Volume III: Technical Appendices for the EIAR

2 of 2

Graiguenamanagh-Tinnahinch Flood Relief Scheme

Report No. W3451-ENV-R008

September 2025

Revision 00

Kilkenny County Council

Preface

This Environmental Impact Assessment Report for Graiguenamanagh-Tinnahinch Flood Relief Scheme comprises three volumes as follows:

Volume 1 – Non-Technical Summary

Volume II – Main Environmental Impact Assessment Report

Volume III – Technical Appendices

This document is Volume III – Technical Appendices, part 2 of 2. This document contains the appendices referenced in the EIAR for Graiguenamanagh-Tinnahinch Flood Relief Scheme. The detailed assessment of the environmental impacts of Graiguenamanagh-Tinnahinch Flood Relief Scheme is contained in Volume II – Main Environmental Impact Assessment Report. A simplified version of this document is outlined in Volume I – Non-Technical Summary which summarises the key findings.

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Graiguenamanagh-Tinnahinch Flood Relief Scheme

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IRELAND - UK - BAHRAIN - UAE - KSA

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GRAIGUENAMANAGH TINNAHINCH

FLOOD RELIEF SCHEME

Ecology Baseline Study and Extended Habitat Survey

Kilkenny County Council
Comhairle Chontae Chill Chainnigh

In association with

CARLOW COUNTY COUNCIL

OPW Oifig na nOibreacha Poiblí Office of Public Works

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Glossary of Terms and Abbreviations

%	Percent
AEP	Annual Exceedance Probability
AFA	Area for Further Assessment
BOCCI	Birds of Conservation Concern in Ireland
c.	Approximately
CCC	Country Carlow Council
CFRAM	Catchment Flood Risk Assessment and Management Study
COVID-19	Coronavirus Disease 2019
DHPLG	Department of Housing, Local Government and Heritage
EC	European Commission
EIA	Environmental impact assessment
EIAR	Environmental impact assessment report
FAQ	Frequently asked questions
FRS	Flood Relief Scheme
GTFRS	Graiguenamanagh-Tinnahinch Flood Relief Scheme
ha	Hectare
II	Two
III	Three
IW	Irish Water
KCC	Kilkenny County Council
km	Kilometres
km^2	Kilometres squared
m	Metres
m^2	Square metres
OPW	Office of Public Works
SAC	Special Area of Conservation
SI	Statutory Instrument
SPA	Special Protection Areas
WwTP	Wastewater Treatment Plant

Executive Summary

Introduction

The objective of this project is the identification, design, and submission of a Flood Relief Scheme, to alleviate the risk of flooding for the communities of Graiguenamanagh and Tinnahinch. The Scheme will be technically, socially, environmentally and economically acceptable to the standards of the EU Directive on the Assessment and Management of Flood Risk (Floods Directive 2007/60/EC) transposed into Irish Law as SI 122 of 2010.

As part of the proposed project, this Report has been prepared to provide an understanding of the current ecological conditions at the site.

The Scheme

The South Eastern CFRAM study area included Graiguenamanagh-Tinnahinch as an Area for Further Assessment (AFA) and concluded that a flood relief scheme would be viable and effective for the community. The viable scheme (currently under review) is comprised mainly of construction of hard defences and associated works through the urban area of Graiguenamanagh along the banks of both the River Duiske and River Barrow.

The flood defence measures are not finalised at the time of writing but typical proposed flood relief works could involve raising the flood defence levels by constructing new flood defence walls, flood gates and/or strengthening and raising existing ones, constructing new flood defence embankments and/or strengthening and raising existing ones, work on channels and culverts and flow diversion, constructing storage ponds, installing new flap valves and repairing or replacing existing ones, installing new screens on culvert inlets and/or replacing existing ones, installing pressure manhole covers, and may include ancillary works such as pumping stations.

Key Findings

Much of the area that is tentatively proposed for flood defence works is occupied by hedgerows, treelines or riparian woodland. A lesser proportion comprises built land. One of the woodlands within this area has been classified as a habitat listed in Annex I of the EU Habitats Directive, and is listed as a Qualifying Interest (QI) of the River Barrow and River Nore Special Area of Conservation (SAC).

The time of year was not ideal for carrying out botanical surveys, and the presence of one other QI habitat within the scheme area is presently unconfirmed. This is:

- 6430 Hydrophilous Tall Herb Fringe Communities

Spawn from the Common Frog (*Rana temporaria*) was located in two locations within the scheme area. The common frog is protected under the Wildlife Acts. This protection makes it an offense to deliberately capture or kill the animal without a derogation licence.

Potential evidence of the presence of otters was recorded in three locations within the scheme area. Otters are protected by the Wildlife Acts and are listed in Annex II of the EU Habitats Directive. Annex II of the Habitats Directive lists 'Animal and plant species of community interest whose conservation requires the designation of Special Areas of Conservation'.

The Great Spotted Woodpecker (*Dendrocopus major*) is considered a likely inhabitant of the woodlands surrounding the scheme area. The characteristic drumming of the woodpecker was noted in two locations, but there is some uncertainty as to whether carrion crows (*Corvus corone*) can sometimes make this sound. The Great Spotted Woodpecker is a recent arrival in Ireland (2005), having been absent for a century or more. It does not have any legal designation for conservation purposes.

Three species of invasive flora are present within the scheme area:

- Himalayan Balsam (*Impatiens glandulifera*)
- Japanese knotweed (*Reynoutria japonica*)
- Giant Rhubarb (*Gunnera tinctoria*)

The above species are listed in the Third Schedule of the Birds and Natural Habitats Regulations (S.I. No. 477 of 2011). Section 49 (2) of the Regulations states that it is an offense to disperse, allow or cause to disperse, spread or otherwise cause to grow any of the species of flora listed in the Third Schedule.

Recommendations

In addition to this report, a number of further studies have been completed as follows and are reported separately:

- Bat Survey
- Fisheries Assessment
- Q-Value Survey

Additional specialist ecology surveys are recommended to identify the presence/absence and population status (where appropriate) of species using the site and its surrounds:

- Aquatic invertebrates (Freshwater Pearl Mussel and White Clawed Crayfish)
- A botanical survey during the optimal surveying period – once the scheme is defined. This will allow for confirmation of:
    - Presence/absence of unconfirmed Annex I habitats
    - Updated distribution and mapping of invasive species (if necessary).

1 Introduction

This report presents the results of an extended habitat survey and desktop study for the Graiguenamanagh-Tinnahinch Flood Relief scheme.

This report forms the basis for decision-making over the need for other specialist ecological surveys as part of the subsequent assessment, which will be reported in full in the EIAR. Where additional specialist surveys are required, these will be reported in full in other Technical Reports.

1.1 Overview

The OPW, working in partnership with Kilkenny County Council (KCC) and Country Carlow Council (CCC) and other Local Authorities, commissioned and have completed the South Eastern Catchment Flood Risk Assessment and Management (CFRAM) Study. The relevant CFRAM Study reports are available, for information purposes, from the publications section of the Office of Public Works (OPW) www.FloodInfo.ie website. (Office of Public Works, 2020).

The South Eastern CFRAM study area included Graiguenamanagh-Tinnahinch as an Area for Further Assessment (AFA) and concluded that a flood relief scheme would be viable and effective for the community. The viable scheme (currently under review) is comprised mainly of construction of hard defences and associated works through the urban areas of Graiguenamanagh and Tinnahinch along the banks of both the River Duiske and River Barrow.

Flood risk in Ireland has historically been addressed through the use of structural or engineered solutions (arterial drainage schemes and/or flood relief schemes). In line with internationally changing perspectives, the government adopted a new policy in 2004 that shifted the emphasis in addressing flood risk towards:

- Catchment-based context for managing risk.
- More pro-active flood hazard[1] and risk assessment and management, with a view to avoiding or minimising future increases in risk, such as that which might arise from development in floodplains.
- Increased use of non-structural and flood impact mitigation measures.

Notwithstanding this shift, engineered solutions to manage existing risks are likely to continue to form a key component of the overall national flood risk management programme and strategy. A further influence on the management of flood risk in Ireland is the 'Directive on the Assessment and Management of Flood Risks 2007/60/EC' (also known as the 'Floods Directive'). The aim

[1] Flood hazard is the potential threat posed by flooding to people, property, the environment, and our cultural heritage. Flooding only presents a risk however when people, property, businesses, farms, infrastructure, the environment, or our cultural heritage can be potentially impacted or damaged by floods.

of this Directive is to reduce the adverse consequences of flooding on human health, the environment, cultural heritage and economic activity.

The proposed flood defence measures are, as of yet, not defined but typical proposed flood relief works could involve raising the flood defence levels by constructing new flood defence walls, flood gates and/or strengthening and raising existing ones, constructing new flood defence embankments and/or strengthening and raising existing ones, work on channels and culverts, constructing storage ponds, installing new flap valves and repairing or replacing existing ones, installing new screens on culvert inlets and/or replacing existing ones, installing pressure manhole covers, and may include ancillary works such as pumping stations.

Kilkenny County Council (KCC) has commissioned a study to further develop and implement Graiguenamanagh-Tinnahinch Flood Relief Scheme (GTFRS) (hereafter referred to as 'the scheme'). KCC wishes to progress the development of the scheme using the statutory provisions of either the Arterial Drainage Act or the Planning and Development Act, 2000 (as amended). A decision of the route will be made after the preferred scheme is identified, but full environmental assessment is necessary regardless of the statutory delivery route chosen.

1.2 Project Background and Need for the Scheme

Graiguenamanagh-Tinnahinch has been affected by numerous flooding events in recent years (see section 0) and the has been identified in the South Eastern CFRAM study as an AFA, which concluded that a flood relief scheme would be viable and effective for the community.

The objective of this project is the identification, design and submission (for statutory consent) of a Flood Relief Scheme, that is technically, socially, environmentally and economically acceptable, to alleviate the risk of flooding[2] to the communities of Graiguenamanagh and Tinnahinch in accordance with the standards of the EU Directive on the Assessment and Management of Flood Risk (Floods Directive 2007/60/EC) transposed into Irish Law as SI 122 of 2010.

The aim of the project at Scheme Development and Preliminary Design Stage is to carry out a detailed evaluation of all viable flood alleviation measures, select the preferred measure or combination of measures and carry out a Preliminary Design.

The proposed flood defence measures are not finalised at the time of writing. However, the CFRAM assessment and project level investigations undertaken to date provide sufficient information on which to understand the minimum project requirements for the purposes of a screening process.

[2] Flood risk is the combination of the probability of flood events of different magnitudes and the degree of the potential impact or damage arising from a flood.

1.3 History of Flooding

Flooding in Graiguenamanagh-Tinnahinch has historically been from either the River Barrow or the River Duiske. The River Barrow drains a large catchment and typically rises slowly during historical flood events. During these events, the two areas affected by the River Barrow are the quays at Graiguenamanagh and Tinnahinch. The River Duiske is a small flashy river that flows through the town of Graiguenamanagh before joining the River Barrow. During past flood events, out of bank flow from the River Duiske has travelled through the town affecting residential and commercial properties along Main Street and Turf Market area, as reported during 2015/2016 flood events.

The GTFRS Hydrology Report states that a total of 17 reports of flood events could be found within the scheme area and a timeline of these events is displayed in Figure 1.1.

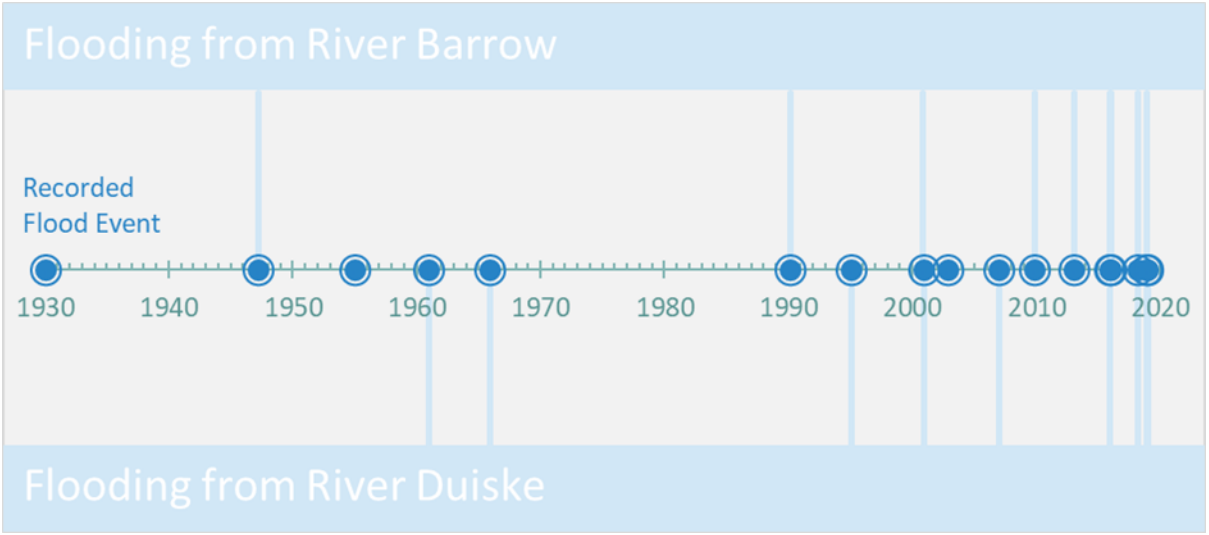

Figure 1.1 Flood Event Timeline and Reported Flooding Source

1.4 Description of the Flood Risk Management Measures

A viable scheme option for Graiguenamanagh-Tinnahinch was identified in the CFRAM level of assessment and the preferred measures outlined in the CFRAM comprise:

- Building hard defences, with at risk properties protected by a series of embankments and walls, sheet piled where necessary and set back where possible from, the river channel.
- Hard defences that would protect properties from the 1% AEP fluvial event and with an estimated average height of 1.56 m and total length of 1.31 km.

The CFRAM study outlined that a project-level options assessment would consider the scheme option outlined in the CFRAM and any other viable options arising out of project-level assessment. Development of the latter is ongoing and will be based on more detailed information than was available for the CFRAM, including detailed hydrological assessment, hydraulic modelling studies and environmental studies. Consequently the type and location of measures

outlined in the CFRAM and shown in Figure 1.2 are liable to change as further information becomes available through project level assessment.

Figure 1.2 shows the location of hard defences in the preferred option in the CFRAM and the potential flood storage areas along the River Duiske. Figure 1.3 shows the scheme area and potential locations (non exhaustive) where alternative options are being considered in the project level assessment that is ongoing. Other options within the overall scheme areas are also being considered. The updated (February 2021) scheme Preliminary Options Layout is provided in Appendix A.

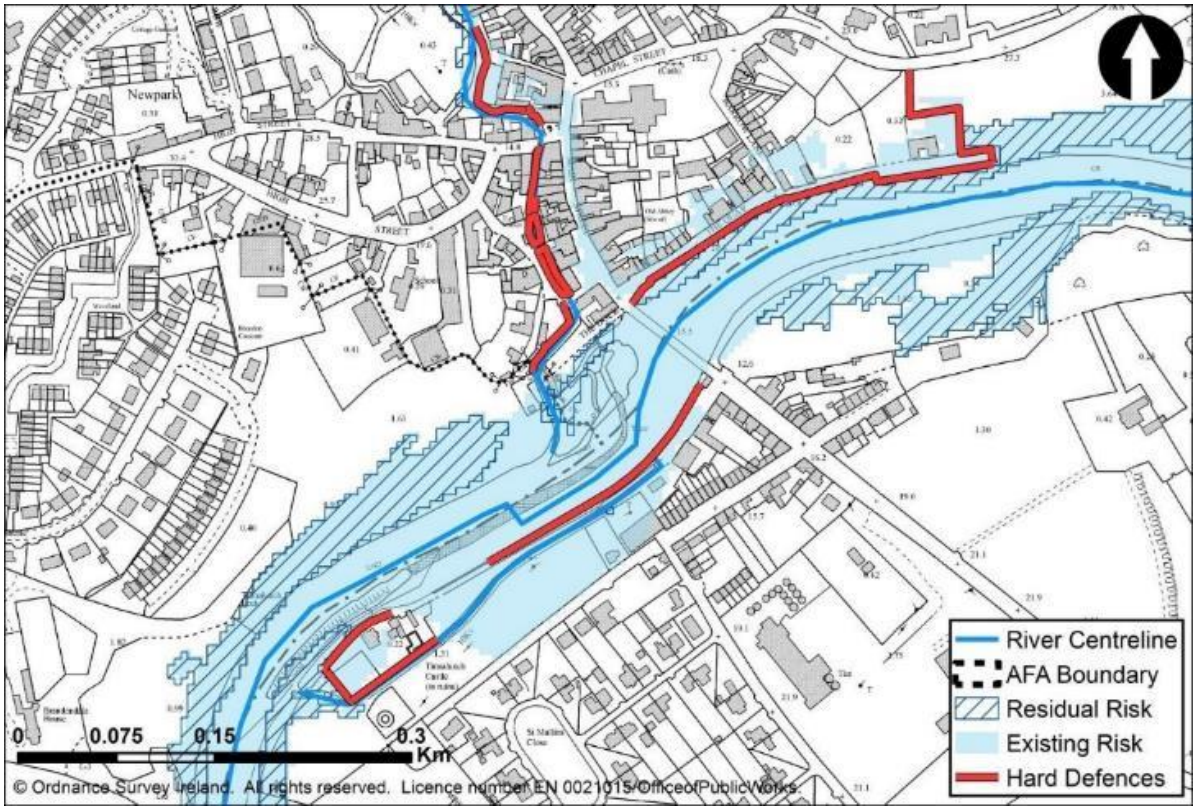

Figure 1.2.CFRAM Proposed flood defence measures

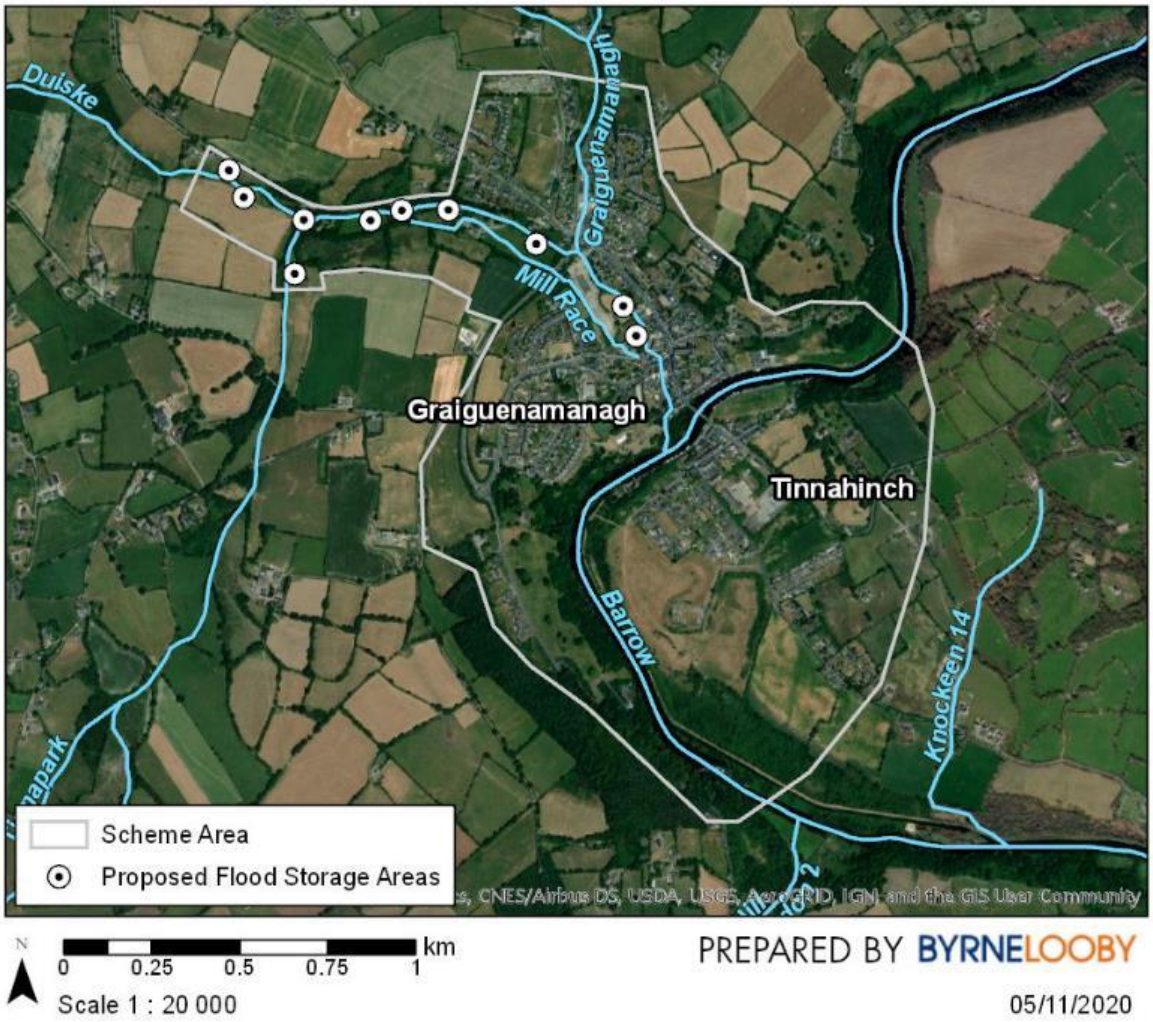

Figure 1.3. Potential locations of proposed flood storage areas and scheme area

2 Methodology

2.1 Introduction

This ecological baseline data collection and survey has comprised:

- Consultations and desk study;
- Extended Habitat survey and mapping; and
- Surveys for other features/species of interest.

The detailed methodology for each component is described in the sections below. Table 2-1 provides a summary of the surveys completed to date and/or ongoing.

Table 2-1 Surveys completed to date

Survey Name	Survey Date
Specialist survey for Bats	14-16 September 2020
Habitats and species walkover	June 2020
Habitats and species walkover	16-18 February 2021
Specialist survey for wintering birds	16-18 February 2021
Specialist survey for Breeding birds	16-18 February 2021
Specialist surveys for mammals, including otter, badger, pine martin, red squirrel	16-18 February 2021
Specialist survey for herpetofauna	16-18 February 2021
Specialist survey for flora	16-18 February 2021
Specialist survey for trees	16-18 February 2021
Specialist survey for alien invasive flora species	16-18 February 2021
Q values/invertebrates	08 February 2021
Electrofishing survey of the Duiske River	10 February 2021
Specialist survey for white-clawed crayfish (inc. eDNA sampling and testing)	29 April 2021
Specialist survey for freshwater pearl mussel (inc. eDNA sampling and testing)	30 April 2021

2.2 Consultations and Desk Study

As part of the EIA process, consultation has been carried out with the public and various stakeholders, the purpose of which was to engage with them and gather local knowledge on flooding and any environmental information/concerns relating to the project.

Five statutory bodies have responded to a stakeholder letter (sent during June 2020, reference no W3451/PCD/0001) asking for their views on the proposed scheme by letter. At the time of writing responses had been provided as follows:

- The Health and Safety Authority (letter dated 3rd July 2020): Based on the information supplied, the Authority has no specific observation to make at this time.
- Department of Culture, Heritage and the Gaeltacht (letter dated 26th August 2020): They recommend that the services of a suitably qualified and experienced underwater

archaeologist be engaged to act as Project Archaeologist (PA) for the proposed scheme. The PA should be integral to advising on tender documents for the engagement of Consultant Archaeologists either directly by the Council/OPW or the main works contractor and any sub-contractors that may need to be engaged.

- Irish water (IW) (letter dated 7th September 2020): They advise that they have assets within the study area. Key comments are:
    - They requested for continued engagement through the feasibility, design and construction stages in order to ensure public water services and sources are protected and access is maintained;
    - Any proposed works within close proximity to Irish Water assets, whether above ground or below ground should be assessed to ensure no impact to IW assets. Any impacts caused by potential increase or decrease to the level of overburden on assets as well as the impact of any increase in river levels on stormwater overflows, WWTP outfalls, etc needs to be taken into consideration;
    - That any proposals by the applicant to divert existing water services (watermains, service connections, rising mains, foul and surface water sewers, culverts, etc.) shall be submitted to Irish Water prior to works commencing;
    - As this is a flood defence scheme with the potential for flood walls/embankments to be part of the scheme we wish to advise that such measures may impact on IW assets such as overflows from pumping stations and sewers, drinking water source intakes, etc. We request that Irish Water is consulted further on the proposed design of flood defences to ensure there is no detriment to the performance of Irish Water assets as a result of the scheme and that interface issues are managed appropriately. All necessary measures to protect and maintain access to Irish Water infrastructure and water sources shall be undertaken and incorporated into the design;
    - Any potential impact on the contributing catchment of water sources either in terms of water abstraction for the development (and resultant potential impact on the capacity of the source) or the potential of the development to influence/ present a risk to the quality of the water abstracted by IW for public supply should be considered; and
    - Any temporary connection throughout the construction phase is subject to a connection agreement with Irish Water.
- Office of Public Works (letter dated 7th September 2020): Based on the information supplied, the Authority has no specific observation to make at this time.

- Department of Agriculture, Food and the Marine (letter dated 7th September 2020): Comments received outline the licencing process for afforestation and tree felling. A high-level outline of the environmental process was also provided.
- Inland Fisheries Ireland (February 2021) provided advice in relation to mitigation required for in-stream works proposed for the proposed preliminary site investigation.
- The Marine Institute (April 2021) provided data with regard to the presence/absence of white-clawed crayfish and the prevalence of *A. Astaci* in the vicinity of the scheme (the causative agent of crayfish plague).

Where communications have been received that advise the inclusion of specific third parties in consultation these requests have been actioned.

Consultation is ongoing as part of the ecological assessment and environmental impact assessment process.

2.3 Desk Study

The desk study included review of the following sources of information:

- River Barrow and River Nore SAC – Site Synopsis (NPWS, 2016)
- River Barrow and River Nore SAC – Conservation Objectives (NPWS, 2011)
- River Barrow and River Nore SAC - Conservation Objectives Supporting Document - Woodland Habitats (NPWS, 2011)
- Article 17 Reports (NPWS, 2019)
    - GIS spatial data for Article 17 Reports[3]
- Assessment of the distribution and abundance of Kingfisher *Alcedo atthis* and other riparian birds on six SAC river systems in Ireland (Birdwatch Ireland, 2010)
- National Biodiversity Data Centre (NBDC) – 1km- and 2km-square species reports (accessed online on 08/02/2021)
- Graiguenamanagh Bat Survey Report - W3394-ECO-R001 (ByrneLooby, 2020)
- Environmental Constraints Study Report – W3451-BL-ENV-R001 (ByrneLooby, 2021)

2.4 Extended Habitat Survey and Mapping

The study area boundary is as shown in Figure 1.3, with particular attention paid to the areas identified in Figure 1.2. The study area was subject to an extended habitat survey between

[3] https://www.npws.ie/maps-and-data/habitat-and-species-data/article-17

16/02 and 18/02/2021, focussing primarily on semi-natural and other vegetated land up to approximately 100 m either side of watercourses within the scheme.

A habitat survey is a standardised method of recording habitat types and characteristic vegetation, as set out in the 'Best Practice Guidance for Habitat Survey and Mapping' (The Heritage Council, 2011). A habitat survey is a method of gathering information about the ecology of a site. The 2011 guidelines provide the following definition of a habitat survey:

"The fundamental piece of information collected is the habitat type to which a particular area can be assigned. Habitat types are determined by reference to a system of habitat classification, which must be clearly identified[4]*. The location and extent of different habitat types that are present in a site are mapped to provide a clear spatial record. Additional information on habitats may also be collected, such as dominant species or conservation status, depending on the objectives of the particular habitat survey. The results of a habitat survey provide basic ecological information that can be used for biodiversity conservation, planning and/or management, including targeting of more detailed botanical or zoological investigations."*

Habitats were classified in accordance with the system outlined by Julie Fossitt (The Heritage Council, 2000).

The site was also assessed for the presence of habitats designated by Annex I of the EU Habitats Directive. The determination of the presence or absence of Annex I habitats was carried out in consultation with the habitat descriptions provided in the most recent Article 17 Reports (NPWS, 2019). The Interpretation Manual of European Union Habitats (European Commission, 2013) was also consulted. In addition, the spatial GIS data for the Article 17 Reports were examined to determine the distribution of these habitats (as known to the NPWS) within the study area.

This habitat survey method was extended in accordance with the "Guidelines for Ecological Impact Assessment in the UK and Ireland" (CIEEM, 2018) through the additional recording of specific features indicating the presence, or likely presence, of protected species or other species of nature conservation significance.

Whilst not a full botanical or protected species survey, the extended method of survey enables suitably-trained and experienced ecologists to obtain an understanding of the ecology of a site such that it is possible either:

1. to confirm the conservation significance of the site and assess the potential for impacts on habitats/species likely to represent a material consideration in planning terms; or

2. to establish the scope and extent of any additional specialist ecological surveys that will be required before such confirmation can be made.

[4] The standard habitat classification system in Ireland is The Heritage Council's 'A Guide to Habitats in Ireland' (Fossitt, 2000).

2.4.1 Other Features/Species of Interest

In practice, the approach to this type of survey is one whereby certain features of interest are searched for and recorded as part of the habitat survey site walkover. Particular features/species of interest for this project were:

1. Mammals – particularly otters, but also badgers, pine martens, red squirrels, hedgehogs and pygmy shrews. The ecologists would take note of the following evidence:
    a. Direct sightings of mammals (live or dead)
    b. Burrows, setts, dens, dreys, holts and otter couches
    c. Prints
    d. Prey/food remains
    e. Faeces

The following guidance documents were consulted when carrying out these surveys:

- Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes (NRA, 2008)
- Guidelines for the Treatment of Badgers prior to the Construction of National Road Schemes (NRA, 2005)
- A Guide to Identifying Evidence of Pine Martens in Wales (Vincent Wildlife Trust, 2017)
- Practical Techniques for Surveying and Monitoring Squirrels (Gurnell *et al.*, 2009, for the Forestry Commission)

2. Amphibians
    a. Spawn
    b. Potential spawning habitat

Any features of interest were photographed and their GPS location recorded.

2.5 Additional Specialist Surveys

In addition to the above-described survey, specific surveys were undertaken for trees and birds. Details are provided in the following sections.

2.5.1 Trees

For each tree surveyed, the following data were collected:

- Species
- Height (estimated)
- Trunk diameter (at 1.3 m)
    a. This was used to calculate girth (circumference). Diameter was the measurement used in the field because close access was not possible on several occasions to allow the ecologist to wrap a tape measure around the tree.
- Notes on its ecological significance. This was measured using three indicators:
    a. Ivy coverage
    b. Presence of cracks, hollows and/or nests
    c. Epiphyte coverage (moss/lichens)

The presence of the above features represent habitat heterogeneity, although heavy ivy coverage can also represent a threat to the health of the tree itself. It should be noted that these observations were carried out at ground level with the aid of binoculars. The presence or absence of certain features could not be confirmed if there was heavy ivy coverage.

The age of each tree was estimated based on species and trunk girth. This was accomplished using a 'growth factor', which is a number representing the average annual increase in girth of a species of tree. An individual tree's growth rate will of course be affected by its own environmental conditions, but for the purpose of this exercise, each species' growth rate is assumed to be constant. Growth factors for a number of species are provided on a website operated by the Hungerford Virtual Museum[5]. These are as follows:

- Holly, Yew: 1.25cm / year
- Oak: 1.88cm / year
- Ash, Beech, Elm, Hazel: 2.5cm / year
- Sycamore: 2.75cm / year
- Pine, Spruce: 3.13cm / year

The average growth factor for broadleaved trees is considered 2.5 cm per year[6]. On this basis, this growth factor was also applied to Horse Chestnut, Hawthorn and Blackthorn. Willow, Alder and Cypress are known to grow at a higher rate, so a growth factor of 2.75cm per year was applied to these species in the absence of published guidance.

[5] https://www.hungerfordvirtualmuseum.co.uk/index.php/15-artefacts/87-how-to-age-a-tree
[6] Royal Forestry Society - https://www.rfs.org.uk/learning/forestry-knowledge-hub/tree-biology/tree-age/

Tree surveys were concentrated around the areas proposed by the CFRAM Study for hard defences (see Figure 1.2). These included:

a. The canal and mill race around Tinnahinch Castle.

b. Along the Duiske from Turf Market up as far as the footbridge over the Duiske that leads to the Aldi carpark.

Other areas were identified by ByrneLooby engineers as additional areas of interest, which should also be targeted for tree surveys. These were:

c. Along the mouth of the Duiske in the wooded area where it joins the Barrow.

d. Further north of the footbridge (see b. above) along the Duiske towards Aldi.

e. The inlet to the culvert where the Killeen Stream flows under the R705 and re-emerges by the roundabout near Aldi.

2.5.2 Birds

- Two surveys were undertaken:
    - Wintering birds (16th-18th of February 2021)
    - Breeding birds (2nd of April 2021)

Both surveys involved line transects along the routes shown in Figure 2.1 and Table 2.2. Surveys were carried out early in the morning, approximately 30 minutes after sunrise. Where possible, surveying was avoided during heavy rain, strong winds or poor visibility (e.g. fog). Each transect line was walked by the ecologist, and all avian species observed (visually or aurally) were recorded. Binoculars were used to scan the surrounding landscape during the transect. Direct sightings were recorded in line with the guidance contained in the Countryside Bird Survey (CBS) Manual (Birdwatch Ireland, 2012), which recommends sightings to be grouped into the following distance bands (perpendicular to and either side of the transect line):

- Within 25m
- Between 25m and 100m
- Greater than 100m
- Birds in flight at any distance

Some crossover is possible during these surveys, and this was noted if it occurred. The ecologist used professional judgement as to whether to include a record that may have been recorded in a separate transect.

Features of the landscape that were deemed significant for birds (e.g. potential breeding habitats, Kingfisher perches, existing nests etc.) were recorded.

Table 2.1. Bird Transect Routes

ID	Start Coordinates (ITM)	End Coordinates (ITM)
A	671190, 642583	670808, 642885
B	670692, 643082	670895, 643529
C	671174, 643780	671491, 643881
D	670854, 643568	670862, 643676
E	670799, 643860	670676, 643993
F	670501, 644128	670312, 644230

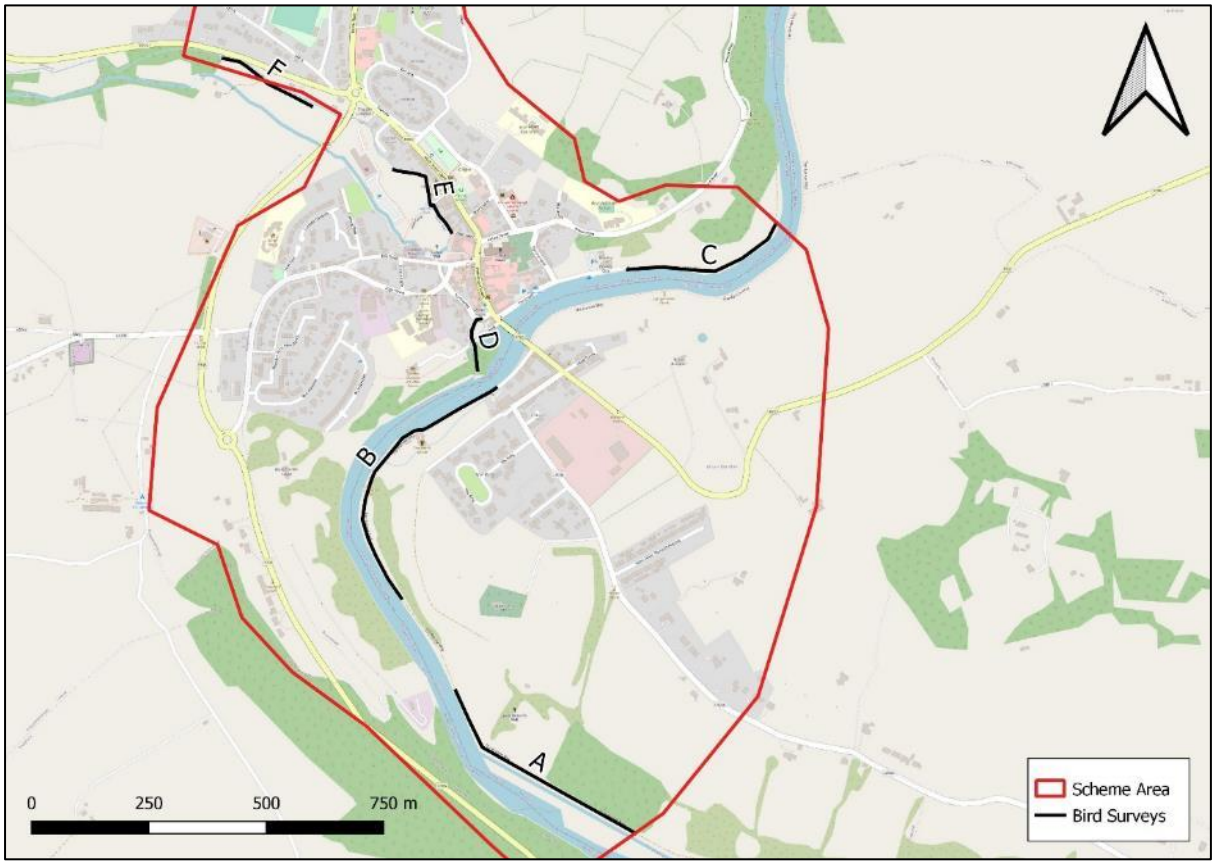

Figure 2.2. Bird Transect Routes

2.6 Data Limitations

As the extended habitat survey was conducted in February, plant identification was limited in its accuracy. This is because flowers were absent from most flora, foliage was absent from deciduous trees and any annual plants were completely absent. This has the following implications:

- Grass species identification is very difficult without the flower. Some species have distinguishable leaf characteristics, such as the velvety hairs and purple stripes on *Holcus*

lanatus. Occasionally a dead flower was present on a specimen, which aided identification.

- Deciduous tree identification was possible if the ecologist had access to the twig and bud. This was mostly possible, and identification was made easier if leaf litter was present at the base of the tree. Occasionally the branches of trees were so high as to be completely out of reach – even with binoculars it was sometimes not possible to identify these trees.

There had been substantial rainfall in the days leading up to the site surveys. This meant that:

- The flow and water levels in watercourses were high, which made any in-stream work difficult. Close access to some areas was impossible for this reason, but observations from a distance were made, and these were kept as accurate as possible. Some trees, for example, had to be surveyed from the opposite bank.

- Features such as scats, prints, otter couches etc. may have been damaged or washed away by rainfall.

Despite the above, it was possible to obtain a robust understanding of the site's ecology from the survey work undertaken. In particular, it was possible to identify sensitive habitats that may be affected by the works. Furthermore, the lack of deciduous foliage was advantageous in terms of searching for mammal burrows (including holts, dens etc.), notable features in trees, and features along the riverbank, all of which would otherwise be obscured by dense foliage later in the year. It is the professional opinion of the ecologists that additional survey of the site would not materially alter the conclusions drawn from the survey work or the recommendations made in respect of mitigation measures.

3 Statutory and Non-statutory Designated Ecological Sites

3.1 Statutory Protected Ecological Sites

3.1.1 European

Graiguenamanagh-Tinnahinch is divided by the River Barrow, the entirety of which falls under the designation of River Barrow and River Nore SAC (Site Code: 002162). Much of the River Duiske, including all of the section that flows through Graiguenamanagh, is also designated (see Figure 3.1).

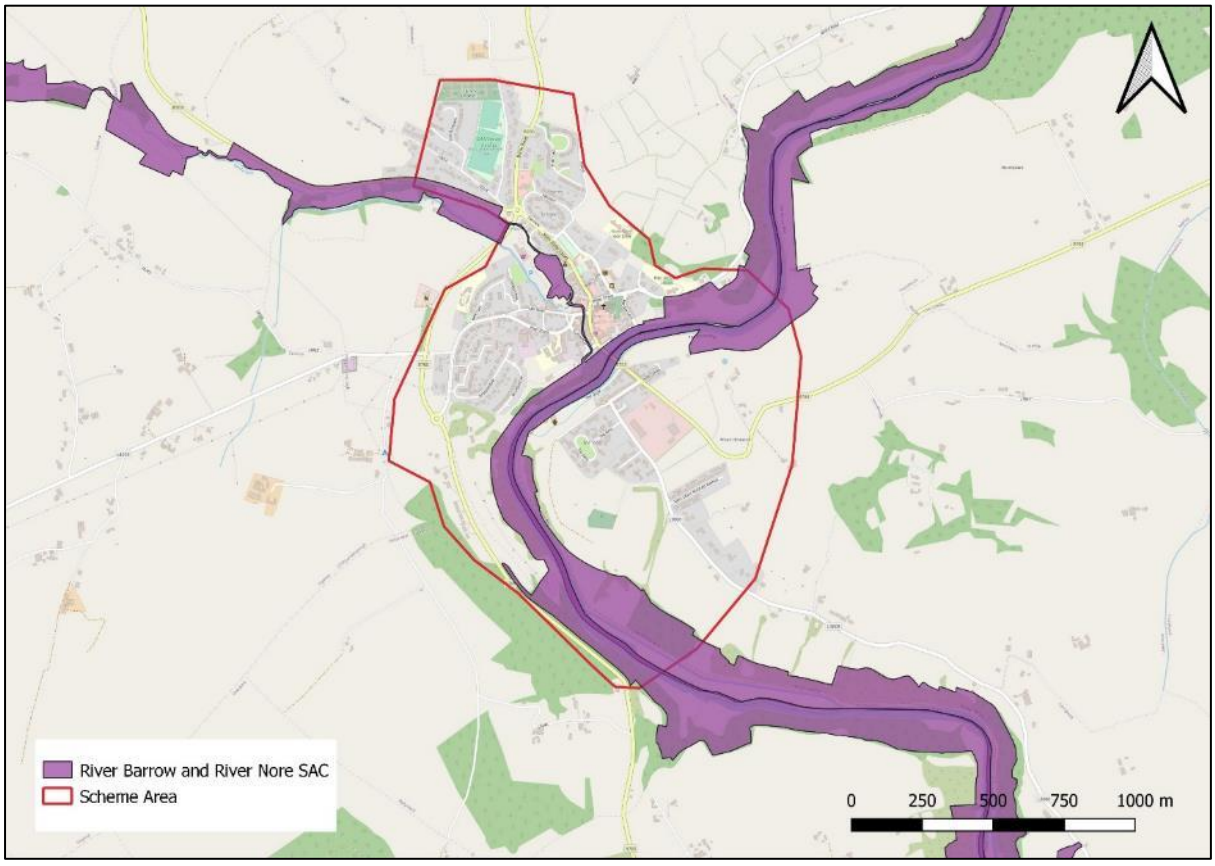

Figure 3.1. River Barrow and River Nore SAC in relation to the proposed Scheme area

Special Areas of Conservation are designated under the EU Habitats Directive. The River Barrow and River Nore SAC has been designated for the presence of the following habitats and species (Note: this is an exhaustive list that applies to the entirety of the site, which stretches from the foothills of the Slieve Bloom Mountains in Co. Laois as far south as Creadon Head in Co. Waterford):

Table 3-1 Qualifying Interests of River Barrow and River Nore SAC

Estuaries [1130]
Mudflats and sandflats not covered by seawater at low tide [1140]
Reefs [1170]
Salicornia and other annuals colonising mud and sand [1310]
Atlantic salt meadows (Glauco-Puccinellietalia maritimae) [1330]
Mediterranean salt meadows (Juncetalia maritimi) [1410]
Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation [3260]
European dry heaths [4030]
Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430]
Petrifying springs with tufa formation (Cratoneurion) [7220]
Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles [91A0]
Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae) [91E0]
Vertigo moulinsiana (Desmoulin's Whorl Snail) [1016]
Margaritifera margaritifera (Freshwater Pearl Mussel) [1029]
Austropotamobius pallipes (White-clawed Crayfish) [1092]
Petromyzon marinus (Sea Lamprey) [1095]
Lampetra planeri (Brook Lamprey) [1096]
Lampetra fluviatilis (River Lamprey) [1099]
Alosa fallax fallax (Twaite Shad) [1103]
Salmo salar (Salmon) [1106]
Lutra lutra (Otter) [1355]
Trichomanes speciosum (Killarney Fern) [1421]
Margaritifera durrovensis (Nore Pearl Mussel) [1990]

The scheme area is not linked hydrologically or otherwise to any other European Sites (SACs or SPAs).

3.1.2 National

The basic national designation for ecology is the Natural Heritage Area (NHA). This is an area considered nationally important for the habitats present or that holds species of plants and animals whose habitat needs protection. NHAs are designated under the Wildlife Act (1976) and its amendments.

There are no NHAs within the proposed scheme area, nor anywhere downstream (see Figure 3.2).

Figure 3.2 Natural Heritage Areas

3.1.2.1 Wildfowl Reserves

These sanctuaries are areas that have been excluded from the 'Open Season Order' so that game birds can rest and feed undisturbed. There are 68 sanctuaries in the State. Shooting of game birds is not allowed in these sanctuaries. There are two Wildfowl Reserves on the River Barrow (Table 3-2).

Table 3-2 Wildfowl Reserves on the River Barrow

Site Code	Location
WFS 01	Muine Bheag (Bagenalstown), Co. Carlow
WFS 31	Goresbridge, Co. Kilkenny

Both of these are upstream of the proposed Scheme Area. There are no other Wildfowl Reserves downstream of the proposed Scheme Area.

3.2 Non-statutory Nature Conservation Designations

3.2.1 Proposed Natural Heritage Areas

A list of proposed NHAs (pNHAs) was published on a non-statutory basis in 1995, but these sites have not since been statutorily proposed or designated. These sites are of significance for wildlife and habitats.

There are four pNHAs downstream of the proposed Scheme Area (see Table 3-3 and Figure 3.2).

Table 3-3 pNHAs downstream of the proposed Scheme Area

Name	Site Code	Location
Barrow River Estuary pNHA	000698	River Barrow, from just south of St. Mullins to its confluence with the River Suir
Duncannon Sandhills pNHA	001738	Duncannon, Co. Wexford
Waterford Harbour pNHA	000787	From Passage East to Creadon Head, Co. Waterford
Ballyhack pNHA	000695	Ballyhack, Co. Wexford

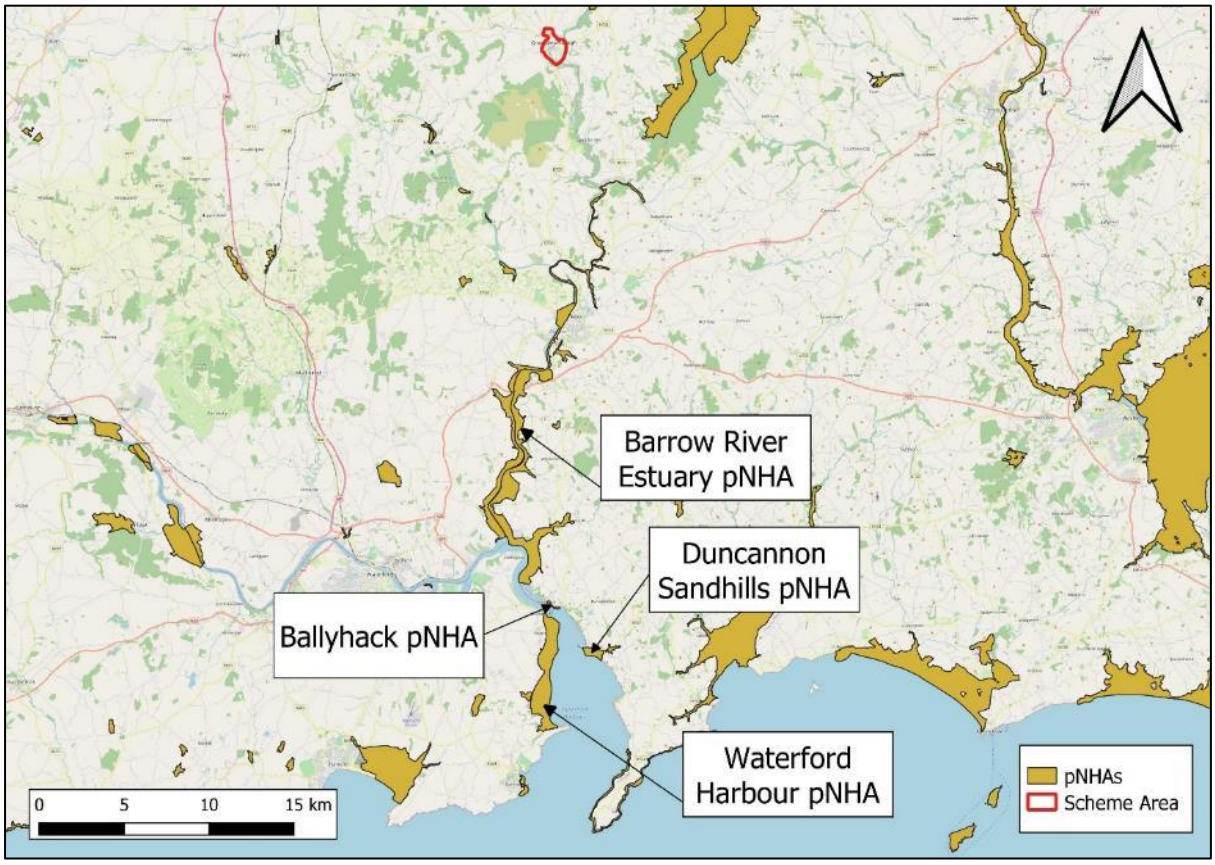

Figure 3.2. Proposed NHAs

The NPWS provide a PDF document containing site synopses of pNHAs in Ireland. However, the above-listed sites are not included in the document – for example, a site synopsis is provided for site no. 690, and the next one is for site no. 699. This is the case for all of the sites shown in Figure 3.3.

