt Habitat Classification System

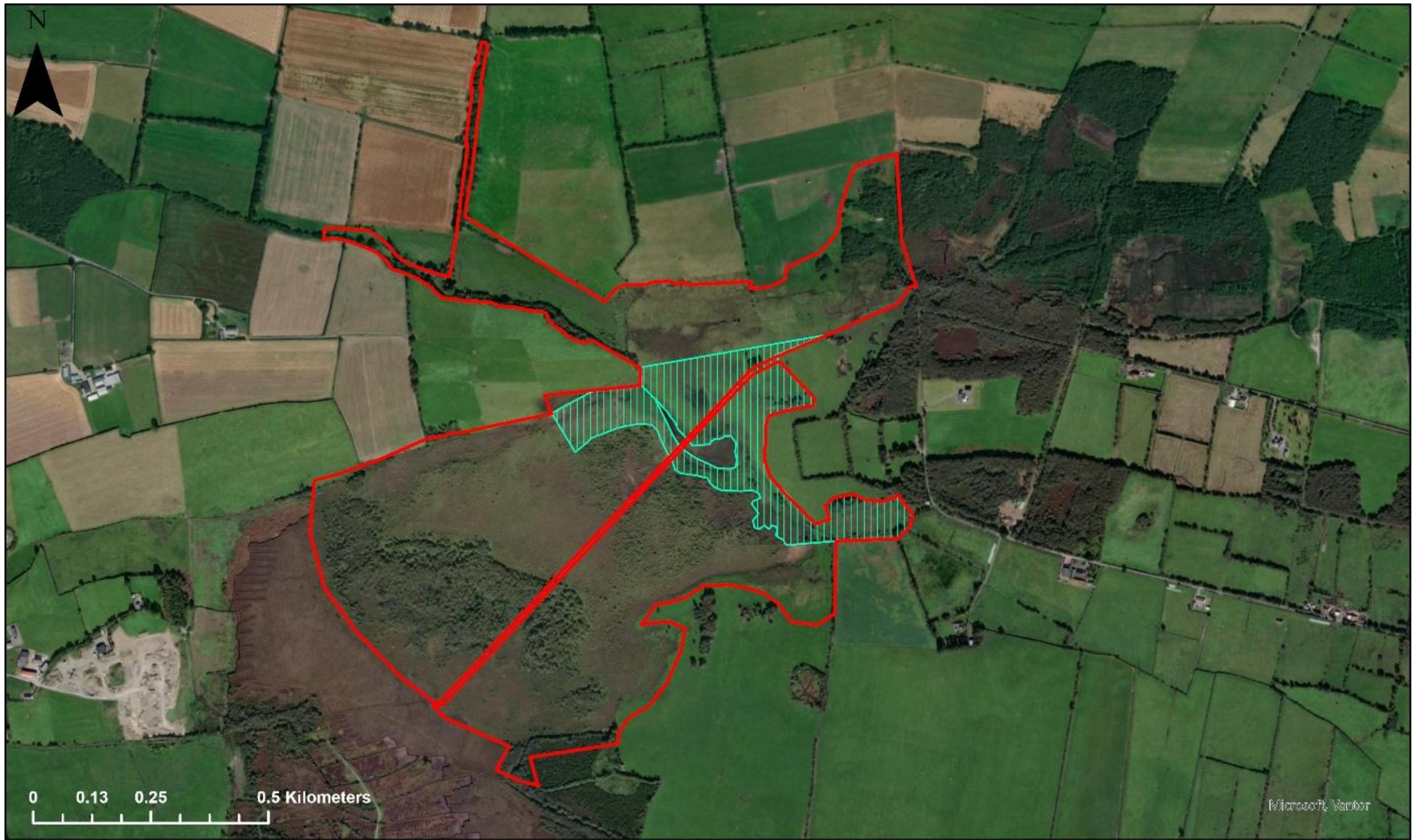


Figure B-2 Land management recorded at time of surveys in 2026

Table B-1 Annex I and Fossitt Habitat Code Directory

Annex I habitat code	Annex I habitat name	Fossitt Habitat Code	Fossitt Habitat Name
3110	Oligotrophic Isoetid lake habitat	FL1	Dystrophic lakes
3130	Slender Naiad-type lakes	FL2	Acid oligotrophic lakes
3140	Hard-water lakes	FL3	Limestone/marl lakes
3150	Rich pondweed lake habitat	FL4	Mesotrophic lakes
3160	Acid oligotrophic lakes	FL5	Eutrophic lakes
3180	Turloughs	FL6	Turloughs
3260	Vegetation of flowing waters	FL7	Reservoirs
3270	Chenopodion rubri	FL8	Other artificial lakes and ponds
4010	Wet heaths	FW1	Eroding/upland rivers
4030	Dry heaths	FW2	Depositing/lowland rivers
4060	Alpine and subalpine heath	FW3	Canals
5130	Juniper scrub	FW4	Drainage ditches
6130	Calaminarian grasslands	FP1	Calcareous springs
6210	Orchid-rich calcareous grassland	FP2	Non-calcareous springs
6230	Species-rich Nardus grassland	FS1	Reed and large sedge swa,.9mps
6410	Molinia meadows	FS2	Tall-herb swamps
6430	Hydrophilous tall-herb swamp	GA1	Improved agricultural grassland
6510	Hay meadows	GA2	Amenity grassland (improved)
7110	Raised bog (active)	GS1	Dry calcareous and neutral grassland
7120	Degraded raised bogs	GS2	Dry meadows and grassy verges
7130	Blanket bog (active)	GS3	Dry-humid acid grassland
7140	Transition mires	GS4	Wet grassland
7150	Rhynchosporion depressions	GM1	Marsh
7210	Cladium fens	HH1	Dry siliceous heath
7220	Petrifying springs	HH2	Dry calcareous heath
7230	Alkaline fens	HH3	Wet heath
8110	Siliceous scree	HH4	Montane heath