All of these sites are within the area covered by the River Barrow and River Nore SAC, which as discussed, is designated at a European level. Any measures to mitigate effects to the SAC will have the same mitigatory effects on the pNHAs in question.

4 Habitats

Habitats recorded in the study area are listed in Table 4.1 below. Each habitat is described in detail in the following sections. They are listed in the order that they appear in 'A Guide to Habitats in Ireland' (Fossitt, 2000) rather than in order of abundance.

Table 4-1. Habitats recorded within the study area

Habitat Name	Habitat Code (as per Fossitt, 2000)
Eroding/Depositing Rivers	FW1/FW2
Canals	FW3
Reed and Large Sedge Swamp	FS1
Improved Agricultural Grassland	GA1
Amenity Grassland	GA2
Dry Meadows and Grassy Verges	GS2
Wet Grassland	GS4
Oak-birch-holly Woodland	WN1
Riparian Woodland	WN5
Wet Willow-alder-ash Woodland	WN6
Mixed Broadleaved Woodland	WD1
Scattered Trees and Parkland	WD5
Scrub	WS1
Ornamental/Non-native Scrub	WS3
Hedgerows/Treelines	WL1/WL2
Spoil and Bare Ground / Recolonising Bare Ground	ED2/ED3
Arable Crops	BC1
Stone Walls and Other Stonework	BL1
Earth Banks	BL2
Buildings and Artificial Surfaces	BL3

Descriptions of the above habitats are provided in the following sections. For each habitat, the description as per Fossitt (2000) is provided first, and is shown in *italics* for visual reference. Thereafter, a description of the habitat in the context of the study area is provided. The habitat mapping is presented in Appendix B.

4.1 Freshwater

4.1.1 Eroding Rivers (FW1)

This category includes natural watercourses, or sections of these, that are actively eroding, unstable and where there is little or no deposition of fine sediment. Eroding conditions are typically associated with the upland parts of river systems where gradients are often steep, and water flow is fast and turbulent. Rivers in spate are included. For some rivers on the seaward side of coastal mountains, particularly in the west of Ireland, eroding conditions persist to sea level because of comparatively steep gradients over short distances, and high rainfall. Small sections of other lowland rivers may also be eroding where there are waterfalls, rapids or weirs. The beds of eroding/upland rivers are characterised by exposed bedrock and loose rock. Pebbles, gravel and coarse sand may accumulate in places, but finer sediments are rarely deposited. These rivers vary in size but are usually smaller and shallower than depositing/lowland rivers - FW2. Small mountain streams that dry out periodically can be included if an obvious channel persists or wetland plants are present. The unstable rocky channels of eroding/upland rivers usually support little vegetation cover. Submerged rocks and boulders may be colonised by aquatic mosses such as Fontinalis spp. and Racomitrium aciculare. Exposed rocks and wet shaded banks may also support extensive cover of lichens and liverworts. Higher plants are generally rare or absent except in places where fine sediments are trapped. Typical species include water-crowfoots (Ranunculus penicillatus, R. aquatilis), Alternate Water-milfoil (Myriophyllum alterniflorum) and the aquatic form of Bulbous Rush (Juncus bulbosus). Plant and animal communities of eroding/upland rivers are influenced by a range of factors including bedrock and substratum type, nutrient status, water force, water quality, shade and human impact. Habitat conditions also vary along different stretches of a river where there are riffles, runs, pools, waterfalls and backwaters.

The entire length of the River Duiske within the study area fits in with the above description, most importantly in terms of riverbed substrate composition (see Figure 4.1). The substrate predominantly consists of boulders, cobbles and gravel. Bedrock is exposed in some areas also. The absence of fine sediments is an indication of the river's tendency to erode rather than deposit. The small watercourse opposite the Friar's Hill housing estate (known as the Killeen Stream) before it enters the culvert can also be classified as FW1 for the same reasons.

The mill race in Graiguenamanagh (flowing by Aldi towards Cushendale Mills) also has these characteristics. Given that it is a man-made diversion of a watercourse, it could be interpreted as a Canal (FW3), as per Fossitt's description. However, it of course lacks other features of a canal (such as its use for navigation for example, and a lack of strong currents). It fits neither classification exactly, but from an ecological perspective the distinctions are arbitrary - it is considered to share the most characteristics with an eroding river, rather than a canal (see Figure 4.2).

Figure 4.1. Example of FW1 (River Duiske flowing under R705, looking north) - 17.02.21

Figure 4.2. Mill race (photographed west of Aldi, looking south) - 17.02.21

4.1.2 Depositing Rivers (FW2)

This category includes watercourses, or sections of these, where fine sediments are deposited on the river bed. Depositing conditions are typical of lowland areas where gradients are low and water flow is slow and sluggish. These rivers vary in size but are usually larger and deeper than those above. In a natural state these rivers erode their banks and meander across floodplains. Because of this, most have been modified to some extent to control water flow, facilitate navigation or prevent flooding and erosion. Canalised or walled sections of rivers are included here, as are natural watercourses that have been dredged or deepened, and those with artificial earth banks. If channels have been excavated to divert water away from the main watercourse, these should be considered under canals – FW3. Tidal sections of rivers with brackish water influence are excluded (see tidal rivers – CW2). Rejuvenated sections of lowland rivers associated with rapids, waterfalls and weirs should be considered under eroding/upland rivers - FW1 if eroding conditions predominate. Plant and animal communities are influenced by numerous factors including substratum type, water force, nutrient status, water quality, channel size, water depth, human impact, disturbance and shade. Within a river channel there may be deep pools, backwaters, banks or mid-channel bars of gravel, sand or mud, in addition to vegetated islands and fringing reedbeds. The substratum of depositing/lowland rivers comprises mainly fine alluvial or peaty sediments. Vegetation may include floating and submerged aquatics, with fringing emergents in shallow water or overgrowing the banks. Floating aquatics can include water-lilies (Nuphar lutea, Nymphaea alba), pondweeds (Potamogeton spp.), water-starworts (Callitriche spp.) and Unbranched Bur-reed (Sparganium emersum). Tall emergents such as Common Club-rush (Schoenoplectus lacustris), Common Reed (Phragmites australis) and Yellow Iris (Iris pseudacorus) may also be present.

This habitat is represented by the entirely of the River Barrow within the study area. The canal by Tinnahinch Castle is excluded, as is the canal at the southernmost extremity of the study area. Portions of the riverbank are walled (east of the bridge in Graiguenamanagh, west of the bridge in Tinnahinch), which is a result of development in c. 1900 as an industrial port[7]. Nowadays the quay walls are lined by pleasure craft (see Figure 4.3).

[7] https://www.buildingsofireland.ie/buildings-search/building/12318002/graiguenamanagh-county-kilkenny

Figure 4.3. Example of FW2 (River Barrow, taken from bridge, looking west – 14.09.20)

4.1.3 Canals (FW3)

Canals are artificial linear bodies of water that were originally constructed for the purpose of navigation. They typically lack strong currents and any significant channel or bank erosion. This means that canals tend to have closer affinities with ponds than rivers. Canals can normally be distinguished from drainage ditches - FW4 by a combination of width and function. Channels that have been excavated to divert water away from the main watercourse are included in this category but canalised sections of rivers are excluded (see depositing/lowland rivers - FW2). Locks that are used to control water levels are considered as part of the canal habitat, but note that any built stone structures, including bridges and banks that are faced with stone, are excluded (see stone walls and other stonework - BL1). All canals require management and maintenance to keep them open and operational. They are readily colonised by aquatic plants and frequently support floating, submerged or emergent vegetation. Typical aquatics include water-milfoils (Myriophyllum spp.), water-lilies (Nuphar lutea, Nymphaea alba), Amphibious Bistort (Polygonum amphibium), bur-reeds (Sparganium spp.) and duckweeds (Lemna spp.). Canals with standing water are included here even if they are overgrown with swamp-like vegetation. Disused dry canals are excluded and should be classified on the basis of habitats they now support.

Two canals exist within the study area – one by Tinnahinch Castle (see Figure 4.4), and another at the southern end of the study area. These provide diversions around weirs so that boats can navigate the river. The mill race by Tinnahinch Castle has also been classified as a canal (see Figure 4.5).

Figure 4.4. Example of FW3 (canal lock by Tinnahinch Castle, looking west – 14.09.20)

Figure 4.5. Mill race by Tinnahinch Castle (FW3) – 17.02.21

4.1.4 Reed and Large Sedge Swamp (FS1)

This category includes species-poor stands of herbaceous vegetation that are dominated by reeds and other large grasses or large, tussock-forming sedges. Most reed and large sedge swamps are overwhelmingly dominated by one or a small number of species, as in the case of reedbeds. Stands of vegetation can range from very dense to open. Typical components include Common Reed (Phragmites australis), Common Club-rush (Schoenoplectus lacustris), Reed Sweet-grass (Glyceria maxima), Branched Bur-reed (Sparganium erectum), Reed Canary-grass (Phalaris arundinacea), Great Fen-sedge (Cladium mariscus), Greater Tussock-sedge (Carex paniculata), Bulrush (Typha latifolia) and Water Horsetail (Equisetum fluviatile). Stands of Sea Club-rush (Bolboschoenus maritimus) may also occur in brackish waters. Note that a number of the possible dominants have a late growing season and their full extent may be difficult to determine before mid-May. Unlike tall-herb swamps - FS2 below, the broadleaved herb component is minor. Vegetation typically lacks stratification as there is little or no development of an understorey element. In some situations there may be a mixture of other species such as Common Marsh-bedstraw (Galium palustre), Water Mint (Mentha aquatica), forget-me-nots (Myosotis spp.), Bogbean (Menyanthes trifoliata), Marsh Cinquefoil (Potentilla palustris), Wild Angelica (Angelica sylvestris), Meadowsweet (Filipendula ulmaria) or Fool's Water-cress (Apium nodiflorum).

Two notable patches of this habitat exist either side of the bridge on the northern bank of the Barrow. The site visit in February was not an ideal time to assess species assemblage, but from Google imagery (Street View (September 2019)) the habitat appears to be dominated by common reed and common club-rush, with the invasive species Himalayan balsam (*Impatiens glandulifera*) also noted. It is likely that the hydrological conditions created by the presence of the bridge are conducive to sediment build-up in these areas, which has led to the formation of this habitat (see Figure 4.6).

Another example of this habitat was noted on the southern side of the Barrow, almost directly opposite the rowing club. It was not on the riverbank, but was separated from the Barrow by a grassy verge and a paved walkway. This area appeared to be dominated by common reed and was partly-inundated at the time of survey. Frogspawn was noted in this location (see Section 6.6.2). Small coverage of FS1 was also noted at the periphery of the canal by Tinnahinch Castle.

Figure 4.6. Example of FS1(northern bank of River Barrow, looking west from bridge) - 17.02.21. Lower image is the same area from Google Street View (dated September 2019). Note that the flow in February 2021 was high after substantial rainfall in the preceding days. There was likely also substantial winter dieback of vegetation.

4.2 Grassland and Marsh

4.2.1 Improved Agricultural Grassland

This category is used for intensively managed or highly modified agricultural grassland that has been reseeded and/or regularly fertilised, and is now heavily grazed and/or used for silage

making. It includes regularly-reseeded monoculture grasslands and rye-grass leys that are planted as part of an arable rotation. These differ significantly from areas of permanent grassland. Improved agricultural grassland is typically species-poor. Sward quality varies depending on soil type, fertility, drainage and management. Rye-grasses (Lolium spp.) are usually abundant and may entirely dominate the sward, often in association with White Clover (Trifolium repens). Many improved varieties or cultivars of these plants are now widely sown. Other grasses that may be prominent include meadow-grasses (Poa spp.), Timothy (Phleum pratense), Crested Dog's-tail (Cynosurus cristatus) and Yorkshire-fog (Holcus lanatus). Among the more frequently occurring 'agricultural' herbs are Dandelion (Taraxacum spp.), Creeping Buttercup (Ranunculus repens), plantains (Plantago spp.), Nettle (Urtica dioica), thistles (Cirsium arvense, C. vulgare) and docks (Rumex spp.). Some reseeded but poorly-drained fields may support abundant rushes.

Improved agricultural grasslands exist around the periphery of the town, which is a typical scenario. However, two fields fitting the above description were noted immediately east/south-east of the Aldi car park, which is a somewhat central location (see Figure 4.7). The areas tentatively proposed for flood storage in the north-west are dominated by GA1.

Figure 4.7. Example of GA1 (field between Aldi car park and the Duiske, looking south-east - 17.02.21)

4.2.2 Amenity Grassland (GA2)

This type of grassland is improved, or species-poor, and is managed for purposes other than grass production. It includes amenity, recreational or landscaped grasslands, but excludes farmland. Most areas of amenity grassland have been reseeded and are regularly mown to maintain very short swards. Fertilisers and herbicides are often applied but there is rarely any grazing by livestock. The sward may comprise a variety of grasses, including some that also

occur in improved agricultural grassland - GA1, but rye-grasses (Lolium spp.) are rarely abundant. Broadleaved herbs such as Daisy (Bellis perennis), Dandelion (Taraxacum spp.), clovers (Trifolium spp.) and plantains (Plantago spp.) are common. Amenity grassland is typically associated with lawns and other managed grassland areas in gardens, parks, grounds of various buildings or institutions, golf course fairways, grassy sports fields and race courses. Ornamental flower beds and borders - BC4 should be excluded and, if trees are a prominent feature, the category scattered trees and parkland - WD5 should be considered.

This habitat occurs quite frequently throughout built-up areas of the study area. All communal greens and private gardens fall into this category, as well as any other grassy areas regularly maintained for aesthetic purposes (see Figure 4.8).

Figure 4.8. Example of GA2 (green area immediately north of residential properties on Hotel Street - 17.02.21)

4.2.3 Dry Meadows and Grassy Verges (GS2)

Dry meadows that are rarely fertilised or grazed, and are mown only once or twice a year for hay are now rare in Ireland. Most have been improved for agriculture and this type of grassland is now best represented on grassy roadside verges, on the margins of tilled fields, on railway embankments, in churchyards and cemeteries, and in some neglected fields or gardens. These areas are occasionally mown (or treated with herbicides in the case of some railway embankments), and there is little or no grazing or fertiliser application. This pattern of management produces grasslands with a high proportion of tall, coarse and tussocky grasses such as False Oat-grass (Arrhenatherum elatius) and Cock's-foot (Dactylis glomerata). Other grasses may include Yorkshire-fog (Holcus lanatus), Smooth Meadow-grass (Poa pratensis), Barren Brome (Anisantha sterilis) and Meadow Foxtail (Alopecurus pratensis). The broadleaved

herb component is characterised by a range of species that either grow tall, such as Cow Parsley (Anthriscus sylvestris), Hogweed (Heracleum sphondylium), Goat's-beard (Tragopogon pratensis), Nettle (Urtica dioica) and Common Knapweed (Centaurea nigra), or climb the stems of others, as in the case of Bush Vetch (Vicia sepium) and Meadow Vetchling (Lathyrus pratensis). Grassy verges may support other smaller broadleaved herbs such as Pignut (Conopodium majus), Creeping Cinquefoil (Potentilla reptans) and clovers (Trifolium spp.).

This classification was applied to any areas of grassland that were unmanaged and showed no evidence of grazing. It occurs along much of the Barrow's banks (see Figure 4.9), except where quays exist (see Section 4.1.2) and where riparian woodland extends to the water's edge (along the western bank at the southern end of the study area). Other examples were noted along the mill race by Aldi, in the field south of Tinnahinch Castle, and in a handful of unmanaged areas in the north where flood storage is currently being considered.

Figure 4.9. Example of GS2 (grassy verge along the southern bank of the Barrow, looking east - 17.02.21)

4.2.4 Wet Grassland (GS4)

This type of grassland can be found on flat or sloping ground in upland and lowland areas. It occurs on wet or waterlogged mineral or organic soils that are poorly-drained or, in some cases, subjected to seasonal or periodic flooding. On sloping ground, wet grassland is mainly confined to clay-rich gleys and loams, or organic soils that are wet but not waterlogged. This category includes areas of poorly-drained farmland that have not recently been improved, seasonally-

flooded alluvial grasslands such as the River Shannon callows, and wet grasslands of turlough basins.

Wet grassland frequently grades into Marsh (GM1) and there are many similarities in the range of species present in both habitats. To be included in the wet grassland category, the cover of grasses should exceed 50%, except in areas where rushes or small sedges predominate, and the total cover of reeds, large sedges and broadleaved herbs should be less than 50%. Among the suite of broadleaved herbs that are present, there should be a significant proportion of drier grassland species in addition to those that are more commonly associated with wetlands.

Wet grasslands were noted in a small number of locations along the Barrow. The example shown in Figure 4.10 is located on the northern bank, east of the rowing club. This area is separated from the Barrow by an elevated walkway, which causes pooling as water is trapped. Grass species recorded were Yorkshire fog (*Holcus lanatus*) and Common Bent (*Agrostis capillaris*). Patches of common reed (*Phragmites australis*) were noted, as well as flag/common Iris (*Iris pseudacorus* – see Figure 4.10) and Meadowsweet (*Filipendula ulmaria*).

Figure 4.10. Wet Grassland (GS4 – 02.04.21)

4.2.5 Marsh (GM1)

Marsh is found on level ground near river banks, lakeshores, and in other places where mineral or shallow peaty soils are waterlogged, and where the water table is close to ground level for most of the year. Unlike swamps, standing water is not a characteristic feature except, perhaps,

during very wet periods or in winter months. To be considered as marsh, the proportion of sedges and grasses should not exceed 50%.

One area of Marsh was identified on the Carlow side of the Barrow in the south of the study area. It was completely flooded in February and was originally marked as a lake. However, during the return visit in April it was observed to have drained partially. A conversation with a local passer-by confirmed that this area floods every winter, but drains completely and remains dry for the rest of the year. Figure 4.11 shows the area partially-drained, with some irises emerging.

Figure 4.11. Example of GM1 (photographed from eastern bank of Barrow walkway, looking east) - 02.04.21

4.3 Woodland and Scrub

4.3.1 Oak-Birch-Holly Woodland (WN1)

Native, semi-natural broadleaved woodland that occurs on acid or base-poor soils that may be either dry or humid, but not waterlogged. Mor humus deposits are included, but not peats. Stands are usually dominated by Sessile Oak (Quercus petraea), or mixed stands of Sessile and Pedunculate Oak (Q. petraea and Q. robur) or their hybrids. Other common trees include Downy Birch (Betula pubescens), Holly (Ilex aquifolium) and Rowan (Sorbus aucuparia). Downy Birch (Betula pubescens) can be the dominant tree in some situations. In places where the soils are less acid, Ash (Fraxinus excelsior) and Hazel (Corylus avellana) may also be present in small numbers. If either of these tree species is abundant, consider the following category, oak-

ash-hazel woodland - WN2. The ground flora typically comprises Ling (Calluna vulgaris), Bilberry (Vaccinium myrtillus), Bracken (Pteridium aquilinum), Hard Fern (Blechnum spicant), Great Wood-rush (Luzula sylvatica), Velvet Bent (Agrostis canina), Common Cow-wheat (Melampyrum pratense) and Wood Sage (Teucrium scorodonia). The climber, Honeysuckle (Lonicera periclymenum), is also common. The cover of mosses and lichens in the ground flora and on trees is often very high.

The woodland along the southern bank of the Barrow, in the easternmost region of the study area, was classified as WN1. It is separated from the Barrow by a paved walkway (see Figure 4.12).

Figure 4.12. Example of WN1 (along southern bank of the Barrow, east of the town – 16.02.21).

4.3.2 Riparian Woodland (WN5)

This category includes wet woodlands of river margins (gallery woodland) and low islands that are subject to frequent flooding, or where water levels fluctuate as a result of tidal movement (in the lower reaches of rivers). Riparian woodland is dominated by stands of willows that may include native (Salix cinerea, S. purpurea, S. triandra) and non-native (Salix fragilis, S. alba, S. viminalis) species. Alder (Alnus glutinosa) is occasional. The field layer is characterised by broadleaved herbs such as Nettle (Urtica dioica), Creeping Buttercup (Ranunculus repens), Wood Dock (Rumex sanguineus), Meadowsweet (Filipendula ulmaria), Wild Angelica (Angelica sylvestris), Hemlock Water-dropwort (Oenanthe crocata) and Hedge Bindweed (Calystegia sepium). Stands of Reed Canary-grass (Phalaris arundinacea) are common. Indian Balsam (Impatiens glandulifera), an introduced species, is locally abundant. These woodlands often reveal an accumulation of river borne debris, including dead vegetation and plastic, when water

levels are low. A fine coating of grey mud on vegetation and tree bases that are regularly submerged and emersed is also characteristic. Willows were widely coppiced and used for basket-making in the past; old Osier (Salix viminalis) beds are included in this category but any actively coppiced areas should be considered under short rotation coppice - WS4.

This classification has been applied to most areas within the study area where woodland extends to the edge of a watercourse. This applies to the western bank of the Barrow in the southern portion of the study area, as well as the mill race by Tinnahinch Castle and much of the northern reaches of the Duiske (see Figure 4.13). Certain areas were excluded and instead classified as treelines (WL2 – see Section 4.3.7) because they were deemed to lack the level of density and 'naturalness' exhibited by other examples in the study area.

Figure 4.13. Example of WN5 (River Duiske near one of the areas being considered for flood storage north of the town – 18.02.21)

Two areas of woodland north of Graiguenamanagh have also been classified as WN5 (see Figure 4.14). The Duiske and the mill race both flow through these woodlands. They are dominated by Alder and Willow, although Birch appeared to be more abundant than Ash. Holly (*Ilex aquifolium*) and Yew (*Taxus baccata*) were also noted. The soil was quite wet, but more so adjacent to the Duiske than to the mill race.

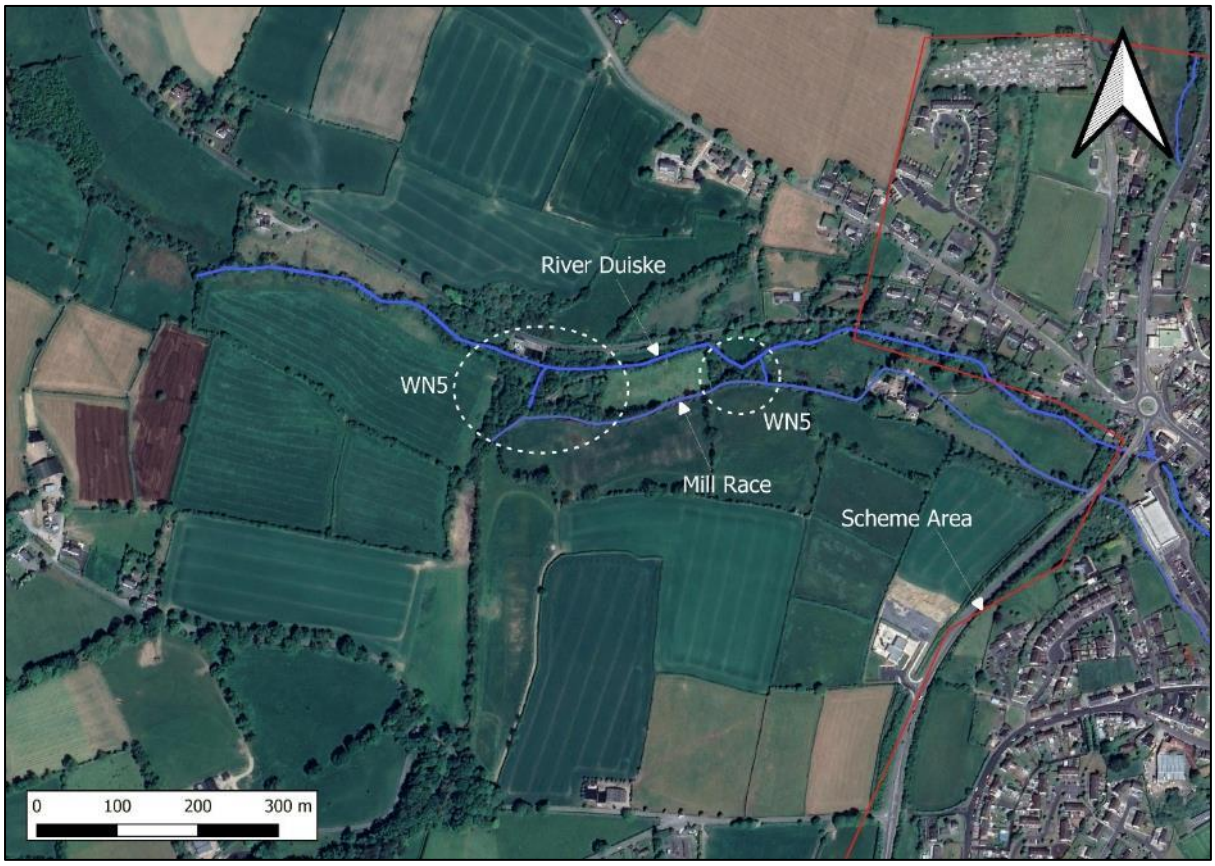

Figure 4.14. Areas of WN5 north of Graiguenamanagh

4.3.3 Wet Willow-Alder-Ash Woodland (WN6)

This broad category includes woodlands of permanently waterlogged sites that are dominated by willows (Salix spp.), Alder (Alnus glutinosa) or Ash (Fraxinus excelsior), or by various combinations of some or all of these trees. It includes woodlands of lakeshores, stagnant waters and fens, known as carr, in addition to woodlands of spring-fed or flushed sites. Carr is dominated by Rusty Willow (Salix cinerea ssp. oleifolia) and Alder (Alnus glutinosa). The field layer comprises Creeping Bent (Agrostis stolonifera), Meadowsweet (Filipendula ulmaria), Common Marsh-bedstraw (Galium palustre), Purple loosestrife (Lythrum salicaria) and Skullcap (Scutellaria galericulata). Mosses such as Climacium dendroides, Calliergon cordifolium and Homalia trichomanoides are characteristic. Carr occurs on organic soils and fen peats that are subject to seasonal flooding but remain waterlogged even when flood waters recede.

An example of this habitat was noted in the area where the Duiske joins the Barrow, just west of the main bridge. It is dominated by Alder (*Alnus glutinosa*), Ash (*Fraxinus excelsior*), willow (*Salix* spp.) and Sycamore (*Acer pseudoplatanus*), with occasional incidences of birch (*Betula* spp.), hawthorn (*Crataegus monogyna*) and oak (*Quercus* spp.). A significant portion of this woodland was flooded at the time of survey (see Figure 4.15). It was partially-drained when the site was revisited in April 2021. The herb layer was dominated by Lesser Celandine (*Ficaria verna*) and Angelica (*Angelica sylvestris*), with patches of Cow Parsley (*Anthriscus sylvestris*), Brooklime (*Veronica beccabunga*), Hemlock Water-dropwort (*Oenanthe crocata*), Ivy (*Hedera*

helix) and Cleavers (*Galium aperine*). During the visit in April there was a notable coverage of Himalayan Balsam (*Impatiens glandulifera*) seedlings that had recently emerged. Two patches of Winter Heliotrope were recorded.

Figure 4.15. Example of WN6 (at confluence of the Duiske and Barrow – 17.02.21)

4.3.4 Mixed Broadleaved Woodland (WD1)

This general category includes woodland areas with 75-100% cover of broadleaved trees, and 0-25% cover of conifers. It should be used in situations where woodland stands cannot be classified as 'semi-natural'. Trees may include native and non-native species. Plantations of broadleaved trees are included if the canopy height is greater than 5 m, or 4 m in the case of wetland areas. Stands of immature or sapling trees are excluded (see immature woodland - WS2). If a number of different broadleaved tree species contribute significantly to the canopy, the term 'mixed' should be used in the habitat title.

This habitat classification has been used to identify areas of woodland where detailed surveys were not undertaken – these areas are largely not relevant to the proposed works at this point, or access was not possible at the time to enable accurate classification. For example, along the western bank of the Barrow in the south of the study area, the woodland on the waterfront has been classified as Riparian Woodland (WN5), but the further inland this woodland has been classified as WD1 to reflect the fact that the riparian zone does not extend across the full width of the woodland. This part of the study area is not currently proposed for works. However, from the data gathered during the rest of the survey, tree species assemblages appear to be similar

across the site. It is therefore considered likely that the species assemblage across these woodlands is similar (i.e. alder, willow, ash, sycamore, birch and oak).

4.3.5 Scattered Trees and Parkland (WD5)

This category can be used in situations where scattered trees, standing alone or in small clusters, cover less than 30% of the total area under consideration but are a prominent structural or visual feature of the habitat. This usually occurs in areas of cultivated grassland, particularly amenity areas. In the case of parkland or parks which originate from former planting and landscaping, the proportion of non-native trees is typically high. This category can also be used for scattered fruit trees in orchards but commercial orchards with heavily pruned trees should be considered under horticultural land - BC2.

The green area surrounding the Barrow Valley Activities Hub has an area that fits the above description (see Figure 4.16).

Figure 4.16. Example of WD5 (area surrounding Activities Hub – 17.02.21)

4.3.6 Scrub (WS1)

This broad category includes areas that are dominated by at least 50% cover of shrubs, stunted trees or brambles. The canopy height is generally less than 5 m, or 4 m in the case of wetland areas. Scrub frequently develops as a precursor to woodland and is often found in inaccessible locations, or on abandoned or marginal farmland. In the absence of grazing and mowing,

scrub can expand to replace grassland or heath vegetation. Trees are included as components of scrub if their growth is stunted as a result of exposure, poor soils or waterlogging. If tall trees are present, these should have a scattered distribution and should not form a distinct canopy. This category does not include areas that are dominated by young or sapling trees (<5 or 4 m in height) or young conifer plantations (see immature woodland - WS2 or conifer plantation - WD4). Linear boundary features of scrub that are less than 4 m wide should be considered under hedgerows - WL1.

Scrub was noted in several locations throughout the study area. Patches of brambles and gorse are common, and fall into this category. A good example is the patch immediately east of the rowing club (see Figure 4.17). Occasional willow shrubs occur along the Duiske as it flows through the town (see Figure 4.18).

Figure 4.17. Example of WS1 (by rowing club on northern bank of the Barrow – 16.02.21)

Figure 4.18. Willow/bramble/*Buddleja* scrub (looking south over River Duiske from High St. bridge – 14.09.20)

4.3.7 Ornamental/Non-native Scrub (WS3)

This category should be used for areas that are dominated by ornamental and non-native shrubs. Most of these originate from planting and can be found in formal beds and borders in gardens, parks and other landscaped areas. It also includes areas where non-native shrubs have escaped and become naturalised in urban and rural situations. The range of possible non-native shrubs is extensive but some of the more common examples include Fuchsia (Fuchsia magellanica), Butterfly-bush (Buddleja davidii), Box (Buxus sempervirens), Snowberry (Symphoricarpos albus), Cotoneaster (Cotoneaster spp.), Rhododendron (Rhododendron ponticum) and Cherry Laurel (Prunus laurocerasus). Ornamental/non-native shrubs should not be recorded as a separate habitat where they occur in the understorey of woodlands. Hedgerows that comprise non-native shrubs, and coastal dunes that have been planted with Sea-buckthorn (Hippophae rhamnoides) are excluded (see hedgerows - WL1 and dune scrub and woodland - CD4). Note that there is a separate category for flower beds and borders - BC4.

This habitat has been applied to any notable areas of scrub within the broad category of 'amenity' habitats (i.e. gardens and other landscaped areas – see Figure 4.19).

Figure 4.19. Example of WS3 (Source: Google - August 2018)

4.3.8 Hedgerows/Treelines (WL1/WL2)

Linear strips of shrubs, often with occasional trees, that typically form field or property boundaries. Most hedgerows originate from planting and many occur on raised banks of earth that are derived from the excavation of associated drainage ditches. Dimensions of hedgerows vary considerably, depending largely on management and composition, and are taken here as

being mainly less than 5 m high and 4 m wide. When wider or taller than this, or dominated by trees, the habitat should be considered as a narrow strip of scrub or woodland, or as a treeline - WL2. Some hedgerows may be overgrown or fragmented if management has been neglected, but they should still be considered in this category unless they have changed beyond recognition. Linear strips of low scrub are included in this category if they occur as field boundaries.

Hedgerows and treelines are most abundant outside the built-up areas of the town, where they form field boundaries mostly. As mentioned in Section 4.3.2, some of the wooded habitats along watercourses have been classified as treelines, instead of riparian woodland, because they were notably narrow and less natural in appearance than other wooded riparian habitats that were observed. An example of this is provided in Figure 4.20.

Figure 4.20. Hedgerows/Treelines along the Duiske. This field is adjacent to the Aldi carpark, and the photograph is looking north-east (17.02.21)

4.4 Disturbed Ground

4.4.1 Spoil and Bare Ground/Recolonising Bare Ground (ED2/ED3)

This category includes heaps of spoil and rubble, and other areas of bare ground that are either very transient in nature, or persist for longer periods of time because of ongoing disturbance or maintenance.

Bare ground can include land that has recently been cleared for agriculture (but not yet tilled - see tilled land - BC3) or construction, and other areas with unconsolidated surfaces that are largely unvegetated because they are heavily trampled or regularly driven over or maintained (weeded or treated with chemicals). Examples of the latter can include unpaved forestry roads, paths and car parks, and derelict land in urban areas. If disturbance or maintenance ceased, these areas would readily be invaded by plants. Note that vegetation cover should not exceed 50% (see recolonising bare ground - ED3) and that any paved areas should be considered under buildings and artificial surfaces - BL3.

The most notable area of ED2/ED3 was noted in a small yard beside Tinnahinch castle. The coverage of ED2 and ED3 is in constant flux, which is why it is considered as one habitat (see Figure 4.21).

Figure 4.21. Example of ED2/ED3 near Tinnahinch Castle – 02.04.21

4.5 Cultivated and Built Land

4.5.1 Arable Crops (BC1)

Agricultural land that is cultivated and managed for the production of arable crops, including cereals (wheat, barley, oats, maize), and root, leaf, energy or fibre crops such as sugar beet, turnips, rape and flax. Fields of potatoes can be included here, but most other vegetable crops are excluded, as are market gardens. If small plots of any of the above crops are mixed with other vegetables or grown in glasshouses or polythene tunnels, they should be classified as horticultural land - BC2. Note that rye-grass leys planted as part of an arable rotation are

excluded (see improved agricultural grassland - GA1). Depending on the intensity of fertiliser or herbicide use, seed sources and soil type, arable crops may harbour a variety of weed species. Common Poppy (Papaver rhoeas), Bladder Campion (Silene vulgaris), Wild Carrot (Daucus carota), Common Field speedwell (Veronica persica), Corn Spurrey (Spergula arvensis), Corn Marigold (Chrysanthemum segetum) and knotgrasses (Polygonum spp.) may be abundant in some arable fields. Other weeds that were formerly very common in corn or flax fields in Ireland but are now extremely rare include Cornflower (Centaurea cyanus) and the grass, Darnel (Lolium temulentum). Note that there is a separate category for tilled land - BC3 that has been prepared for planting but where the type of crop is unknown.

A field was identified in the eastern area of Tinnahinch from examining aerial imagery (see Figure 4.22, showing the placement of plastic film for maize cultivation). Ecologists did not actually enter this area because of its distance from the proposed works.

Figure 4.22. Example of BC1 (Source: Google (May 2020))

4.5.2 Stone Walls and Other Stonework (BL1)

This category incorporates stone walls and most other built stone structures in rural and urban situations, apart from intact buildings (see buildings and artificial surfaces - BL3) and coastal constructions made of stone (see sea walls, piers and jetties - CC1). It includes dry stone and old mortar walls that occur as field or property boundaries; retaining walls against banks of soil; stone walls that rise from rivers, canals or moats; stone bridges, viaducts and aqueducts; stone jetties or piers in lakes or rivers; derelict or ruinous buildings made of stone; and old stone monuments, fortifications or ruins. Note that modern or intact buildings made of stone are

excluded, as are any structures made of bricks, cement blocks or mass concrete (see buildings and artificial surfaces - BL3).

The most notable example of this habitat is Tinnahinch Castle (see Figure 4.23). The stone bridges and stone walls that form the quays along the Barrow have been mapped as BL3 (see Section 4.5.4) because they occur in conjunction with roads or other paved surfaces. The old stone buildings at the bottom of Turf Market have also been classified as BL3 because these are intact and not in ruins.

Figure 4.23. Example of BL1 (Tinnhinch Castle - 02.04.20)

4.5.3 Earth Banks (BL2)

Earth banks are a common type of field boundary in many parts of Ireland. Constructed from local materials such as peat, earth, gravel or stone, these narrow linear ridges are often bordered by drainage ditches. Most are completely vegetated when intact and feature elements of a range of habitats, including grassland, heath, hedgerow and scrub. Earth banks usually support abundant grasses and a wide range of broadleaved herbs such as Foxglove (Digitalis purpurea), violets (Viola spp.), Yarrow (Achillea millefolium), Common Knapweed (Centaurea nigra), Wild Strawberry (Fragaria vesca) and Primrose (Primula vulgaris). Dwarf shrubs (Calluna vulgaris, Vaccinium myrtillus, Erica spp.), shrubs, ferns and Ivy (Hedera helix) may also be common. Earth banks differ from hedgerows - WL1 in that the bank is the dominant physical feature in the former and, while trees and shrubs may be present, they do not dominate. They

differ from stone walls and other stonework - BL1 in that earth banks are usually wider, stones may be visible but not dominant, and vegetation cover is extensive.

Two earth banks were observed within the study area. The first is located along the river bank at the edge of the amenity grassland by the Barrow Valley Activities Hub. The second is at the northern edge of the amenity grassland that lies between the Barrow and Hotel St. in Tinnahinch (see Figure 4.24).

Figure 4.24. Example of BL2 at the edge of an amenity grassland in Tinnahinch - 16.02.21.

4.5.4 Buildings and Artificial Surfaces (BL3)

This broad category incorporates areas of built land that do not fit elsewhere in the classification. It includes all buildings (domestic, agricultural, industrial and community) other than derelict stone buildings and ruins (see stone walls and other stonework - BL1). It also includes areas of land that are covered with artificial surfaces of tarmac, cement, paving stones, bricks, blocks or astroturf (e.g. roads, car parks, pavements, runways, yards, and some tracks, paths, driveways and sports grounds). Unpaved areas are excluded (see spoil and bare ground - ED2). Any other built structures that are not made of natural stone, including walls made of bricks, cement blocks and mass concrete, should be considered here. Note that greenhouses and polythene tunnels are excluded (see horticultural land - BC2), as are refuse dumps (see refuse and other waste - ED5). Plant cover should not exceed 50%.

Being the site of a town, this habitat dominates the landscape. All roads, buildings, footpaths etc. fall into this category. Examples are available in many of the previous photographs – see Figure 4.18 for a good example of BL3 extending directly to the bank of the Duiske.

4.6 Annex I Habitats

This section provides a description of the confirmed/likely presence/absence of the habitats listed as Qualifying Interests of the River Barrow and River Nore SAC.

1130 Estuaries, 1140 Mudflats and sandflats, 1170 Reefs, 1310 *Salicornia* mud, 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*), 1410 Mediterranean salt meadows (*Juncetalia maritimi*).

These habitats are found in saline conditions (near the coast), and a significant distance downstream of the scheme area.

3260 Floating River Vegetation (Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation)

The following habitat description is taken from the most recent (2019) Article 17 Report by the NPWS:

"'Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation' has a broad definition, covering upland, flashy, oligotrophic, bryophyte- and algal-dominated rivers, to tidal reaches dominated by higher plants. In Ireland, the riverine areas of highest conservation interest are associated with lowland depositing and tidal rivers and unmodified, fast-flowing, low-nutrient rivers. A number of rare submerged and marginal species are found in the former including opposite-leaved pondweed (Groenlandia densa), water-starworts (e.g. Callitriche truncata), triangular club-rush (Schoenoplectus triqueter), needle spike-rush (Eleocharis acicularis) and mud-dwelling mosses (e.g. Ephemerum spp.).

Many Irish rivers have been heavily modified, particularly through arterial drainage and channelisation. These activities have changed channel hydrology and morphology, resulting in the accumulation of larger amounts of fine sediment. Such fines provide a rooting medium for plants and, as a result, stream water crowfoot (Ranunculus penicillatus) has increased in abundance. Consequently, the habitat erroneously became synonymous with water-crowfoot in Ireland. Crowfoot-dominated reaches frequently have low diversity and are of low conservation value, and an abundance of the species generally indicates poor condition and damage."

Further to the above, the Conservation Objectives for the River Barrow and River Nore SAC (NPWS, 2011) contains the following statement on this habitat (emphasis added):

"The full distribution of this habitat and its sub-types in this site is currently unknown. The basis of the selection of the SAC for the habitat is the presence of an excellent example of the vegetation community (nutrient-rich type) associated with extensive tufa deposits on the river bed in the Kings tributary of the Nore (Heuff, 1987). Other examples of this or other sub-types may be present within the SAC."

It should be noted that the Nore catchment does not include Graiguenamanagh-Tinnahinch, and there is no hydrological pathway between Graiguenamanagh-Tinnahinch and above-referenced tufa deposits in the Kings River. The Kings River is underlain by limestone (Geological Survey Ireland, 2021), which is what gives rise to tufa deposits. The underlying bedrock geology in Graiguenamanagh-Tinnahinch is non-calcareous, consisting of various compositions of slate, phyllite, schist, granite and granodiorite (GSI, 2021). The absence of calcareous bedrock (limestone) is a reliable indicator that tufa deposits are also absent. On the basis that tufa deposits are absent, this particular habitat does not occur within the study area.

4030 European dry heaths

This habitat is associated with peatland. It does not occur within the scheme area.

6430 Hydrophilous tall herb fringe communities

The following habitat description is taken from the most recent (2019) Article 17 Report by the NPWS:

"Three distinct communities can be considered for Hydrophilous tall-herb swamp in Ireland. The first is a lowland community of watercourses, particularly unmanaged edges of slow-moving rivers and the margins of lakes, which is dominated by tall hydrophilous herbs such as wild angelica (Angelica sylvestris), meadowsweet (Filipendula ulmaria), yellow iris (Iris pseudacorus), yellow loosestrife (Lysimachia vulgaris), purple-loosestrife (Lythrum salicaria) and common valerian (Valeriana officinalis). While horsetails (Equisetum spp.) are a common feature, monospecific stands of horsetails should not be included. Reed beds, large sedge swamps, large areas of fallow wet meadow and neophyte communities, e.g. with Indian balsam (Impatiens glandulifera), are also excluded.

The second community is an upland community of ungrazed or lightly grazed cliff ledges. Small patches (<1m across) occur on calcareous cliffs and on wet siliceous cliffs where there is some base enrichment from the water. Characteristic species include lady' s-mantles (Alchemilla spp.), wild angelica, marsh hawk' s-beard (Crepis paludosa), meadowsweet (Filipendula ulmaria), water avens (Geum rivale) and lesser meadow-rue (Thalictrum minus). Great wood-rush (Luzula sylvatica) may be present but ledges strongly dominated by this species are not included.

A third lowland community type also possibly occurs as a nitrophilous tall-herb community of woodland borders, referred to as a 'saum' community. This habitat has been little studied in Ireland and further investigation is required to determine if examples exist in Ireland."

From the surveys completed in February, the species assemblage of the habitats classified as FS1 suggest that they lack the species richness required to be considered an example of this Annex I habitat (referring in particular to the description of the "first community" in the first paragraph above). However, given the time of year, many species may not have been visible. Further surveys will be completed once the extents of the scheme are confirmed to establish presence/absence.

91A0 Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles

The following habitat description is taken from the most recent (2019) Article 17 Report by the NPWS:

"Old oak woodland generally occurs on podzolised soils in upland, southern and western regions, but also occurs on localised, non-waterlogged acid soils elsewhere. In areas with high rainfall a western oceanic subtype occurs that is rich in bryophytes, lichens and filmy ferns. A drier, comparatively species-poor subtype occurs on less rocky terrain. A third, more base-rich subtype is also found, differing from the previous two in the greater diversity of tree and herb species.

Typical species include the trees sessile oak (Quercus petraea), holly (Ilex aquifolium), downy birch (Betula pubescens) and rowan (Sorbus aucuparia); low woody species such as honeysuckle (Lonicera periclymenum), ivy (Hedera helix) and bilberry (Vaccinium myrtillus); ferns such as buckler ferns (Dryopteris spp.) and hard fern (Blechnum spicant); great wood-rush (Luzula sylvatica); and many bryophytes including Dicranum spp., Hylocomium brevirostre, Mnium hornum, Plagiothecium undulatum, Polytrichum formosum, Rhytidiadelphus spp., Thuidium tamariscinum, Diplophyllum albicans, Saccogyna viticulosa and Scapania gracilis."

Old oak woodlands are present on the southern side of the Barrow, south-east of the rowing club. This woodland has been identified and mapped in the Article 17 Report spatial data.

91E0 Alluvial forests with *Alnus glutinosa* and Fraxinus excelsior (*Alno-Padion, Alnion incanae, Salicion albae*)*

The following habitat description is taken from the most recent (2019) Article 17 Report by the NPWS:

"A number of variants of Alluvial woodland habitat exist, of which riparian forests of ash (Fraxinus excelsior) and alder (Alnus glutinosa) (Alno-Padion) of temperate and Boreal Europe lowland and hill watercourses are the most common in Ireland. All types occur on heavy soils which are periodically inundated by the annual rise of river levels but otherwise well-drained and aerated during low water. The herbaceous layer includes many large species such as meadowsweet (Filipendula ulmaria), wild angelica (Angelica sylvestris), wood dock (Rumex sanguineus) and sedges (Carex spp.), vernal species such as lesser celandine (Ficaria verna) and wood anemone (Anemone nemorosa), and other indicative species such as remote sedge (Carex remota), gypsywort (Lycopus europaeus), common nettle (Urtica dioica) and water avens (Geum rivale). In addition, there are gallery forests of tall willows (Salicion albae) alongside river channels and occasionally on river islands, where the tree roots are almost continuously submerged. These are dominated by white willow (Salix alba), osier (S. viminalis) and almond willow (S. triandra), sometimes with grey willow (S. cinerea), but alder should be rare. There is a luxuriant herb layer of species such as reed canary-grass (Phalaris arundinacea), common nettle and meadowsweet.

A number of pressures affect this habitat in Ireland, the most serious being invasive species, particularly sycamore (Acer pseudoplatanus), beech (Fagus sylvatica), Indian balsam (Impatiens glandulifera) and currant species (Ribes nigrum and R. rubrum). Some native species such as brambles (Rubus fruticosus agg.) and common nettle can also become over-vigorous. Small area losses due to clear-felling have also occurred."

The woodland located at the confluence of the Duiske and the Barrow fits this description (see Section 4.3.3). This is therefore considered an Annex I habitat, it is a Qualifying Interest of the SAC and is for this reason of high ecological significance.

5 Flora

This chapter provides a summary of the flora identified on site. Please see Section 2.5 for an explanation of the limitations for flora surveys. A full list of flora observed during the site visit is presented in Appendix C.

5.1 Species of Conservation Interest

No flora species of conservation interest were observed. This includes all species listed in Schedules A and B of the Flora (Protection) Order 2015 (S.I. No. 356/2015).

5.2 Invasive Species

in

Figure 5.1. Himalayan Balsam seedlings (example circled) – 02.04.21

Figure 5.2. Japanese Knotweed Signage - 16.02.21

Figure 5.3. Giant Rhubarb - photograph taken from R705 bridge over River Duiske – 02.04.21

5.3 Trees

In accordance with the methodology outlined in Section 2.4.1, a total of 77 trees were surveyed in Graiguenamanagh-Tinnahinch. The survey results are presented in Appendix F.

As a general observation, the assemblage of tree species was reasonably consistent across the site. Dominant species were Alder, Ash, Willow and Sycamore.

At least 13 species of tree were observed. The time of year was not ideal for identifying willows, oaks and birches to species level. On occasion certain features were available to enable this – Tree ID 57 for example was able to be identified as Pedunculate Oak because its leaves were still attached.

Section 2.4.1 made reference to the following areas where tree surveys were to be concentrated, which corresponded to areas proposed by the CFRAM Study for hard defences, as well as areas identified by ByrneLooby engineers as being of interest:

a. The canal and mill race around Tinnahinch Castle

b. Along the Duiske from Turf Market up as far as the footbridge over the Duiske that leads to the Aldi carpark

c. Along the mouth of the Duiske in the wooded area where it joins the Barrow

d. Further north of the footbridge (see b. above) along the Duiske towards Aldi

e. The inlet to the culvert where the Killeen Stream flows under the R705 and re-emerges by the roundabout near Aldi.

General comments on these areas are provided below.

a. Along this short stretch of the canal there are no trees at the water's edge. Two large trees with ecological potential were noted in a private walled garden (T58 and T63), but these are separated from the canal by a boundary wall and a public walkway. The mill race is quite heavily-wooded, with tree height ranging from ~8-20 metres. Trunk diameters ranged from ~15-60 cm.

b. Trees are generally scarce in this area, save for a small area at the very southern end (by Turf Market). Access to these trees was restricted due to the flow in the Duiske at the time of surveying. Trees are infrequent moving up the Duiske through the town, although there is a handful of small scrubby willows and *Buddleja*. There is a small treeline along the western bank of the Duiske, just south of the footbridge used to access Aldi car park. This comprised willow, alder, ash and sycamore. Heights ranged from ~5m to ~20m, with trunk diameters ranging from ~10-50 cm.

c. A handful of quite large trees exist in this area. These were ash, oak, sycamore and birch. These trees' heights ranged between ~20-25 metres, and trunk diameter between

~30-65 cm. Many of these trees had significant ivy and moss growth, and one of the trees (T30) had some cracks in the bark that were identified from ground level.

d. Most of the trees were on the opposite bank (see Figure 10). These were mostly moderate in height (~15m) with trunk diameters of ~15-20 cm. Two large stands of trees were noted – one of sycamore and the other of ash. This habitat continues north for ~100m as far as the bridge that vehicles use to access Aldi car park. This 100m stretch was inaccessible, but the ecologist is confident that sufficient data has been obtained from the adjoining area to be confident that the habitat and species assemblage is consistent. There were no obvious notable features (cracks, hollows or nests) on any of the trees, although ivy was an occasional feature.

e. Two trees were noted along the eastern bank of the Killeen Stream in this area. These were pedunculate oak and alder. Neither of these are particularly mature or possess any features of ecological note.

At least 13 species of tree were observed.

Three species were estimated as being over 100 years old (Tree IDs T53, T58 and T63) – see Table 5.1 overleaf). These trees have intrinsic value by virtue of their age, as well as ecological value due to their size and shelter opportunity for fauna.

Of these, only T58 and T63 loosely correspond to one of the areas identified for potential works in the CFRAMS study ("loosely" in the sense that they are in a private garden and not on the waterfront).

Table 5-1. Trees >100 years old (estimated)

Tree ID	Species	Estd. Age (yrs)	Location
T53	Ash	126	By mill race, ~10m south of where it flows under the R705.
T58	Horse chestnut	101	In a private garden by Tinnahinch Castle.
T63	Horse chestnut	101	In a private garden by Tinnahinch Castle.

The maps in Appendix G show the locations of all trees surveyed.

6 Fauna

This section of the report provides a summary of the desk study and site surveys for the following faunal species:

- Otter (*Lutra lutra*)
- Red Squirrel (*Sciurus vulgaris*)
- Pine Marten (*Martes martes*)
- Badger (*Meles meles*)
- Bats
- Other mammals
- Herpetofauna
- Birds
- Aquatic Fauna

6.1 Otter (*Lutra lutra*)

6.1.1 Existing Records

Records were available from the National Biodiversity Data Centre (NBDC) and from the NPWS Article 17 Spatial Dataset (2019). IDs A and B in Table 6.1 below are from the NBDC, and IDs C-F are from the Article 17 dataset. Locations are shown in Table 6-1, Figure 6.1 and Figure 6.2).

Table 6-1. Existing Records - Otter

ID	Grid Ref.	Date	Precision	Notes
A	S684444	23/11/04	100m	NBDC Narrow stream with dense riparian vegetation of gorse and brambles and a few trees. Surrounding grassland very wet and used for grazing cattle. / 2 spraints 200m u/s on rock just away from stream
B	S722446	04/04/17	100m	NBDC Sighting of live animal
ID	Coordinates (ITM)	Date	Precision	Notes
C	673585, 645895	n/a	n/a	Article 17 Spatial Data
D	673534, 645845	n/a	n/a	Article 17 Spatial Data
E	672186, 644694	n/a	n/a	Article 17 Spatial Data
F	671990, 639396	n/a	n/a	Article 17 Spatial Data

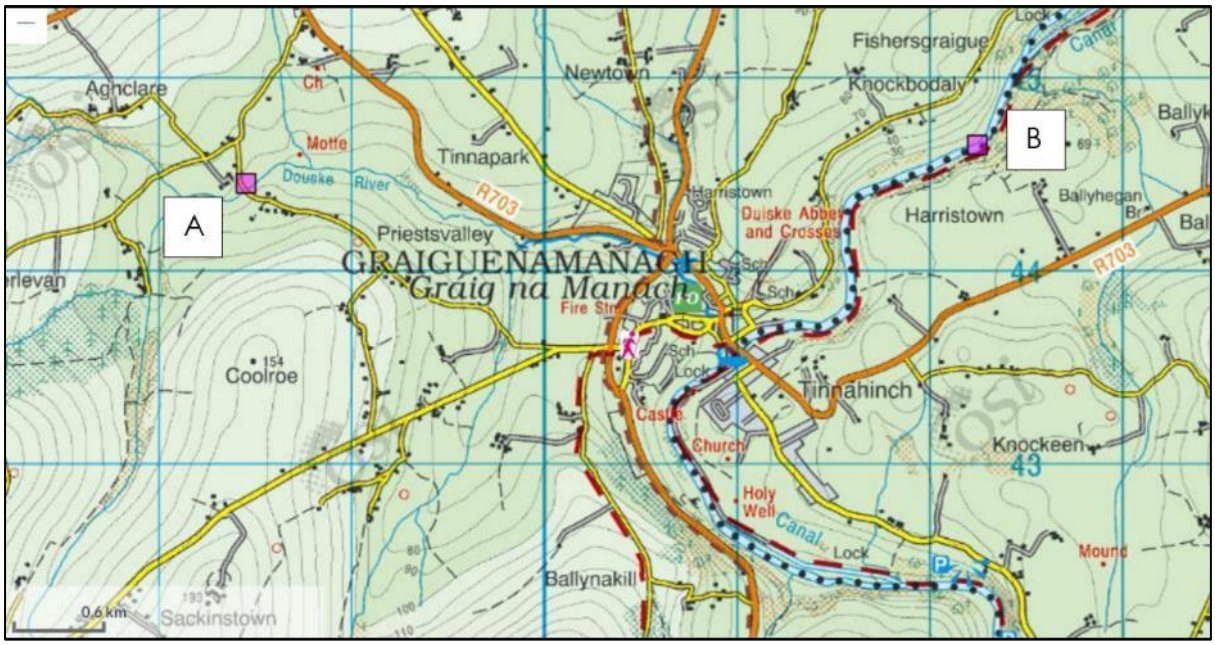

Figure 6.1. NBDC Records for Otter

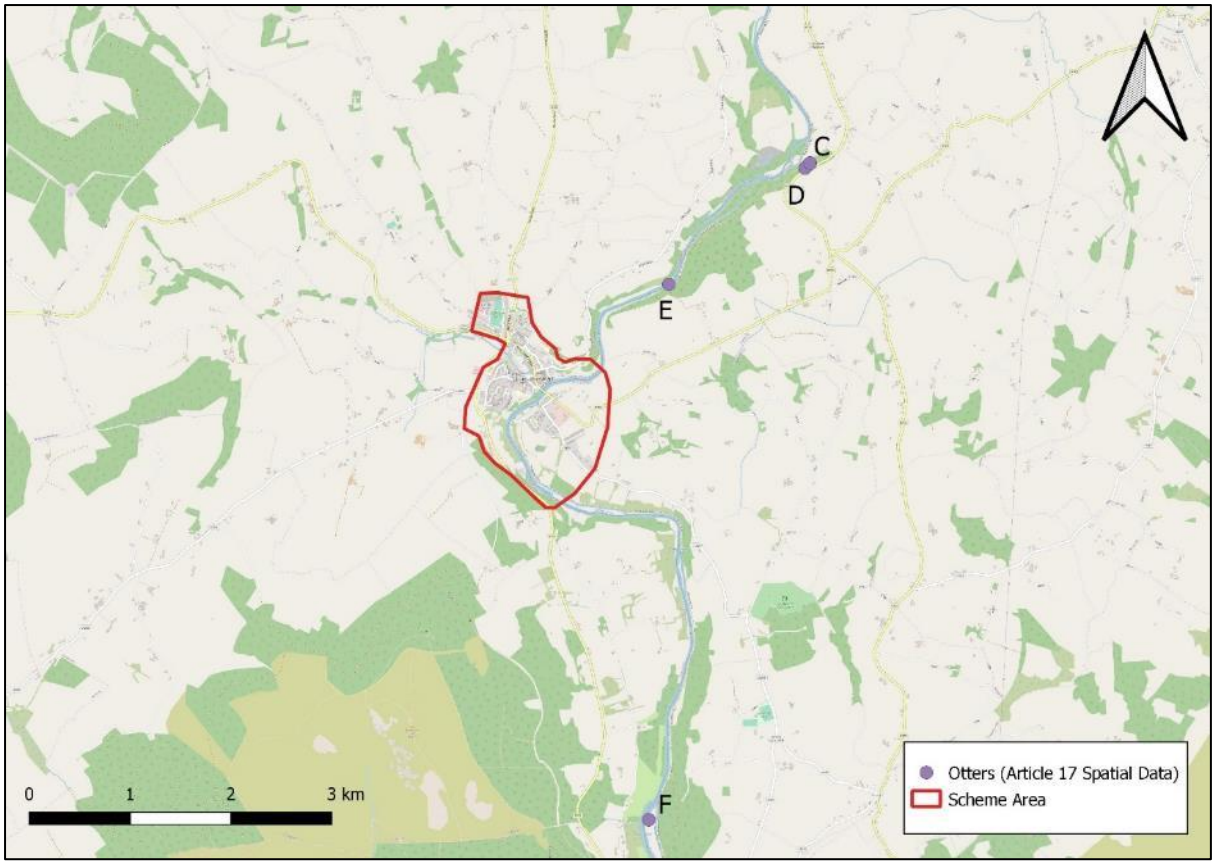

Figure 6.2. Records from Article 17 Report Spatial Dataset (NPWS, 2019)

6.1.2 Field Survey

Evidence of otter activity is presented in table 6.2 and the locations shown in Figure 6.3.

Table 6-2. Field Survey - Evidence of Otters

ID	Coordinates (ITM)	Notes
1	670526, 644040	Potential couch – adjacent to where the mill race joins the canal by Tinnahinch Castle (see Figure 6.4).
2	670659, 643367	Potential holts. Located where mill race goes under the R705 near Aldi. This area is extremely dry due to the shelter of the overpass – there is very little vegetation, and the soil is very loose. There are a number of scars in the embankment where it seems otters have attempted to burrow, but the soil was too unstable to sustain a solid tunnel and kept collapsing. For this reason, the BL ecologists note that it is unclear if any of these were ever viable holts (see Figure 6.5).
3	670624, 643195	Potential spraint. It had a grainy texture common with otter spraints, but had a pale colour that suggested that it may simply be dog faeces. Located on a clump of grass on the riverbank (see Figure 6.6).

Figure 6.3. Locations of evidence of otters

Figure 6.4. Potential otter couch (ID-1) – 16.02.21

Figure 6.5. Potential otter holt (ID-2) – 17.02.21

Figure 6.6. Potential spraint (ID-3) – 16.02.21

6.2 Red Squirrel (*Sciurus vulgaris*)

6.2.1 Existing Records

Records available from the NBDC:

Table 6-3. Existing Records – Red Squirrel

ID	Grid Ref	Date	Precision	Notes
A	S705431	20/05/11	100m	Live animal sighting
B	S710434	11/05/18	100m	Roadkill
C	S720435	16/09/15	100m	Live animal sighting

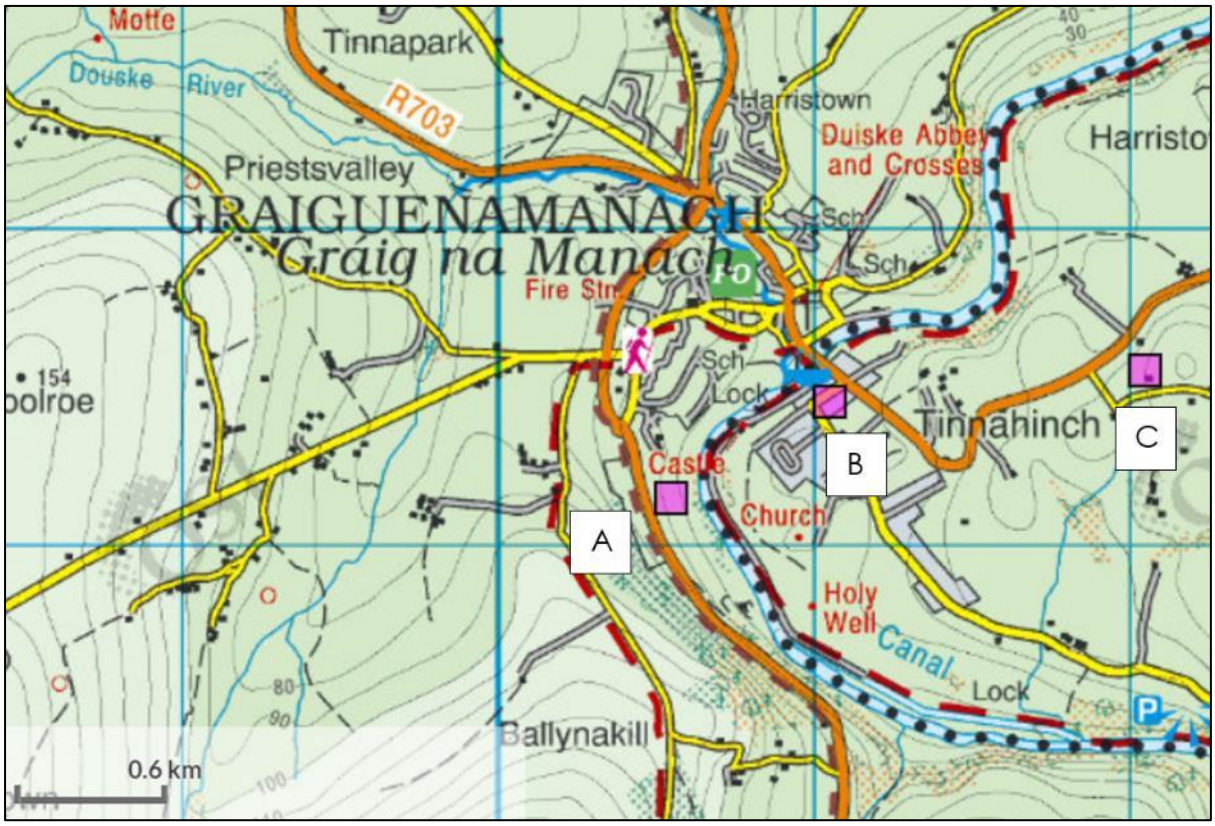

Figure 6.7. NBDC records for red squirrel

6.2.2 Field Survey

No evidence of squirrel activity was observed during the field surveys.

6.3 Pine Marten (*Martes martes*)

6.3.1 Existing Records

There are no records available from the NBDC of pine martens in Graiguenamanagh-Tinnahinch or its surroundings. There is a record from 1984 that applies to the 10-km square in which Graiguenamanagh-Tinnahinch is situated, but this resolution is too low to provide location details.

6.3.2 Field Survey

No evidence of pine marten activity was observed during the field surveys.

6.4 Badger (*Meles meles*)

6.4.1 Existing Records

Records available from the NBDC:

Table 6-4. Existing Records - Badger

ID	Grid Ref	Date	Precision	Notes
A	S6944	2006	1km	Badger Setts
B	S7044	2005	1km	
C	S7144	2005	1km	
D	S7143	2004, 2005	1km	

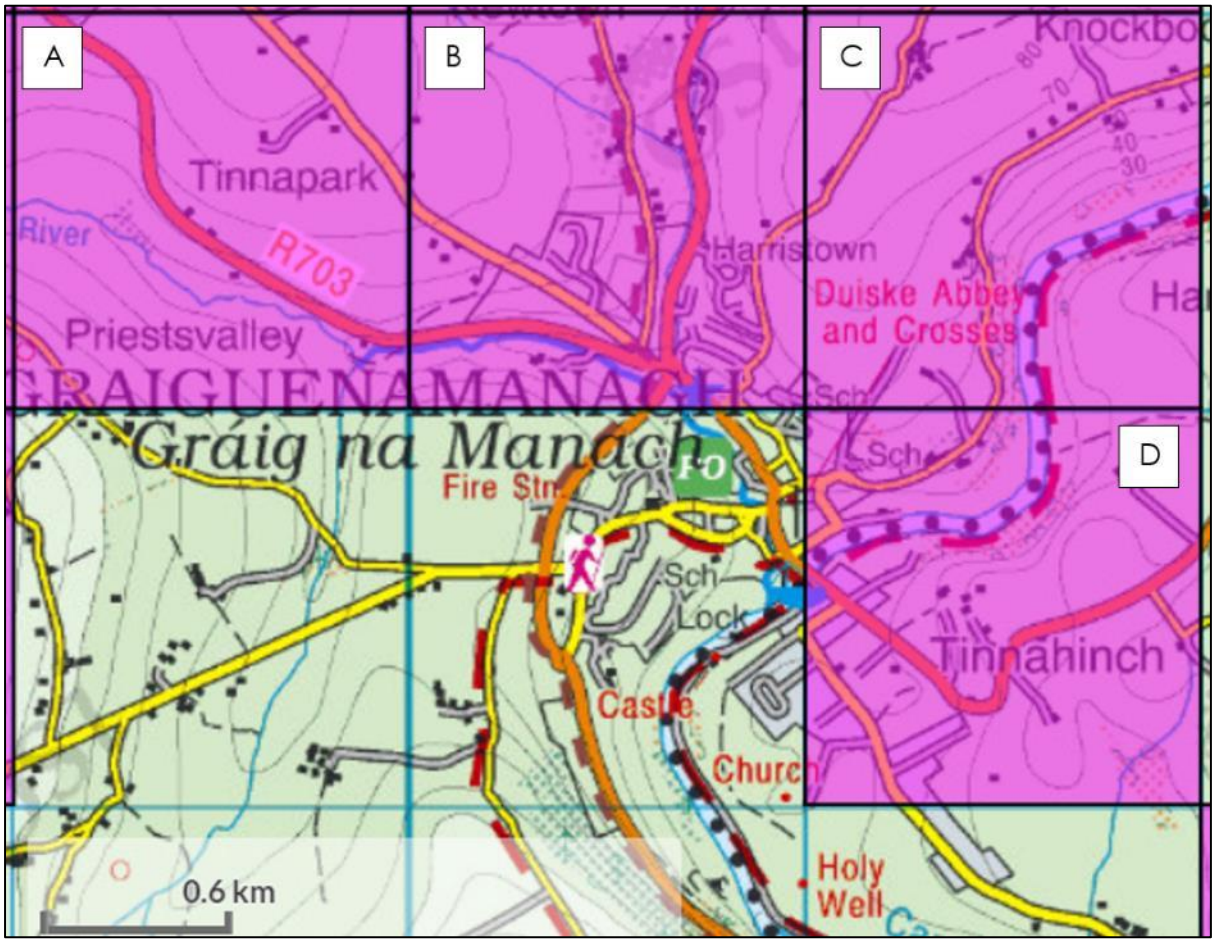

Figure 6.8. NBDC records for badger

6.4.2 Field Survey

No evidence of badger activity was observed during the field surveys.

6.5 Bats

A bat survey has already been completed. Soprano pipistelles (*Pipistrellus pygmaeus*) were observed emerging from and returning to roosts in (or very near to) Tinnahinch Castle and an old building on Turf Market, near Peg Washington Lane. The survey also noted frequent observations of commuting and foraging bats. Other species observed were common pipistrelle (*Pipistrellus pipistrellus*) and Daubenton's bat (*Myotis daubentonii*).

6.6 Other Mammals

Faeces of the Eurasian rabbit (*Oryctolagus cuniculus*) were observed in the field adjoining the Killeen Stream at the northern end of the scheme area.

6.7 Herpetofauna

6.7.1 Existing Records

Records available from the NBDC are as follows.

6.7.1.1 Smooth Newt (*Lissotriton vulgaris*)

There are no records available from the NBDC of smooth newt in Graiguenamanagh-Tinnahinch or its surroundings.

6.7.1.2 Natterjack Toad (*Epidalea calamita*)

There are no records available from the NBDC of natterjack toad in Graiguenamanagh-Tinnahinch or its surroundings. This is a very rare species with a distribution restricted to coastal habitats in Co. Kerry.

6.7.1.3 Common Frog (*Rana temporaria*)

Records available from the NBDC:

Table 6-5. Existing Records - Common Frog

ID	Grid Ref	Date	Precision	Notes
A	S7043	09/02/13 09/02/19	1km	Spawn
B	S715440	09/02/19	100m	Spawn

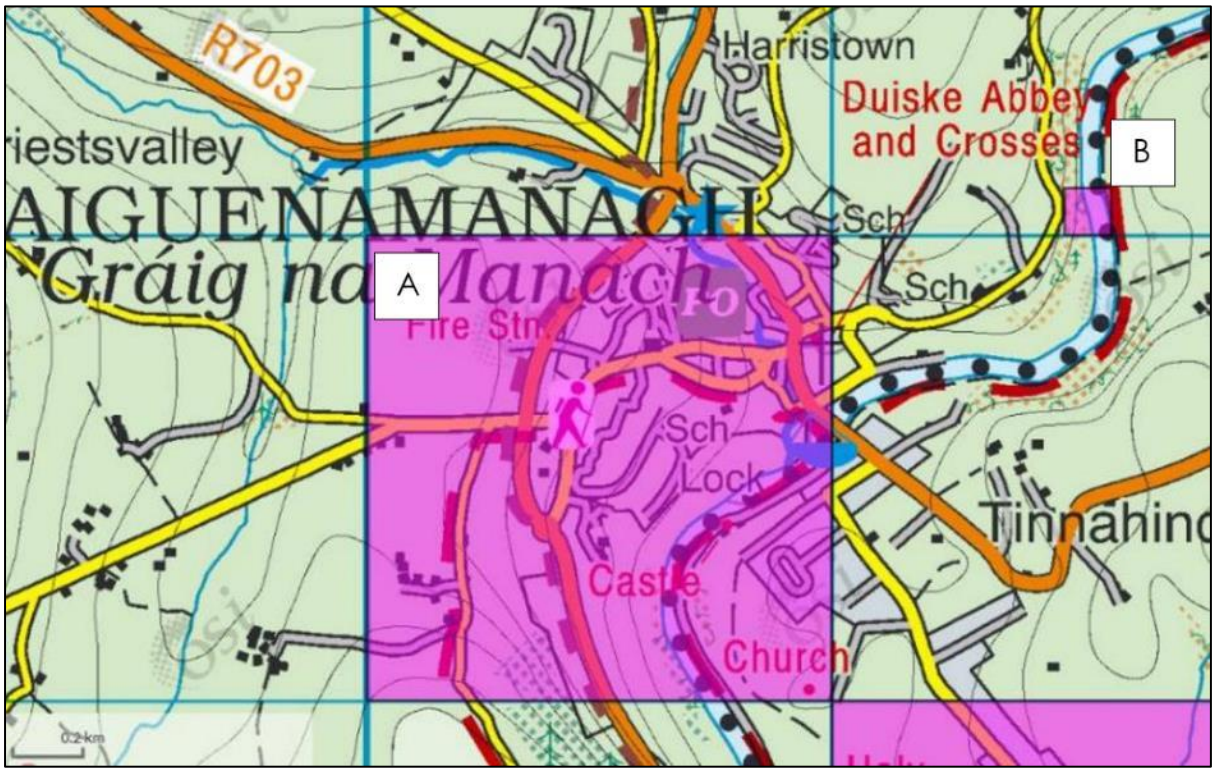

Figure 6.9. NBDC records for the common frog

6.7.2 Field Survey

6.7.2.1 Smooth Newt (*Lissotriton vulgaris*)

No evidence of smooth newt was observed during the field surveys.

6.7.2.2 Natterjack Toad (*Epidalea calamita*)

No evidence of natterjack toad was observed during the field surveys.

6.7.2.3 Common Frog (*Rana temporaria*)

Evidence of common frog activity is presented in table 6.6 and the locations shown in Figure 6.10.

Table 6-6. Field Records - Common Frog

ID	Coordinates (ITM)	Notes
1	671192, 643714	Frogspawn. Located in small area of reed swamp (see section 4.1.4). See photograph – Figure 6.11
2	671349, 643713	Frogspawn. Located on leaf litter, creeping buttercup and cleavers – not in standing water (see Figure 6.12)

Figure 6.10. Locations of common frog spawn sightings

Figure 6.11. Frogspawn (ID-1) – 16.02.21

Figure 6.12. Frogspawn (ID-2) – 16.02.21

6.8 Birds

6.8.1 Existing Records

The species listed in Appendix E have been recorded in the 2-km grid squares S74B and S74C as illustrated in Figure 6.13. Records go as far back as 1991.

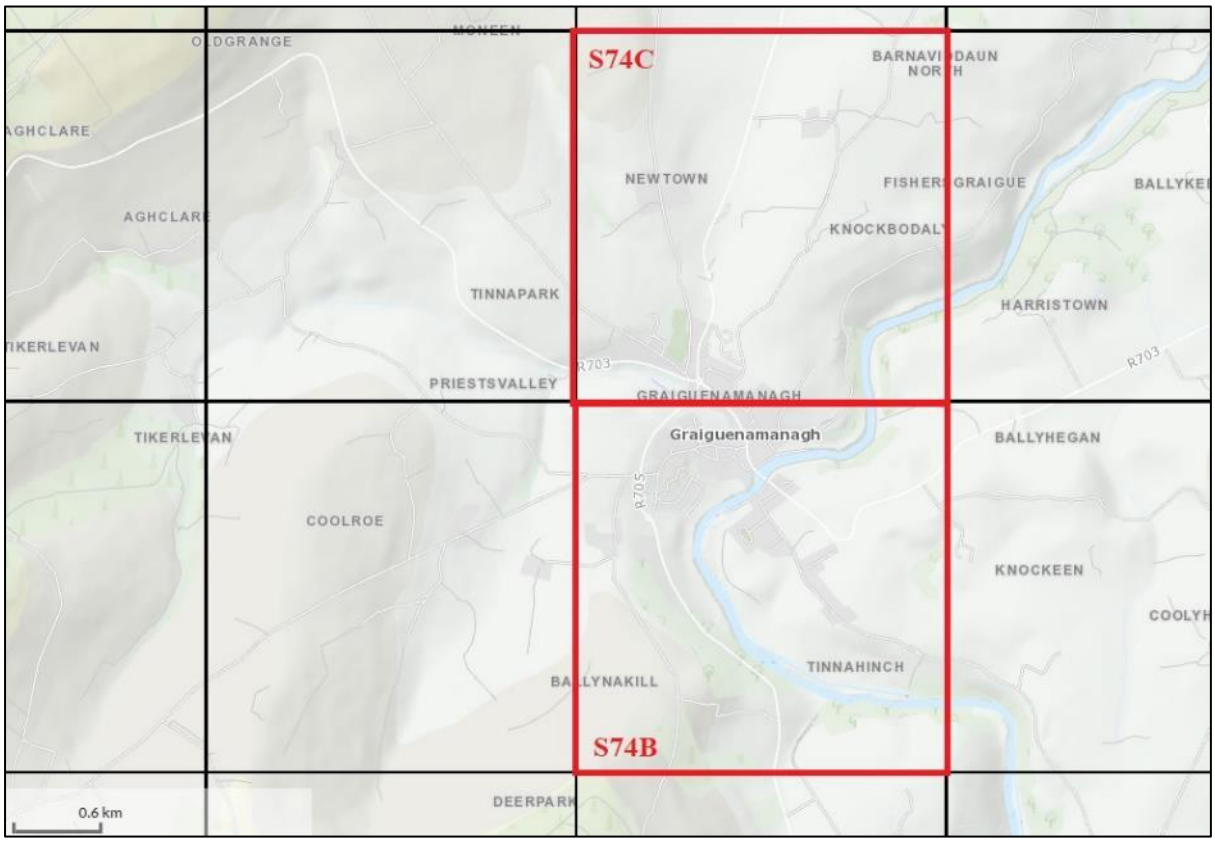

Figure 6.13. Location of S74B and S74C, from which existing records of birds were sourced.

6.8.2 Field Survey

A total of 32 bird species were recorded at the site between the wintering survey and breeding survey. Tables 6.7 and 6.8 list the species in order of abundance for each survey period. Mean species richness was highest in Transect A, and lowest in Transect D (see Table 6.9). During the wintering survey, 21 species were recorded; 25 were recorded during the breeding survey. Results of the bird surveys are presented in Appendix E.

Of the species identified, 8 are protected under the Wildlife Acts, 5 are listed on BOCCI's Amber list, and 3 are listed in Annex II and III of the EU Birds Directive.

The Great Spotted Woodpecker is not designated, but had been absent from Ireland for over 100 years until 2005, when it re-appeared in Co. Wicklow. It appears to have been gradually increasing its range since then, although no official records exist for the woodlands around Graiguenamanagh-Tinnahinch. There is a record from 2015 near Borris, Co. Carlow (~7km

upstream). During the surveys, the characteristic drumming of the woodpecker was heard in two locations – in the woodland on the Carlow side of the Barrow opposite the boat club, and in the woodland on the Kilkenny side, northwest of Tinnahinch Castle. However, anecdotal information suggests that this sound is a lesser-known sound made by a "raven". There are several resources online making reference to a vocalised "drumming" sound sometimes made by carrion crows (*Corvus corone*) that is sometimes misinterpreted as the drumming of a woodpecker (British Birds, 1951). There are no existing records of *C. corone*. The ecologist could not obtain a sighting of the bird, so it could not be confirmed one way or the other. If Great Spotted Woodpeckers inhabit woodlands a short distance upstream, then it is not unlikely that they have increased their range to include the woodlands around Graiguenamanagh-Tinnahinch.

Table 6-7. Species Abundance (Wintering Survey)

Species	Scientific Name	No. of Transects with +ve ID	Designation
Rook	*Corvus frugilegus*	5	N/A
Blackbird	*Turdus merula*	4	N/A
Chaffinch	*Fringilla coelebs*	4	N/A
House Sparrow	*Passer domesticus*	4	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Blue tit	*Cyanistes caeruleus*	3	N/A
Great tit	*Parus major*	3	N/A
Coal tit	*Periparus ater*	2	N/A
Collared Dove	*Streptopelia decaocto*	2	N/A
Jackdaw	*Corvus monedula*	2	N/A
Magpie	*Pica pica*	2	N/A
Mallard	*Anas platyrhinchos*	2	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III
Pied wagtail	*Motacilla alba yarrellii*	2	N/A
Wren	*Troglodytes troglodytes*	2	N/A
Buzzard	*Buteo buteo*	1	N/A
Cormorant	*Phalacrocorax carbo*	1	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Great Spotted Woodpecker	*Dendrocopus major*	1	N/A
Greenfinch	*Carduelis chloris*	1	N/A
Mute swan	*Cygnus olor*	1	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Robin	*Erythacus rubecula*	1	N/A
Song thrush	*Turdus philomelos*	1	N/A
Woodpigeon	*Columba palumbus*	1	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III

Table 6-8. Species Abundance (Breeding Survey)

Species	Scientific Name	No. of Transects with +ve ID	Designation
Blackbird	*Turdus merula*	5	N/A
Chaffinch	*Fringilla coelebs*	5	N/A
Great tit	*Parus major*	4	N/A
Rook	*Corvus frugilegus*	4	N/A
Woodpigeon	*Columba palumbus*	4	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III
Blue tit	*Cyanistes caeruleus*	3	N/A
Robin	*Erythacus rubecula*	3	N/A
Song thrush	*Turdus philomelos*	3	N/A
Starling	*Sturnus vulgaris*	3	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Wren	*Troglodytes troglodytes*	3	N/A
Blackcap	*Sylvia atricapilla*	2	N/A
Chiffchaff	*Phylloscopus collybita*	2	N/A
Goldfinch	*Carduelis carduelis*	2	N/A
Great Spotted Woodpecker	*Dendrocopus major*	2	N/A
House Sparrow	*Passer domesticus*	2	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Long-tailed tit	*Aegithalus caudatus*	2	N/A
Magpie	*Pica pica*	2	N/A
Barn Swallow	*Hirundo rustica*	1	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Jackdaw	*Corvus monedula*	1	N/A
Mallard	*Anas platyrhinchos*	1	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III
Pheasant	*Phasianus colchicus*	1	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III
Raven	*Corvus corax*	1	N/A
Treecreeper	*Certhia familiaris*	1	N/A
Whitethroat	*Sylvia communis*	1	N/A
Willow warbler	*Phylloscopus trochilus*	1	N/A

Table 6-9. Species richness at each survey transect

Transect ID	Species Richness		
	Wintering Survey	Breeding Survey	Mean
A	10	10	10
B	6	13	9.5
C	9	10	9.5
D	9	6	7.5
E	6	10	8
F	8	10	9

6.8.3 Kingfisher Perches

Sites deemed suitable for perching Kingfishers were recorded and are shown in Table 6.10 and Figures 6.14 and 6.15 below. Suitable perches are generally narrow, stable structures that allow Kingfishers to perch above flowing water while searching for prey. In total, 18 Kingfisher perches were recorded.

Table 6-10. Kingfisher Perches

ID	Coordinates (ITM)	Notes
KF1	671422, 643799	Alder branches
KF2/3	671362, 643720	Ash branches
KF4	670806, 643465	Pollarded tree – species unconfirmed (probably willow)
KF5	670605, 643229	Ash branches
KF6	670688, 643377	Overhanging willow
KF7	670785, 643871	Willow branches
KF8	670781, 643876	Alder branches
KF9	670755, 643920	Alder branches
KF10	670744, 643945	Ash and sycamore branches
KF11	670735, 643972	Sycamore branches
KF12	670735, 643972	Overhanging ivy
KF13	670596, 643965	Steel bar associated with concrete structure on mill race
KF14	670572, 644012	Fallen branch (blackthorn) spanning mill race
KF15	670267, 644235	Collection of dead stumps and branches spanning Duiske
KF16	670226, 644244	Alder branches
KF17	670126, 644179	Fallen branches with ivy spanning Duiske
KF18	669975, 644210	Sycamore branches

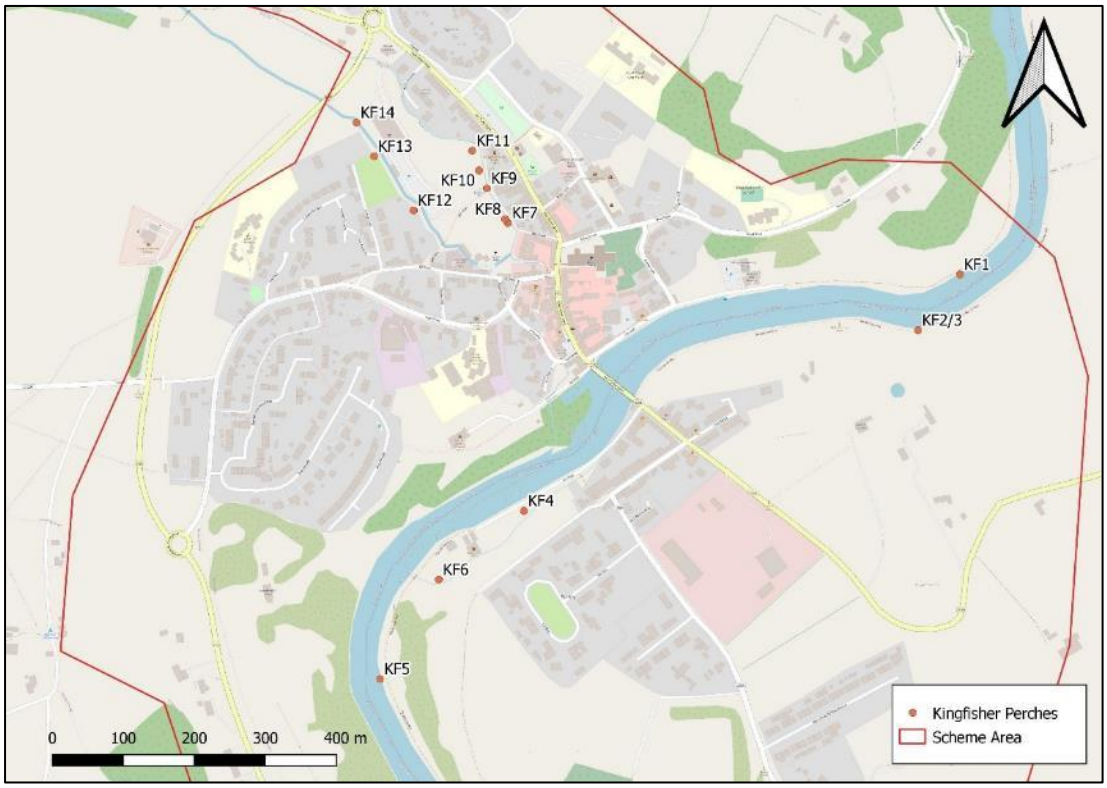

Figure 6.14. Kingfisher Perches (KF1-KF14)

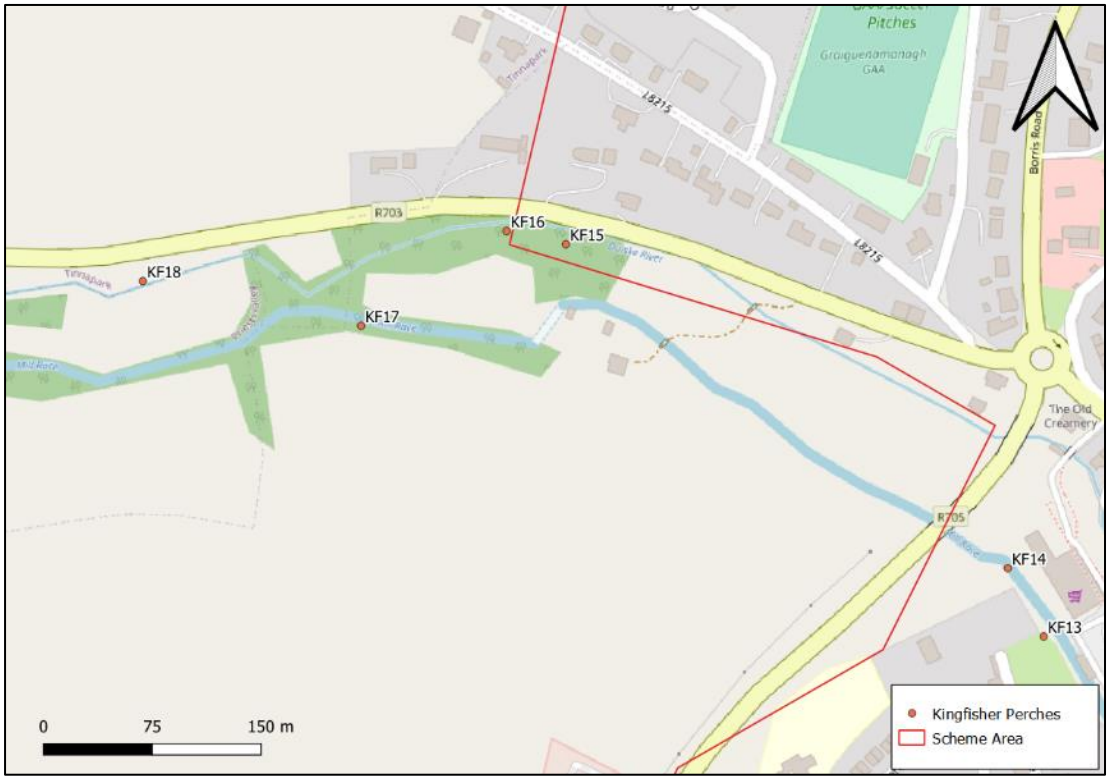

Figure 6.15. Kingfisher Perches (KF15-KF18)

6.9 Aquatic Fauna

This section summarises the existing records available for aquatic fauna.

6.9.1 Fisheries Assessment

A desk-based fisheries assessment was carried out by Aquafact in 2021. This report focuses on a study carried out by Delanty *et al.* (2017) on fish stocks in the entire catchment of the Barrow. The below text is adapted from the concluding summary of Aquafact's Fisheries Assessment.

The River Duiske catchment supports at least four species of fish, namely brown trout (*Salmo trutta*), Atlantic salmon (*Salmo salar*), European eel (*Anguilla anguilla*) and at least one of three species of lamprey. The adjacent River Barrow supports up to twelve species of fish as per the below table from Delanty *et al.* (2017).

Table 6-11. Fish species in the River Barrow catchment (Delanty *et al.*, 2017).

Fish Species	Total Count	No sites present
Dace	1381	32
Roach	754	28
Perch	224	26
Minnow	442	24
Atlantic Salmon (juvenile)	774	20
Atlantic Salmon (adult)	19	7
Pike	58	19
Gudgeon	215	17
Brown Trout (juvenile and adult)	139	16
European Eel	33	15
Stone loach	22	11
Roach x Bream hybrids	14	6
3 spined stickleback	8	1
Flounder	2	1

The non-migratory fish species listed could be expected to inhabit the main River Barrow throughout the year. Migratory adult Atlantic salmon, destined to spawn in the River Duiske catchment, might be expected to enter the River Barrow during the summer months and perhaps remain in the river's deep water until the completion of maturation and the initiation of movement into the River Duiske perhaps during the month of December. The nature of the River Duiske does not suggest that it offers suitable holding habitat for adult salmon over a prolonged period. Juvenile salmon might be expected to leave the River Duiske at the smolt stage, typically during the months of March through May, when river flows are elevated and the water temperature range is 7-13°C. Salmon smolt migrating downstream from areas higher up in the River Barrow catchment might also be expected to pass through Graiguenamanagh during the months March through May when river flows are elevated and the water temperature range is 7-13°C. The River Barrow catchment currently supports an Atlantic salmon population / stock which is

estimated to be below its Conservation Limit, based on recent catchment wide electrofishing survey data.

6.9.2 NBDC Records and Article 17 Reports Spatial Data

6.9.2.1 Twaite Shad (*Alosa fallax*)

One record is held by the NBDC (see table below and Figure 6.16).

Table 6-12. Existing Records – Twaite Shad (NBDC)

ID	Grid Ref	Date	Precision	Notes
A	S726379	10/05/2014	100m	Irish Federation of Sea Anglers Catch Data

The Article 17 Spatial Dataset provides an indication of the species' distribution and range. For this species, the distribution was deemed (by NPWS and their consultants) to be same as the range. The range and distribution is represented at a resolution of 10km. Each 10km-square inside which records exist is simply shaded in.

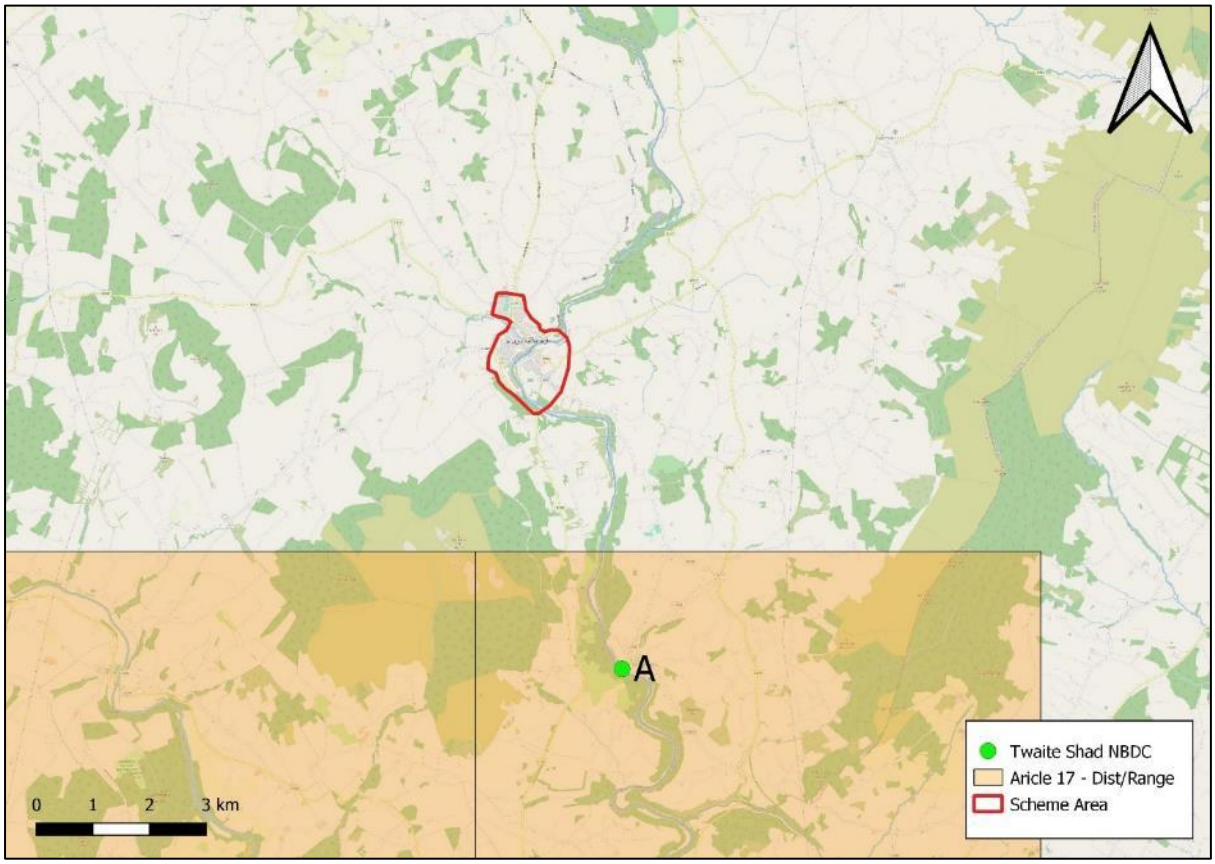

Figure 6.16. Existing Records - Twaite Shad

6.9.2.2 Sea Lamprey (*Petromyzon marinus*)

The NBDC records relevant to this site are at a resolution of 10km, and correlate exactly to the 10km-squares shown in Figure 6.17, which represent the distribution and range of sea lamprey, according to the most recent Article 17 Report Data.