8120	Calcareous scree	HD1	Dense bracken

8210	Calcareous rocky slopes	PB1	Raised bog
8220	Siliceous rocky slopes	PB2	Upland blanket bog
8240	Limestone pavement	PB3	Lowland blanket bog
8310	Caves	PB4	Cutover bog
8330	Sea caves	PB5	Eroding blanket bog
91A0	Old oak woodland	PF1	Rich fen and flush
91D0	Bog woodland	PF2	Poor fen and flush
91E0	Alluvial woodland	PF3	Transition mire and quaking bog
91J0	Yew woodland	WN1	Oak-birch-holly woodland
		WN2	Oak-ash-hazel woodland
		WN3	Yew woodland
		WN4	Wet pedunculate oak-ash woodland
		WN5	Riparian woodland
		WN6	Wet willow-alder-ash woodland
		WN7	Bog woodland
		WD1	(Mixed) broadleaved woodland
		WD2	Mixed broadleaved/conifer woodland
		WD3	(Mixed) conifer woodland
		WD4	Conifer plantation
		WD5	Scattered trees and parkland
		WS1	Scrub
		WS2	Immature woodland
		WS3	Ornamental/non-native shrub
		WS4	Short rotation coppice
		WS5	Recently-felled woodland
		WL1	Hedgerows
		WL2	Treelines
		ER1	Exposed siliceous rock
		ER2	Exposed calcareous rock
		ER3	Siliceous scree and loose rock
		ER4	Calcareous scree and loose rock
		EU1	Non-marine caves
		EU2	Artificial underground habitats

		ED1	Exposed sand, gravel or till
		ED2	Spoil and bare ground
		ED3	Recolonising bare ground
		ED4	Active quarries and mines
		ED5	Refuse and other waste
		BC1	Arable crops
		BC2	Horticultural land
		BC3	Tilled land
		BC4	Flower beds and borders
		BL1	Stone walls and other stonework
		BL2	Earth banks
		BL3	Buildings and artificial surfaces

Appendix C – Restoration and Monitoring Map

Table C-1: Long-term monitoring points for fen restoration at Annaghmore Lough Fen (Offaly) pNHA