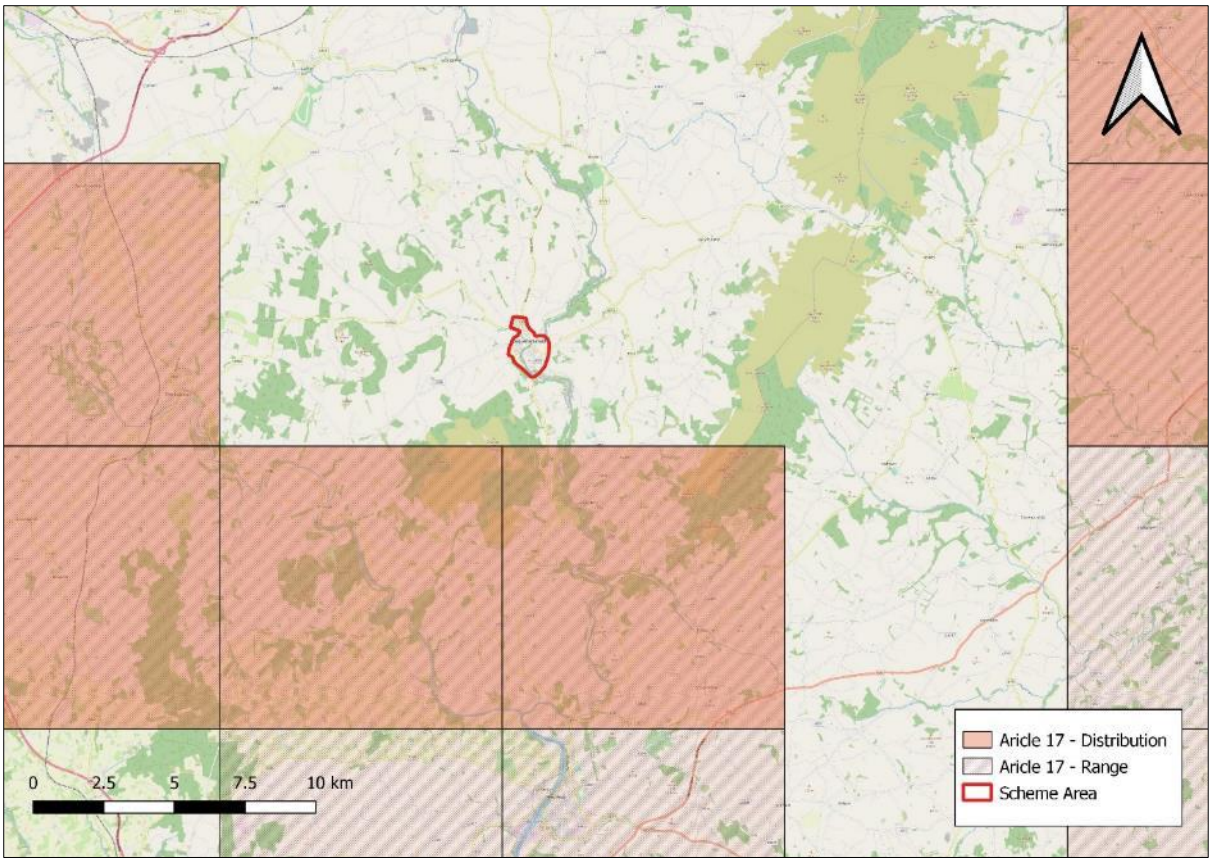

Figure 6.17. Existing Records - Sea Lamprey

6.9.2.3 Atlantic Salmon (*Salmo salar*)

There are no NBDC records relevant to this site. The distribution and range of Atlantic salmon (as per Article 17 Reports) are shown in Figure 6.18. Its distribution and range spans almost the entire country.

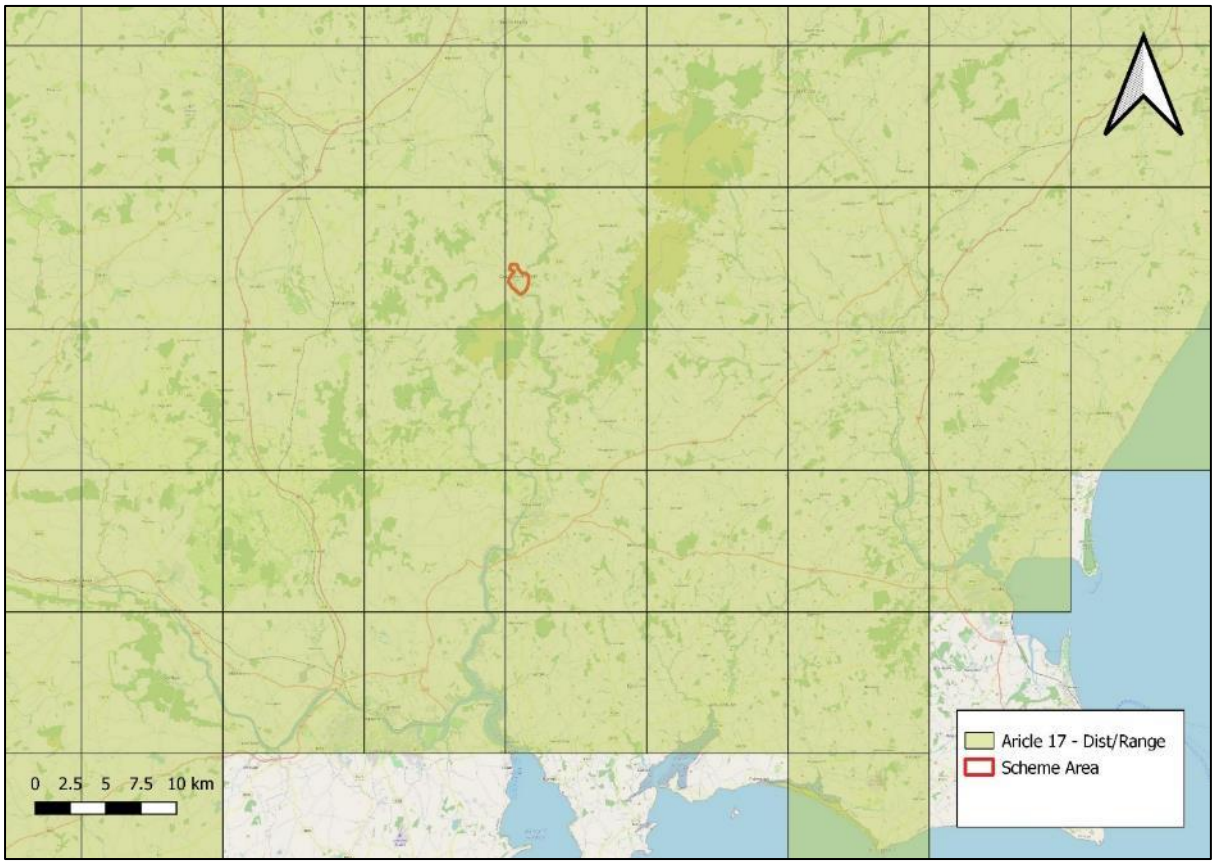

Figure 6.18. Existing Records - Atlantic Salmon

6.9.2.4 Brook lamprey (*Lampetra planeri*)

There are no NBDC records relevant to this site. The distribution and range of brook lamprey (as per Article 17 Reports) are shown in Figure 6.19.

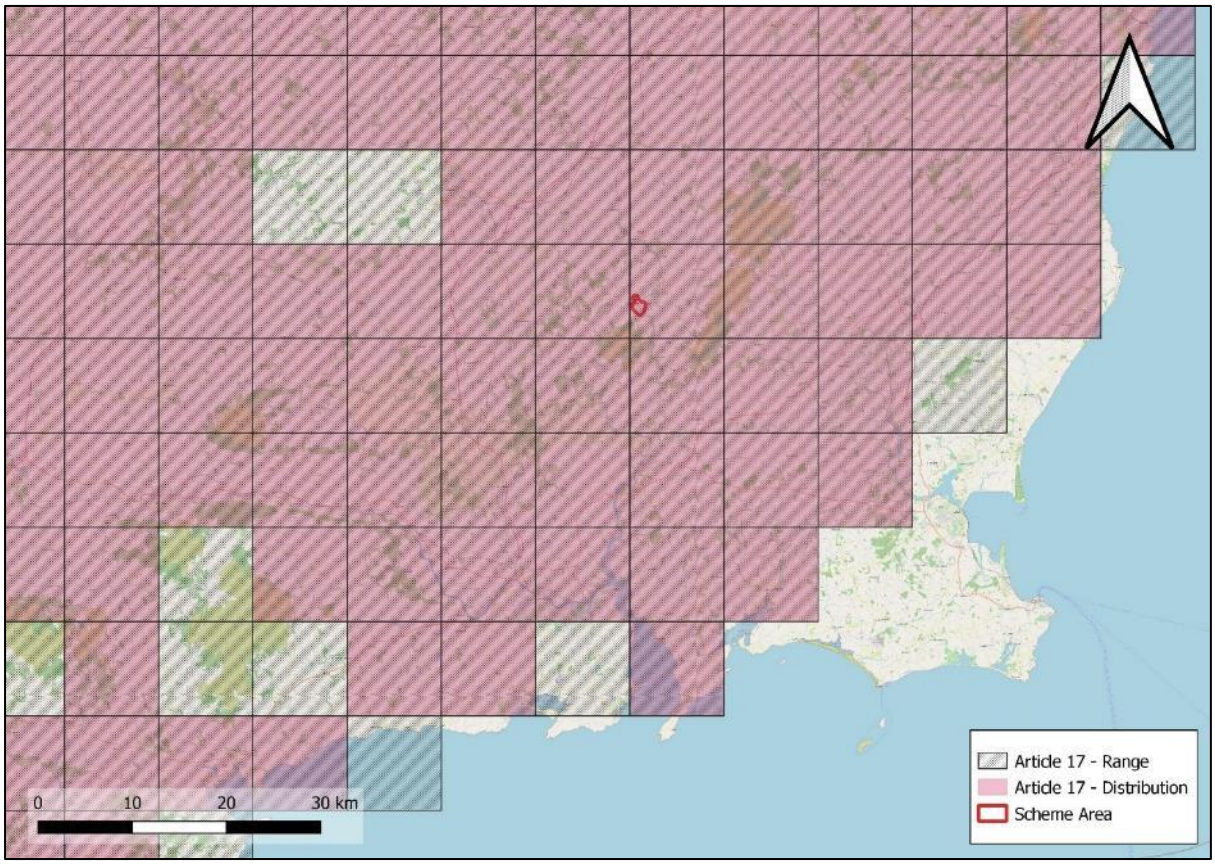

Figure 6.19. Existing Records - Brook Lamprey

6.9.2.5 River lamprey (*Lampetra fluviatilis*)

One record is held by the NBDC (see table below and Figure 6.20). Figure 6.20 also shows the distribution and range of river lamprey (as per Article 17 Reports).

Table 6-13. Existing Records – River Lamprey (NBDC)

ID	Grid Ref	Date	Precision	Notes
A	S721392	06/06/2012	100m	3 individuals part eaten, found on the bank of the river. More than likely caught by otters

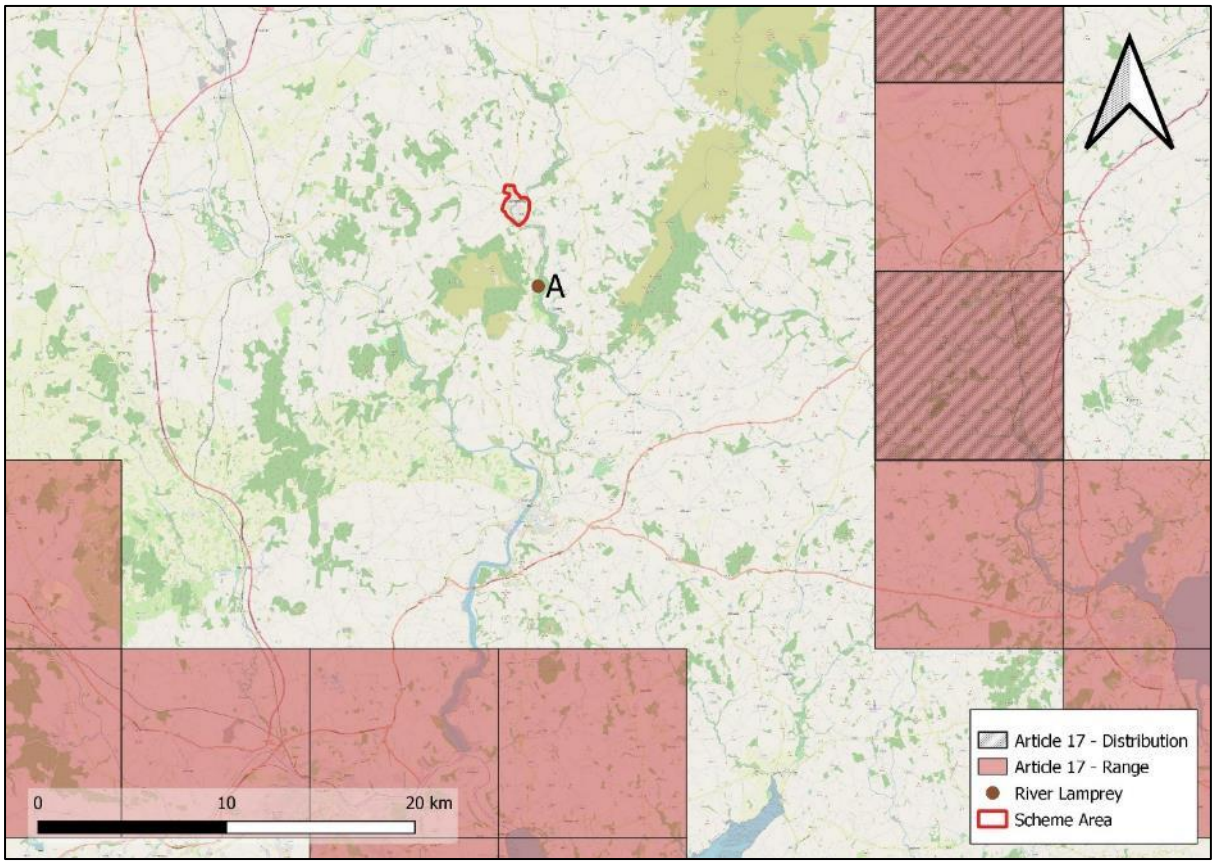

Figure 6.20. Existing Records - River Lamprey

6.9.2.6 White-Clawed Crayfish (*Austropotamobius pallipes*)

Several records are held by the NBDC, but they are all from the same 100m square (see table below and Figure 6.21). The Article 17 Reports Spatial Dataset on this occasion has point locations for this species (see Table 6.15 and Figure 6.22). Records are also held by the Marine Institute who undertake eDNA surveys to detect White Clawed Crayfish (Table 6-16) (*pers. comm.* 2021).

Crayfish Plague (a water-mould *Aphanomyces astaci*) has previously been reported in waterways the vicinity of the scheme area with periodical outbreaks occurring within different locations with the catchment. The Marine Institute detected *A. astaci* from eDNA sampling undertaken at Graiguenamanagh in November 2020. During previous sampling undertaken in 2018 and July 2020 the crayfish plague was not detected.

Table 6-14. Existing Records (NBDC)

ID	Grid Ref	Date	Precision	Notes
A	S721392	30/08/2006 19/10/2007 03/10/2008 13/10/2009 05/07/2011 05/07/2016	100m	River Biologists' Database (EPA)

Figure 6.21. NBDC Records Locations – White-Clawed Crayfish

Table 6-15. Existing Records - Article 17 Spatial Dataset

ID	Coordinates (ITM)	Date	Precision	Notes
B	670933, 643644	N/A	N/A	N/A
C	670909, 643586	N/A	N/A	N/A
D	670885, 643596	N/A	N/A	N/A
E	670847, 643566	N/A	N/A	N/A
F	670844, 643638	N/A	N/A	N/A
G	670838, 643639	N/A	N/A	N/A
H	670809, 643631	N/A	N/A	N/A

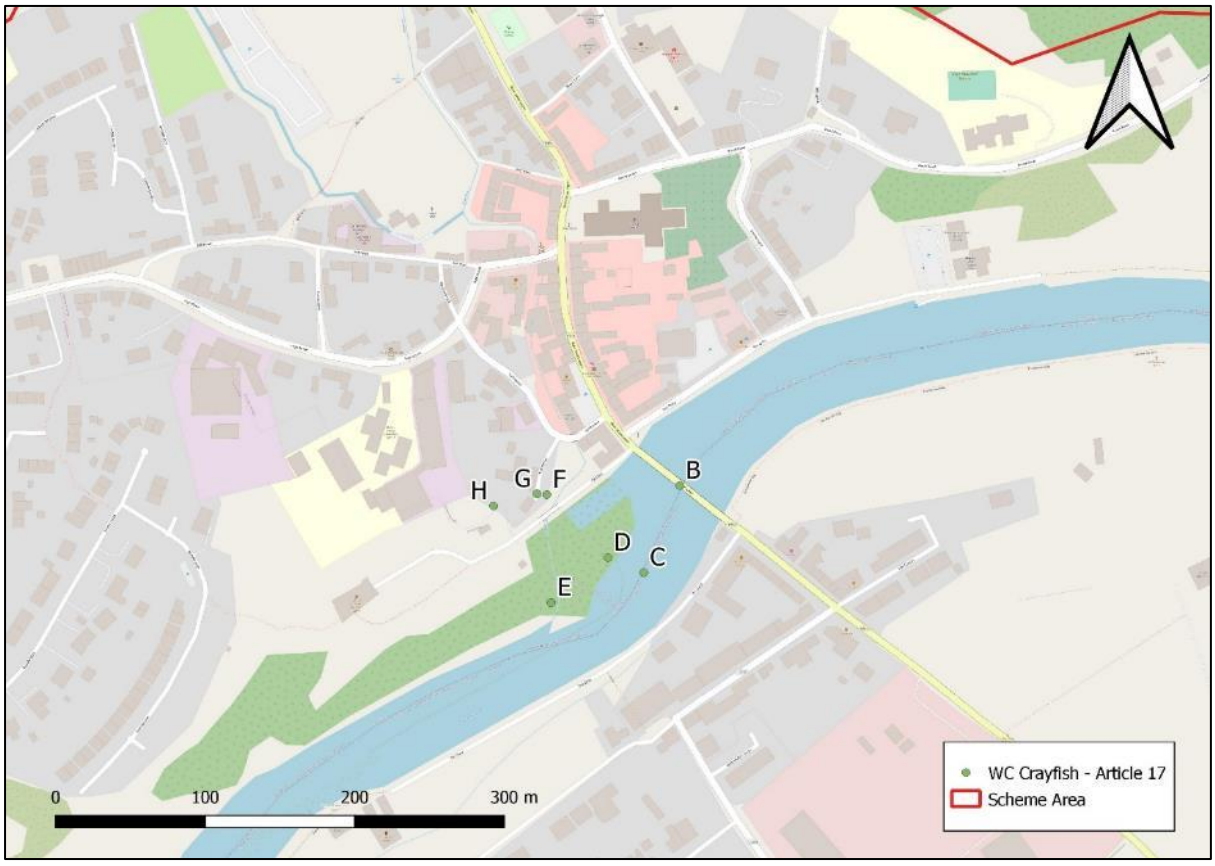

Figure 6.22. Article 17 Spatial Dataset - White-Clawed Crayfish.

It should be noted that the locations marked F, G and H would have been recorded in the Duiske, and not on land as suggested by the coordinates. This is most likely due to accuracy issues with the GPS recording device used by the surveyors.

Table 6-16 White Clawed Crayfish existing records (Marine Institute)

Location name	Latitude	Longitude	River/Lake	eDNA survey periods		
				July 2020	November 2020	2018
Two Mile Bridge	53.15546	-7.3692	Barrow	negative	negative	-
Owenass	53.09624	-7.37968	Owenass	positive	negative	-
Millgrove	53.21849	-7.10309	Figile	negative	positive	-
Rathangan	53.22075	-6.99262	Slate	negative	negative	-
Monasterevin	53.13728	-7.06422	Barrow	negative	positive	positive
Athy	52.99178	-6.9843	Barrow	negative	negative	negative
Tankerstown Bridge	52.94038	-6.95414	Barrow	negative	negative	-
Carlow Town	52.83836	-6.93435	Barrow	negative	negative	negative
Leighlinbridge	52.73619	-6.97886	Barrow	negative	negative	negative
Royal Oak Bridge	52.69999	-6.98059	Barrow	negative	negative	-
Gorse Bridge	52.63009	-6.98999	Barrow	negative	negative	negative
Graignamanagh	52.5391	-6.9539	Barrow	negative	positive	negative
Key: - = no data						

6.9.2.7 Duck Mussel (*Anadonta anatina*)

During the specialist surveys for Freshwater Peral Mussel (April 2021) Triturus Environmental Ltd identified Duck Mussel as present in low densities in the River Barrow upstream and downstream of Graiguenamanagh Weir. Many dead shells were observed and based on initial observations it is considered that the observed eutrophication (blanket algae) on the river bed is negatively impacting the habitat.

Duck Mussel is not included in the NBDC Article 17 Spatial Dataset. However, it has been included herein as it is recognised as an ICUN vulnerable species (Byrne *et al.* 2009) considered to be of high conservation value that is known to be present in the scheme area.

NBDC species records for Duck Mussel in the scheme area (1987 – 1993) show this species as present upstream of Graiguenamanagh Bridge and in the section of river broadly adjacent to Graiguenamanagh Quay.

6.9.3 Electrofishing Survey

An electrofishing Survey was carried out by Triturus Environmental Ltd (on behalf of Aquafact) in February 2021. A full report has been prepared separately. The survey sites are shown in Figure 6.23.

6.9.3.1 Results

The below has been adapted from Aquafact's report.

Five species were encountered during the survey, namely, brook lamprey (*Lampetra planeri)*, Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta),* European Eel (*Anguilla anguilla)* and stone loach (*Barbatula barbatula*).

Atlantic Salmon were present at the two sites on the Duiske River but were absent at site D1 on the Killeen Stream. Brown Trout were present at all of the survey locations. Brook lamprey were present at two of the three sites being absent at the most downstream site D3. Eels were present at both sites on the Duiske River but were absent at site D1 on the Graiguenamanagh Stream. A single Stone Loach was found on the most downstream survey site D3. Results are presented in Table 6-17. Results of Electrofishing Survey (Aquafact, 2021).

Figure 6.23. Electrofishing Survey Locations (Site D1, D2 and D3) – from Aquafact (2021)

Table 6-17. Results of Electrofishing Survey (Aquafact, 2021)

Site Number	0+ brown trout		1++ brown trout		0+ salmon		1++ salmon		European eel		Brook lamprey	
	No.	No./m^2	No.	No./m^2	No.	No./m^2	No.	No./m^2	No.	No./m^2	No.	No./m^2
D1	0		3	0.022							3	0.022
D2	11	0.039	9	0.032	8	0.029	7	0.025	3	0.011	35	0.125
D3	8	0.04	3	0.015	14	0.07	7	0.035	2	0.01		

7 Summary and Recommendations

Having assessed the available information and the results from the surveys described in this report, the following broad conclusions and recommendations can be made.

7.1 Habitats

Much of the area that is tentatively proposed for flood defence works is occupied by hedgerows, treelines or riparian woodland. A lesser proportion comprises built land. Linear woodland habitats have intrinsic value in Ireland, because at a national scale Ireland has very low woodland coverage relative to other European countries. According to the Irish Wildlife Trust (2018) Ireland has the second-lowest in Europe, with Iceland having the lowest coverage of woodland. Aside from their intrinsic value, these habitats provide foraging and commuting corridors for many species of fauna (bats in particular) through an otherwise quite urban setting. They also provide nesting habitat for many breeding birds. In accordance with the NRA's (2009) guidance, these habitats are significant at a local (high) scale.

The woodland at the mouth of the Duiske is ecologically-significant for the same reasons outlined above. It also fits the description of one of the habitats listed as a Qualifying Interest of the River Barrow and River Nore SAC. In accordance with the NRA's (2009) guidance, this habitat is significant at an international scale, because of its protection under the EU Habitats Directive.

The presence of one other Annex I habitat is unconfirmed (see Section 4.6):

- 6430 Hydrophilous Tall Herb Fringe Communities

While all watercourses within the scheme area and their adjoining terrestrial habitats (excluding the Killeen Stream) are within the SAC, the above-mentioned woodland is the only habitat that has been identified within the scheme area as a Qualifying Interest of this SAC.

7.1.1 Recommendations

Once the scheme is defined, a specialist botanical survey should be undertaken during the optimal survey period (Summer to early Autumn) to enable the detection of key indicator species that will enable the presence/absence of the two unconfirmed Annex I habitats mentioned above to be determined. Hydrophilous Tall Herb Fringe Communities, if present, will most likely be associated with the areas identified as Reed Swamp (FS1) along the fringes of the Barrow. Floating River Vegetation is most likely to be associated with fine sediment deposition in the vicinity of the main bridge.

7.2 Flora

7.2.1 Recommendations

Once the scheme is defined, a full botanical survey should be carried out during the optimal survey period (Summer to early Autumn) to enable the detection of protected species where

works are proposed. This will also enable the extents of any invasive species to be updated and mapped.

7.3 Trees

7.3.1 Recommendations

Once the scheme is defined, it should be assessed for its potential impacts on the trees surveyed. The requirement for further surveys will be determined at this stage.

7.4 Mammals

The mammal surveys were carried out at an optimal time of year, in that the entrances to holts and burrows etc. were not obscured from view by foliage. Potential evidence of otter activity has been identified at 3 locations within the scheme area.

7.4.1 Recommendations

No further mammal studies are recommended.

7.5 Herpetofauna

Spawn from the Common Frog (*Rana temporaria*) was recorded in two locations within the scheme area. All amphibians are protected under the Wildlife Acts. No other species of amphibian or reptile were recorded.

7.5.1 Recommendations

No further herpetofauna studies are recommended. However, if works are proposed in either of the two locations identified above, mitigation is likely to be a requirement.

7.6 Birds

No BOCCI red-listed species or species listed in Annex I of the EU Birds Directive were recorded during the surveys. There are existing records of Kingfishers (Annex I), Black-headed Gulls and Yellowhammers (both BOCCI Red List), whose presence in the area is assumed to persist despite not having been detected during the surveys.

The Great Spotted Woodpecker is considered likely to be present at two locations within the scheme area. While not protected by any legislation, it is rare in Ireland and appears to be gradually expanding its range since re-establishing itself in Ireland in 2005.

7.6.1 Recommendations

No further bird studies are recommended. Any works involving the clearance of vegetation will need to be cognisant of the potential impacts to breeding passerines, as well as the potential disturbance of birds by noise.

8 References

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Appendices

Appendix A: Preliminary Options Layout

Appendix B: Habitat Mapping

Appendix C: Plant species present in the survey area

Appendix D: Animal species present in the survey area

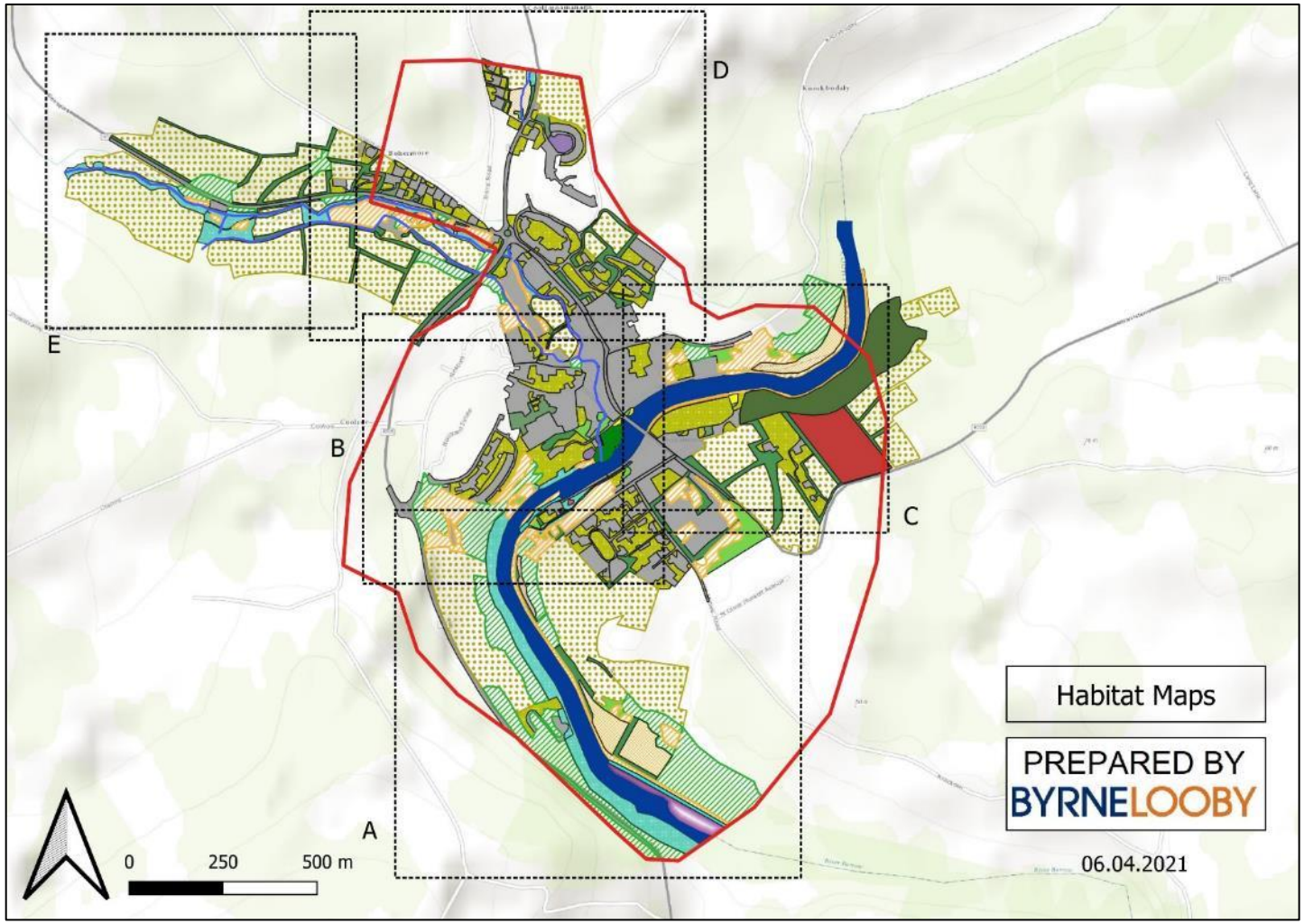
Appendix E: Bird Survey Results

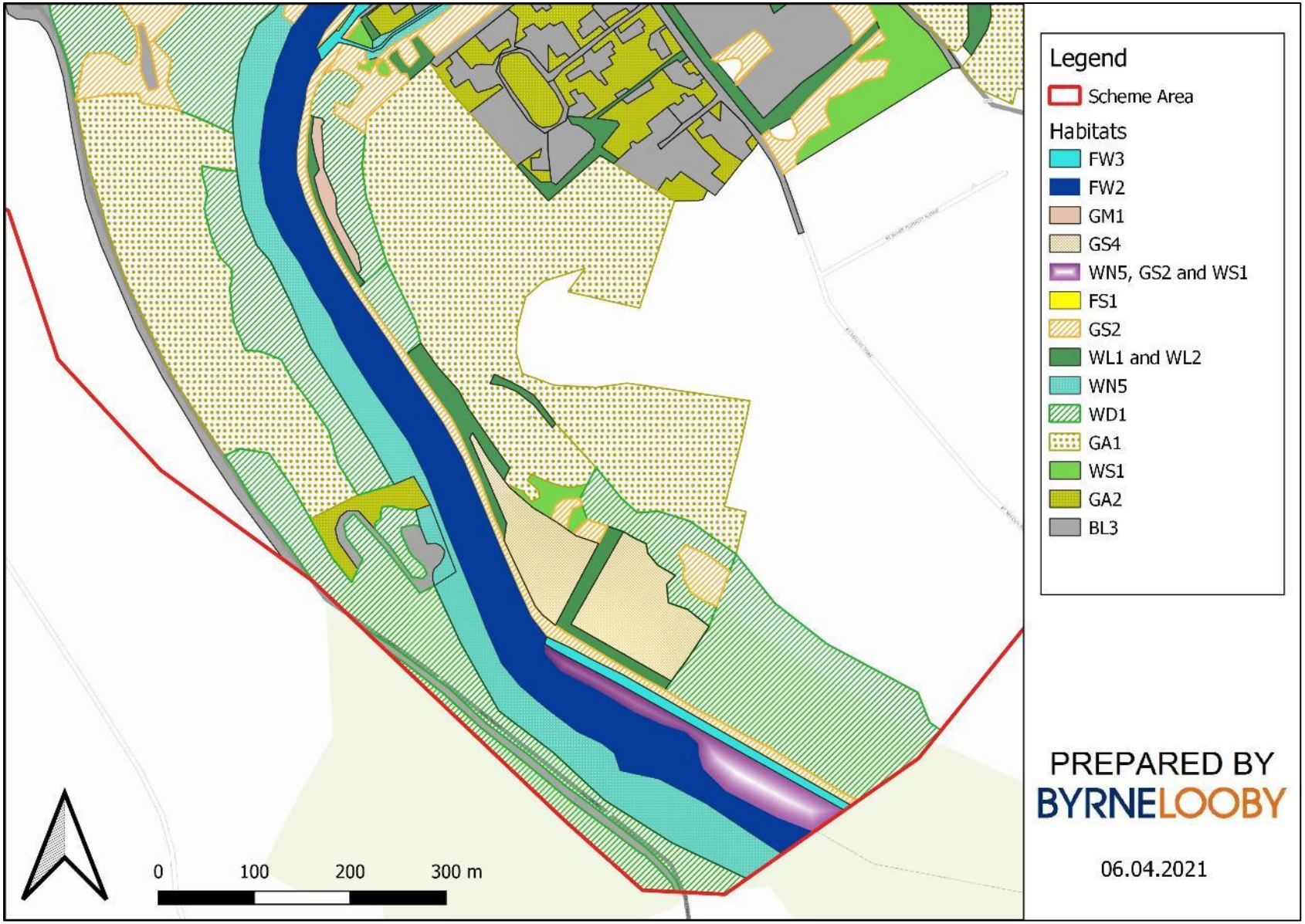
Appendix F: Tree Survey Results

Appendix G: Tree Survey Mapping

Appendix A – Preliminary Options Layout

Appendix B – Habitat Mapping

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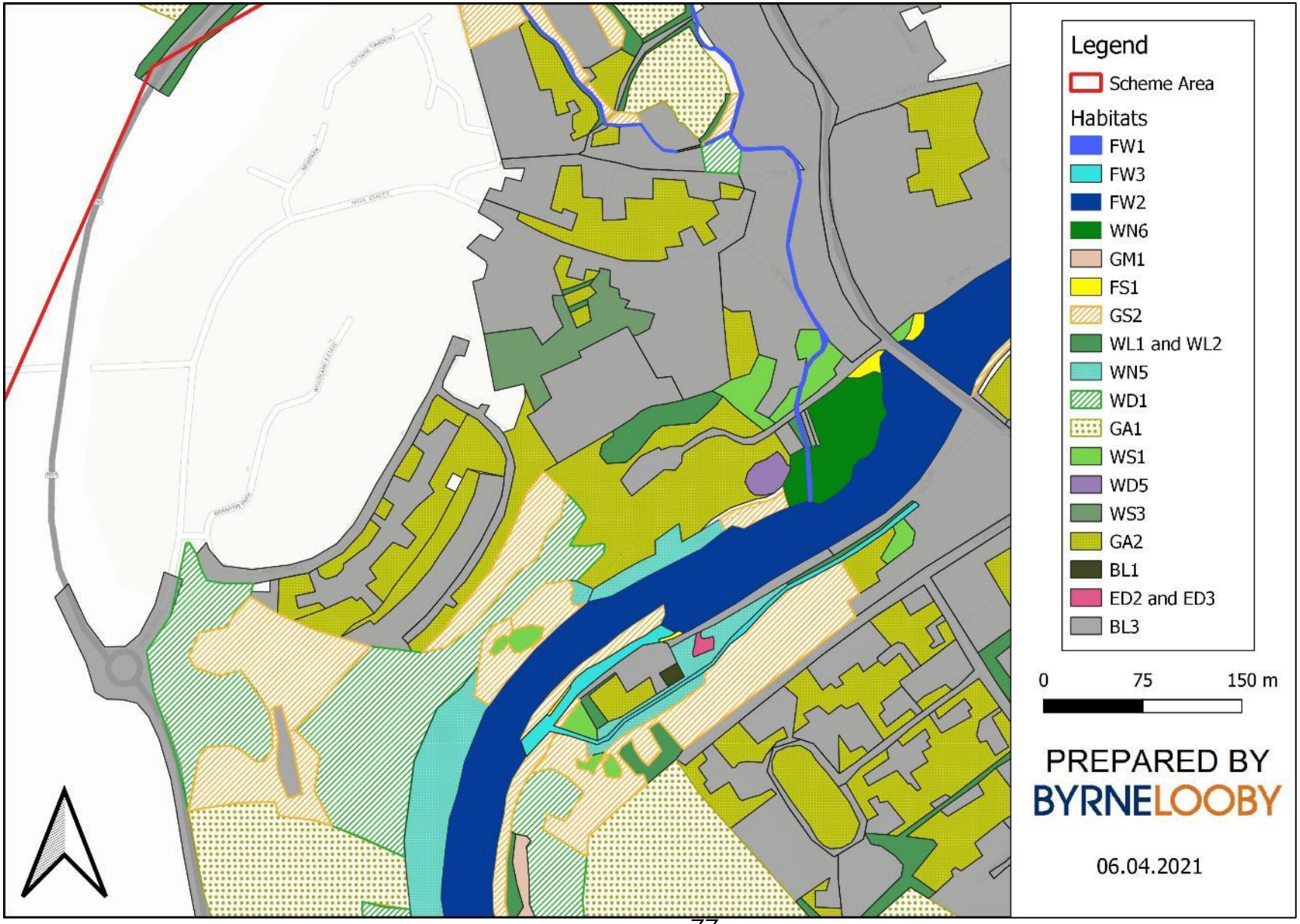
Scheme Area
Habitats
FW3
FW2
GM1
GS4
WN5, GS2 and WS1
FS1
GS2
WL1 and WL2
WN5
WD1
GA1
WS1
GA2
BL3
0
100
200
300 m
PREPARED BY
BYRNELOOBY
06.04.2021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Scheme Area
Habitats
FW1
FW3
FW2
WN6
GM1
FS1
GS2
WL1 and WL2
WN5
WD1
GA1
WS1
WD5
WS3
GA2
BL1
ED2 and ED3
BL3
0
75
150 m
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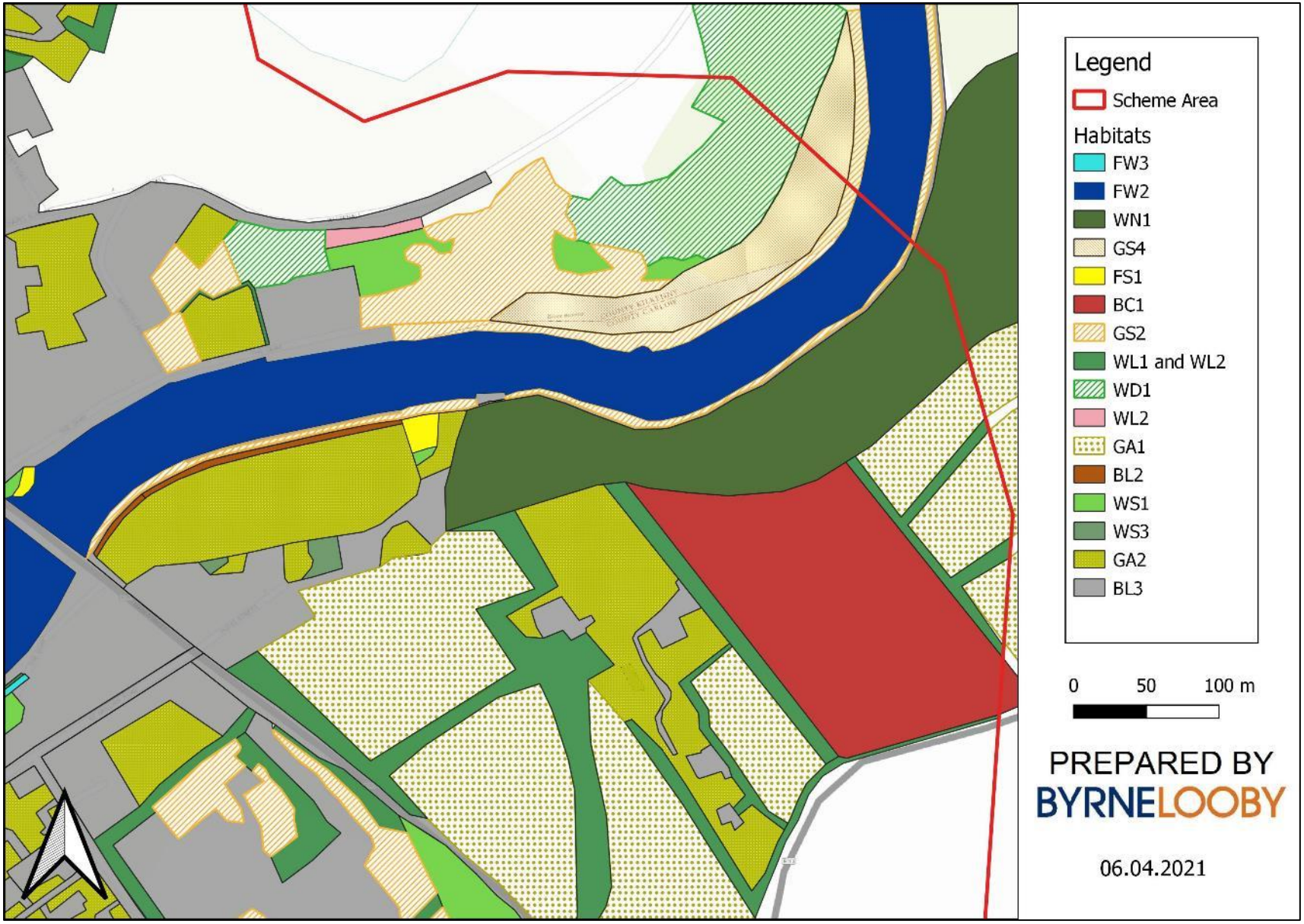
06.04.2021


Legend
Scheme Area
Habitats
FW3
FW2
WN1
GS4
FS1
BC1
GS2
WL1 and WL2
WD1
WL2
GA1
BL2
WS1
WS3
GA2
BL3
0
50
100 m
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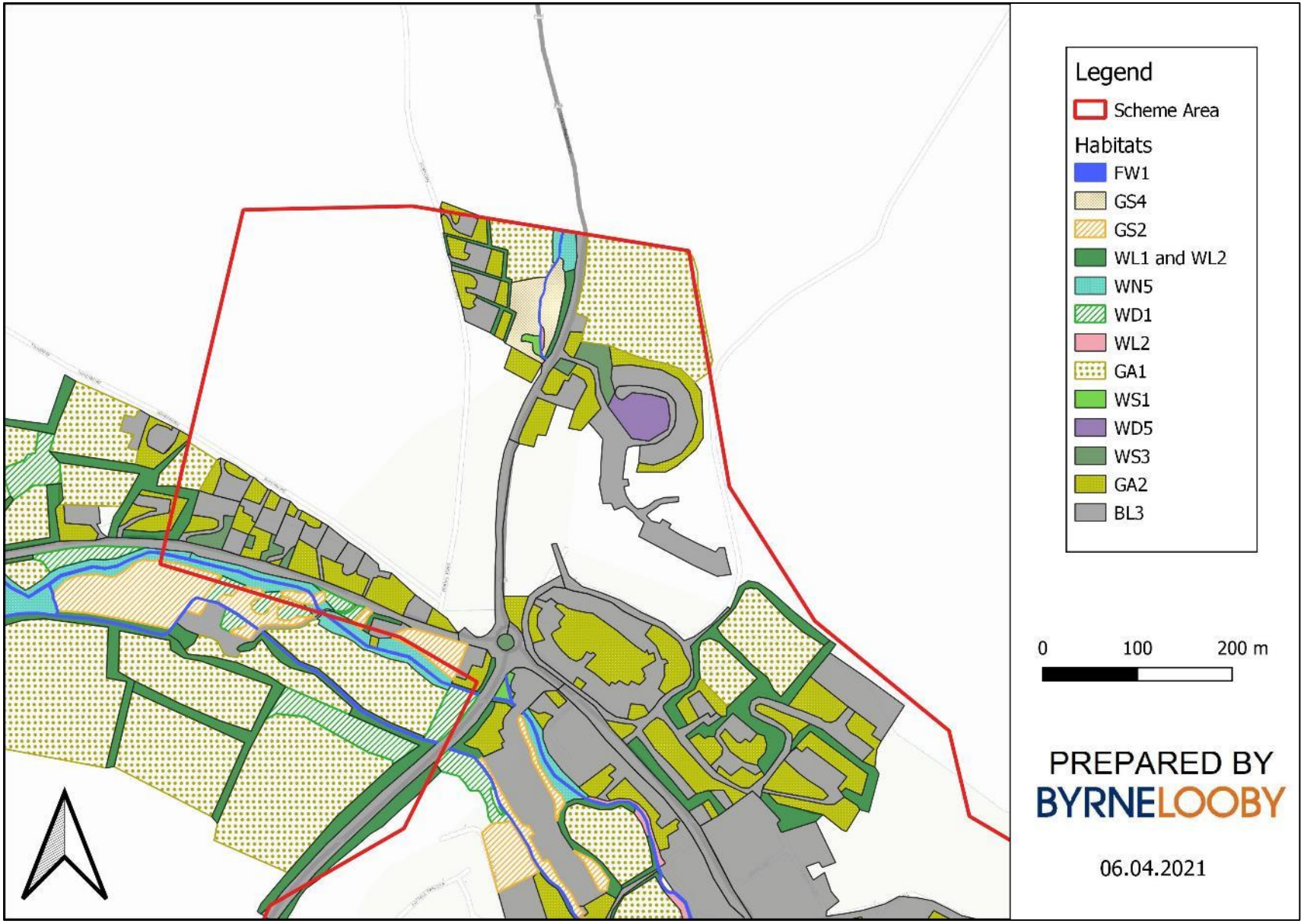
BYRNELOOBY
06.04.2021


Legend
Scheme Area
Habitats
FW1
GS4
GS2
WL1 and WL2
WN5
WD1
WL2
GA1
WS1
WD5
WS3
GA2
BL3
0
100
200 m
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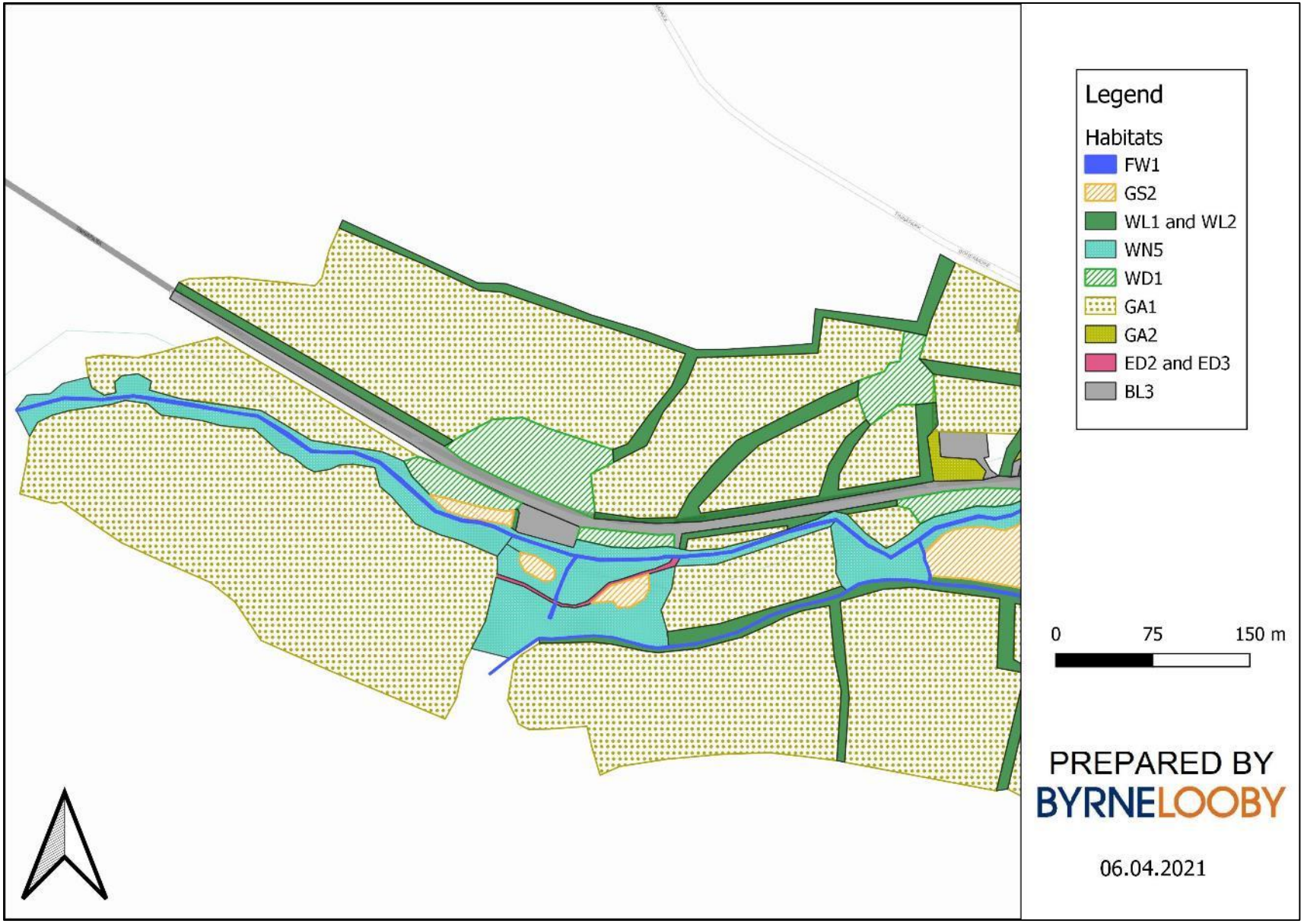
BYRNELOOBY
06.04.2021


Legend
Habitats
FW1
GS2
WL1 and WL2
WN5
WD1
GA1
GA2
ED2 and ED3
BL3
0
75
150 m
PREPARED BY
BYRNELOOBY
06.04.2021

Appendix C – Plant Species present in the Survey Area

Common Name	Scientific Name
TREES	
Sycamore	*Acer pseudoplatanus*
Horse chestnut	*Aesculus hippocastanum*
Alder	*Alnus glutinosa*
Silver birch	*Betula pendula*
Downy birch	*Betula pubescens*
Birch species	*Betula sp.*
Cypress species	*Chamaecyparis sp.*
Hawthorn	*Crataegus monogyna*
Beech	*Fagus sylvatica*
Ash	*Fraxinus excelsior*
Blackthorn	*Prunus spinosa*
Sessile oak	*Quercus petraea*
Pedunculate oak	*Quercus robur*
Oak species	*Quercus sp.*
Willow species	*Salix sp.*
Grey willow	*Salix cinerea*
Crack willow	*Salix fragilis*
Yew	*Taxus baccata*
Irish Yew	*Taxus baccata* 'fastigiata'
SHRUBS	
Butterfly bush	*Buddleja davidii*
Holly	*Ilex aquifolium*
Cherry Laurel	*Prunus laurocerasus*
Bramble	*Rubus fruticosus agg.*
Gorse	*Ulex europaeus*
Rose species	*Rosa* spp.
Box	*Buxus sempervirens*
CLIMBERS	
Hedge Bindweed	*Calystegia sepium*
Old man's beard	*Clematis vitalba*
Ivy	*Hedera helix*
Honeysuckle	*Lonicera periclymenum*
GRASSES	
Common bent	*Agrostis capillaris*
Cock's-foot	*Dactylis glomerata*
Yorkshire fog	*Holcus lanatus*
Perennial rye grass	*Lolium perenne*
Common reed	*Phragmites australis*
Annual meadow grass	*Poa annua*
RUSHES	
Soft rush	*Juncus effusus*
AQUATIC PLANTS	
Crowfoot species	*Ranunculus* sp.
HERBS	
Ground elder	*Aegopodium podagraria*

Common Name	Scientific Name
Wild cabbage	*Brassica oleracea*
Wild turnip	*Brassica rapa*
Ivy-leaved toadflax	*Cymbalaria muralis*
Wild angelica	*Angelica sylvestris*
Cow parsley	*Anthriscus sylvestris*
Lords-and-ladies	*Arum maculatum*
Daisy	*Bellis perennis*
Wavy bitter-cress	*Cardamine flexuosa*
Hairy bitter-cress	*Cardamine hirsuta*
Common mouse-ear	*Cerastium fontanum*
Rosebay willowherb	*Chamerion angustifolium*
Opposite-leaved golden-saxifrage	*Chrysosplenium oppositifolium*
Creeping thistle	*Cirsium arvense*
Marsh thistle	*Cirsium paluste*
Foxglove	*Digitalis purpurea*
Great willowherb	*Epilobium hirsutum*
Broad-leaved willowherb	*Epilobium montanum*
Square-stalked willowherb	*Epilobium tetragonum*
Japanese knotweed	*Fallopia japonica*
Meadowsweet	*Filipendula ulmaria*
Cleavers	*Galium aparine*
Dove's foot crane's bill	*Geranium molle*
Herb-robert	*Geranium robertianum*
Wood avens	*Geum urbanum*
Giant rhubarb	*Gunnera tinctoria*
Hogweed	*Heracleum sphondylium*
Bluebell	*Hyacinthoides non-scripta*
Hamalyan balsam	*Impatiens glandulifera*
Yellow iris	*Iris pseudacorus*
Red dead-nettle	*Lamium purpureum*
Great woodrush	*Luzula sylvatica*
Water forget-me-not	*Myosotis scorpioides*
Forget-me-not species	*Myosotis* spp.
Hemlock water-dropwort	*Oenanthe crocata*
Ribwort plantain	*Plantago lanceolata*
Silverweed	*Potentilla anserina*
Creeping cinquefoil	*Potentilla reptans*
Primrose	*Primula vulgaris*
Selfheal	*Prunella vulgaris*
Winter heliotrope	*Petasites pyrenaicus*
Meadow buttercup	*Ranunculus acris*
Lesser celandine	*Ranunculus ficaria*
Creeping buttercup	*Ranunculus repens*
Common sorrel	*Rumex acetosa*
Curled dock	*Rumex crispus*
Broad-leaved dock	*Rumex obtusifolius*
Water figwort	*Scrophularia auricularia*
Common ragwort	*Senecio jacobaea*
Groundsel	*Senecio vulgaris*
Smooth sow-thistle	*Sonchus oleraceus*
Russian comfrey	*Symphytum x uplandicum*

Common Name	Scientific Name
Dandelion	*Taraxacum officinalis agg.*
White clover	*Trifolium repens*
Navelwort	*Umbilicus rupestris*
Common nettle	*Urtica dioica*
Brooklime	*Veronica beccabunga*
Germander speedwell	*Veronica chamaedrys*
Wood speedwell	*Veronica montana*
Common vetch	*Vicia sativa*
Bush vetch	*Vicia sepium*
Dog violet	*Viola riviniana*
FERNS & ALLIES	
Scaly male fern	*Dryopteris affinis*
Southern polypody	*Polypodium cambricum*
Polypody	*Polypodium vulgare*
Bracken	*Pteridium aquilinum*
Water horsetail	*Equisetum fluviatile*
MOSSES *	
Brachythecium species	
Grimmia pulvinata	
Tortula muralis	

* This represents those species positively identified by surveyors and is not intended to provide a complete list.

Appendix D – Existing Bird Records

Species name	Record count	Date of last record	Designation
Barn Swallow (*Hirundo rustica*)	10	19/08/2017	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Black-billed Magpie (*Pica pica*)	5	04/09/2012	N/A
Blackcap (*Sylvia atricapilla*)	5	21/05/2016	N/A
Black-headed Gull (*Larus ridibundus*)	1	31/12/2011	Protected Species: Wildlife Acts Birds of Conservation Concern - Red List
Blue Tit (*Cyanistes caeruleus*)	4	28/12/2014	N/A
Chaffinch (*Fringilla coelebs*)	6	21/05/2016	N/A
Coal Tit (*Periparus ater*)	4	31/12/2011	N/A
Common Blackbird (*Turdus merula*)	8	21/05/2016	N/A
Common Bullfinch (*Pyrrhula pyrrhula*)	3	31/12/2011	N/A
Common Chiffchaff (*Phylloscopus collybita*)	3	21/05/2016	N/A
Common Coot (*Fulica atra*)	1	31/12/2011	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III Birds of Conservation Concern - Amber List
Common Cuckoo (*Cuculus canorus*)	1	31/07/1991	N/A
Common Kestrel (*Falco tinnunculus*)	1	28/04/2010	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Common Kingfisher (*Alcedo atthis*)	3	21/05/2016	Protected Species: Wildlife Acts EU Birds Directive - Annex I Birds of Conservation Concern - Amber List
Common Linnet (*Carduelis cannabina*)	2	20/12/1999	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Common Moorhen (*Gallinula chloropus*)	2	31/12/2011	N/A
Common Pheasant (*Phasianus colchicus*)	2	31/12/2011	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III
Common Raven (*Corvus corax*)	1	20/12/1999	N/A
Common Starling (*Sturnus vulgaris*)	4	31/12/2011	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Common Swift (*Apus apus*)	2	31/12/2011	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Common Whitethroat (*Sylvia communis*)	1	31/07/1991	N/A
Common Wood Pigeon (*Columba palumbus*)	7	21/05/2016	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III
Eurasian Collared Dove (*Streptopelia decaocto*)	4	31/03/2013	N/A
Eurasian Jackdaw (*Corvus monedula*)	9	19/08/2017	N/A
Eurasian Jay (*Garrulus glandarius*)	4	25/06/2017	N/A

Species name	Record count	Date of last record	Designation
Eurasian Siskin (*Carduelis spinus*)	1	31/12/2011	N/A
Eurasian Sparrowhawk (*Accipiter nisus*)	1	31/12/2011	N/A
European Goldfinch (*Carduelis carduelis*)	3	31/12/2011	N/A
European Greenfinch (*Carduelis chloris*)	2	31/12/2011	N/A
European Robin (*Erithacus rubecula*)	9	21/05/2016	N/A
Fieldfare (*Turdus pilaris*)	1	31/12/2011	N/A
Goldcrest (*Regulus regulus*)	4	21/05/2016	N/A
Great Cormorant (*Phalacrocorax carbo*)	4	20/08/2017	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Great Tit (*Parus major*)	6	21/05/2016	N/A
Grey Heron (*Ardea cinerea*)	14	19/08/2017	N/A
Grey Wagtail (*Motacilla cinerea*)	9	21/05/2016	N/A
Hedge Accentor (*Prunella modularis*)	4	21/05/2016	N/A
Hooded Crow (*Corvus cornix*)	3	31/12/2011	N/A
House Martin (*Delichon urbicum*)	3	04/09/2012	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
House Sparrow (*Passer domesticus*)	3	31/12/2011	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Lesser Redpoll (*Carduelis cabaret*)	1	18/01/2015	N/A
Little Grebe (*Tachybaptus ruficollis*)	1	31/12/2011	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Long-tailed Tit (*Aegithalos caudatus*)	2	31/12/2011	N/A
Mallard (*Anas platyrhynchos*)	16	19/08/2017	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III
Mistle Thrush (*Turdus viscivorus*)	5	28/12/2014	N/A
Mute Swan (*Cygnus olor*)	8	03/10/2012	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Pied Wagtail (*Motacilla alba* subsp. *yarrellii*)	3	21/05/2016	N/A
Red Grouse (*Lagopus lagopus*)	1	31/12/2011	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III Birds of Conservation Concern - Red List
Redwing (*Turdus iliacus*)	3	18/01/2015	N/A
Reed Bunting (*Emberiza schoeniclus*)	1	09/04/2010	N/A
Rock Pigeon (*Columba livia*)	3	04/09/2012	Protected Species: Wildlife Acts EU Birds Directive - Annex II
Rook (*Corvus frugilegus*)	5	04/09/2012	N/A
Sand Martin (*Riparia riparia*)	10	21/05/2016	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List

Species name	Record count	Date of last record	Designation
Sky Lark (*Alauda arvensis*)	1	31/12/2011	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Song Thrush (*Turdus philomelos*)	5	21/05/2016	N/A
Spotted Flycatcher (*Muscicapa striata*)	2	04/09/2012	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Stock Pigeon (*Columba oenas*)	1	29/07/2015	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
White Wagtail (*Motacilla alba*)	2	31/12/2011	N/A
White-throated Dipper (*Cinclus cinclus*)	3	20/08/2017	N/A
Willow Warbler (*Phylloscopus trochilus*)	3	21/05/2016	N/A
Winter Wren (*Troglodytes troglodytes*)	8	21/05/2016	N/A
Yellowhammer *(Emberiza citrinella*)	1	31/07/1991	Protected Species: Wildlife Acts Birds of Conservation Concern - Red List

Appendix E – Bird Survey Results

Wintering Survey (16-18/02/2021)

Transect ID	Date Start/End Time Weather	Species	Visual Distance bands				Aural records	
			0-25m	25-100m	>100m	In flight	+	-
A	16/02/21 09:30-09:52 Overcast, dry, 8°C, calm	Cormorant		1				X
		Great tit					X	
		Rook					X	
		Coal tit					X	
		Magpie					X	
		Wren					X	
		Robin					X	
		Blue tit					X	
		Mallard	2					X
		Buzzard		1				X
B	17/02/21 08:05-08:26 Light rain from 09:05 to end, 6°C, windy	Rook		6		4	X	
		Chaffinch					X	
		Collared Dove					X	
		Robin	1					X
		Blackbird	1					X
		Pied wagtail	1					X
C	16/02/21 08:30-08:50 Overcast, dry, 8°C, calm	Robin					X	
		Rook	1	6		7	X	
		Magpie					X	
		Chaffinch					X	
		Song thrush					X	
		Great Spotted Woodpecker					X	
		House Sparrow					X	
		Wren	1					X
		Mallard	4					X

Transect ID	Date Start/End Time Weather	Species	Visual Distance bands				Aural records	
			0-25m	25-100m	>100m	In flight	+	-
D	17/02/21 08:40-09:53 Overcast, dry, 6°C, windy	Jackdaw	1				X	
		Chaffinch					X	
		Blue tit					X	
		Rook	2			3	X	
		Robin					X	
		Great tit				1	X	
		Greenfinch					X	
		Collared dove		1			X	
		Blackbird	4					X
E	17/02/21 10:12-10:32 Overcast, dry, 6°C, windy	House sparrow	10				X	
		Jackdaw	2	6			X	
		Blackbird					X	
		Great tit					X	
		Pied wagtail	6					X
		Mute swan	1					X
F	18/02/21 09:09-09:29 Clear, dry, 7°C, calm	Chaffinch					X	
		Blue tit					X	
		House Sparrow					X	
		Coal tit					X	
		Woodpigeon	1				X	
		Blackbird	1					X
		House Sparrow	3					X
		Rook	1					X

Notes:

1. 3x house sparrows recorded near old forge (Between transect D and E)

Breeding Bird Survey (02/04/2021)

Transect ID	Date Start/End Time Weather	Species	Visual Distance bands				Aural records	
			0-25m	25-100m	>100m	In flight	+	-
A	02/04/21 08:50-09:17 Clear, dry, 10°C, calm	Blackbird				1	X	
		Willow warbler					X	
		Chaffinch					X	
		Rook				1	X	
		Song thrush	1				X	
		Starling	1				X	
		Robin	1				X	
		Wren	1					X
		Whitethroat	1					X
		Long-tailed tit	2					X
B	02/04/21 08:17-08:47 Clear, dry, 10°C, calm	Blue tit					X	
		Great tit					X	
		Magpie					X	
		Woodpigeon					X	
		Chaffinch					X	
		Chiffchaff					X	
		Wren	1				X	
		Mallard	2					X
		Rook	1			3	X	
		Blackcap	1				X	
		Great Spotted Woodpecker					X	
		Starling	2					X
		Barn Swallow	6					X

Transect ID	Date Start/End Time Weather	Species	Visual Distance bands				Aural records	
			0-25m	25-100m	>100m	In flight	+	-
C	02/04/21 07:24-07:54 Clear, dry, 10°C, calm	Rook	20			6	X	
		Chiffchaff					X	
		Woodpigeon					X	
		Blackbird					X	
		Song thrush					X	
		Jackdaw					X	
		Blue tit					X	
		Great tit					X	
		Great Spotted Woodpecker					X	
		Pheasant					X	
D	02/04/21 10:08-10:30 Clear, dry, 10°C, calm	Woodpigeon					X	
		Song thrush					X	
		Blackbird					X	
		Chaffinch	1				X	
		Treecreeper	1					X
		Robin	1					X
E	02/04/21 11:00-11:20 Clear, dry, 10°C, calm	Starling					X	
		Blackbird	1				X	
		Blue tit					X	
		Chaffinch	1				X	
		House Sparrow	3				X	
		Great tit	1				X	
		Magpie					X	
		Raven	3					X
		Woodpigeon	1					X
		Goldfinch	2					X

Transect ID	Date Start/End Time Weather	Species	Visual Distance bands				Aural records	
			0-25m	25-100m	>100m	In flight	+	-
F	02/04/21 11:50-12:10 Clear, dry, 10°C, calm	Long-tailed tit	1				X	
		Blackbird	1				X	
		Robin	1				X	
		Chaffinch					X	
		Great tit					X	
		House Sparrow	2				X	
		Goldfinch					X	
		Rook					X	
		Blackcap	1					X
		Wren	1					X

Notes

1. 10x Barn Swallows recorded circling outside the Waterside Guesthouse along the northern quay. Outside transect.
2. Some Rooks recorded in flight in Transect C were carrying twigs for nest-building
3. 2x House Sparrows recorded in Transect E were building a nest (in Tree ID T37)
4. Lone Mute Swan recorded by main bridge. Outside transect.
5. The drumming sound attributed to the Great Spotted Woodpecker may be from a Carrion Crow. This information came from a verbal communication with a local passer-by during Transect B.

Appendix F – Tree Survey Results

Tree ID	Species	Scientific Name	Height (m) (Approx.)	Trunk(s) ø (cm)	Largest Trunk ø (cm)	Girth (cm)	Est. Age (years)	Ivy (Absent, Light, Moderate, Heavy)	Cracks, Hollows, Nests Y/N (C/H/N)	Epiphytes (Absent, Light, Moderate, Heavy)
Notes: Growth factors (average annual girth increase) **Oak**: 1.88cm / year **Ash, Beech, Birch, Elm, Hazel, Horse Chestnut, Hawthorn, Blackthorn**: 2.5cm / year **Sycamore, Willow, Alder, Cypress**: 2.75cm / year **Pine, Spruce**: 3.13cm / year						NC – Not Confirmed Certain features could not be confirmed due to restricted visibility and restricted access. Where a mix of species is listed, the age is determined by the oldest specimen.				
T1	Crack/White Willow	*Salix fragilis/alba*	20	50, 30, 40, 40	50	157.08	57.12	Absent	Y (3x C)	Light
T2	NC	*NC*	20	30, 15, 30, 20, 25, 15	30	94.25	34.27	Absent	N	Light
T3	Grey Willow	*Salix cinerea*	15	20, 20, 20	20	62.83	22.85	Absent	N	Heavy
T4	Willow	*Salix* sp.	20	40, 30, 20	40	125.66	45.70	Moderate	N	Absent
T5	Sycamore	*Acer pseudoplatanus*	20	35	35	109.96	39.98	Absent	N	Light
T6	Sycamore	*Acer pseudoplatanus*	15	25,25	25	78.54	28.56	Absent	N	Light
T7	Ash	*Fraxinus excelsior*	15	25, 30, 15, 30	30	94.25	37.70	Light	N	Light
T8	Sycamore	*Acer pseudoplatanus*	15	25, 25, 25	25	78.54	28.56	Moderate	N	Light
T9	Sycamore	*Acer pseudoplatanus*	15	30	30	94.25	34.27	Heavy	NC	NC

Tree ID	Species	Scientific Name	Height (m) (Approx.)	Trunk(s) ø (cm)	Largest Trunk ø (cm)	Girth (cm)	Est. Age (years)	Ivy (Absent, Light, Moderate, Heavy)	Cracks, Hollows, Nests Y/N (C/H/N)	Epiphytes (Absent, Light, Moderate, Heavy)
T10	Horse chestnut	*Aesculus hippocastanum*		30, 30, 15	30	94.25	37.70	Heavy	NC	NC
T11	NC	*NC*	20	45	45	141.37	56.55	Moderate	N	Light
T12	NC	*NC*	20	50	50	157.08	62.83	Moderate	N	Light
T13	NC	*NC*	20	20, 20, 40	40	125.66	50.27	Moderate	N	Light
T14	NC	*NC*	20	30	30	94.25	37.70	Moderate	N	Light
T15	Leyland Cypress	*Cupressus × leylandii*	20	NC	NC	NC	NC	Absent	NC	NC
T16	NC	*NC*	8	NC	NC	NC	NC	Absent	NC	NC
T17	Alder	*Alnus glutinosa*	15	30	30	94.25	34.27	Absent	N	Light
T18	Alder (10x)	*Alnus glutinosa*	15-20	20	20	62.83	22.85	Absent	N	Absent
T19	Birch	*Betula* sp.	15	30, 30	30	94.25	37.70	Absent	N	Absent
T20	Mix of Alder/Willow	*Alnus glutinosa/ Salix* sp.	10	15-20	20	62.83	22.85	Absent	N	Absent
T21	Willow (5x)	*Salix* sp.	10	15	15	47.12	17.14	Absent	N	Absent
T22	Ash	*Fraxinus excelsior*	6	30	30	94.25	37.70	Light	N	Absent
T23	Ash	*Fraxinus excelsior*	20	65	65	204.20	81.68	Heavy	NC	NC
T24	Sycamore	*Acer pseudoplatanus*	20	60	60	188.50	68.54	Heavy	NC	NC
T25	Mix of Alder/Willow	*Alnus glutinosa/ Salix* sp.	10	15-20	20	62.83	22.85	Absent	N	Absent
T26	Mix of Alder/Willow	*Alnus glutinosa/ Salix* sp.	10	15-20	20	62.83	22.85	Absent	N	Absent

Tree ID	Species	Scientific Name	Height (m) (Approx.)	Trunk(s) ø (cm)	Largest Trunk ø (cm)	Girth (cm)	Est. Age (years)	Ivy (Absent, Light, Moderate, Heavy)	Cracks, Hollows, Nests Y/N (C/H/N)	Epiphytes (Absent, Light, Moderate, Heavy)
T27	Mix of Alder/Willow/ Sycamore/ Oak/ Beech	*Alnus glutinosa/ Salix* sp./ *A. pseudoplatanus / Quercus* sp./ *Fagus sylvatica*	10-15	15-20	20	62.83	33.42	Absent	N	Absent
T28	Alder (x4)	*Alnus glutinosa*	6	30	30	94.25	34.27	Light	N	Light
T29	Alder	*Alnus glutinosa*	6	20, 15	20	62.83	22.85	Light	N	Light
T30	Crack Willow	*Salix fragilis*	25	60	60	188.50	68	Moderate	Y (C)	Light
T31	Downy Birch	*Betula pubescens*	25	30, 30	30	94.25	37.70	Absent	N	Light
T32	Downy Birch	*Betula pubescens*	25	30, 30, 15, 10	30	94.25	37.70	Absent	N	Light
T33	Sycamore	*Acer pseudoplatanus*	20	50	50	157.08	57.12	Heavy	NC	NC
T34	Willow	*Salix* sp.	15	50, 40	50	157.08	57.12	Heavy	NC	NC
T35	Alder (x4)	*Alnus glutinosa*	15	30	30	94.25	34.27	Moderate	N	Absent
T36	Willow	*Salix* sp.	5	20	20	62.83	22.85	Absent	N	Absent
T37	Willow	*Salix* sp.	5	10	10	31.42	11.42	Absent	N	Light
T38	Mix of Sycamore (x2)/ Willow	*Acer pseudoplatanus/ Salix* sp.	15	30, 10, 50, 40	50	157.08	57.12	Heavy	NC	NC
T39	Alder (x2)	*Alnus glutinosa*	20	40	40	125.66	45.70	Heavy	NC	NC
T40	Ash	*Fraxinus excelsior*	20	40	40	125.66	50.27	Heavy	NC	NC
T41	Sycamore (x2)	*Acer pseudoplatanus*	15	30	30	94.25	34.27	Moderate	N	Absent
T42	Ash	*Fraxinus excelsior*	12	30, 20	30	94.25	37.70	Heavy	NC	NC

Tree ID	Species	Scientific Name	Height (m) (Approx.)	Trunk(s) ø (cm)	Largest Trunk ø (cm)	Girth (cm)	Est. Age (years)	Ivy (Absent, Light, Moderate, Heavy)	Cracks, Hollows, Nests Y/N (C/H/N)	Epiphytes (Absent, Light, Moderate, Heavy)
T43	Alder	*Alnus glutinosa*	15	10, 10, 15, 20, 20, 20, 30	30	94.25	34.27	Absent	N	Light
T44	Alder (x3)	*Alnus glutinosa*	15	15, 10, 20	20	62.83	22.85	Absent	N	Light
T45	Ash and Sycamore	*Fraxinus excelsior* *Alnus glutinosa*	15	15-20	20	62.83	22.85	Absent	N	Light
T46	Sycamore	*Acer pseudoplatanus*	15	20, 20	20	62.83	22.85	Absent	N	Absent
T47	Sycamore (x5)	*Acer pseudoplatanus*	20	40, 50, 30, 30, 15	50	157.08	57.12	Absent	N	Absent
T48	Sycamore	*Acer pseudoplatanus*	10	20, 20, 15, 15, 10	20	62.83	22.85	Light	N	Absent
T49	Alder	*Alnus glutinosa*	15	15 (x10)	15	47.12	18.48	Absent	N	Absent
T50	Ash (x7)	*Fraxinus excelsior*	20	50, 50, 40, 50, 40, 30	50	157.08	61.60	Heavy	NC	NC
T51	Alder	*Alnus glutinosa*	20	30, 30, 30, 30	30	94.25	34.27	Moderate	N	Absent
T52	Alder	*Alnus glutinosa*	20	40, 30, 30, 20	40	125.66	45.70	Moderate	N	Light
T53	Ash	*Fraxinus excelsior*	30	100	100	314.16	125.66	Heavy	NC	NC
T54	Downy Birch	*Betula pubescens*	20	40	40	125.66	50.27	Moderate	N	Light
T55	NC	*NC*	20	30, 30	30	94.25	34.27	Moderate	N	Absent
T56	Alder	*Alnus glutinosa*	10	20, 20	20	62.83	22.85	Absent	N	Absent

Tree ID	Species	Scientific Name	Height (m) (Approx.)	Trunk(s) ø (cm)	Largest Trunk ø (cm)	Girth (cm)	Est. Age (years)	Ivy (Absent, Light, Moderate, Heavy)	Cracks, Hollows, Nests Y/N (C/H/N)	Epiphytes (Absent, Light, Moderate, Heavy)
T57	Oak (pedunculate)	*Quercus robur*	12	50	50	157.08	57.12	Moderate	N	Absent
T58	Horse chestnut	*Aesculus hippocastanum*	5 (Pollarded or fallen)	80	80	251.33	100.53	Absent	Y (C)	Absent
T59	NC	*NC*	25	80	80	251.33	91.39	Absent	N	Light
T60	Leyland Cypress	*Cupressus × leylandii*	15	30, 20, 20, 20	30	94.25	34.27	Absent	N	Absent
T61	Sycamore	*Acer pseudoplatanus*	15	70	70	219.91	79.97	Heavy	NC	NC
T62	Irish Yew	*Taxus baccata* 'fastigiata'	6	NC	NC	NC	NC	Absent	NC	NC
T63	Horse chestnut	*Aesculus hippocastanum*	25	80	80	251.33	100.53	Absent	Y (C)	Light
T64	Ash	*Fraxinus excelsior*	10	40	40	125.66	45.70	Absent	N	Absent
T65	Hawthorn	*Crataegus monogyna*	8	30, 10, 10	30	94.25	37.70	Heavy	NC	NC
T66	Hawthorn	*Crataegus monogyna*	8	30, 10, 10	30	94.25	37.70	Heavy	NC	NC
T67	Ash	*Fraxinus excelsior*	15	40, 30	40	125.66	50.27	Heavy	NC	NC
T68	Ash (x2)	*Fraxinus excelsior*	15	60, 30	60	188.50	75.40	Heavy	NC	NC
T69	Hawthorn	*Crataegus monogyna*	15	30, 40	40	125.66	50.27	Heavy	NC	NC
T70	Hawthorn	*Crataegus monogyna*	10	20	20	62.83	25.13	Heavy	NC	NC

Tree ID	Species	Scientific Name	Height (m) (Approx.)	Trunk(s) ø (cm)	Largest Trunk ø (cm)	Girth (cm)	Est. Age (years)	Ivy (Absent, Light, Moderate, Heavy)	Cracks, Hollows, Nests Y/N (C/H/N)	Epiphytes (Absent, Light, Moderate, Heavy)
T71	Ash	*Fraxinus excelsior*	15	20, 20, 20, 25	25	78.54	31.42	Moderate	N	Light
T72	Ash	*Fraxinus excelsior*	12	20, 20, 20, 20	20	62.83	25.13	Moderate	N	Light
T73	Ash	*Fraxinus excelsior*	15	NC	NC	NC	NC	Heavy	NC	NC
T74	Ash	*Fraxinus excelsior*	10	30, 20	30	94.25	37.70	Light	N	Absent
T75	Hawthorn	*Crataegus monogyna*	5	15	15	47.12	18.85	Moderate	N	Absent
T76	Butterfly bush	*Buddleja davidii*	4	NC	NC	NC	NC	Absent	N	Absent
T77	Hawthorn	*Crataegus monogyna*	6	NC	NC	NC	NC	Heavy	NC	NC

Appendix G – Tree Survey Mapping

Map 1. Trees Surveyed. Annotation 'a' denotes an inset. For example, Map 2a is inset in Map 2.

T1
0 20 40 m
T77
T75
T76
T73
T74
T71
T72
T69
T70
T67
T68
T65
T66
T5/6
T7
T8
T63
T64
T9
T11
T10
T12-14
T62
T61
T60
T58
T59
T4
T3
T2
0 10 20 30 m
Trees
Scheme Area

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Map 2 (2a inset)

Map 3

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Map 4 (4a inset)

Appendix 10-2 Habitat and Species Baseline Report Upstream Storage Area 2024

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Graiguenamanagh-Tinnahinch Flood Relief Scheme

Habitats and Species Baseline Report – Upstream Storage Area

Kilkenny and Carlow County Council

Report No. W3451-ENV-R012
24 March 2023
Revision 00

CARLOW COUNTY COUNCIL

Kilkenny County Council
Comhairle Chontae Chill Chainnigh

OPW Oifig na nOibreacha Poiblí Office of Public Works

Rialtas na hÉireann Government of Ireland | Tionscadal Éireann Project Ireland 2040

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Disclaimer: Please note that this report is based on specific information, instructions, and information from our Client and should not be relied upon by third parties.					

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Glossary of Terms and Abbreviations

Birds and Natural Habitats Regulations	S.I. no. 477 of 2011 and subsequent amendments (2011-2021)
BoCCI	Birds of Conservation Concern, Ireland
CCC	Carlow County Council
CFRAM	Catchment Flood Risk Assessment and Management Study
DHPLG	Department of Housing, Local Government and Heritage
EC	European Commission
EIA	Environmental impact assessment
EIAR	Environmental impact assessment report
EPA	Environmental Protection Agency
EU Habitats Directive	Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora.
FRS	Flood Relief Scheme
I, II, III, IV, V	One, two, three, four, five.
IUCN	International Union for Conservation of Nature
ISMP	Invasive Species Management Plan
KCC	Kilkenny County Council
km	Kilometres
km^2	Kilometre squared
m	Metres
mm	Millimetre
NBDC	National Biodiversity Data Centre
NHA	Natural Heritage Areas
NPWS	National Parks and Wildlife Service
OPW	Office of Public Works
OSPAR	Oslo/Paris Convention for the Protection of the Marine Environment of the North-East Atlantic
pNHA	Proposed Natural Heritage Areas
PRA	Preliminary Roost Assessment PRA (Bat Survey)
R	River
SAC	Special Area of Conservation; Prime wildlife conservation areas/sites considered of importance at both Irish and European level; the legal basis for their designation is the Habitats Directive.
SCI	Special Conservation Interests of Special Protection Areas

SoP	Standard of Protection
SPA	Special Protection Areas; Sites/areas primarily classified for the conservation of bird species; the legal basis for their designation is the EU Birds Directive.
UNESCO	United Nations Educational, Scientific and Cultural Organisation
Wildlife Acts	Wildlife Act (no. 39 of 1976) and subsequent amendments (1976-2021).
QI	Qualifying Interests of Special Protection Areas
ZoI	Zone of Influence

Executive Summary

Introduction

Kilkenny County Council (KCC) has commissioned ByrneLooby (BL) to develop and implement a flood relief scheme (FRS) for the 'Graiguenamanagh-Tinnahinch Flood Relief Scheme (GTFRS)' project (hereafter referred to as 'the proposed scheme').

The Proposed Scheme has undergone assessment and optioneering, including a Multi-Criteria Assessment (MCA) to determine the most technically, socially, environmentally and economically acceptable design. From this, the emerging preferred option was determined, and includes the construction of raised defences on the River Barrow and River Duiske, as well as an upstream storage area 2km upstream from the town of Graiguenamanagh.

In 2020 / 2021 extended environmental surveying was undertaken in the Study Area, encompassing the defences proposed within the original scheme area. This did not include the upstream storage area, which has since been identified as a viable solution for the GTFRS.

This report presents the results of an extended habitat survey and desktop study for the upstream storage are proposed for the GTFRS.

Purpose of Report

A Habitats and Species walkover survey was completed in January 2023 in the area encompassing the proposed upstream storage for the GTFRS. The aim of this report is to outline the observations/findings from this survey in conjunction with existing desktop data. Any critical information gaps have been identified, and any necessary field surveys required to address such information gaps are specified, to be undertaken as part of the Environmental Impact Assessment (EIA) and Nature Impact Statement (NIS) for the proposed scheme.

Key Findings

The following habitat types (as per Fossitt, 2000) have been noted within 100m of the planned flood defences (Wilson & Duff, 2014; Ryan, 2015; Smith, 2018; NPWS 2019):

- Scrub (WS1)
- Stone Walls and Other Stonework (BL1)
- Recolonising Bare Ground (ED3)
- (Mixed) Broadleaved Woodland (WD1)
- Riparian Woodland (WN5)
- Wet Pedunculate Oak-Ash Woodland
- Hedgerows (WL1)
- Wet Grassland (GS4)
- Eroding/Upland Rivers (FW1)

- Improved Agricultural Grassland (GA1)
- Dry Meadows and Grassy Verges (GS2)
- Treelines (WL2)

The following habitats and species are the QIs of the River Barrow and River Nore SAC, and the River Nore SPA.

The Freshwater Pearl Mussel (*Margaritifera margaritifera*), Nore Pearl Mussel (*Margaritifera durrovensis*), White-clawed Crayfish (*Austropotamobius pallipes*), Sea Lamprey (*Petromyzon marinus*), River Lamprey (*Lampetra fluviatilis*), Brook Lamprey (*Lampetra planeri*), Twaite Shad (*Alosa fallax fallax*), Atlantic Salmon (*Salmo salar*), Desmoulin's Whorl Snail (*Vertigo moulinsiana*) and Otter (*Lutra lutra*) are the faunal species listed as the Qualifying Interests (QIs) of the River Barrow and River Nore SAC.

Estuaries [1130], Mudflats and sandflats not covered by seawater at low tide [1140], Reefs [1170], Salicornia and other annuals colonising mud and sand [1310], Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330], Mediterranean salt meadows (*Juncetalia maritimi*) [1410], Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260], European dry heaths [4030], Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430], Petrifying springs with tufa formation (*Cratoneurion*) [7220], Old sessile oak woods with Ilex and Blechnum in the British Isles [91A0], and Alluvial forests with *Alnus glutinosa* and Fraxinus excelsior (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0] are the habitat QIs of the R. Barrow and R. Nore SAC.

The River Nore SPA is a long, linear site including both the river channel and marginal vegetation, located ~8km from the scheme area (closest edge to closest edge). The site is a Special Protection Area (SPA) under the E.U. Birds Directive of special conservation interest (SCI) for the following species: Kingfisher (*Alcedo atthis*).

Several observations of mammals (non-volant) were observed during the field survey including a badger run and latrine/droppings, otter spraints, food remains, small mammal burrow, and bird (duck/geese) droppings/guano. Potential evidence of the presence of otter (QI species of the R. Barrow and R. Nore SAC) was recorded; several accounts of food remains (namely dead/eaten bird remains) and 2 otter spraints. Otters are protected by the Wildlife Acts and are listed in Annex II of the EU Habitats Directive. Annex II of the Habitats Directive lists 'Animal and plant species of community interest whose conservation requires the designation of Special Areas of Conservation'.

Available online data and the observed potential bat roosting sites (derelict buildings and trees covered in dense ivy) observed during field surveys suggest that bats utilize the various ecological corridors, i.e., linear features such as the rivers and treeline/hedgerows located along the proposed works for commuting, foraging and breeding. All bat species are protected under the Wildlife Acts and Annex IV of the EU Habitats Directive.

Ecological constraints maps may be provided at EIA/NIS stage to advise areas to avoid of ecological importance to certain species, focusing on potential habitats (high suitability) and on identifying the principal factors that constrain life-history outcomes (success/productivity/resilience/fitness) for specific species. During construction and/or operations, the ecological constraint maps can be

consulted and used as a guideline for the efficient development of actionable knowledge on ecological issues and development of optimal solutions to a wide range of conservation and management problems that aligns with national and international legislation.

Recommendations

Designated Sites (Appropriate Assessment):

The most significant ecological constraint in Graiguenamanagh town is the designation of the River Barrow and River Nore Special Areas of Conservation (SAC site code 002162). This site consists of the freshwater stretches of the River Duiske and its catchment area.

It has been determined that a Natura Impact Statement (NIS) in accordance with Articles 6(3) and 6(4) of the EU Habitats Directive (Directive 92/43/EEC) is required for the proposed scheme. This will include the upstream storage area, as well as the area encompassing the proposed defences in the towns of Graiguenamanagh and Tinnahinch.

Terrestrial and Aquatic Ecology:

Additional specialist ecology surveys are recommended to identify the presence/absence and population status (where appropriate) of species using the site and its surrounds, in particular those species listed as QIs of the SAC. These are recommended to inform the AA and Environmental Impact Assessment (EIA), as required, for the Scheme.

- Otter Survey
- Badger Survey
- Avifaunal Survey (breeding)
- Bat Survey
- Tree Survey
- Aquatic Surveys, as needed (requirements determined by APEM under Appendix D).
- Amphibian Survey
- Habitat/species constraints mapping

A full review of the survey recommendations is provided in Chapter 6.

Invasive Species:

The study area was surveyed specifically for the presence of invasive plant species. Previous to this report, an Invasive Species Management Plan (ISMP) was completed separately (Report No. W3451-CS-R009) for the scheme area established at the time. Should it be deemed a requirement, the management of the invasive species noted as part of this report should be undertaken in line with the recommendations made within that ISMP.

1 Introduction

1.1 Overview

Kilkenny County Council (KCC) has commissioned ByrneLooby (BL) to develop and implement a flood relief scheme (FRS) for the 'Graiguenamanagh-Tinnahinch Flood Relief Scheme (GTFRS)' project (hereafter referred to as 'the proposed scheme'). The overriding purpose of the proposed scheme is the identification, design and submission (for planning consent) of a Flood Relief Scheme (FRS) to alleviate the risk of flooding to the community of Graiguenamanagh and Tinnahinch in accordance with to the standards of the EU Directive on the Assessment and Management of Flood Risk (Floods Directive 2007/60/EC) transposed into Irish Law as SI 122 of 2010.

1.2 Project background

The proposed scheme has undergone rigorous optioneering, including a Multi-Criteria Assessment (MCA) to determine the most technically, socially, environmentally and economically acceptable design. From this, the emerging preferred option was determined.

The emerging preferred scheme consists of upstream storage of flood waters, which facilitates a reduced extent of flood walls downstream in the built-up area of Graiguenamanagh.

The scheme further includes series of raised flood defence walls and embankments along the River Duiske (Graiguenamanagh) and River Barrow (Graiguenamanagh and Tinnahinch), as well as flood gates along the Graiguenamanagh and Tinnahinch quays and a debris trap on the River Duiske.

In 2020 / 2021 extended environmental surveying was undertaken in the Study Area within the towns of Graiguenamanagh and Tinnahinch. These included:

Survey Name	Survey Date
Specialist survey for Bats	14-16/09/2020
Habitats and species walkover	13/05/2020, 19/06/2020 & 16-18/02/2021
Specialist survey for wintering birds	16-18/02/2021
Specialist survey for Breeding birds	16-18/02/2021
Specialist surveys for mammals, including otter, badger, pine martin, red squirrel	16-18/02/2021
Specialist survey for herpetofauna	16-18/02/2021
Specialist survey for flora	16-18/02/2021
Specialist survey for trees	16-18/02/2021
Specialist survey for alien invasive flora species	09/07/2020 & 16-18/02/2021
Q values/invertebrates	08/02/2021
Electrofishing survey of the Duiske River	10/02/2021
Specialist survey for white-clawed crayfish (inc. eDNA sampling and testing)	29/04/2021

Survey Name	Survey Date
Specialist survey for freshwater pearl mussel (inc. eDNA sampling and testing)	30/04/2021
Additional habitats and species walkover for the proposed upstream storage area	**09/01/2023**

The 2020/2021 surveys did not include the upstream storage area, which has since been identified as a viable solution for the GTFRS.

1.3 Purpose of Report

This report is intended to review all relevant existing and historical information regarding the ecology of the area within and surrounding the upstream storage area proposed for the GTFRS.

As mentioned, a Habitats and Species Walkover Survey was completed in January 2023 within the proposed upstream storage area of the GTFRS, as illustrated in Figure 1.1 below. The aim of this report is to outline these observations/findings in conjunction with relevant existing and historical desktop data regarding the ecology of the surrounding area.

This report forms the basis for decision-making over the need for other specialist ecological surveys as part of the subsequent assessment, which will be reported in full in the EIA Report and NIS. Where additional specialist surveys are required, these will be reported in full in other Technical Reports.

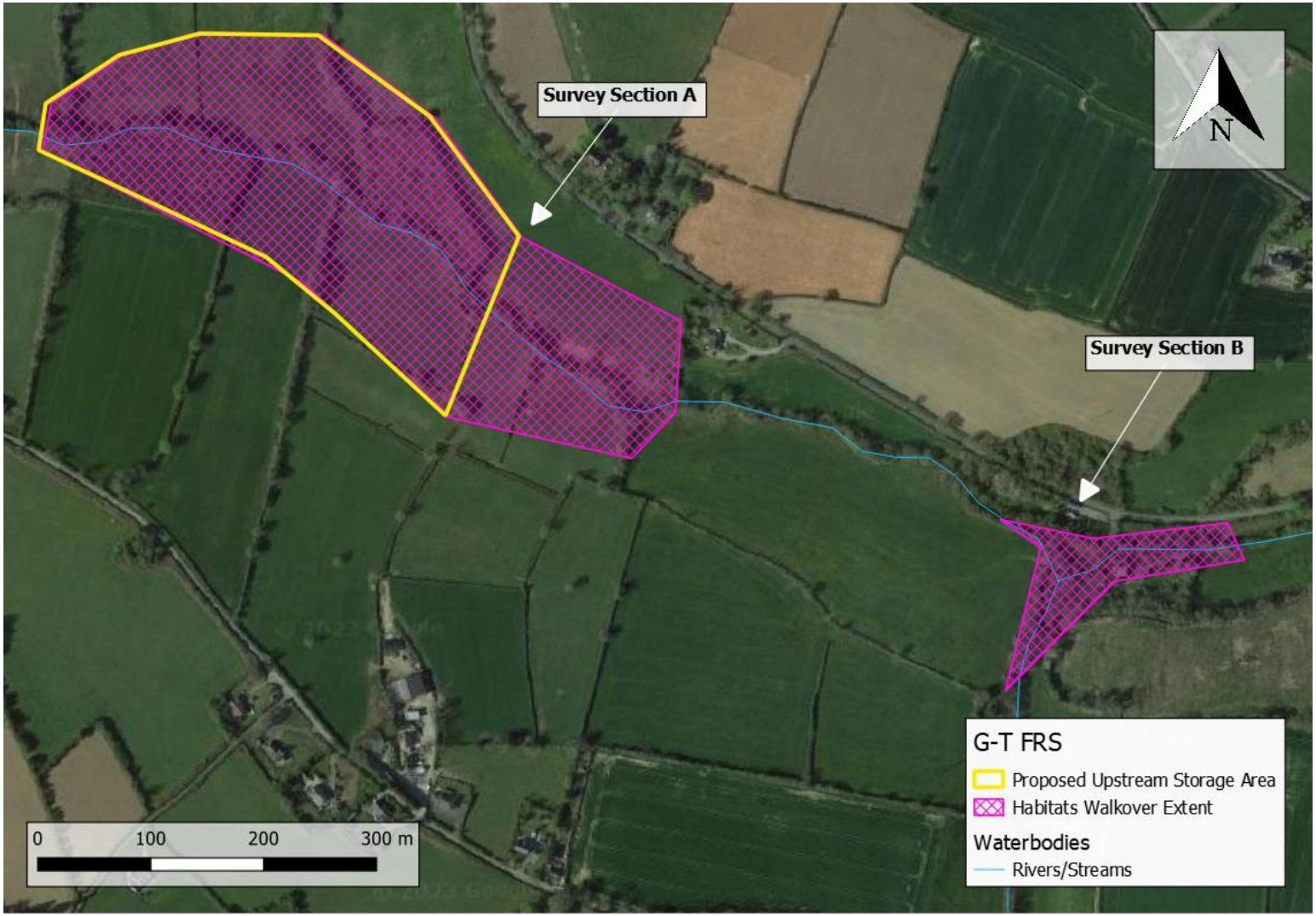

Figure 1.1 Upstream Storage Area and Habitats Walkover Extents.

1.4 Roles and Qualifications

The following provides detail to the team involved in the technical completion of the surveys and preparation of this report. Further staff were involved in QA procedures.

Title	Name	Role	Qualifications	Years' experience
Senior Ecologist	Jeff Hean	Report reviewer	BSc (Ecology) BSc Honours (Ecology) MSc (Ecology) Ph. D (Zoology)	>5
Senior Environmental Specialist	Jackelyn Wren	Report reviewer	BA Honours (Geography)	8
Ecologist	Joe Butler	Completion of survey	BSc (Zoology) MSc (Wildlife Conservation & Management) QCIEEM	4
Ecologist	Maggie Starr	Completion of survey and Report preparation	BSc (Marine Science)	<1

Joe Butler has worked as an ecologist with ByrneLooby since 2018. He has conducted numerous ecological and environmental assessments, including Appropriate Assessment reports, for submission to various regulatory bodies in Ireland.

Maggie started working as an ecologist with ByrneLooby in 2022. She has experience in planning and conducting protected species surveys and ecological report writing in both voluntary and professional capacities.

Jeff is an aquatic ecologist who commenced working with ByrneLooby in 2023. His work experience includes biodiversity and conservation projects, Impact assessments of construction projects, including water and fuel pipelines, renewable energy facilities, roads and railways, and wastewater treatment plants, environmental auditing, macro- and micro-plastic waste source-pathway determination, and environmental management.