Point	Measure	Objective	Timeframe	Frequency of monitoring	Monitoring indicator
Gw_1	Hydrological	Monitoring groundwater levels and quality	Long-term	One data logger Seasonal[5] for year 1 Annual for year 2-5	Groundwater level
Gw_2					Groundwater level
Gw_3					Groundwater level
Gw_4					Groundwater level
Gw_5					Groundwater level
Gw_6					Groundwater level
Gw_7					Groundwater level
Sw_1		Monitoring of surface water levels and quality	Long-term	Seasonal for year 1 Annual for year 2-5	Water level and quality in the main drain
Ec_1	Ecological	Monitoring within 7230 Alkaline fens and 7140 Transition mires habitats	Long-term	Seasonal for year 1 Every 3 years for year 2-5	Ecological monitoring
Ec_2					
Ec_3					
Ec_4					
Ec_5					
Ec_6					
Ec_7					

[5] Seasonal: every quarter to represent a hydrological year

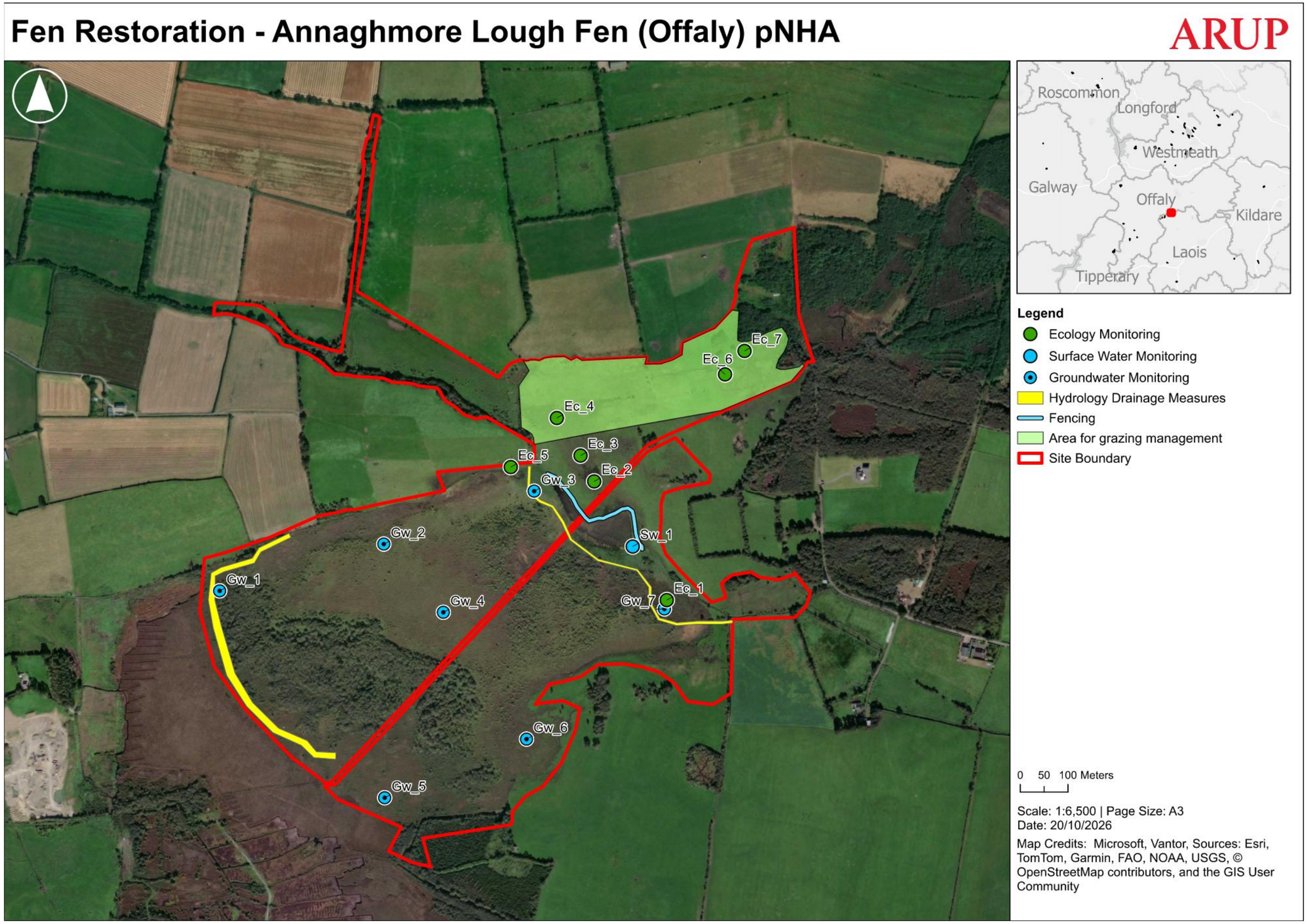


Figure C-9-1: Restoration and monitoring map

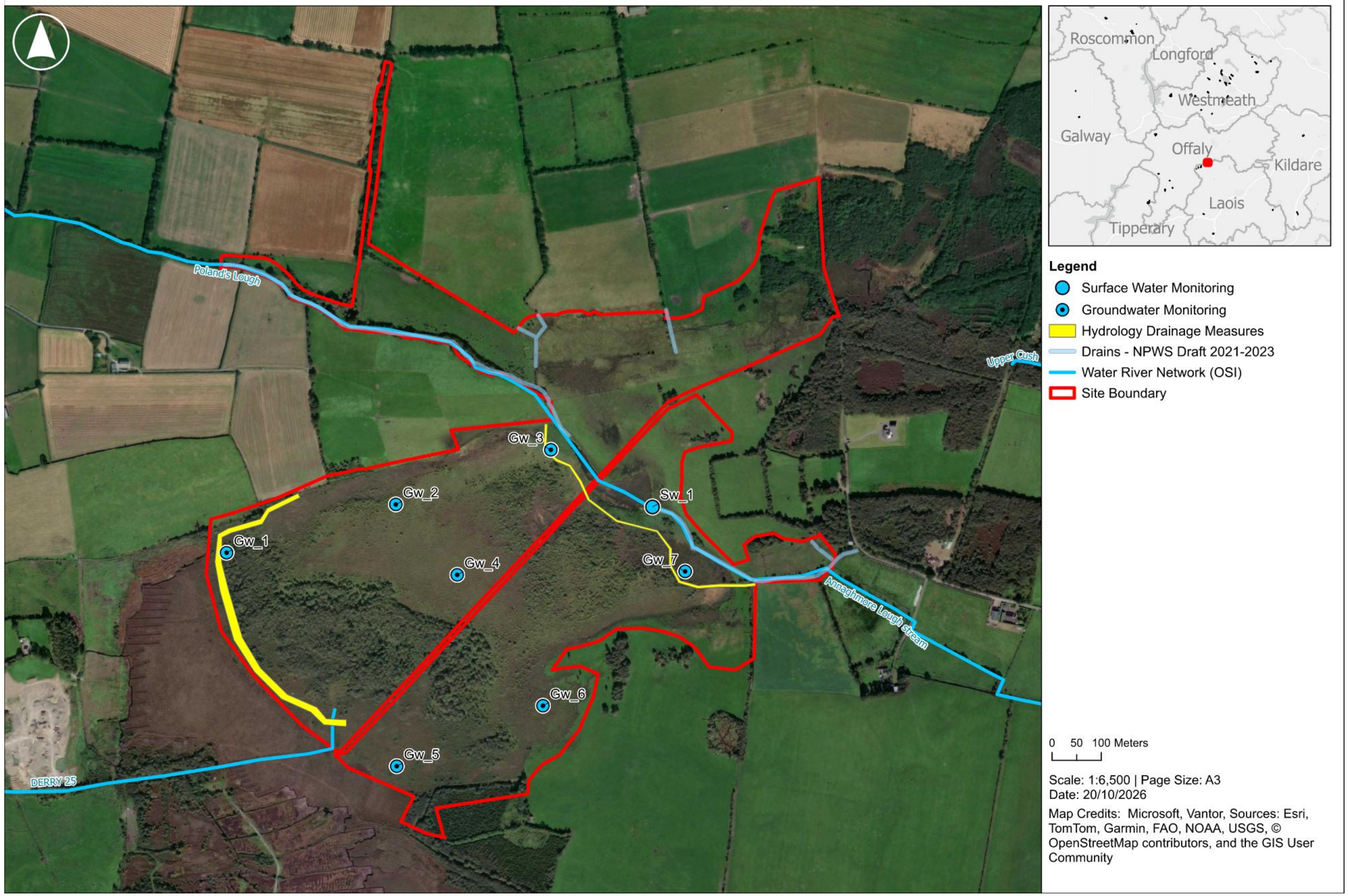
Appendix D – Drainage Management Plan

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan: Drainage Management Plan			
Site name	Annaghmore Lough Fen (Offaly)		
County	Laois-Offaly Co. border	NFS site No.	107009
Catchment overview:			
Altitude at the site ranges from 81 m to 90 m and the site is generally flat. The site generally slopes towards the main drain located through the centre of the site. Elevated ground occurs both north and south of the site, reaching approximately 90 mOD and 89 mOD, respectively.			
WFD catchment	25A- Lower Shannon	WFD Sub-catchment	CLODIAGH[TULLAMORE]_SC_010
Drainage Area	C8(17A) - Brosna East	Drainage District	No
Responsible authority	OPW	Maintenance date	TBD
Surrounding landowners	Landowners, farmers, OPW		
Wetland drainage			