Jackelyn Wren is a Senior Environmental Specialist with 8 years' experience in environmental management and delivering Environmental Impact Assessments across Ireland and the Middle East.

2 Statutory and Non-statutory Designated Ecological Sites

International, European and National legislation affords biodiversity protection for species and their habitats, most particularly the EU Habitats and Birds Directives, the Planning and Development (Amendment) Act, 2001 (as amended), the EU (Natural Habitats) Regulations 2011 and the Irish Wildlife Acts (1976 and subsequent amendments).

"*The Habitats Directive ensures the conservation of a wide range of rare, threatened, or endemic animal and plant species. Some 200 rare and characteristic habitat types are also targeted for conservation in their own right*" – European Commission (EU Nature Law).

European and national legislation places a collective obligation in Ireland and its citizens to maintain habitats and species in the Natura 2000 network (SPAs and SACs) at favourable conservation condition.

2.1 European Designated Sites

A key measure to protect nature and biodiversity in the EU is the establishment of a network of nature protection areas under the Habitats Directive and the Birds Directive. The areas designated under these two pieces of legislation are known collectively as Natura 2000 sites, also referred to as European Sites under national legislation (NPWS).

2.1.1 Natura 2000 Sites

Natura 2000 is a European network of ecologically important sites comprising of SACs, candidate SACs and SPAs, designated under the EU Directives – a combination of the Habitats Directive and Birds Directive.

The Birds and Natural Habitats Regulations (2011 and amendment in 2021) seek to conserve species of wild birds and require the designation of a network of habitats for birds, based on scientific criteria. These designated sites are assessed through the regular monitoring of waterbirds from which the conservation value and subsequent basis for SPA (Council Directive 79/409/EEC) selection in Ireland is appointed.

The four main parameters considered are:

I. the protection of listed bird species considered rare and vulnerable,

II. regular migratory species,

III. species that are vulnerable to specific changes occurring to their habitat, and

IV. wetland areas of special interest and importance that supply the environmental features satisfying the needs of waterbird species.

The Regulations (2011 and 2021), also require the designation of Special Areas of Conservation (SACs) for the protection of certain habitats and species of plants and animals (other than birds) – the EU Habitats Directive (92/43/EEC). Articles 6(3) and 6(4) of the Directive call for the undertaking of an Appropriate Assessment for plans and projects likely to affect designated sites.

Best practice guidance (DEHLG, 2010 and DAFM, 2019) recommends a distance of 15km (likely zone of influence from the project zone whereby any Natura 2000 sites and their Qualifying Interests (QIs) within the 15km radius should be initially screened for direct, indirect or cumulative effects during construction and/or operation of the proposed developments. Although there is no legal

requirement for this 15km radius zone, this method has become common practice in screening projects for AA. However, the distance of the radius zone can vary depending on the project and therefore should be evaluated on a case-by-case basis with reference to the nature, size and location of the project with regards to the sensitivities of the ecological receptors, and the potential for in combination effects. In the case with sites with water dependent habitats and species, and proposed development that could affect water quality or quantity it may be necessary to consider the full extent of the upstream and/or downstream catchment within the 15km radius zone.

The Office of the Planning Regulator (OPR, Practice Note PN01, 2021) recommends the zone of influence of a project should be considered using the Source-Pathway-Receptor model, stating "*A European site will only be at risk from likely significant effects where the Source-Pathway-Receptor link exists between the proposed development and the European site*". If no pathway exists between the source and receptor site, the proposed development can be screened out with confidence. If no direct/indirect effect exists to the QIs of the European designated sites from any impact resulting from the proposed development, during the screening process a likely significant effect can then also be ruled out.

The proposed works for this project include instream works, altering the flow characteristics of the River Duiske and creating restrictions within the river Duiske. The following direct/indirect impacts are of potential concern:

- Habitat loss and/or fragmentation affecting species such as freshwater pearl mussel, white-clawed crayfish, fish and benthic flora and fauna;
    - extensive riparian and bank-side habitat loss owing to excavations
- Water quality impacts – pollution from sediment and silt, chemicals, hydrocarbon spills (diesel, hydraulic fluids from vehicles during construction) and/or eutrophication (caused by run-off from fertilised agricultural land) owing to bankside mechanical works, excavation and potential rock cutting;
    - fish gills may be adversely affected by the elevated levels (as a direct effect of the construction) of suspended solids and heavy silt loads in the river with possible negative implications to upstream migration in late autumn
    - macroinvertebrate prey and algal food sources may become smothered – crayfish gills may be adversely affected, and their habitat could be potentially covered/suffocated.
- Noise, vibration, human disturbance arising from construction activities causing, deterring animals from foraging, hunting, roosting and breeding sites within the proposed development;
- Physical hydrological changes impacting connectivity to upstream/downstream sites and any alterations to the channel characteristics such as change to the riverbed substrate(s);

  - permanent/temporary interruptions to hydrological linkages possibly disrupting upstream migration of migratory fish species such as salmon and brown trout (salmonid species – freshwater pearl mussel rely on salmonid fish to complete their life cycle), twaite shad, etc.
  - potential impact to the normal summer/winter flow regime affecting spawning/breeding events (fish and bird species) – permanent/temporary displacement from breeding grounds
  - localised, increased bed disturbance downstream from changes to the flow dynamics – potential reduction to peak velocity in-channel may affect silt levels in gravel beds used by salmon and trout for spawning sites and lamprey larvae and ammocoetes as burrowing grounds

- Potential impact on the riverbanks during construction and/or operations;
  - causing possible destruction/displacement of otter holt/couch, badger setts, etc.
  - loss of tree cover/tree felling along the riverbanks causing habitat loss i.e., roosting/resting/breeding sites for bats and birds, and loss of linear ecological corridors for foraging bats, otters, pine martens and stoats
  - Loss of bankside vegetation such as scrub, earth banks (crayfish may emerge from refuge from within the banks), treelines, wet grassland and wet swampy areas suitable for amphibians.
  - Removal of plant cover and invertebrates (food source for many species including otter, birds, etc.) owing to mechanical damage – the impact will be very localised, confined to the immediate footprint of the proposed works and will not affect the overall integrity of the SAC

The nature, size, location and the extents of the works involved in the proposed upstream storage area, and the above-mentioned potential impacts on habitat and species (including QIs of the R. Barrow and R. Nore SAC and species of high local importance) were considered. The impacts could be considerable, therefore, all sites within a 15km radius of the proposed development have been identified as a precautionary measure. It should be noted that impacts at this distance from the proposed development are highly unlikely in the absence of significant aqueous or air emissions.

The sites designated for nature conservation within 15 km of the proposed upstream storage area are discussed in the following section. In total, there are 8 Natura 2000 sites within Co. Kilkenny, and 4 of these sites are located within the 15km zone of influence (ZoI). The 15 km radius search area was selected for the Natura 2000 Sites due to the hydrological links surface and groundwater, between the Site and the River Barrow and River Nore SAC. Graiguenamanagh-Tinnahinch is divided by the River Barrow, and much of the River Duiske, including the section that flows through the proposed upstream storage area, are also designated (see Figure 2.1 and Table 2.1). In Table 2.1, the distance from the Natura 2000 sites is detailed from closest edge to closest edge.

The River Nore SPA is a long, linear site including both the river channel and marginal vegetation, located ~8km from the in the proposed upstream storage area (closest edge to closest edge). The site is a Special Protection Area (SPA) under the E.U. Birds Directive of special conservation interest (SCI) for the following species: Kingfisher (*Alcedo atthis*).

Table 2.1 SPAs and SACs located within the 15km radius of the proposed upstream storage area

Type	Site Code	Site Name	Distance from Scheme Area
SPA	004233	River Nore SPA	8km
SAC	002162	River Barrow and River Nore SAC	N/A
SAC	000770	Blackstairs Mountains SAC	8km
SAC	002252	Thomastown Quarry SAC	11km

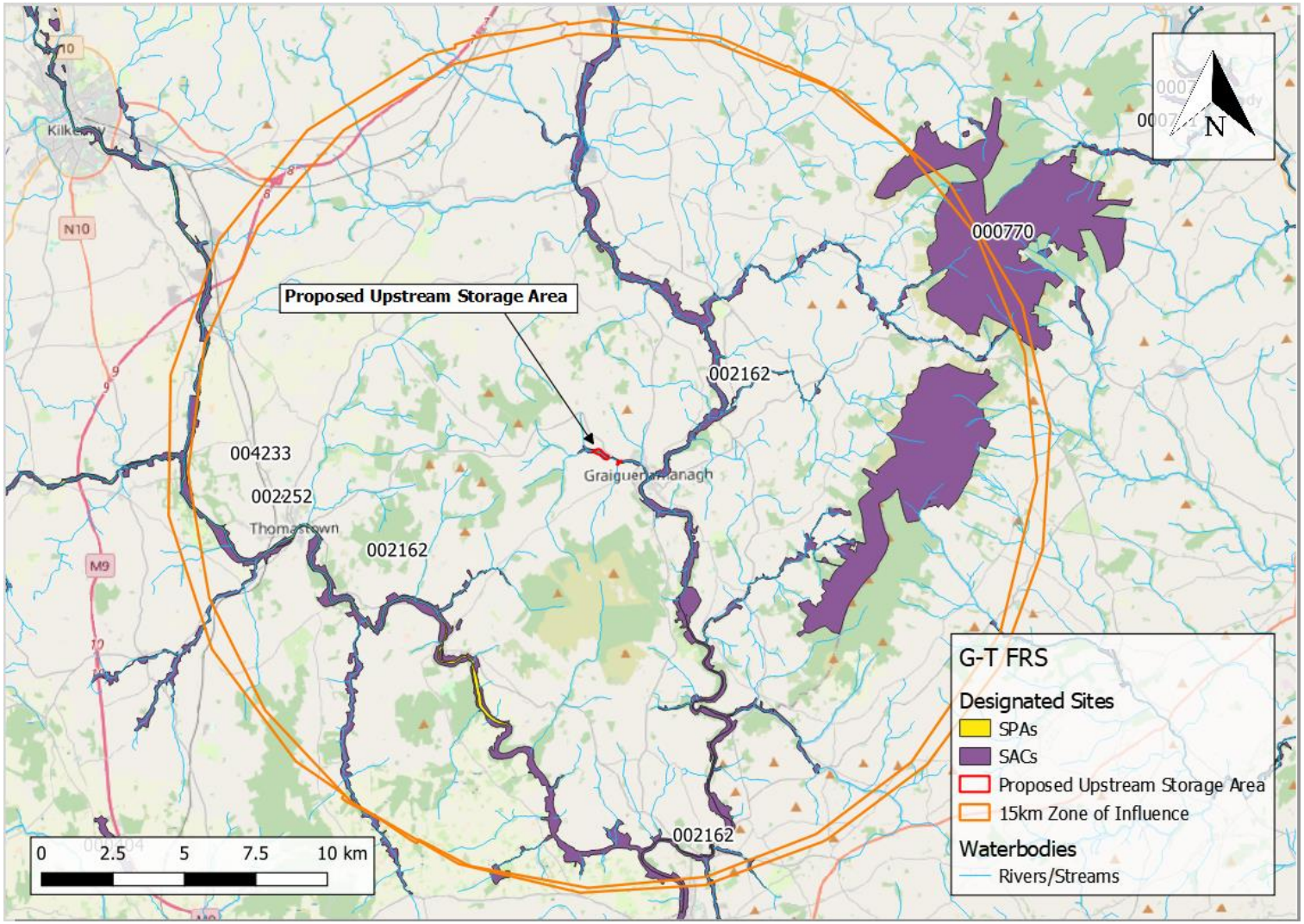

Figure 2.1 Natura 2000 sites within the 15km zone of influence of the propose works.

2.1.2 Annex Habitats and Species

The annexes of the directive outline the protected habitats and species:

- Annex I: Habitat types whose conservation requires the designation of Special Areas of Conservation. Priority habitats, which are in danger of disappearing within the EU territory, are highlighted with an asterisk.
- Annex II: Animal and plant species whose conservation requires the designation of Special Areas of Conservation
- Annex IV: Animal and plant species in need of strict protection.
- Annex V: Animal and plant species whose taking in the wild and exploitation may be subject to management measures.

The River Nore is an SPA, and collectively the River Barrow and River Nore are an SAC, under the terms of the EU Directives. The SAC is selected for the following habitats and/or species listed on Annex I/II of the EU Habitats Directive (*= priority; numbers in brackets are Natura 2000 codes):

Habitats:

- Estuaries [1130]
- Mudflats and sandflats not covered by seawater at low tide [1140]
- Reefs [1170]
- *Salicornia* and other annuals colonising mud and sand [1310],
- Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]
- Mediterranean salt meadows (Juncetalia maritimi) [1410]
- Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260]
- European dry heaths [4030]
- Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430]
- *Petrifying springs with tufa formation (*Cratoneurion*) [7220]
- Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles [91A0]
- Alluvial forests with *Alnus glutinosa* and Fraxinus excelsior (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0]

Species:

- Desmoulin's Whorl Snail (*Vertigo moulinsiana*) [1056]
- Freshwater Pearl Mussel (*Margaritifera margaritifera*) [1029]
- White-clawed Crayfish (*Austropotamobius pallipes*) [1092]
- Sea Lamprey (*Petromyzon marinus*) [1095]
- Brook Lamprey (*Lampetra planeri*) [1096]
- River Lamprey (*Lampetra fluviatilis*) [1099]
- Twaite Shad (*Alosa fallax*) [1103]
- Atlantic Salmon (*Salmo salar*) [1106]

- Otter (*Lutra lutra*) [1355]
- Killarney Fern (*Trichomanes speciosum*) [1421]
- Nore Freshwater Pearl Mussel (*Margaritifera durrovensis*) [1990]

2.1.3 RAMSAR Convention

'The 'RAMSAR Convention (or 'Wetlands Convention') on Wetlands' is an intergovernmental environmental treaty established by UNESCO that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources' RAMSAR. Ramsar Sites are wetlands of international importance that have been designated under the criteria of the Ramsar Convention on Wetlands for containing representative, rare or unique wetland types or for their importance in conserving biological diversity (JNCC).

The three main 'pillars' of activity are:

- the designation of wetlands of international importance as Ramsar Sites;
- the promotion of the wise use of all wetlands in the territory of each country; and
- international co-operation with other countries to further the wise use of wetlands and their resources.

No sites are designated as RAMSAR sites within the R. Barrow and R. Duiske.

2.2 Nationally Designated Sites

The basic national designation for wildlife and their habitats is the Natural Heritage Areas (NHAs) and proposed Natural Heritage Areas (pNHAs) designated under the Wildlife (Amendment) Act 2000. These areas are considered important for the habitats present or which holds species of plants and animals whose habitat needs protection.

2.2.1 Wildlife Acts (1976 and subsequent amendments)

"The aims of the Wildlife Act, 1976, are to provide for the protection and conservation of wild fauna and flora, to conserve a representative sample of important ecosystems, to provide for the development and protection of game resources and to regulate their exploitation, and to provide the services necessary to accomplish such aims" - NPWS.

Under the act it is an offence to "wilfully interfere with or destroy the breeding place or resting place of any protected wild animal''. Interference of such species can only occur under a derogation licence (application to the Minister for Housing, Local Government and Heritage, NPWS) – i.e., a licence to disturb or interfere with protected plant and animal species. The Minister has power to attach conditions to any licence granted under the Act and to vary them.

2.2.2 Natural Heritage Areas (NHA)

The basic designation for wildlife is the Natural Heritage Area (NHA). This is an area considered important for the habitats present or which holds species of plants and animals whose habitat needs protection (NPWS). Under the Wildlife Amendment Act (2000) NHAs are legally protected from damage. NHAs are not part of the Natura 2000 network and so the Appropriate Assessment process does not apply to them.

Proposed NHAs (pNHA) are sites of significance for wildlife and habitats published on a non-statutory basis in 1995 but have not since been statutorily proposed or designated. The pNHAs cover approximately 65,000ha and designation will proceed on a phased basis over the coming years (NPWS).

Prior to statutory designation, pNHAs are subject to limited protection, in the form of:

- Agri-environmental farm planning schemes such as Rural Environment Protection Scheme (REPS 3 and 4) and Agri Environmental Options Scheme (AEOS) continue to support the objective of maintaining and enhancing the conservation status of pNHAs. The farm plans operate for a period of 5 years. REPS 4 plans will continue to operate until 2014.
- Forest Service requirement for NPWS approval before they will pay afforestation grants on pNHA lands.
- Recognition of the ecological value of pNHAs by Planning and Licencing Authorities.

Under the Wildlife Amendment Act (2000), NHAs are legally protected from damage from the date they are formally proposed for designation (NPWS).

No NHAs are located within the 15km zone of influence surrounding the proposed upstream storage area however thirteen pNHAs are, as outlined below (see Table 2.2 and Figure 2.2).

Table 2.2 pNHAs within 15km of the proposed works.

Type	Site Code	Site Name	County
pNHA	000846	Red Bog, Dungarvan	Kilkenny
pNHA	000770	Blackstairs Mountains	Carlow
pNHA	000830	Clohastia	Kilkenny
pNHA	000843	Mount Juliet	Kilkenny
pNHA	000410	Thomastown	Kilkenny
pNHA	000837	Inistioge	Kilkenny
pNHA	002094	Ice House, Near Inistioge, Co. Kilkenny	Kilkenny
pNHA	000844	Murphy's Of The River	Kilkenny
pNHA	000409	Rathsnagadan Wood	Kilkenny
pNHA	000812	Pollmounty River Valley	Wexford
pNHA	000698	Barrow River Estuary	Wexford
pNHA	000842	Kylecorragh Wood	Kilkenny
pNHA	000827	Brownstown Wood	Kilkenny

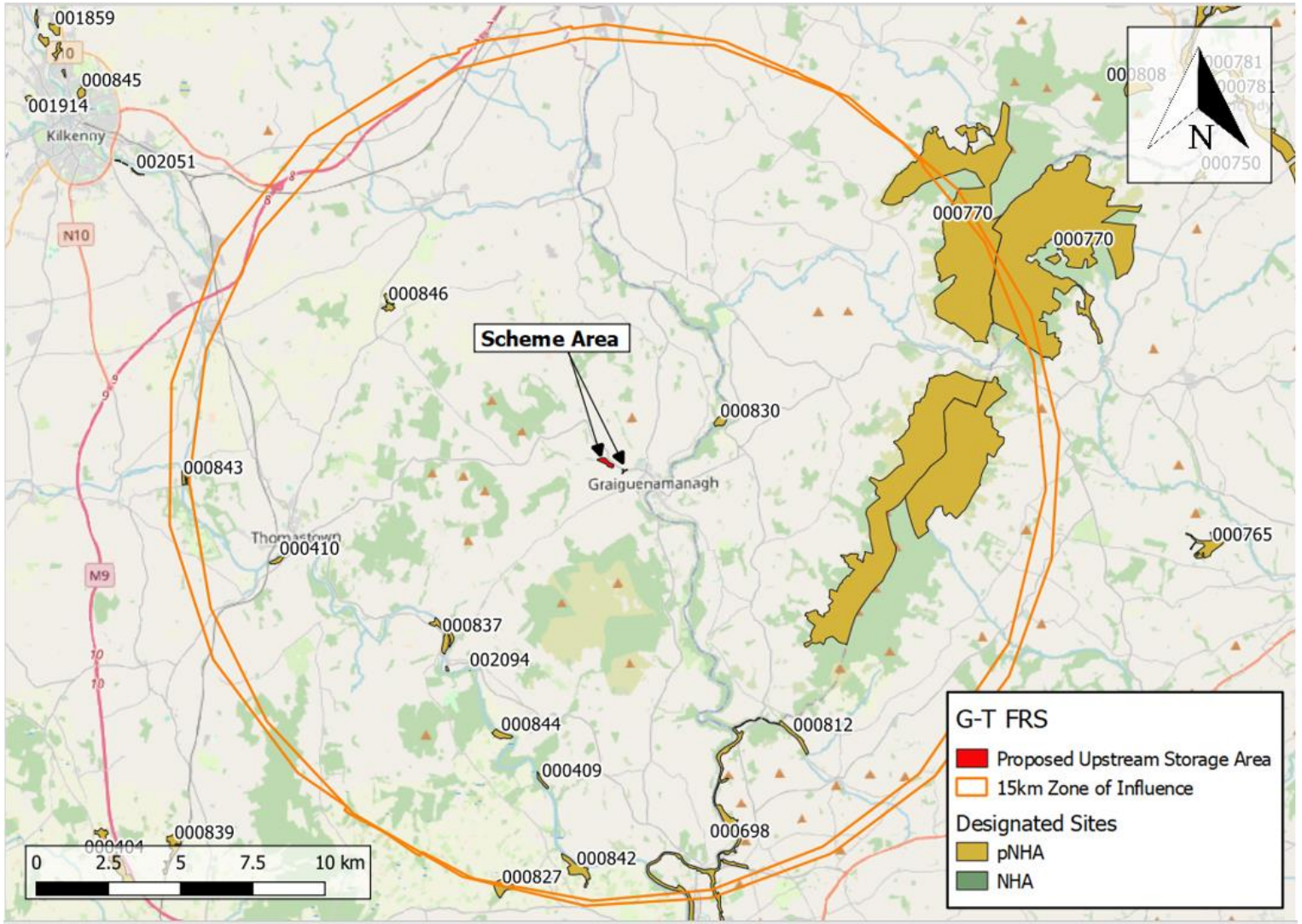

Figure 2.2 pNHAs within the 15km zone of influence of the proposed upstream storage area

2.2.3 Statutory Nature Reserves

A Nature Reserve is an area of importance to wildlife, which is protected under Ministerial Order. Most nature reserves area State owns, however, some are owned by organisations/private landowners, and persons interested in acquiring statutory protection for their lands. There are 4 Statutory Nature Reserves in County Kilkenny, none of which are located within the 15 km Zone of Influence (ZoI).

2.2.4 Wildfowl Sanctuary

Wildfowl Sanctuaries are areas that have been excluded from the 'Open Season Order' so that game birds can rest and feed undisturbed. Shooting of game birds is not allowed in these sanctuaries. In County Kilkenny and Carlow, the River Barrow (Goresbridge) and the River Barrow (Muine Bheag), respectively, are Wildfowl Sanctuaries. In addition, Lough Gill is designated as a Wildfowl Sanctuary in Co. Kilkenny (outside the ZoI).

3 Methodology

3.1 Introduction

This ecological baseline data collection and survey has comprised:

- Consultations and desk study;
- Extended habitat survey and mapping; and
- Preliminary surveys for other features/species of interest (where such interests have been identified, further specialist surveying has been recommended).

The detailed methodology for each component is described in the sections below.

3.2 Desktop Research

The desk study included review of the following sources of information:

- River Barrow and River Nore SAC – Site Synopsis (NPWS, 2016)
- River Barrow and River Nore SAC – Conservation Objectives (NPWS, 2011)
- River Barrow and River Nore SAC - Conservation Objectives Supporting Document - Woodland Habitats (NPWS, 2011)
- Article 17 Reports (NPWS, 2019)
    - GIS spatial data for Article 17 Reports[1]
- 2019 Spatial data for breeding distributions and ranges of bird species protected under Article 12 of the Bird Directive (79/409/ECC) (NPWS, 2019a).
- 2019 Spatial data for habitats (Annex I) and species (Annexes II, IV and V) protected under Article 17 of the Habitats Directive (92/43/EEC) (NPWS, 2019b).
- National Biodiversity Data Centre (NBDC, 2022) – 2km-square species reports (accessed online on 21/11/2022);
- Water Flow Network – shapefile containing spatial data on the integrated flow network of known flow connections through rivers, lakes and groundwater aquifers (EPA, 2017).

The following websites were used to access information and data:

- National Parks and Wildlife Service - www.npws.ie

[1] https://www.npws.ie/maps-and-data/habitat-and-species-data/article-17

- National Biodiversity Data Centre - www.biodiversitycentre.ie
- Ordinance Survey Ireland - www.osi.ie
- The Vincent Wildlife Trust Ireland – www.vincentwildlife.ie
- Environmental Protection Ireland - www.epa.ie
- Kilkenny County Council - www.kilkennycoco.ie
- Carlow County Council – www.carlow.ie
- DATA.GOV.IE - https://data.gov.ie/

3.3 Study Area

The ecological study area has been developed in consideration of the proposed upstream storage area identified from project-level assessment and optioneering. Further the study area was extended to encompass the area envisaged for constructional related storage, and to provide a review of the environment surrounding the water treatment plant (WTP) – refer back to Figure 1.1.

A 15km zone of influence (ZoI) was applied when identifying protected sites and species in line with DEHLG, 2010, DAFM, 2019 and the justification provided in Section 2.1.1.. Two 15km ZoI's have been applied for the purpose of this report, one for each of the Survey Areas (Areas A and B, as illustrated in Figure 5.3 and Figure 5.4). It should be noted, however, that impacts at this distance from the proposed development are highly unlikely in the absence of significant hydrological connection. The study area is shown in Figure 1.1 with the extents of the habitats and species walkover survey identified, as outlined below.

For ease of reference, the walkover survey areas have been divided into 2 survey sections, labelled A and B (see Figure 1.1). It should be noted that this system is specific to this report and is not representative of nomenclature used in other aspects of this FRS project. Survey Section A is included as it has been identified as a proposed area for works. No works are proposed in survey Section B; this section of the river was included in the Habitats and Species Walkover to review the habitat(s) present in the area as the flood frequency in this area will be reduced.

3.4 Field Surveys

Site visit was carried out on the 9th of January 2023 to conduct field walkover surveys, examining the habitats, fauna, and invasive flora within and in the vicinity of the proposed upstream storage area. These field surveys were carried out using the methodology outlined below.

3.4.1 Extended Habitat Survey

A habitat survey is a standardised method of recording habitat types and characteristic vegetation, as set out in the 'Best Practice Guidance for Habitat Survey and Mapping' (The Heritage Council,

2011). A habitat survey is a method of gathering information about the ecology of a site. The 2011 guidelines provide the following definition of a habitat survey:

"*The fundamental piece of information collected is the habitat type to which a particular area can be assigned. Habitat types are determined by reference to a system of habitat classification, which must be clearly identified. The location and extent of different habitat types that are present in a site are mapped to provide a clear spatial record. Additional information on habitats may also be collected, such as dominant species or conservation status, depending on the objectives of the particular habitat survey. The results of a habitat survey provide basic ecological information that can be used for biodiversity conservation, planning and/or management, including targeting of more detailed botanical or zoological investigations*."

Habitats were classified in accordance with the system outlined by Julie Fossitt (The Heritage Council, 2000).

The survey areas were also assessed for the presence of habitats designated by Annex I of the EU Habitats Directive. The determination of the presence or absence of Annex I habitats was carried out in consultation with the habitat descriptions provided in the most recent Article 17 Reports (NPWS, 2019). The Interpretation Manual of European Union Habitats (European Commission, 2013) was also consulted. In addition, the spatial GIS data for the Article 17 Reports were examined to determine the distribution of these habitats (as known to the NPWS) within the study area.

This habitat survey method was extended in accordance with the "Guidelines for Ecological Impact Assessment in the UK and Ireland" (CIEEM, 2019) through the additional recording of specific features indicating the presence, or likely presence, of protected species or other species of nature conservation significance.

Whilst not a full botanical or protected species survey, the extended method of survey enables suitably trained and experienced ecologists to obtain an understanding of the ecology of a site such that it is possible either:

1. to confirm the conservation significance of the site and assess the potential for impacts on habitats/species likely to represent a material consideration in planning terms; or

2. to establish the scope and extent of any additional specialist ecological surveys that will be required before such confirmation can be made.

3.4.2 Other Features of Interest

In addition to conducting an extended habitat survey, the ecologists also noted other features of interest during the field survey. In practice, the approach to this type of survey is one whereby certain features of interest are searched for and recorded as part of the habitat survey site walkover. Any features of interest were photographed, and their GPS location were recorded. Particular features of interest for this project were:

1) Mammals – particularly bats, otters, badgers, pine martens, red squirrels, hedgehogs and pygmy shrews.

The ecologist took note of the following evidence:

- Direct sightings of mammals (live or dead)
- Burrows, setts, dens, dreys, holts and otter couches
- Prints
- Prey/food remains
- Faeces
- Potential Roost Features (PRFs)

The following guidance documents were consulted when carrying out these surveys:

- Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes (NRA, 2008)
- Guidelines for the Treatment of Badgers prior to the Construction of National Road Schemes (NRA, 2005)
- A Guide to Identifying Evidence of Pine Martens in Wales (Vincent Wildlife Trust, 2017)
- Practical Techniques for Surveying and Monitoring Squirrels (Gurnell et al., 2009, for the Forestry Commission)

2) Amphibians

The ecologist took note of the following evidence:

- Spawn
- Potential spawning habitat

3) Other Species

Incidental sightings of other protected/notable species were recorded.

All findings are outlined in Chapter 5.

3.4.3 Flora Survey

A complete inventory was made of all flora species observed within the survey areas. Each species was cross-referenced with the Third Schedule of the Birds and Natural Habitats Regulations (invasive species), the Flora (Protection) Order, 2022, and Ireland Red List No. 10: Vascular Plants (Wyse Jackson et al., 2015. This is further outlined in Chapter 4.

3.5 Survey/Data Limitations

The following limitations are recognised:

i. Surveys were undertaken outside the recommended window for amphibian surveys. Amphibians are best observed during the breeding season in spring and early summer,

when they congregate in standing or slow-moving water. However, during the site visits, terrestrial and aquatic habitats were assessed for their suitability for amphibians.

ii. In large scale surveys, nocturnal and/or rare and cryptic mammals such as otter, badger, Irish stoat (though not strictly nocturnal, the majority of their hunting occurs at night), hedgehog, and pine marten (largely nocturnal) cannot be enumerated by direct observations. True representation of species presence/absence and abundance cannot be achieved as a result of this limitation.

iii. Ecological survey timing and seasonal constraints providing limited or preliminary data – Due to suboptimal seasonality it is likely that some annual or ephemeral flora taxa will have been undetectable, and some conservation significant taxa, including perennial taxa, may not have been detectable. Many protected faunal species are also seasonally constrained with survey timing; potential limitations included periods of hibernation, seasons of low activity (certain species only emerging in the summertime during the day), and outside the breeding season (high activity).

iv. Access limitations to sites or features; Areas that were inaccessible during the field surveys – water levels in watercourse were high making instream work difficult. Access to some areas was impossible for this reason, however observations were made from a distance, and kept as accurate as possible. As a result, natal otter holts were difficult to locate and may have been overlooked due to the inaccessibility of certain sections of the watercourse.

v. Substantial rainfall in the days leading up to the site survey. This meant that:

- The flow and water levels in watercourses were high – any in-stream work was difficult in some areas. Observations from a distance were made, and these were kept as accurate as possible.
- Features such as scats, prints, food remains, otter couches etc. may have been damaged or washed away by rainfall.

vi. Plant identification was limited in its accuracy – survey conducted in January resulting in the absence of flowers from most flora, foliage was absent from deciduous trees and any annual plants were completely absent. This had the following implications:

- Grass species identification is very difficult without the flower. Distinguishable leaf characteristics were not available for some species identification. Occasionally a dead flower was present on a specimen, which aided identification.
- Deciduous tree identification was possible if the ecologist had access to the twig and bud. If leaf litter was present at the base of the tree, identification was made easier.

Despite the above-mentioned limitations, a robust understanding of the site's ecology from the site survey was obtained. In particular, it was possible to identify sensitive habitats that may be affected by the works. Furthermore, the lack of deciduous foliage was advantageous in terms of searching

for mammal burrows (including setts, holts, dens, etc.), notable features in trees, and features along the riverbank, all of which would otherwise be obscured by dense foliage later in the year.

It is the professional opinion of the ecologists that additional surveys of the site would not materially alter the conclusions drawn from the survey work or the recommendations made in respect of mitigation measures.

3.6 Additional Specialist Surveys

The study area was surveyed specifically for the presence of invasive alien species (IAS). None were found at Survey Area A, whilst some were observed in Survey Area B.

An IAS Report and Invasive Species Management Plan (ISMP) was prepared under reference W3451-CS-R009, dated November 2020, for the scheme area established at this time. If deemed a requirement, all invasives noted in the upstream storage area, as described in Section 4.8 of this report, should be managed in line with this ISMP.

Unless specified otherwise, the term “invasive species” in this report refers to species listed in the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011 and 2015. The Regulations make it an offence to plant, disperse, allow or cause to disperse, spread or otherwise cause to grow any of the scheduled species.

4 Habitats and Flora

Habitats recorded in the study area are listed in Table 4.1 below. Each habitat is described in detail in the following sections.

Table 4.1 Habitats recorded within the study area.

Habitat Name	Habitat Code (as per Fossitt, 2000)
Stone Walls and other Stonework	BL1
Improved Agricultural Grassland	GA1
Dry Meadows and Grassy Verges	GS2
(Mixed) Broadleaved Woodland	WD1
Hedgerows	WL1
Treelines	WL2
Scrub	WS1
Eroding/Upland Rivers	FW1
Wet Grassland	GS4
Recolonising Bare Ground	ED3
Riparian Woodland	WN5
Wet Pedunculate Oak-Ash Woodland	WN4

Descriptions of the above habitats are provided in the following sections (Table 4.1). For each habitat, the description as per Fossitt (2000) is provided first and is shown in *italics* for visual reference. Thereafter, a description of the habitat in the context of the study area is provided, with evidence of the habitat found during the field survey. The habitat map in Figure 1.1 outlining the sections surveyed (labelled A and B) are illustrated clearly in Appendix A (Figure A.1 and Figure A.2) of this report.

4.1 Annex I Habitats:

This section provides a description of the confirmed/likely presence/absence of the habitats listed as Qualifying Interests of the River Barrow and River Nore SAC. It should be noted that the Nore catchment does not include Graiguenamanagh-Tinnahinch, and there is no hydrological pathway between Graiguenamanagh-Tinnahinch and the River Nore SPA.

The known extant mapped areas of 47 Annex I habitats (92/43/EEC) found in Ireland was consulted (NPWS, 2019b). None of these habitats are known to occur within the scheme area.

The following habitats listed as QIs of the R. Barrow and R. Nore locations are detailed below;

a) Estuaries [1130], Mudflats and sandflats [1140], Reefs [1170], *Salicornia* mud, Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330], Mediterranean salt meadows (*Juncetalia maritimi*) [1410].

These habitats are found in saline conditions (near the coast), and a significant distance downstream of the proposed upstream storage area.

b) Floating River Vegetation (Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation) [3260]

This habitat is connected with tufa deposits in the Kings River (underlain by limestone – resulting in tufa deposits), this habitat does not occur within the scheme area as the underlying bedrock geology in Graiguenamanagh Tinnahinch (G-T) is non-calcareous, consisting of various composition of slate, granite, phyllite, granodiorite and schist (GSI, 2021). No hydrological connection pathway between the G-T area exists and the absence of calcareous bedrock (limestone) is a reliable indicator that tufa deposits are also absent. On the basis that tufa deposits are absent, this particular habitat does not occur within the study area.

c) European dry heaths [4030]

This habitat is associated with peatland. It does not occur within the scheme area.

d) Hydrophilous tall herb fringe communities [6430]

This habitat was not observed during the field survey and does not occur within the proposed upstream storage area. From Article 17 data, this habitat has been recorded ~6km downstream of the proposed upstream storage area, following the centre line of the River Duiske and the River Barrow. This is a significant distance downstream and outside of the study area.

e) Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles [91A0]

No habitat fitting this description was observed during the field survey within the scheme area.

f) Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae)** [91E0]

No habitat fitting this description was observed during the field survey within the scheme area. This woodland has been identified and mapped in the Article 17 Report spatial data, upstream of the proposed scheme area along the River Duiske and downstream of the proposed scheme area along the River Barrow (~ 8km from the G-T town area).

4.2 Exposed Rock/Disturbed Ground

4.2.1 Recolonising Bare Ground (ED3)

This category is used for any areas where bare or disturbed ground, derelict sites or artificial surfaces of tarmac, concrete or hard core have been invaded by herbaceous plants. Vegetation cover should be greater than 50% for inclusion in this category. Most of the typical colonisers are ruderals, or weed plants. Common examples include Colt's Foot (Tussilago farfara), Nettle (Urtica dioica), Dandelion (Taraxacum spp.), willow-herbs (Epilobium spp.) and ragworts (Senecio spp.). Grasses are usually also present but should not dominate. Ground that is regularly trampled or driven over is usually characterised by Greater Plantain (Plantago major), Knotgrass (Polygonum aviculare), Pineappleweed (Matricaria discoidea) and Shepherd's-purse (Capsella bursa-pastoris). In urban areas, recolonising bare ground can be important for wildlife and may support a diverse flora, typically with a

high proportion of nonnative species, including Butterfly-bush (Buddleja davidii), Japanese Knotweed (Reynoutria japonica) and many other garden escapes. Note that if shrubs or grasses dominate, the habitat should be considered under the appropriate scrub/transitional woodland or grassland category.

Several small patches of ED3 were observed in survey section B. Species observed included:

Table 4.2 Species observed in Recolonising Bare Ground (ED3) in the survey areas.

Common Name	Scientific Name
False Oat-grass	*Arrhenatherum elatius*
Lesser Hawkbit	*Leontodon saxatilis*
Nettle	*Urtica dioica*
Ragwort	*Jacobaea vulgaris*
Ribwort Plantain	*Plantago lanceolata*
Spear Thistle	*Cirsium vulgare*

Figure 4.1 Recolonising Bare Ground (ED3 as per Fossitt, 2000) – 09/01/2023. Photo taken in survey section B.

4.3 Cultivated and Built Land

4.3.1 Stone Walls and Other Stonework (BL1)

This category incorporates stone walls and most other built stone structures in rural and urban situations, apart from intact buildings (see buildings and artificial surfaces - BL3) and coastal constructions made of stone (see sea walls, piers and jetties - CC1). It includes dry stone and old mortar walls that occur as field or property boundaries; retaining walls against banks of soil; stone walls that rise from rivers, canals or moats; stone bridges, viaducts and aqueducts; stone jetties or piers in lakes or rivers; derelict or ruinous buildings made of stone; and old stone monuments, fortifications or ruins. Note that modern or intact buildings made of stone are excluded, as are any structures made of bricks, cement blocks or mass concrete (see buildings and artificial surfaces - BL3).

Stone walls and other types of stonework differ in terms of physical structure and composition (type of stone, presence of mortar), age and the degree of maintenance. Older and more neglected structures are generally the most important for wildlife. Stone walls may support a diverse flora with abundant lichens, mosses and ferns (particularly 67 Retaining wall (L.Lysaght) Asplenium trichomanes, A. ruta-muraria and A. ceterach). Other common components include Ivy (Hedera helix) and other creepers, grasses (Aira and Catapodium spp.), stonecrops (Sedum spp.), Herb-robert (Geranium robertianum) and Navelwort (Umbilicus rupestris). Non-native species such as Red Valerian (Centranthus ruber), Wallflower (Erysimum cheiri) and Ivy-leaved Toadflax (Cymbalaria muralis) are often prominent. Stone walls that are overgrown by trees, shrubs or brambles should be considered in the woodland section under hedgerows - WL1 or treelines - WL2. Bridges and derelict buildings can be important habitats for birds or bats in particular.

This habitat (wall and old derelict buildings) was observed in survey section B. Species observed included:

Table 4.3 Species observed in Stone Walls and Other Stonework (BL1) in the survey areas.

Common Name	Scientific Name
Ivy	*Hedera helix*
Nettle	*Urtica dioica*
Bramble	*Rubus fructicosus*

Figure 4.2 Stone Walls and Other Stonework (BL1) - 09/01/2023. Photo taken in survey section B.

4.4 Freshwater

4.4.1 Eroding/Upland Rivers (FW1)

This category includes natural watercourses, or sections of these, that are actively eroding, unstable and where there is little or no deposition of fine sediment. Eroding conditions are typically associated with the upland parts of river systems where gradients are often steep, and water flow is fast and turbulent. Rivers in spate are included. For some rivers on the seaward side of coastal mountains, particularly in the west of Ireland, eroding conditions persist to sea level because of comparatively steep gradients over short distances, and high rainfall. Small sections of other lowland rivers may also be eroding where there are waterfalls, rapids or weirs. The beds

of eroding/upland rivers are characterised by exposed bedrock and loose rock. Pebbles, gravel and coarse sand may accumulate in places, but finer sediments are rarely deposited. These rivers vary in size but are usually smaller and shallower than depositing/lowland rivers – FW2. Small mountain streams that dry out periodically can be included if an obvious channel persists or wetland plants are present.

The unstable rocky channels of eroding/up–and rivers usually support little vegetation cover. Submerged rocks and boulders may be colonised by aquatic mosses such as Fontinalis spp. And Racomitrium aciculare. Exposed rocks and wet shaded banks may also support extensive cover of lichens and liverworts. Higher plants are generally rare or absent except in places where fine sediments are trapped. Typical species include water-crowfoots (Ranunculus penicillatus, R. aquatilis), Alternate Water-milfoil (Myriophyllum alterniflorum) and the aquatic form of Bulbous Rush (Juncus bulbosus). Plant and animal communities of eroding/upland rivers are influenced by a range of factors including bedrock and substratum type, nutrient status, water force, water quality, shade and human impact. Habitat conditions also vary along different stretches of a river where there are riffles, runs, pools, waterfalls and backwaters.

This habitat (River Duiske and old millrace) was located in survey section A and B. Species observed included:

Table 4.4 Species observed in Eroding/Upland Rivers (FW1) in the survey areas.

Common Name	**Scientific Name**
Fool's-water-cress	*Apium nodiflorum*
Lesser Water-parsnip	*Berula erecta*
Water Dock	*Rumex hydrolapathum*
Water-dropwort	*Oenanthe crocata*

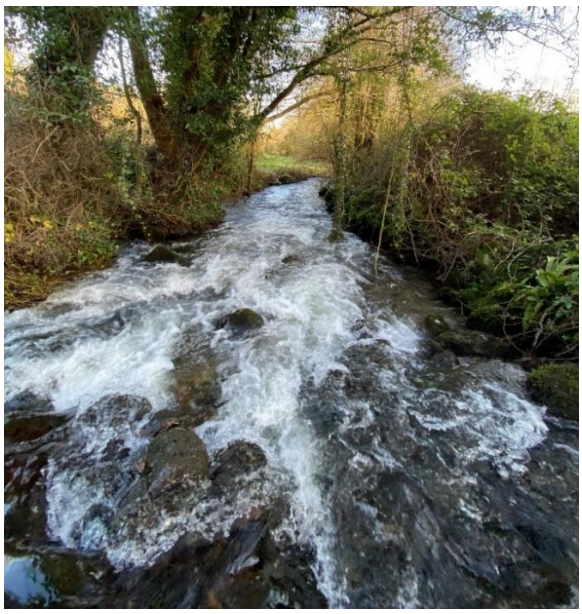

Figure 4.3 Eroding Upland Rivers (FW1 as per Fossitt, 2000) – 09/01/2023. Photo taken in survey section B.

The millrace channel was located in survey section B and was originally built to turn a water wheel and generate power. The millrace was classified as Eroding/Upland River (FW1). Species observed included:

Table 4.5 Species observed in the millrace channel.

Common Name	Scientific Name
Common Duckweed	*Lemna minor*
Fool's-water-cress	*Apium nodiflorum*
Lesser Water-parsnip	*Berula erecta*
Water-dropwort	*Oenanthe crocata*

Figure 4.4 Millrace channel connecting to the River Duiske - 09/01/2023. Photo taken in survey section B.

4.5 Grassland and Marsh

4.5.1 Improved Agricultural Grassland (GA1)

This category is used for intensively managed or highly modified agricultural grassland that has been reseeded and/or regularly fertilised, and is now heavily grazed and/or used for silage making. It includes regularly-reseeded monoculture grasslands and rye-grass leys that are planted as part of an arable rotation. These differ significantly from areas of permanent grassland. Improved agricultural grassland is typically species-poor. Sward quality varies depending on soil type, fertility, drainage and management. Rye-grasses (Lolium spp.) are usually abundant and may entirely dominate the sward, often in association with White Clover (Trifolium repens). Many improved varieties or cultivars of these plants are now widely sown. Other grasses that may be prominent include meadow-grasses (Poa spp.), Timothy (Phleum pratense), Crested Dog's-tail (Cynosurus cristatus) and Yorkshire-fog (Holcus lanatus). Among the more frequently occurring 'agricultural' herbs are Dandelion (Taraxacum spp.), Creeping Buttercup (Ranunculus repens), plantains (Plantago spp.), Nettle (Urtica dioica), thistles (Cirsium arvense, C. vulgare) and docks (Rumex spp.). Some reseeded but poorly-drained fields may support abundant rushes.

Improved agricultural grassland was found in survey sections A and B. Species observed in these areas included:

Table 4.6 Species observed in Improved Agricultural Grassland (GA1) in the survey areas.

Common Name	Scientific Name
Broadleaved Dock	*Rumex obtusifolius*
Creeping Bentgrass	*Agrostis stolonifera*
Creeping Buttercup	*Ranunculus repens*
Creeping Thistle	*Cirsium arvense*
Ribwort Plantain	*Plantago lanceolata*
Soft Rush	*Juncus effusus*
Yorkshire Fog	*Holcus lanatus*

Figure 4.5 Improved Agricultural Grassland (GA1, as per Fossitt, 2000) – 09/01/2023. Photo taken in survey section A.

4.5.2 Wet Grassland (GS4)

This type of grassland can be found on flat or sloping ground in upland and lowland areas. It occurs on wet or waterlogged mineral or organic soils that are poorly-drained or, in some cases, subjected to seasonal or periodic flooding. On sloping ground, wet grassland is mainly confined to clay-rich gleys and loams, or organic soils that are wet but not waterlogged. This category includes areas of poorly-drained farmland that have not recently been improved, seasonally-flooded alluvial grasslands such as the River Shannon callows, and wet grasslands of turlough basins (see also turloughs - FL6).

Species composition varies considerably. Wet grassland often contains abundant rushes (Juncus effusus, J. acutiflorus, J. articulatus, J. inflexus) and/or small sedges (Carex flacca, C. hirta, C. ovalis), in addition to grasses such as Yorkshire-fog (Holcus lanatus), Creeping Bent (Agrostis stolonifera), Marsh Foxtail (Alopecurus geniculatus), Rough Meadow-grass (Poa trivialis) and Tufted Hair-grass (Deschampsia caespitosa). Purple Moor-grass (Molinia caerulea) may also be present but should not dominate. The proportion of broadleaved herbs is often high; those that commonly occur in wet grassland include Creeping Buttercup (Ranunculus repens), Marsh Thistle (Cirsium palustre), Silverweed (Potentilla anserina), Meadowsweet (Filipendula ulmaria), Water Mint (Mentha aquatica), Common Marsh-bedstraw (Galium palustre), Devil's-bit Scabious (Succisa pratensis), Lesser Ribwort Plantain Plantago lanceolata (R. T. Mills) Spearwort (Ranunculus flammula) and Cuckooflower (Cardamine pratensis). Other common broadleaved herbs that occur on drier grasslands may also be

present, depending on the degree of wetness. Wet grassland may be important for orchids such as Spotted-orchid (Dactylorhiza maculata). Horsetails (Equisetum spp.), Yellow Iris (Iris pseudacorus), Floating Sweet-grass (Glyceria fluitans) and clumps of tall reeds may be locally abundant.

Wet grassland frequently grades into marsh - GM1 and there are many similarities in the range of species present in both habitats. To be included in the wet grassland category, the cover of grasses should exceed 50%, except in areas where rushes or small sedges predominate, and the total cover of reeds, large sedges and broadleaved herbs should be less than 50%. Among the suite of broadleaved herbs that are present, there should be a significant proportion of drier grassland species in addition to those that are more commonly associated with wetlands.

This type of grassland is frequent throughout survey section A and can be found on flat or sloping ground in low intensity managed agricultural grassland within the fields adjacent to the River Duiske. Wet grassland occurs on wet or waterlogged mineral or organic soils that are poorly-drained or, in some cases, subjected to seasonal or periodic flooding.

Improved agricultural grassland was found in survey sections A within the scheme area. Species observed in these areas included:

Table 4.7 Species observed in Wet Grassland (GS4) in the survey areas.

Common Name	Scientific Name
Broadleaved Dock	*Rumex obtusifolius*
Cow Parsley	*Anthriscus sylvestris*
Creeping Bentgrass	*Agrostis stolonifera*
Creeping Buttercup	*Ranunculus repens*
Creeping Cinquefoil	*Potentilla reptans*
Creeping Thistle	*Cirsium arvense*
Grass-like Starwort	*Stellaria graminea*
Herb-Robert	*Geranium robertianum*
Meadow Buttercup	*Ranunculus acris*
Prickly Sowthistle	*Sonchus asper*
Soft Rush	*Juncus effusus*
Yellow Iris	*Iris pseudacorus*
Yorkshire Fog	*Holcus lanatus*

Figure 4.6 Wet Grassland (GS4, as per Fossitt, 2000) - 09/01/2023. Photo taken in survey section A.

4.5.3 Dry Meadows and Grassy Verges (GS2)

Dry meadows that are rarely fertilised or grazed, and are mown only once or twice a year for hay are now rare in Ireland. Most have been improved for agriculture and this type of grassland is now best represented on grassy roadside verges, on the margins of tilled fields, on railway embankments, in churchyards and cemeteries, and in some neglected fields or gardens. These areas are occasionally mown (or treated with herbicides in the case of some railway embankments), and there is little or no grazing or fertiliser application. This pattern of management produces grasslands with a high proportion of tall, coarse and tussocky grasses such as False Oat-grass (Arrhenatherum elatius) and Cock's-foot (Dactylis glomerata). Other grasses may include Yorkshire-fog (Holcus lanatus), Smooth Meadow-grass (Poa pratensis), Barren Brome (Anisantha sterilis) and Meadow Foxtail (Alopecurus pratensis). The broadleaved herb component is characterised by a range of species that either grow tall, such as Cow Parsley (Anthriscus sylvestris), Hogweed (Heracleum sphondylium), Goat's-beard (Tragopogon pratensis), Nettle (Urtica dioica) and Common Knapweed (Centaurea nigra), or climb the stems of others, as in the case of Bush Vetch (Vicia sepium) and Meadow Vetchling (Lathyrus pratensis). Grassy verges may support other smaller broadleaved herbs such as Pignut (Conopodium majus), Creeping Cinquefoil (Potentilla reptans) and clovers (Trifolium spp.).

This habitat was located along the edges of the water treatment plant in survey section B. Species observed in this area included:

Table 4.8 Species observed in Dry Meadows and Grassy Verges (GS2) in the survey areas.

Common Name	Scientific Name
Broadleaved Dock	*Rumex obtusifolius*
Bramble	*Rubus fructicosus agg.*
Common Hogweed	*Heracleum sphondylium*
Creeping Buttercup	*Ranunculus repens*
Creeping Cinquefoil	*Potentilla reptans*
*Japanese Knotweed	*Fallopia japonica*

Nettle	*Urtica dioica*
Opposite-leaved Golden-Saxifrage	*Chrysosplenium oppositifolium*
Soft Rush	*Juncus effusus*

Figure 4.7 Dry Meadows and Grassy Verges – 09/01/2023. Photo taken in survey section B.

4.6 Woodland and Scrub

4.6.1 (Mixed) Broadleaved Woodland (WD1)

This general category includes woodland areas with 75-100% cover of broadleaved trees, and 0-25% cover of conifers. It should be used in situations where woodland stands cannot be classified as semi-natural on the basis of the criteria outlined above. Trees may include native and non-native species. Plantations of broadleaved trees are included if the canopy height is greater than 5 m, or 4 m in the case of wetland areas. Stands of immature or sapling trees are excluded (see immature woodland – WS2). If a number of different broadleaved tree species contribute significantly to the canopy, the term 'mixed' should be used in the habitat title.

This habitat was observed across the survey sections A and B within the scheme area. Species observed in these areas included (*fungus species):

Table 4.9 Species observed in (Mixed) broadleaved woodland (WD1) in the survey areas.

Common Name	Scientific Name
Alder	*Alnus glutinosa*
Ash	*Fraxinus excelsior*
Beech	*Fagus sp.*
Bracken	*Pteridium*
Bramble	*Rubus fructicosus agg.*
Broad Buckler Fern	*Dryopteris dilatata*
Cleavers	*Galium aparine*
Common Hogweed	*Heracleum sphondylium*

Cow Parsley	*Anthriscus sylvestris*
Creeping Buttercup	*Ranunculus repens*
Goat Willow	*Salix caprea*
Golden Saxifrage	*Chrysosplenium oppositifolium*
Grey Willow	*Salix cinerea*
Hart's Tongue Fern	*Asplenium scolopendrium*
Hawthorn	*Crataegus monogyna*
Herb Robert	*Geranium robertianum*
Holly	*Ilex aquifolium*
Horse Chestnut	*Aesculus hippocastanum*
Ivy	*Hedera helix*
Lesser Celandine	*Ficaria verna ssp verna*
Lords-and-ladies	*Arum maculatum*
Nettle	*Urtica dioica*
Pedunculate Oak	*Quercus robur*
Sycamore	*Acer pseudoplatanus*
Woodrush	*Luzula sylvatica*
Wych Elm	*Ulmus glabra*
*Scarlet Elf Cup	*Sarcoscypha austriaca*
Yellow Iris	*Iris pseudacorus*
Soft Rush	*Juncus effusus*
Moss species (Unknown)	N/A

*Sycamore was observed in survey section B.

Figure 4.8 (Mixed) broadleaved woodland (WD1 as per Fossitt, 2000) – 09/01/2023. Photo taken in survey section A.

In Figure 4.10, Scarlet Elf Cup (*Sarcoscypha austriaca*) was recorded in several locations within survey section B of the proposed scheme area. This elf cup fungus is fairly widespread, however is

uncommon in Ireland. It favours areas with high rainfall and can be located on decaying sticks and branches, especially in damp areas of the woodland floor and stream banks. The River Duiske ran adjacent to this section of the woodland - many sections of the woodland floor were waterlogged.

Figure 4.9 (Mixed) Broadleaved Woodland in survey section B - 09/01/2023.

Figure 4.10 Scarlet Elf Cup (*Sarcoscypha austriaca*) observed in WD1 habitat - 09/01/2023. Photo taken in survey section B.

4.6.2 Hedgerows (WL1)/Treelines (WL2)

WL1

Linear strips of shrubs, often with occasional trees, that typically form field or property boundaries. Most hedgerows originate from planting, and many occur on raised banks of earth that are derived from the excavation of associated drainage ditches. Dimensions of hedgerows vary considerably, depending largely on management and composition, and are taken here as being mainly less than 5 m high and 4 m wide. When wider

or taller than this, or dominated by trees, the habitat should be considered as a narrow strip of scrub or woodland, or as a treeline – WL2. Some hedgerows may be overgrown or fragmented if management has been neglected, but they should still be considered in this category unless they have changed beyond recognition. Linear strips of low scrub are included in this category if they occur as field boundaries.

Species composition varies with factors such as age, management, geology, soils and exposure. Hedgerows commonly support a high proportion of spinose plants such as Hawthorn (Crataegus monogyna), Blackthorn (Prunus spinosa), Gorse (Ulex europaeus), Holly (Ilex aquifolium), Dog-rose (Rosa canina) or Bramble (Rubus fruticosus agg.), in addition to many other native and non-native trees and shrubs including, for example, Ash (Fraxinus excelsior), Hazel (Corylus avellana), Beech (Fagus sylvatica), Elder (Sambucus nigra), elms (Ulmus spp.) and willows (Salix spp.). Some of these may occur as scattered tall trees. Fuchsia (Fuchsia magellanica), an introduced shrub, is a common component of hedgerows in parts of the south and west of Ireland. Hedgerows frequently support climbing plants such as Ivy (Hedera helix), Honeysuckle (Lonicera periclymenum), Hedge Bindweed (Calystegia sepium), Cleavers (Galium aparine) and Bush Vetch (Vicia sepium). Tall grasses, including False Brome (Brachypodium sylvaticum) and Hairy-brome (Bromopsis 36ibern), ferns, and woodland herbs are characteristic.

Drainage ditches are often closely associated with hedgerows and should be recorded separately if they contain standing water or support aquatic plants (see drainage ditches – FW4). Dry ditches are not distinguished as separate habitats. Linear boundaries of low scrub, Gorse (Ulex europaeus) and Bramble (Rubus fruticosus agg.) in particular, should be included here, but note that earth banks – BL2 and stone walls and other stonework – BL1 are treated as separate categories.

WL2

A treeline is a narrow row or single line of trees that is greater than 5 m in height and typically occurs along field or property boundaries. This category includes tree-lined roads or avenues, narrow shelter belts with no more than a single line of trees, and overgrown hedgerows that are dominated by trees. Most treelines are planted, and trees are often regularly spaced. They commonly comprise a high proportion of non-native species such as Beech (Fagus sylvatica), Horse Chestnut (Aesculus hippocastanum), Sycamore (Acer pseudoplatanus), limes (Tilia spp.), some poplars (Populus spp.) and conifers. Trees may occur on level ground or on banks of earth. The presence or absence of hedgerow or scrub at the base should be noted. If treelines are greater than 4 m wide at the base they should be considered as narrow stretches of woodland.

Hedgerows and treelines are most abundant on agricultural lands within the proposed scheme area, where they form field boundaries mostly. Some of the wooded habitats along watercourses (river Duiske and the old millrace) have been classified as treelines, as opposed to riparian woodland, because they were notably narrow and less natural in appearance than other wooded riparian habitats that were observed. The WL1 habitat was observed across the survey section A, and the WL2 was observed within survey section A and B within the scheme area. Species observed in the Hedgerows (WL1) included:

Table 4.10 Species observed in the Hedgerows (WL1) in the survey areas.

Common Name	Scientific Name
Alder	*Alnus glutinosa*
Ash	*Fraxinus excelsior*
Blackthorn	*Prunus spinosa*
Bramble	*Rubus fructicosus*
Buckthorn	*Rhamnus cathartica*
Common Bent	*Agrostis capillaris*
Creeping Thistle	*Cirsium arvense*

False-oat Grass	*Arrhenatherum elatius*
Hawthorn	*Crataegus monogyna*
Herb Robert	*Geranium robertianum*
Ivy	*Hedera helix*
Nettle	*Urtica dioica*
Pedunculate Oak	*Quercus robur*
Wynch Elm	*Ulmus glabra*

Figure 4.11 Hedgerows (WL1 as per Fossitt, 2000) – 09/01/2023. Photo taken in survey section A.

Figure 4.12 Treelines (WL2 as per Fossitt, 2000) – 09/01/2023. Photo taken in survey section A.

4.6.3 Scrub (WS1)

This broad category includes areas that are dominated by at least 50% cover of shrubs, stunted trees or brambles. The canopy height is generally less than 5 m, or 4 m in the case of wetland areas. Scrub frequently develops as a precursor to woodland and is often found in inaccessible locations, or on abandoned or marginal farmland. In the absence of grazing and mowing, scrub can expand to replace grassland or heath vegetation. Trees are included as components of scrub if their growth is stunted as a result of exposure, poor soils or waterlogging. If tall trees are present, these should have a scattered distribution and should not form a distinct canopy. This category does not include areas that are dominated by young or sapling trees (<5 or 4 m in height) or young conifer plantations (see immature woodland – WS2 or conifer plantation – WD4). Linear boundary features of scrub that are less than 4 m wide should be considered under hedgerows – WL1.

Scrub can be either open, or dense and impenetrable, and it can occur on areas of dry, damp or waterlogged ground. Common components include spinose plants such as Hawthorn (Crataegus monogyna), Blackthorn (Prunus spinosa), Gorse (Ulex europaeus), Juniper (Juniperus communis), Bramble (Rubus fruticosus agg.) and erect or scrambling roses (Rosa spp.), in addition to a number of willows (Salix spp.), small birches (Betula spp.) and stunted Hazel (Corylus avellana). Scrub may also contain Bog-myrtle (Myrica gale) and Broom (Cytisus scoparius). The field layer is often impoverished and poorly-developed but, in some situations, may be similar to that of woodland. Lowgrowing Western Gorse (Ulex gallii) and prostrate Juniper (Juniperus communis) can also be components of heath. Note that any areas that are dominated by non-native shrubs should be excluded (see ornamental/non-native shrub – WS3).

Patches of scrubby vegetation were widespread in fields and along riverbanks across the scheme area (survey sections A and B). Species observed in these areas included:

Table 4.11 Species observed in the Scrub (WS1) in the survey areas.

Common Name	Scientific Name
Alder	*Alnus glutinosa*
Blackthorn	*Prunus spinosa*
Bramble	*Rubus fructicosus*
Common Gorse	*Ulex sp.*
Ivy	*Hedera helix*
Logweed	*Calystegia sepium*

Figure 4.13 Scrub (WS1 as per Fossitt, 2000) – 09/01/2023. Photo taken in survey section A.

4.6.4 Riparian Woodland (WN5)

This category includes wet woodlands of river margins (gallery woodland) and low islands that are subject to frequent flooding, or where water levels fluctuate as a result of tidal movement (in the lower reaches of rivers). Riparian woodland is dominated by stands of willows that may include native (Salix cinerea, S. purpurea, S. triandra) and non-native (Salix fragilis, S. alba, S. viminalis) species. Alder (Alnus glutinosa) is occasional. The field layer is characterised by broadleaved herbs such as Nettle (Urtica dioica), Creeping Buttercup (Ranunculus repens), Wood Dock (Rumex sanguineus), Meadowsweet (Filipendula ulmaria), Wild Angelica (Angelica sylvestris), Hemlock Water-dropwort (Oenanthe crocata) and Hedge Bindweed (Calystegia sepium). Stands of Reed Canary-grass (Phalaris arundinacea) are common. Indian Balsam (Impatiens glandulifera), an introduced species, is locally abundant. These woodlands often reveal an accumulation of river borne debris, including dead vegetation and plastic, when water levels are low. A fine coating of grey mud on vegetation and tree bases that are regularly submerged and emersed is also characteristic. Willows were widely coppiced and used for basket-making in the past; old Osier (Salix viminalis) beds are included in this category but any actively coppiced areas should be considered under short rotation coppice - WS4.

This classification has been applied to an area within the survey section A where woodlands extend to the edge of the watercourse along the northern edges of the Duiske river. Species observed in this area included:

Table 4.12 Species observed in Riparian Woodland (WN5) in the survey areas.

Common Name	Scientific Name
Alder	*Alnus glutinosa*
Ash	*Fraxinus*
Birch	*Betula sp.*

Ivy	*Hedera helix*
Willow	*Salix caprea*
Holly	*Ilex aquifolium*

Figure 4.14 Riparian woodland (WN5) - 09/01/2023. Photo taken in survey section B.

4.6.5 Wet Pedunculate Oak-Ash Woodland (WN4)

This type of woodland is associated with areas that are flooded or waterlogged in winter but which dry out in summer. It occurs on periodically-flooded alluvial sites that are well above the limits of regular inundation, and on drumlins and other sites with heavy, poorly-drained clay soils that are subject to waterlogging. Woodland is dominated by Pedunculate Oak (Quercus robur) and/or Ash (Fraxinus excelsior); other common components include Hazel (Corylus avellana), Hawthorn (Crataegus monogyna), Holly (Ilex aquifolium) and willows (Salix spp.). Alder (Alnus glutinosa) can be locally abundant. The ground flora typically comprises Meadowsweet (Filipendula ulmaria), Primrose (Primula vulgaris), Enchanter's-nightshade (Circaea lutetiana), Ivy (Hedera helix), Bramble (Rubus fruticosus agg.), Remote Sedge (Carex remota), Golden-saxifrage (Chrysosplenium oppositifolium) and Ramsons (Allium ursinum). When flooding subsides in alluvial sites, exposed channels and depressions may remain wet or waterlogged. Alder (Alnus glutinosa) is often prominent in these situations.

This habitat was observed in survey section A, along the banks of the river Duiske. Species observed in these areas included:

Table 4.13 Species observed in Wet Pedunculate Oak-Ash Woodland (WN4) in the survey areas.

Common Name	Scientific Name
Alder	*Alnus glutinosa*
Ash	*Fraxinus excelsior*
Creeping Buttercup	*Ranunculus repens*
Curled Dock	*Rumex crispus*
Hawthorn	*Crataegus monogyna*
Hogweed	*Heracleum sphondylium*
Moss species	N/A
Nettle	*Urtica dioica*
Pedunculate Oak	*Quercus robur*
Starwort	*Callitriche stagnalis*
Water dropwort	*Oenanthe crocata*
Yellow Iris	*Iris pseudacorus*

Figure 4.15 Wet Pedunculate Oak-Ash Woodland (WN4) - 09/01/2023. Photo taken in survey section A.

Figure 4.16 WN4 observed in survey section A, within the (mixed) broadleaved woodland - 09/01/2023.

4.7 Species of Conservation Interest

No flora species of conservation interest were observed. This includes all species listed in Schedules A and B of the Flora (Protection) Order 2022 (S.I. No. 235/2022).

4.8 Invasive Plant Species

Non-native species are species that have been introduced outside their natural range, either intentionally or unintentionally. These non-native species can live in harmony with native species, however when these species out-compete native flora and fauna causing negative impacts on native the species these species are known as invasive species or invasive alien species. Second only to that caused by habitat destruction, invasive non-native plant and animal species are widely recognised as the greatest threat to biodiversity worldwide (Invasive Species Ireland, 2018).

An invasive species survey was carried out by the ByrneLooby ecologists on the 9th of January 2023 to identify locations and type of invasive species within the footprint of the locations of the upstream storage works.

4.8.1 Existing Records

Online records of invasive flora species from NBDC within the proposed scheme area are listed in Table 4.14.

Table 4.14 NBDC records of invasive flora species found within the 2km grid cells (Figure 5.1)

Species Name	Record Count	Date of Last Record	Designation
Himalayan Honeysuckle (Leycesteria formosa)	1	15/07/2021	Invasive Species: Medium Impact

Indian Balsam (Impatiens glandulifera)	3	01/05/2021	Invasive Species: High Impact, Regulation S.I. 477 (Ireland)
Sycamore (Acer pseudoplatanus)	2	20/04/2019	Invasive Species: Medium Impact

4.8.2 Field Survey

Species listed in the Third Schedule of the Birds and Natural Habitats Regulations (2011) were recorded by the ByrneLooby ecologists. During the habitat survey site walkover, Japanese Knotweed *Fallopia japonica* was identified and documented within survey section B (see Figure 4.17). In Figure 4.18 and Figure 4.19 the ecologist observed potential Japanese knotweed (die-back/chemically treated) in survey section B, located along the water treatment plant (dry meadows and grassy verges). In addition, a single sycamore tree (*Acer pseudoplatanus*) was recorded in survey section B (WD1, as per Fossitt, 2000).

Refer to the Preliminary Invasive Species Management Plan (report number W3451-CS-R009) for the strategy that will be adopted during the pre-construction, construction and operation phases of the flood relief scheme in order to prevent the spread of invasive plant species.

Figure 4.17 Japanese Knotweed *Fallopia japonica* observed during the field survey in survey section B, surrounding the old derelict building – 09/01/2023.

Figure 4.18 Potential Japanese Knotweed *Fallopia japonica* observed in survey section B - 09/01/2023.

Figure 4.19 Close-up picture of potential Japanese Knotweed observed in survey section B of the scheme area - 09/01/2023.

5 Fauna

This section of the report provides a summary of the desk study and field surveys for the identification of species listed below. This list is determined by the available existing records within the study area and the data collected during the field survey.

- Mammals
    - Otter *Lutra lutra*
    - Irish Stoat *Mustela erminea* subsp. *Hibernica*
    - Pine Marten *Martes martes*
    - West European Hedgehog *Erinaceus europaeus*
    - Eurasian Badger *Meles meles*
    - Eurasian Red Squirrel *Sciurus vulgaris*
    - Irish Hare *Lepus timidus* subsp. *Hibernicus*
- Avifauna
- Bats
- Herpetofauna
- Molluscs (terrestrial)
- Invasive Fauna

Aquatic fauna (including Freshwater Pearl Mussel, Nore Pearl Mussel, Freshwater White-clawed Crayfish) are addressed separately within the aquatics survey report.

5.1 Wildlife Records – NBDC

This section of the chapter sets out the baseline ecological conditions at the proposed upstream storage area using the findings of the desk study and surveys. The NBDC database was searched for records (species listed above) within the 2km squares covering the footprint of the proposed area (see Figure 5.1). Species records were sourced from the National Biodiversity Data Centre (NBDC) within the 2km square grids (marked in red), covering the footprint of the proposed works as shown in Figure 5.1. Additionally, records from Article 17 spatial data (NPWS) were also revised.

Given that works are proposed in-stream, the zone of influence was broadened to 15 km downstream for aquatic fauna, amphibians, otters, pine martens and the Irish stoat (see Section 2.1.1 for explanation).

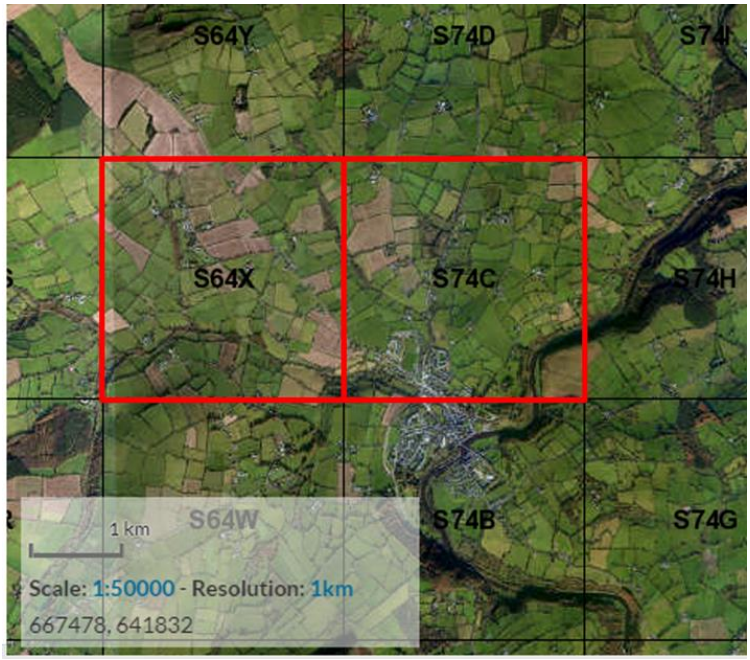

Figure 5.1 2km grid squares (in red) of the project footprint from which NBDC species records were sourced.

In Figure 5.2, the river flow direction of Graiguenamanagh – Tinnahinch (hereafter referred to as G-T area) area depicts the hydrological connection between the proposed upstream storage area and the surrounding waterbodies. The river flow direction within the is moving from north to south.

Figure 5.2 River flow direction within the Graigeunamanagh - Tinnahinch area (EPA river-flow map).

5.2 Overview of Survey Findings

In Figure 5.3 and Figure 5.4, the survey sections A and B are illustrated with the locations of faunal evidence observed during the field survey.

Figure 5.3 Survey section A, outlining the evidence observed during the field survey.

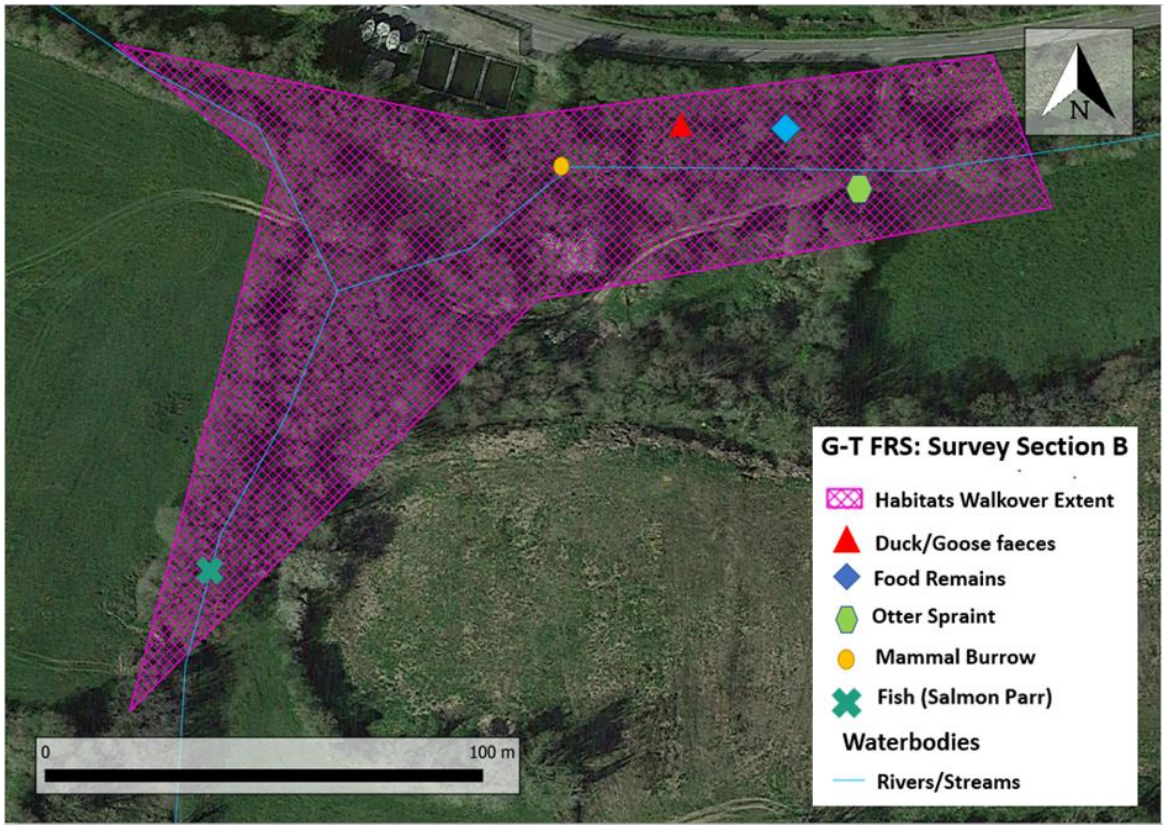

Figure 5.4 Survey section B, outlining the evidence observed during the field survey .

5.3 Mammals (Non-Volant)

In Table 5.1 the protected mammals (non-volant) recorded within the scheme area (as shown in Figure 5.1) are summarised (NBDC online records). Further information on these species is outlined in the following sections.

Table 5.1 NBDC records of protected non-volant mammals recorded within the 2km square grids (Figure 5.1).

Species Name	Record Count	Date of Last Record	Designation
Eurasian Pygmy Shrew (*Sorex minutus*)	1	30/07/2018	Wildlife Acts
West European Hedgehog (*Erinaceus europaeus*)	3	18/04/2021	Wildlife Acts
Eurasian Badger (*Meles meles*)	22	31/12/2006	Wildlife Acts
European Otter (*Lutra lutra*)	1	23/11/2004	EU Habitats Directive: Annex II, Annex IV. Wildlife Acts.
Red Fox (*Vulpes vulpes*)	1	18/05/2013	N/A

5.3.1 Otter (*Lutra lutra*)

Otters (*Lutra lutra*) are protected under the Wildlife Acts (1976, as amended) and are listed under Annex II and IV of the EU Habitats Directive. In addition, the otter is a QI of the River Barrow and River Nore SAC. Depending on food availability, the territories of otters can reach for several kilometres (Vincent Wildlife Trust – Ireland, 2023). During the National Otter Survey of Ireland 2010/12 carried by the NPWS, it was observed that otter diet did not vary with levels of productivity or availability of salmonids (usually relying predominantly). There was distinct niche separation between riverine and lacustrine systems, the latter being dominated by Atlantic eel (*Anguilla ibernic*). Otters prey opportunistically on a range of prey sources where available, including insects, invertebrates such as freshwater mussels and crayfish, birds, amphibians, small mammals and even fruit. Otters residing along coastlines have a greater niche breath than those in freshwater systems which encompasses a wide variety of intertidal prey though pelagic fish are rarely taken (NPWS, 2010/12).

Due to their plasticity regarding the extent of habitat types suitable for otters and their wide range in prey taxa, any proposed works within scheme area and/or within a few kilometres of their recorded sightings (NBDC records), in particular downstream River Barrow and the River Nore, and associated tributaries such as River Duiske, need to be sensitive to their potential presence. It should be noted, the fast flowing river and the thick vegetation along the river banks proved difficult in parts to identify the presence/absence of otter holts. Within the literature, very little published evidence has demonstrated any consistent relationship with pollution and human disturbance negatively affecting otters (NPWS 2010/12, and references therein).

5.3.1.1 Existing Records

Article 17 spatial data (see Figure 5.5) contains 38 records of otter within 15km of the proposed upstream storage area 5 of which were located downstream.

NBDC species reports for the area show high densities of otter within the surrounding area of the GTFRS (see Figure 5.6).

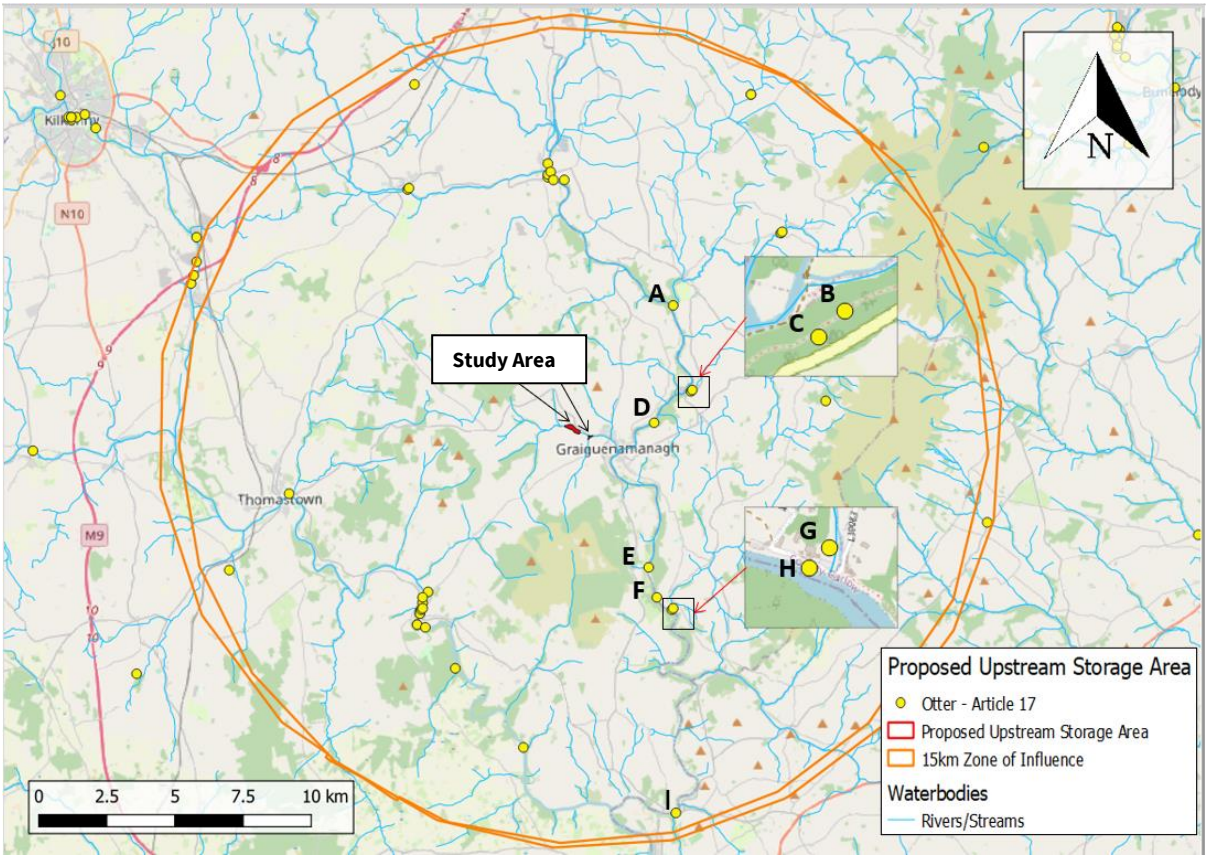

Figure 5.5 Otter records within 15km of the proposed upstream storage area from Article 17 (NPWS).

Table 5.2 Records of otter illustrated in within the 15km zone of influence.

I.D.	Grid Ref.	Date	Precision	Notes	Hydrological Connection
A	S729489	17/05/2011	100m	Sighting of live animal	Yes
B	S736458	17/11/2004	100m	6 Counts of droppings	Yes
C	S736458	20/01/2011	100m	Otter spraint and tracks	Yes
D	S722446	04/04/2017	100m	Sighting of live animal	Yes
E	S720393	16/06/2012	100m	Sighting of live animal	Yes
F	S723382	07/11/2016	100m	Abundance of 3. Sighting of live animals.	Yes
G	S729378	17/11/2004	100m	5 spraints on rock.	Yes
H	S729378	20/01/2011	100m	Otter spraint	Yes
I	S730303	05/09/2012	100m	No comment	Yes

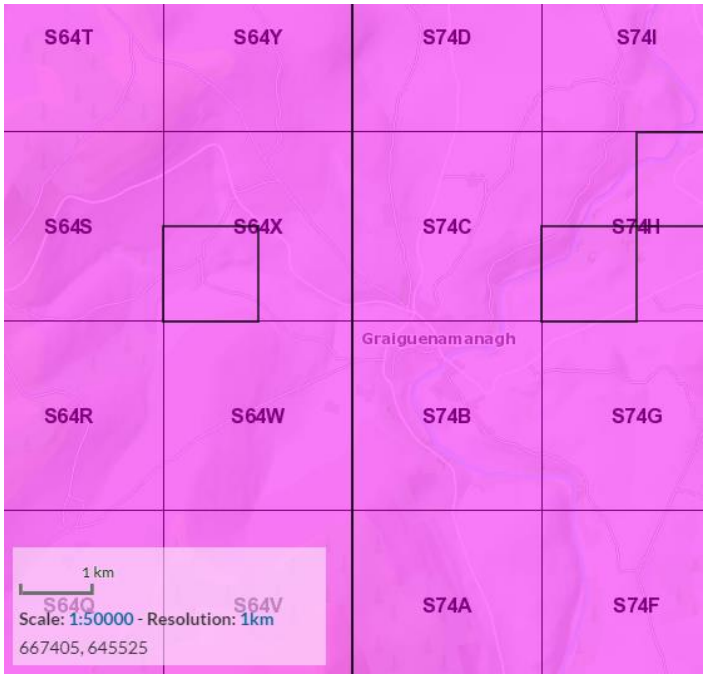

Figure 5.6 NBDC records of otter recorded within the proposed upstream storage area

5.3.1.2 Field Survey

The ByrneLooby ecologists did not observe any live sightings of otter during the field surveys. No otter holt/couch was observed; however, otter spraints and potential food remains were observed. This evidence is presented below – see Figure 5.7. In Figure 5.8 and Figure 5.9, potential otter food remains are shown found in survey section A and B, respectively (see mapped 'food remains' in Figure 5.3 and Figure 5.4). Other carnivore mammals such as the pine marten (*Martes martes*), the Irish stoat (*Mustela erminea hibernica*) and the invasive species the American mink (*Neovison vison*) have similar diets (all including birds) to the otter, competing with one another in the winter. Therefore, it is possible the food remains observed are the food remain of any one of these species occurring within the proposed scheme area.

Figure 5.7 Otter spraint found during the field survey, Photo taken at section A and section B, respectively, – 09/01/2023.

Figure 5.8 Potential otter food remains (bird carcasses) located in survey section A - 09/01/2023.

Figure 5.9 Potential otter food remains observed in survey section B – 09/01/2023.

5.3.2 Pine Marten (*Martes martes*)

The pine marten (*Martes martes*) is the only member of the genus *Martes* native to Ireland and is protected under the Wildlife Acts (1976, as amended). The European Union's Habitats & Species Directive listed the species in Annex V of the EU Habitats Directive 1992 and is designated under Appendix III of the Bern Convention to continue to increase populations to a favourable conservation status throughout its range in Ireland. Recent abundance estimates suggest the total population of the pine marten in Ireland is approximately 2,700 individuals – Ireland's rarest native mammal species (Vincent Wildlife Trust, Ireland).

Pine martens are very territorial and covers a large area (varies depending on the type of and quality of habitat), mainly in deciduous and coniferous woodland, and has adapted to scrubland. Pine martens follow linear features such as valleys and rivers in search of prey taxa connected with such habitats (Irish Wildlife Trust). Males especially have vast territories, travelling as far as 8km in one night and defending territories varying in size from 60 (~0.6km2) hectares to 430 (~5km2) hectares – twice the area covered by females (Woodland Trust). Natural dens are in hollow trees and/or cavities, subterranean burrows, buildings (occupied or unoccupied), squirrel dreys, bird nests, tree roots and rock crevices – favouring the location of their dens above ground makes ancient woodland, like the woodland found in Graiguenamanagh – Tinnahinch area, an ideal habitat. Due to their large range of woodland and scrubland, records of pine marten in the desk study were extended to the surrounding areas outside the scope of the proposed scheme (see Figure 5.1). In terms of diet, pine martens exploit a variety of resources including berries, fruits, small mammals (particularly grey squirrels and voles), invertebrates, birds, and amphibians (hydrological connection for their preference of prey).

Due to the pine marten's elusive and primarily nocturnal habits they are notoriously difficult to spot. Footprints, droppings, and strands of lost fur are more often recorded during surveys in comparison to direct live sightings. The pine marten does not hibernate in winter; however, they venture out less.

5.3.2.1 Existing Records

Article 17 point-distribution of the pine marten within and surrounding the scheme area contain numerous records of pine marten as shown below (Figure 5.10and Table 5.3). Records of the pine marten from NBDC species reports for the proposed scheme are shown in Figure 5.11 (with precision of 100m) – it is evident from NBDC records that the area holds a high density of pine marten.

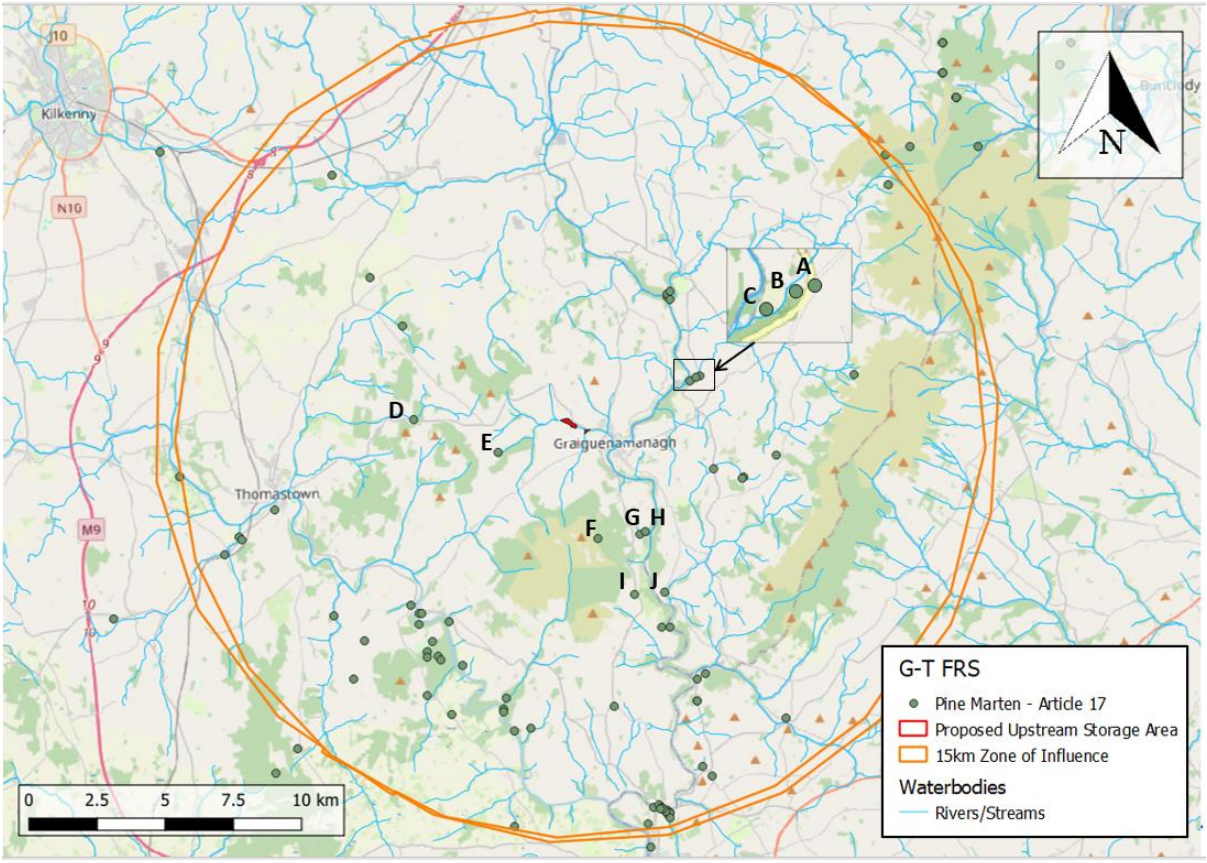

Figure 5.10 Pine marten (Martes martes) records within the scheme area (Article 17 - NPWS).

Table 5.3 NPWS (Article 17 data) records of the pine marten shown in Figure 5.10within the proposed upstream storage area, cross-referenced with online NBDC records.

I.D.	Grid Ref.	Date	Precision	Notes	Hydrological Connection
A	S740461	12/06/2012		N/A	Yes
B	S739461	18/06/2018	100m	Road-kill. 1	No
C	S736459	2011	100m	Sighting of live animal.	Yes
D	S635445	12/05/2013	100m	Road-kill. Juvenile, eyes not yet open. Other sibling alive in ditch.	Yes
E	S666433	08/05/2017	100m	Sighting of live animal.	Yes
F	S703401	2011	100m	Road-kill	No
G	S718403	24/06/2013	100m	Road-kill	Yes
H	S720404	08/02/2016	100m	Sighting of live animal	Yes
I	S716381	17/06/2015	100m	Sighting of live animal	Yes
J	S727382	2011	100m	Sighting of live animal	Yes

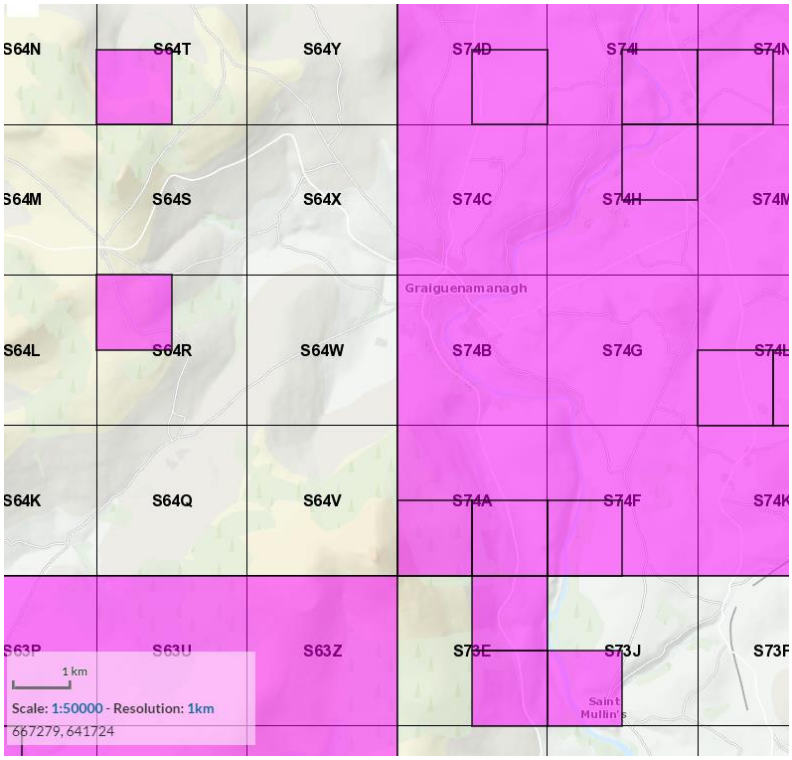

Figure 5.11 NBDC records of the Pine Marten within the footprint of the proposed upstream storage area

5.3.2.2 Field Survey

The ByrneLooby ecologists did not observe any live sightings or evidence of pine marten during the field surveys; however, as previously mentioned in 5.2.1 of this report, it is possible the food remains (bird) observed in the field survey are potentially that of the pine marten given the similarity in diet.

5.3.3 Irish Stoat (*Mustela erminea* subsp. *hibernica*)

The Irish stoat is protected under the Wildlife Act (1976, as amended) and is one of the species protected under regulations (Protection of Wild Animals) in 1980 which enabled Ireland to comply with the provisions of the Bern Convention of European Wildlife and Natural Habitats, which was ratified by Ireland in April 1982.

Irish stoats occur in most habitats with sufficient cover, including urban areas. Their main prey is rabbits, followed by pygmy shrews, birds, birds' eggs, rats, mice and voles. It is also possible that fruit and insects may form part of their diet. There are several reports of Irish stoat predating and eating fish on seashores, which has led to suggestions that they are originally coastal animals. As competent swimmers the Irish stoat can hunt fish in slow moving rivers (Irish Wildlife Trust). However, studies have shown that they occur most often in wooded areas, and readily climb trees.

5.3.3.1 Existing Records

Records of Irish stoat distributions are not available from NPWS (Article 17, 2019). NBDC species reports are shown in Figure 5.12 and – no records exist of Irish stoat (*Mustela erminea* subsp. *ibernica*) within the proposed upstream storage area (grid cell S64X and S74C).

Table 5.4 NBDC records of Irish stoat (shown in Figure 5.12) in the surrounding areas of the proposed scheme area.

I.D.	Grid Ref.	Date	Precision	Notes	Hydrological Connection
A (1)	S711472	01/07/2012	100m	Sighting of live animal. Dry meadows and grassy verges	No
A (2)	S710479	03/10/2018	100m	Sighting of live animal.	No
B	S739460	13/11/2014	100m	Sighting of live animal.	Yes
C	S744414	02/11/2014	100m	Road-kill.	Yes
D	S742409	01/05/2010	100m	Road kill.	No

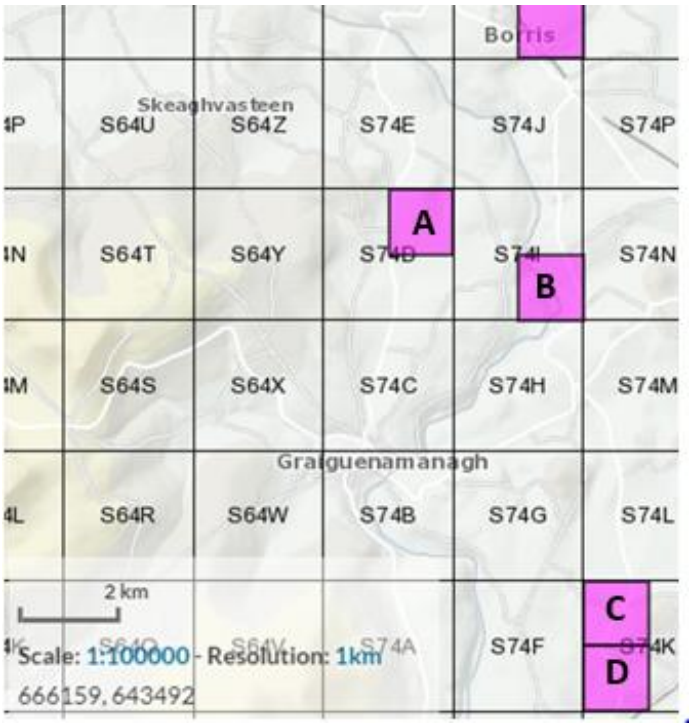

Figure 5.12 NBDC records of the Irish stoat in the surrounding areas of the proposed upstream storage area

5.3.3.2 Field Survey

The ByrneLooby ecologists did not observe any sightings or evidence of Irish stoat during the field surveys; however, as previously mentioned in 5.2.1 of this report, it is possible the food remains (bird) observed in the field survey are potentially that of the Irish stoat given the similarity in diet.