The hydrology of Annaghmore Lough Fen has been modified by historical drainage and peat extraction activities in the surrounding landscape. Historical mapping indicates a substantial reduction in the extent of open water within the site, while aerial imagery shows significant expansion of peat extraction within the raised bog southwest of the fen. The Clodiagh River and deep drainage associated with the peat extraction may be influencing the groundwater table through drawdown, placing pressure on the groundwater-dependent fen habitats. No springs or groundwater seepages were identified during the site survey. However, the National Fen Survey reported widespread iron-rich flushes within the transition mire southwest of the lake, suggesting localised groundwater influence (Brophy et al., in prep.). The occurrence of these flushes may reflect groundwater movement through the surrounding gravel deposits and discharge where more permeable materials interface with lower permeability peat. The hydrological regime at the site is primarily controlled by the Clodiagh River, which provides the principal surface water inflow and outflow, together with historical drainage modifications. These include channelisation of parts of the river, reduction of Annaghmore Lough from a substantially larger waterbody to a small central lake, and drainage associated with peat extraction along the southwestern site boundary.			
Surface water inflow	Clodiagh River	Surface water outflow	Clodiagh River
Groundwater inflow	No springs or groundwater seepages were identified during the site survey. However, the National Fen Survey reported widespread iron-rich flushes within the transition mire southwest of the lake, suggesting localised groundwater influence.		
Internal drains	The Clodiagh River passes through the site, draining south-east and connecting with a small central lake.	Perimeter drains	Several smaller drains discharge into the main channel from adjacent farmland to the south and east, one west-east drain along the southwest portion of the site, and the BALLYNACARRIG_010 south of the site
On site hydrology measures			
On-site measure 1	Assessment of water table drawdown	Role player	NPWS to facilitate site access

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan: Drainage Management Plan					
Install a network of piezometers and water level loggers within the fen, adjacent to the Clodiagh River corridor, and along the southwestern site boundary to determine whether water table drawdown is occurring. Monitoring results will determine whether hydrological restoration measures are required and to inform the design of any future interventions.					
Off-site hydrology measures					
Off-site measure 1	No off-site hydrology measures	Role player			
Proposed Water Monitoring:					
Groundwater and surface water monitoring in a network of piezometers and standpipes at key locations within the site to monitor changes to water levels as a result of the installation of drain blocking measures.					
Indicator	Water level	Location	Various locations across site	Role players	NPWS
Rainfall and evaporation monitoring using site-specific or nearby stations.					

Fen Restoration - Annaghmore Lough Fen (Offaly) pNHA

ARUP



Legend

- Surface Water Monitoring
- Groundwater Monitoring
- Hydrology Drainage Measures
- Drains - NPWS Draft 2021-2023
- Water River Network (OSI)
- Site Boundary

0 50 100 Meters

Scale: 1:6,500 | Page Size: A3
Date: 20/10/2026

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Figure 1: Mapped drainage network at Annaghmore Lough Fen (Offaly)