5.3.4 West European Hedgehog (*Erinaceus europaeus*)

The West European Hedgehog is the only species of hedgehog in Ireland and is protected under the Wildlife Acts (1976, and 2000). It is classed Least Concern on the IUCN red list; however, this is due to the fact that the species is data deficient (classed in Britain as Vulnerable to Extinction).

5.3.4.1 Existing Records

Records of hedgehog distributions are not available from NPWS (Article 17 data). Records available from the National Biodiversity Data Centre (NBDC) within the study area are shown in Figure 5.13 and Table 5.5 below.

Table 5.5 NBDC records of hedgehog (shown in Figure 5.13) in the surrounding areas of the proposed scheme area .

I.D.	Grid Ref.	Date	Precision	Notes
A (1)	S696451	06/05/2012	100m	Road kill.
A (2)	S691455	25/07/2016	100m	Road kill.
B	S704453	18/04/2021	100m	Sightings of live animal. Abundance of 2.
C	S694439	10/05/2021	100m	Sightings of live animal.

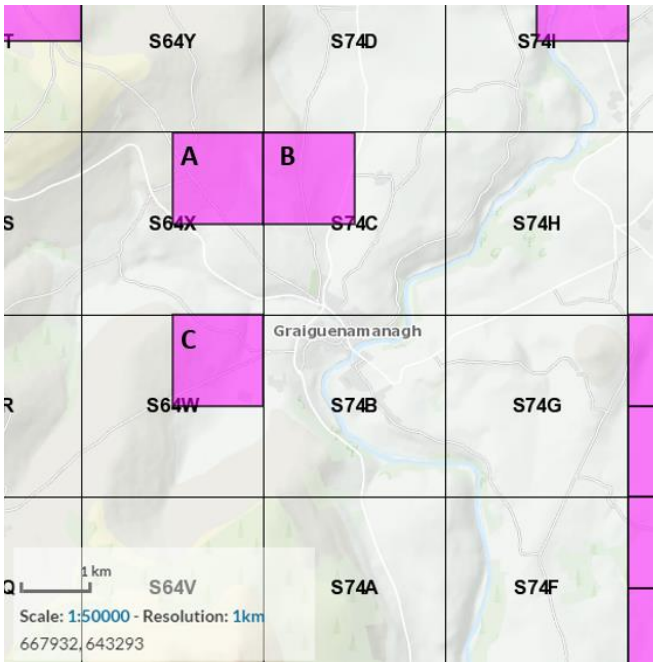

Figure 5.13 NBDC records of West European Hedgehog within and in the vicinity of the proposed upstream storage area

5.3.4.2 Field Surveys

The ByrneLooby ecologists did not observe any sightings or evidence of hedgehog activity within the survey areas during the field surveys.

5.3.5 Eurasian Red Squirrel (*Sciurus vulgaris*)

Red squirrels are protected under the Wildlife Acts (as amended) and is the only species of squirrel native to Ireland. It is totally dependent on woodland habitat and nest in dreys, which are round structures built of sticks and foliage against the trunks of trees. Red squirrels are particularly elusive, often hiding against the opposite side of the tree trunk from intruders (Vincent Wildlife Trust Ireland).

5.3.5.1 Existing Records

Records of red squirrel distributions are not available by NPWS (Article 17, 2019). Records available from the National Biodiversity Data Centre (NBDC) within the study area are shown in Figure 5.14. It is evident from the online NBDC records high density of red squirrel are present in the surrounding areas of the proposed upstream storage area.

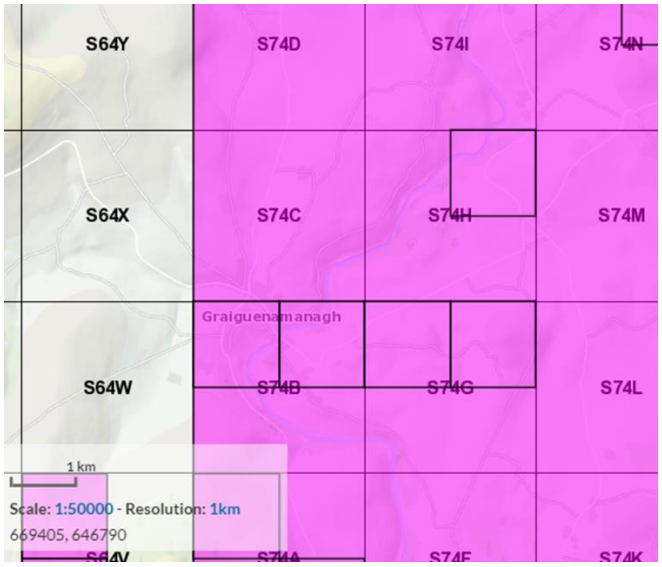

Figure 5.14 NBDC records for Red Squirrel within the proposed upstream storage area

5.3.5.2 Field Survey

The ByrneLooby ecologists did not observe any sightings or evidence of red squirrel during the field surveys.

5.3.6 Eurasian Badger (*Meles meles*)

The Eurasian Badger is the largest terrestrial carnivore in Ireland. Badgers are protected under the Wildlife Acts (as amended), and in Northern Ireland under the Wildlife (N.I.) Order of 1985. Furthermore, they are protected under Appendix III of the Berne Convention.

5.3.6.1 Existing Records

Records of badger distributions are not available from NPWS (Article 17, 2019). NBDC recorded signs of badger activity within and in the surrounding areas of the proposed upstream storage area are shown in Figure 5.15, ranging from 100m to 1km precision. High densities of badger are recorded within the surrounding area.

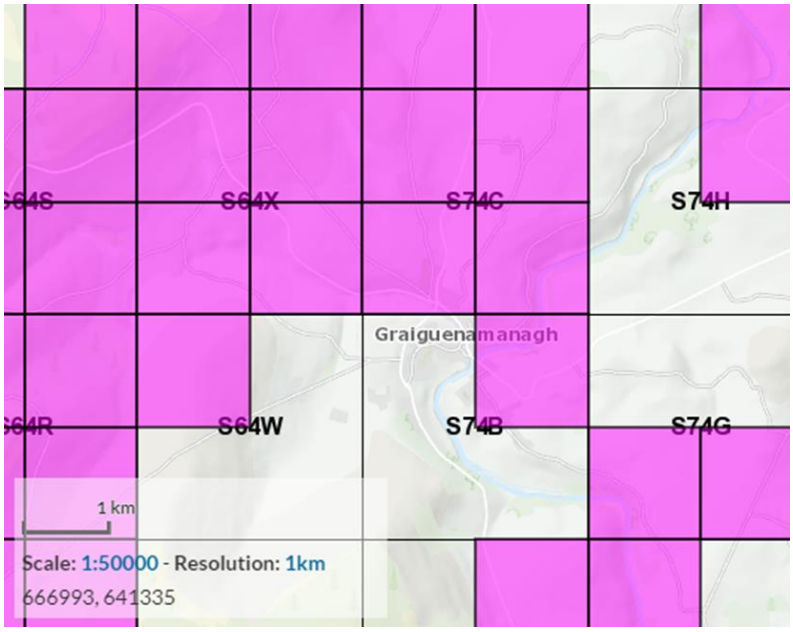

Figure 5.15 NBDC records of badger within and surrounding the proposed upstream storage area.

5.3.6.2 Field Survey

The ByrneLooby ecologists did not observe any live sightings of badger; however, evidence of badger activity was observed including badger runs and a possible badger latrine, located in an improved agricultural land adjacent to the river Duiske. This evidence is presented below (Figure 5.16 and Figure 5.17), and the location of the evidence is mapped in Figure 5.3. It should be noted, the mammal trail identified as a badger run may be that of other mammals such as the otter and/or that of the American mink.

Figure 5.16 Badger excrement and latrines; potential evidence of badger activity in survey section A – 09/01/2023.

Figure 5.17 Badger runs located in survey section A, adjacent to the River Duiske – 09/01/2023.

5.3.7 Irish Hare (*Lepus timidus* subsp. *Hibernicus*)

The Irish hare (*Lepus timidus* subsp. *Hibernicus*) is one of Ireland's longest established indigenous species of mammal and are protected under the Wildlife Acts (1976, as amended).

5.3.7.1 Existing Records

Article 17 records from NPWS (2019) are shown in Figure 5.18. No record of Irish hare from NBDC records has been documented within the proposed upstream storage area (within grid cell S64X and S74C in Figure 5.19).

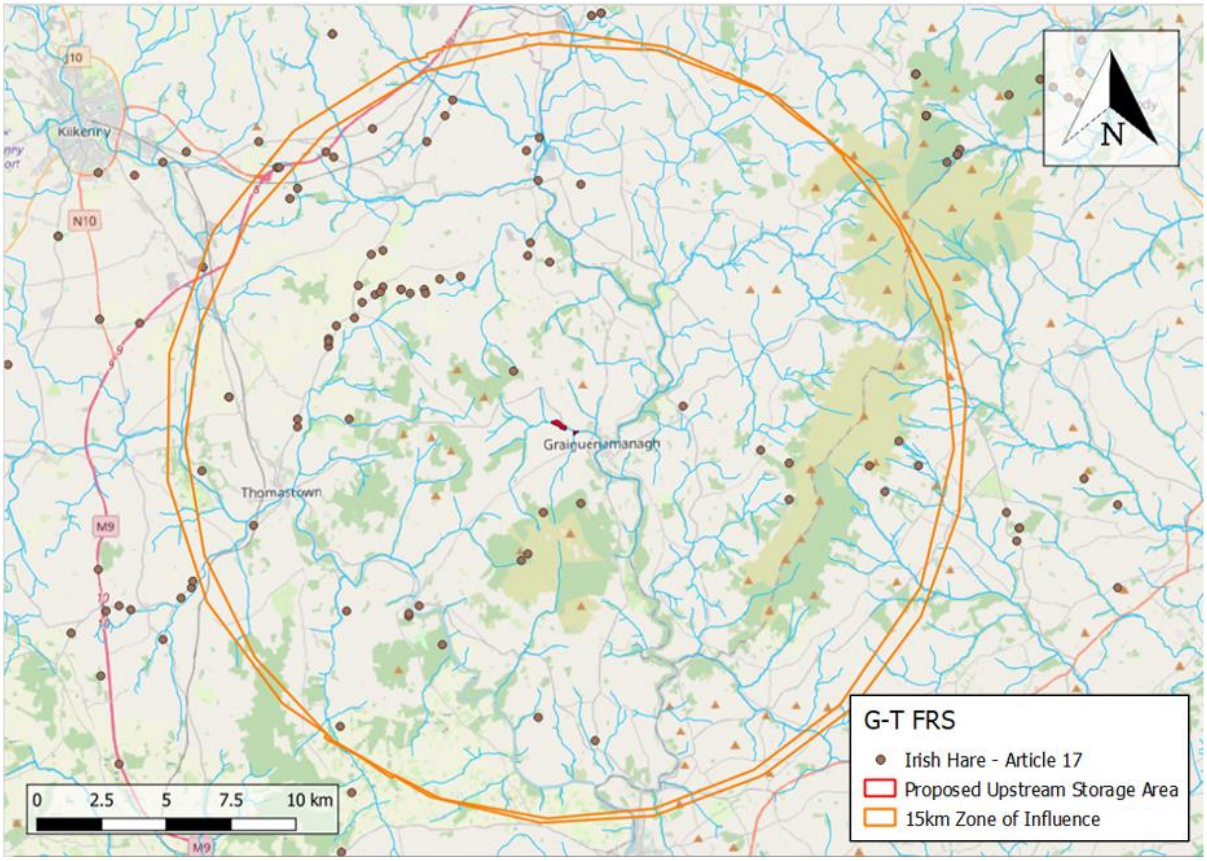

Figure 5.18 Irish Hare records within the surrounding area of the proposed upstream storage area (Article 17 – NPWS, 2019).

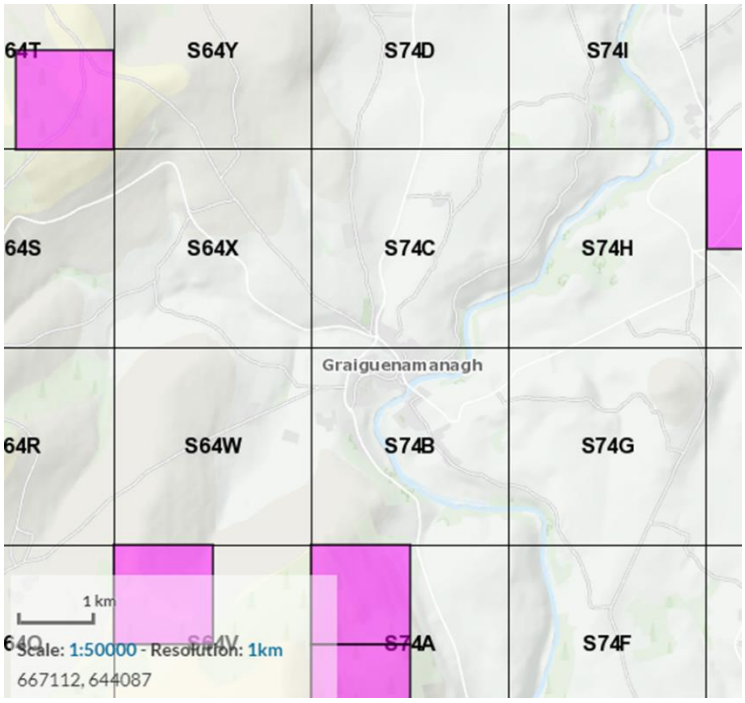

Figure 5.19 NBDC records for the Irish Hare surrounding the proposed upstream storage area

5.3.7.2 Field Survey

The ByrneLooby ecologists did not observe any sightings or evidence of Irish Hare activity during the field surveys.

5.4 Bats

All bat species are protected under the Wildlife Acts and Annex IV of the EU Habitats Directive. Lesser horseshoe bats (*Rhinolophus hipposideros*) are listed under Annex II of the EU Habitats Directive.

5.4.1 Existing Records

5.4.1.1 Habitat Suitability

The NBDC assembles data from the National Bat Database (maintained by the Irish National Bat Database) and the National Lesser Horseshoe Bat database to gather information on the suitability of areas as habitats for individual bat species in Ireland. Landcover (CORINE), climate, soil pH, topography, riparian habitats and human bias factors were incorporated into a Maximum Entropy Modelling (MaxEnt) to produce habitat suitability models for each bat species (Lundy et al., 2011). The tables below provide the 'habitat suitability index', where the index ranges between 0 and 100, With 0 being the least favourable and 100 the most favourable for bats.

As shown in Figure 5.20, the habitat suitability for the proposed upstream storage area (grid cells S64X and S74C) is colour coded indicating the habitats are high (colour coded orange) to very high

suitability (colour coded red). In Table 5.6, a list of habitat suitability for each of the bat species for the area is shown. The scheme area is deemed highly suitable for all bat species in Ireland, with the exception of the Lesser Horseshoe (*Rhinolophus hipposideros*) and the Nathusius' pipistrelle bat (*Pipistrellus nathussi*).

No records of bats were documented on the NBDC within the proposed upstream storage area (see Figure 5.1).

The surrounding landscape is reasonably diverse, comprising a mixture of agricultural grassland, woodland and urban areas, which are punctuated by a network of criss-crossing treelines/hedgerows and a river system. The diverse landscape, as well as the presence of ecological corridors (in the form of hedgerows/treelines and rivers) contribute to the increased habitat suitability for bats.

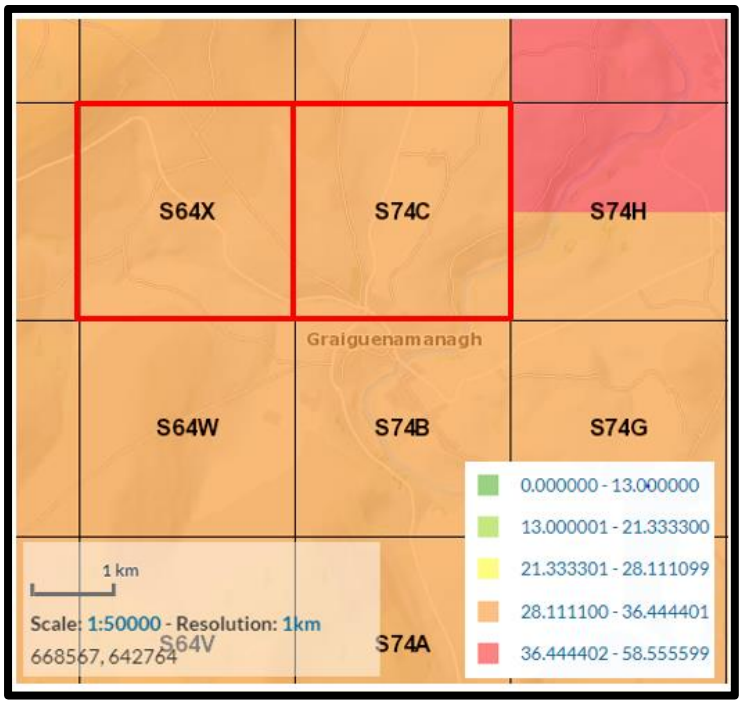

Figure 5.20 Bat Habitat Suitability Index.

Table 5.6 Suitability indices for the bats in the area for grid cells S64X and S74C in Figure 5.20.

Scientific Name	Common Name	Suitability Index
All Bats		31.67
Pipistrellus pygmaeus	Soprano pipistrelle	38
Plecotus auritus	Brown long-eared bat	47
Pipistrellus pipistrellus	Common pipistrelle	46
Rhinolophus hipposideros	Lesser horseshoe bat	3
Nyctalus leisleri	Leisler's bat	40
Myotis mystacinus	Whiskered bat	40
Pipistrellus nathussi	Nathusius' pipistrelle	4
Myotis daubentonii	Daubenton's bat	25
Myotis nattereri	Natterer's bat	42

5.4.2 Field Survey

The ByrneLooby ecologists did not observe live sighting of bats; however, derelict buildings (in survey section B, see Figure 5.21, and Appendix A Table A.2 map of survey section B) and three trees (in survey section A and B) covered in dense ivy were observed (see Figure 5.22 and Figure 5.23). The ByrneLooby ecologists identified these derelict buildings and trees as potential bat roosts (PBRs).

Figure 5.21 Derelict building with dense ivy cover – potential roosting site in survey section B – 09/01/2023.

Figure 5.22 Another derelict building in survey section B – 09/01/2023.

Figure 5.23 Trees (ash and hawthorn) covered in dense ivy – identified as potential roosting sites – 09/01/2023. Photos were taken in survey section A, survey section A, and survey section B (from left to right).

5.5 Other Mammals

Other evidence of mammal activity observed during the field survey included a burrow/hole (Figure 5.24) found in survey section B (see Figure 5.4). The dimensions of the burrow (pen in the photo for reference) was small and was located on the riverbank under a tree. The burrow/hole did not match descriptions of otter holts, nor did it match descriptions of the bank vole (preferring coniferous forests containing a thick shrub layer); possibly hare/rabbit, rat or wood mouse (*Apodemus sylvaticus*) burrow.

Figure 5.24 Burrow/hole observed in survey section B – 09/01/2023.

5.6 Herpetofauna

There are three native species of amphibian in Ireland and one native species of reptile, all of which are protected under the Wildlife Acts (1976, as amended). The natterjack toad (*Epidalea calamita*) is listed under Annex IV of the Habitats Directive. The natural range of the natterjack toad is restricted to the coastal zones of the Dingle and Iveragh peninsulas in Co. Kerry (NPWS, 2021), more specifically Castlemaine Harbour and Castlegregory in Co Kerry (DHLGH, 2022).

No evidence of herpetofauna were observed during the field surveys. However, field surveys were conducted outside the breeding season for amphibians. The habitats within the study area were evaluated for their potential to support amphibians. There were numerous observations of standing and slow-moving water within the survey sections A and B of the proposed upstream storage area, and these are considered highly suitable breeding habitats for amphibians.

In Table 5.7, the protected herpetofauna recorded within the scheme area (as shown in Figure 5.1) are summarised (NBDC online records).

Table 5.7 Summary of NBDC records of protected amphibians found within the 2km square grids S64X and S74C (Figure 5.1).

Species Name	Record Count	Date of Last Record	Designation
Common Frog (Rana temporaria)	1	09/02/2019	Protected Species: EU Habitats Directive – Annex V; Wildlife Acts

5.6.1 Common Frog (*Rana temporaria*)

The Common frog (*Rana temporaria*) is the only species of frog found in Ireland. It is listed as an internationally important species and is protected under the Habitats Directive (92/43/EEC) and the Irish Wildlife Act (as amended).

5.6.1.1 Existing Records

Article 17 data listed 8 records of common frog downstream of the GTFRS within the 15km ZoI, (A – I as shown in Figure 5.25 and Table 5.8). Records of the common frog were not observed within the proposed upstream storage area footprint. In Figure 5.26, NBDC records of common frog are shown – 20 records of frog with varying precisions (100m, 1km and 10km) documented within grid cell S74C.

Table 5.8 1 Records of common frog available from the NBDC within the proposed upstream storage area.

I.D.	Grid Ref.	Date	Precision	Notes	Hydrological Connection
A	No grid ref.	2011	100m	N/A	Yes
B	S7043	09/02/2013	1km	Adult.	Yes
C	S7142	09/02/2013	1km	Life stage; spawn.	Yes
D	S7242	09/02/2013	1km	Adult and Spawn.	Yes
E	S7241	09/02/2013	1km	Life stage; spawn.	Yes
F	S738372	23/06/2016	100m	No notes.	Yes

G	No grid ref.	2011	100m	N/A	Yes
H	No grid ref.	2011	100m	N/A	No
I	S72863012	10/02/2013	100m	N/A	Yes

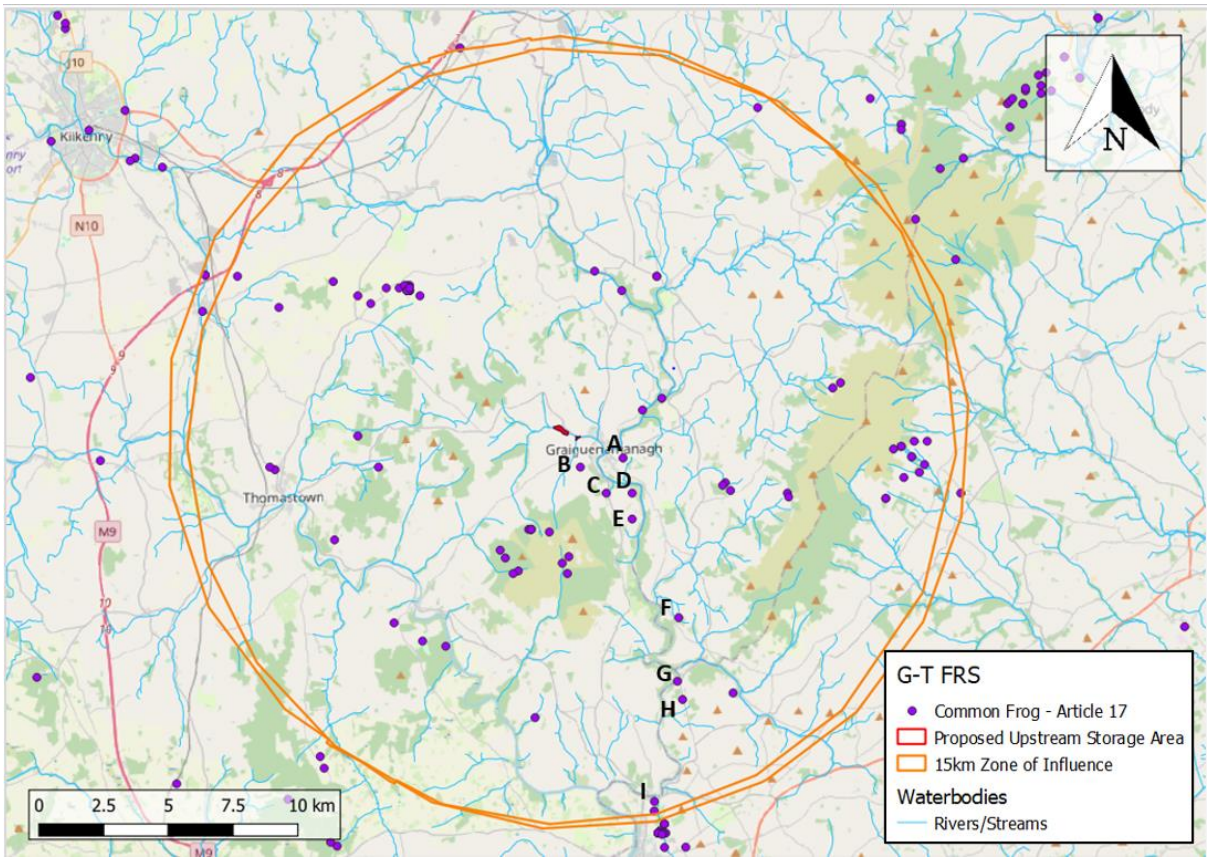

Figure 5.25 Common Frog (Rana temporaria) records within 15km of the proposed upstream storage area (Article 17 data, NPWS).

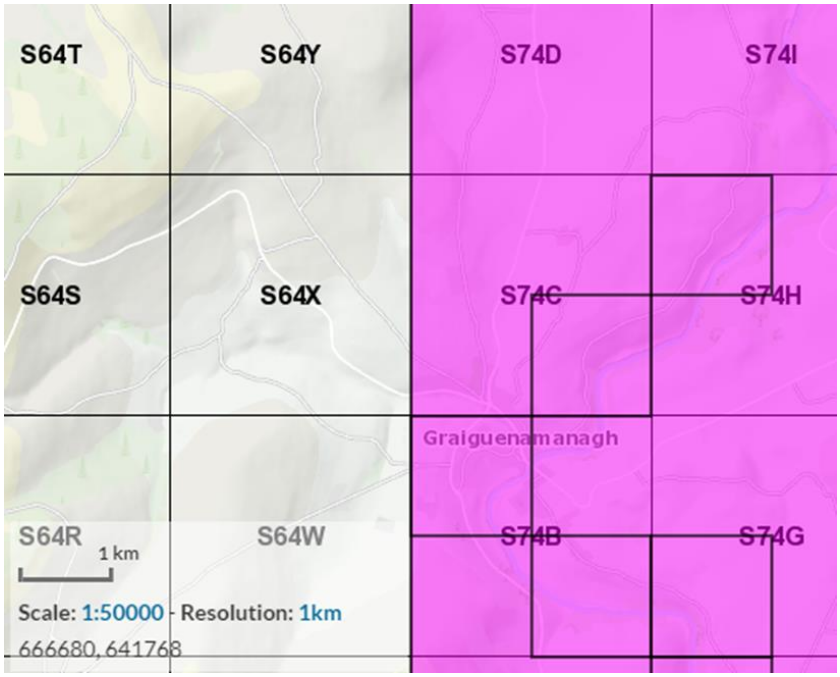

Figure 5.26 NBDC records of common frog in the surrounding area of the proposed upstream storage area

5.6.1.2 Field Survey – Common Frog (*Rana temporaria*)

The ByrneLooby ecologists did not observe live sightings or evidence of frog activity during the field surveys.

5.6.2 Smooth Newt (*Lissotriton vulgaris*)

The smooth newt (*Lissotriton vulgaris*) is the only member of the Urodela (the tailed amphibians) found in Ireland. Smooth newts are protected in Ireland under Schedule 5 of the Wildlife Act, 1976. The species is also afforded additional protection under Appendix III of the Convention on the Conservation of European Wildlife and Natural Habitats (The Bern Convention).

While commonly encountered near water bodies, adult newts are in fact terrestrial, only returning to wetland bodies to breed in February and March, remaining there until June (O'Neill et al., 2004).

5.6.2.1 Existing Records

Online records (NBDC) for the smooth newt are not recorded within the proposed upstream storage area or within the 15km ZoI of the proposed works. Article 17 (NPWS) records of smooth newt distributions are not available.

5.6.2.2 Field Survey

No evidence of smooth newt was observed during the field surveys.

5.6.3 Common Lizard (*Zootoca vivipara*)

The Common Lizard is Ireland's only native terrestrial reptile and is protected under the Wildlife Acts (1976, as amended).

5.6.3.1 Existing Records

Online records (NBDC) for the common lizard are not recorded within the proposed upstream storage area or within the 15km ZoI of the proposed works. Article 17 data (NPWS) is not available for the common lizard.

5.6.3.2 Field Survey

No evidence of the common lizard was observed during the field surveys.

5.7 Molluscs (terrestrial species)

There are eight species of whorl snails in Ireland, and three are protected under Annex II of the Habitats Directive, *Vertigo geyeri*, *V. angustior* and *V. moulinsiana*. These species are all dependant on stable and specific ground water conditions, and as they only live for just over a year, are vulnerable to the effects of negative changes in wetness conditions.

5.7.1 Desmoulin's Whorl Snail (*Vertigo moulinsiana*)

The Desmoulin's whorl snail *Vertigo moulinsiana* is the largest *Vertigo* species, with a shell height up to 2.6 mm. The *Vertigo moulinsiana* is listed as Endangered on the IUCN Red List (IUCN 2020) and is protected under the Wildlife Acts (1976, as amended). Additionally, the *V. moulinsiana* is a QI of the River Barrow and River Nore SAC.

The whorl snail is normally restricted to calcareous wetlands, usually bordering lakes or rivers, marshes or in fens, residing on tall-growing vegetation such as reed-grasses and sedges. As such, it is important to consider the hydrological connection of this species, along the River Duiske and downstream within the 15km ZoI along the River Barrow and River Nore SAC.

5.7.1.1 Existing Records

Article 17 data including 1km and 10km spatial distributions of the Desmoulins's whorl snail is shown in Figure 5.27. No records are downstream of the proposed works. The NBDC was checked for existing records of the *V. moulinsiana* in the vicinity of the proposed scheme area. In Figure 5.28, NBDC records are shown – all records (grid cell S74) were historical data dating between 1901 to 1940.

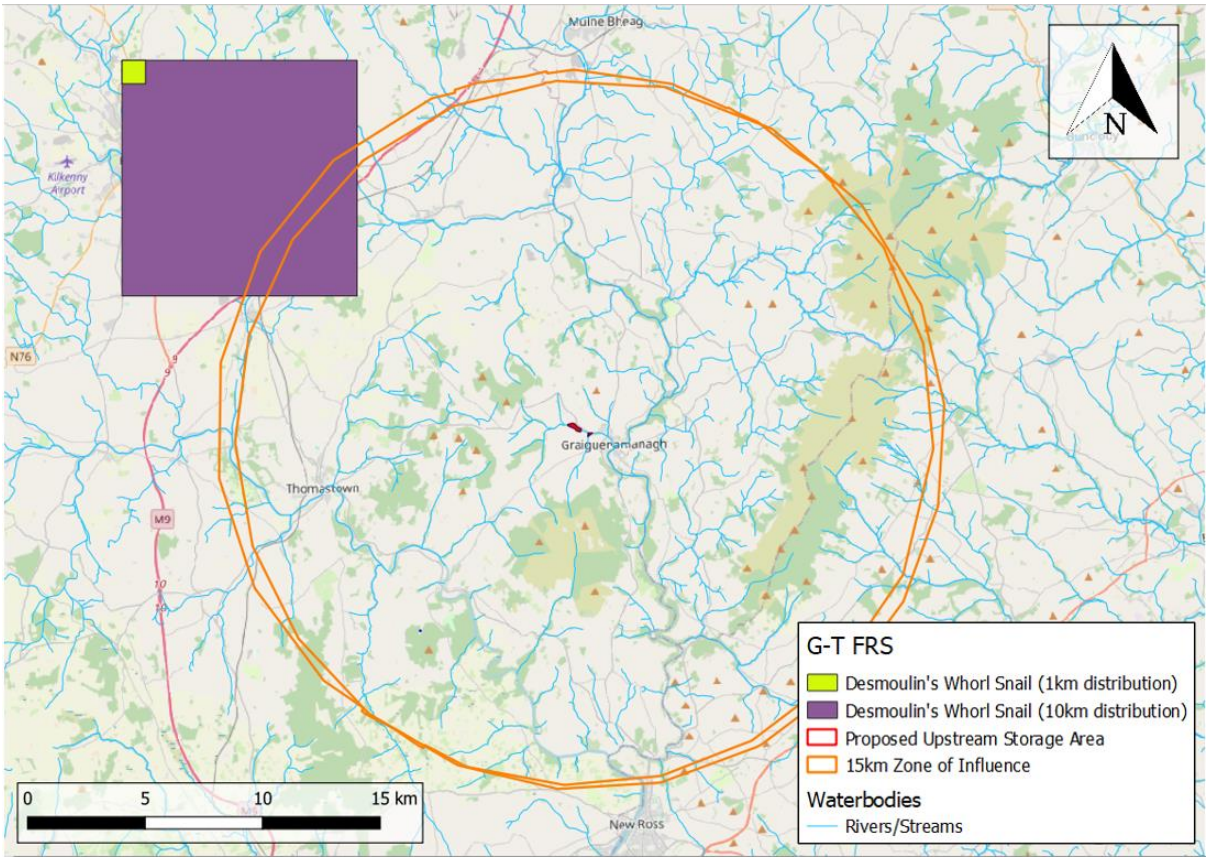

Figure 5.27 Desmoulin's Whorl Snail (Vertigo moulinsiana) records within 15km of the proposed upstream storage area (Article 17 data, NPWS).

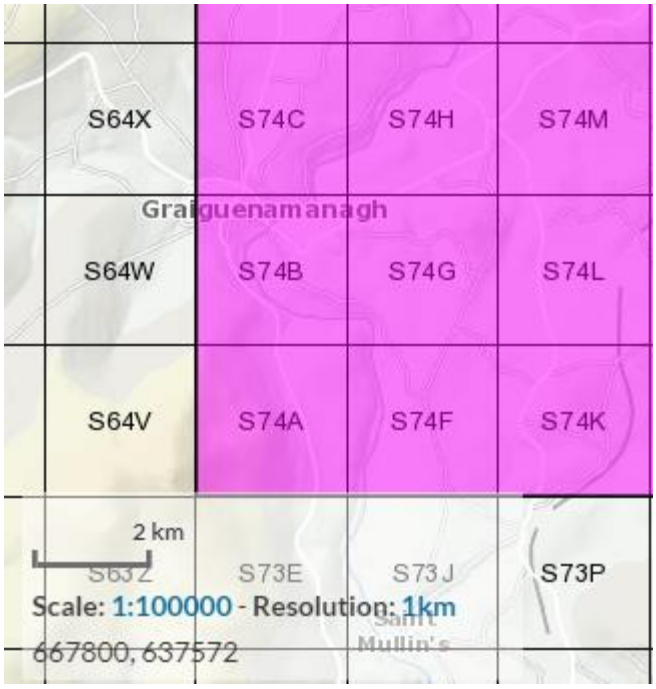

Figure 5.28 NBDC records of Desmoulin's whorl snail in the surrounding area of the proposed upstream storage area

5.7.1.2 Field survey

The Desmoulin's whorl snail was not observed by the ecologist during the field survey.

5.7.2 Other Whorl Snail Species

No records (NBDC or the NPWS) are documented of *V. geyeri* and *V. angustior* within the 15km ZoI of the proposed works.

5.8 Aquatic Fauna (Freshwater Fish and Other Taxa)

This section of the report summarises the existing records for aquatic fauna available from NPWS (Article 17 data, 2019).

The ByrneLooby habitats and species survey site walkover did not include dedicated surveys for aquatic fauna, only a review of secondary data. A dedicated walkover and desk-based exercise for aquatics has been undertaken by APEM (appointed aquatic specialist), with detailed survey requirements to be identified. Their findings are outlined in Appendix D. Additional environmental surveys will be undertaken, as appropriate, and a full impact assessment will be undertaken to feed into the EIA Report.

However, during the field studies, a fish was observed swimming in the survey section B. The ecologists identified this fish as either salmon parr or brown trout.

5.9 Avifauna

The R. Barrow and R. Nore SAC is a site of ornithological importance for several EU Birds Directive Annex I species, including Greenland White-fronted Goose, Whooper Swan, Bewick's Swan, Bar-tailed Godwit, Peregrine and Kingfisher. Nationally important numbers of Golden Plover and Bar-tailed Godwit are found during the winter. Wintering flocks of migratory birds are seen in Shanahoe Marsh and the Curragh and Goul Marsh, both in Co. Laois, and along the Barrow Estuary in Waterford Harbour. There is also an extensive autumnal roosting site in the reedbeds of the Barrow Estuary used by Swallows before they leave the country (NPWS, Site Synopsis – 2016).

The River Nore SPA is of high ornithological importance as it supports a nationally important population of Kingfisher (*Alcedo atthis*), a species that is listed on Annex I of the EU Birds Directive. Other species supported within the site also include: Mute Swan (*Cygnus olor*), Sand Martin (*Riparia riparia*), Snipe (*Gallinago gallinago*), Mallard (*Anas platyrhynchos*), Grey Heron (*Ardea cinerea*), Cormorant (*Phalacrocorax carbo*) and Moorhen (*Gallinula chloropus*). A survey in 2010 recorded 22 pairs of Kingfisher (based on 16 probable and 6 possible territories) within the SPA. Other species which occur within the site include Mute Swan (35), Mallard (267), Cormorant (14), Grey Heron (45), Moorhen (14), Snipe (17) and Sand Martin (1,029) – all figures are peak counts recorded during the 2010 survey (NPWS, Site Synopsis – 2011).

Conservation objective for River Nore SPA [004233]:

To maintain or restore the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA: Kingfisher (Alcedo atthis) (NPWS, 2022).

5.9.1 Existing Records (NBDC)

The species listed in Appendix C (Table C1) were recorded in the 2km grid squares, S64X and S74C, as illustrated in Figure 5.1 (NBDC online records). The protected avifaunal species are summarised in Appendix C (Table C2).

5.9.2 Birds of Conservation Concern in Ireland (BoCCI)

Based on qualitative data on species populations and distributions, BoCCI comprises lists of priority birds so that resources can be effectively allocated for their conservation. The system follows a traffic light system (i.e., red, amber and green) – red being the highest conservation priority and species are green when deemed low conservation concern. Some of the criteria, which may trigger a species to be Red or Amber-listed, reflect global or European status regardless of how the species is faring in Ireland. It is Important to have this wider context in status assessments to ensure protection of populations which are declining elsewhere in their range.

5.9.3 EU Birds Directive

- **Annex I**: 194 species and sub-species are particularly threatened. Member States must designate Special Protection Areas (SPAs) for their survival and all migratory bird species.
- **Annex II**: 82 bird species can be hunted. However, the hunting periods are limited and hunting is forbidden when birds are at their most vulnerable: during their return migration to nesting areas, reproduction and the raising of their chicks.
- **Annex III**: overall, activities that directly threaten birds, such as their deliberate killing, capture or trade, or the destruction of their nests, are banned. With certain restrictions, Member States can allow some of these activities for 26 species listed here.
- **Annex IV**: the directive provides for the sustainable management of hunting but Member States must outlaw all forms of non-selective and large scale killing of birds, especially the methods listed in this annex.
- **Annex V**: the directive promotes research to underpin the protection, management and use of all species of birds covered by the Directive, which are listed in this annex.

5.9.4 Field Survey

During the habitats and species walkover, the ByrneLooby ecologists made record of any bird sightings or aural recordings. Surrounding areas (within and outside the project site) were scanned continuously using a pair of binoculars (Kenro 10-30x60) and all birds observed were recorded on a notepad.

Aural recordings were also obtained from each stationary survey point. The ecologist used the app BirdNET (Kahl *et al*., 2021) to record the calls of nearby birds where possible. BirdNET's in-app machine learning was used to determine species, according to Kahl *et al.* (2021) BirdNET has a mean average precision of 0.791 for single-species recordings. Regardless of this relatively high level of confidence, the ecologist compared aural records obtained in the field to existing records to add a higher level of certainty to species identification.

Of the species listed in Table 5.9, the mallard duck (*Anas platyrhynchos*) and Woodpigeon (*Columba palumbus*) are designated under Annex II and Annex III species.

Table 5.9 Bird Species recorded in the 2km grid squares during the field surveys by the ecologists.

Common Name	Scientific Name	Abundance	Designation
Blackbird	*Turdus merula*	1	N/A
Chaffinch	*Fringilla coelebs*	1	N/A
Crows	*Corvus Sp.*	>10	N/A
Mallard	*Anas platyrhynchos*	Potentially heard 2	Wildlife Acts; EU Birds Directive-- Annex II & Annex III
Magpie	*Pica pica*	1	N/A
Pied Wagtail	*Motacilla alba* subsp. *yarrellii*	1	N/A
Robin	*Erithacus rubecula*	3	N/A
Woodpigeon	*Columba palumbus*	2	Wildlife Acts; EU Birds Directive-- Annex II & Annex III

During the field survey the ecologist observed bird guano (see Figure 5.29) along the riverbanks amongst the trees located in survey section A and B (see locations in Figure 5.3 and Figure 5.4). The guano/droppings were identified as either duck or goose droppings.

In addition to this, two duck calls could be heard by the ecologist during the field survey, however the ecologist could not obtain a sighting of the ducks, nor could the call be recorded on the BirdNet app.; the species level could not be confirmed. It is possible from online resources referencing to various duck calls that the two species were Mallard (*Anas platyrhynchos*).

Figure 5.29 Guano/droppings observed along field survey in survey section A and B – 09/01/2023.

5.10 Faunal Invasive Species

An invasive species is an organism that is not indigenous, or native, to a particular area, and introduced outside their natural range, either intentionally or unintentionally. Invasive species can cause great economic and environmental harm to the new area. To be invasive, a species must adapt to the new area easily and reproduce quickly. When non-native species become invasive, they can transform ecosystems, and threaten native and endangered species. Invasions by non-native species are a major threat to global biodiversity. Terrestrial and aquatic habitats can be negatively affected, resulting in grave damage to conservation and economic interests, such as agriculture, forestry and civil infrastructure (Stokes *et al.,* 2004–- NPWS).

The vectors and pathways by which non-native species are transported are numerous and result from the diverse array of human activities which operate over a range of scales. Accidental transport of invasive species via hull fouling or ship ballast water are primary introductions of directly orchestrated by human activity. Accidental release such as the expansion of exotic species from its initial place of establishment is a secondary introduction again from direct causation of human activity. Invasive species can lead to the extinction of native plants and animals, destroy biodiversity, and permanently alter habitats (NOAA).

The invasive faunal species from online records (NBDC) are listed in Table 5.10

Table 5.10 NBDC records of invasive species recorded within the 2km square grids (Figure 5.1).

Species Name	Record Count	Date of Last Record	Designation
Eastern Grey Squirrel (*Sciurus carolinensis*)	1	29/09/2011	High Impact Invasive Species. EU Regulation No. 1143/2014; Regulation S.I. 477 (Ireland)

6 Summary and Recommendations

Having assessed the available information and the results from the walkover surveys described in this report, the following broad conclusions and recommendations can be made in relation to further surveying requirements.

6.1 Protected Sites

The most significant ecological considerations for the proposed upstream storage area for the GTFRS are the R. Barrow and R. Nore SAC and the River Nore SPA.

All work that is to be carried out on the riverbank must be carried out in such a way as to minimise the potential for events such as diesel or concrete spillages, water run-off with suspended sediment loadings or any accidental spillages. If considered necessary to re-build or build in-river structures (e.g., culverts, weirs, bridges), the same sort of construction approach should be designed in to minimise resuspension and loss of concrete to the river.

An NIS in accordance with Articles 6(3) and 6(4) of the EU Habitats Directive (Directive 92/43/EEC) will be undertaken required for the proposed scheme, encompassing the works proposed for the upstream storage area.

6.2 Habitats

6.2.1 Summary

Much of the proposed upstream storage area is occupied by hedgerows, treelines, agricultural land, broadleaved woodland or riparian woodland. Linear woodland habitats have intrinsic value in Ireland, because at a national scale Ireland has very low woodland coverage relative to other European countries. Aside from their intrinsic value, these habitats provide ecological corridors for linear transport and food provisions for many species (in particular bats), and nesting sites for breeding birds.

No habitats fitting the descriptions under Annex I habitats were observed during the field survey within the scheme area.

6.2.2 Recommendations

No further terrestrial habitat surveys are recommended at this stage. However, ecological constraints maps may be provided at EIA/NIS stage to advise areas to avoid of ecological importance to certain species, focusing on potential habitats (high suitability) and on identifying the principal factors that constrain life-history outcomes (success/productivity/resilience/fitness) for specific species. An additional brief site walkover may be required to facilitate this. During construction and/or operations, the ecological constraint maps can be consulted and used as a guideline for the efficient development of actionable knowledge on ecological issues and

development of optimal solutions to a wide range of conservation and management problems that aligns with national and international legislation.

6.3 Flora

In Appendix B, the lists of the flora recorded within the footprint of the proposed scheme area are outlined (records from NBDC).

6.3.1 Invasive Plant Species

6.3.1.1 Summary

During the field survey, terrestrial, invasive alien plant species, Japanese Knotweed (*Fallopia japonica*), and Sycamore (*Acer pseudoplatanus*), were identified and documented within survey area B.

Sycamore is classed as a Medium Impact invasive species by NBDC. This tree species is widespread and common in Ireland occurring in treelines/hedgerows and woodlands throughout the country. In spite of being non-native and having potentially invasive characteristic towards native species, it is not considered a problematic species in this context. As these species are located in survey section B (no proposed works), theproposed works do not have the potential to cause spread of this species.

Therefore, sycamore will not be considered further in the Invasive Species Management Plan.

6.3.1.2 Recommendations

The preliminary invasive species management plan (report number W3451-CS-R009), completed for the GTFRS, will be adopted during the pre-construction, construction and operation of the proposed scheme in order to manage and prevent the spread of the invasive plant species. The management plan is intended to be a working document and will be updated during both the construction and operational phases. During construction, it will be updated by the contractor to form the Construction Stage Invasive Species Management Plan (ISMP) which will form part of the detailed Construction Environmental Management Plan (CEMP). Following construction, the plan will be updated for the operational phase, taking into account the results of the detailed construction invasive species management plan and operational maintenance requirements.

6.3.2 Trees

6.3.2.1 Summary

Areas of woodland are present from historical mapping. Significant lengths of the riverbanks are currently occupied by hedgerows, treelines or woodland – habitats which are considered to have intrinsic value in Ireland, because at a national scale Ireland has very low woodland coverage relative to other European countries. Aside from their intrinsic value, these habitats provide

foraging and commuting corridors for many species of fauna (bats in particular) through an otherwise quite urban setting. They also provide nesting habitat for many breeding birds and provide habitat for otters, pine martens, stoats, and the red squirrel.

6.3.2.2 Recommendations

The proposed upstream storage will require significant ground shifting and the construction of raised embankments that may directly impact on trees located in the area. Therefore, a dedicated tree survey and associated Arboricultural Impact Assessment (AIA) is recommended, to identify trees of ecological value, outline the potential impact of the scheme to these trees and recommend appropriate mitigation to avoid impact. This is recommended for Survey Area A only, as works are not proposed in Survey Area B.

In summary, the objectives of the tree survey and report are:

- To identify and map trees of significance along the route/areas of the proposed flood relief measures.
- To identify the species and approximate age of these trees
- To identify features of potential ecological significance in these trees (including roosting sites for bats).
- To propose Root Protection Areas (RPAs) and other protective measures for trees recoded.

6.4 Mammals

During the field surveys the ByrneLooby ecologists reported potential roosting sites for bats within a derelict building and a tree covered in dense ivy, otter spraint, badger run and latrine, several food remains and a unidentified burrow/hole. However, desk study data indicates more mammal species are present within and surrounding the proposed scheme area.

6.4.1 Otter

6.4.1.1 Summary

Evidence of otter (spraints) and potential food remains were observed during the field surveys, and otters have been previously recorded within the footprint of the proposed scheme area.

The otter (*Lutra lutra*) is a protected species at national and European level, therefore any scheme option that have the potential to disturb otters must be assessed. In addition, the otter is listed as a Qualifying Interest (QI) of the River Barrow and River Nore SAC. This development is proposed within areas consisting of rivers, lakes and/or along banksides and the coastline, therefore there is potential for the disturbance of otter habitats. As this species is protected by European and national legislation, it is an offence to:

- Kill or injure an otter.
- Disturb them during breeding or hibernation.
- Damage a breeding or resting site (known as holts located underground and couches located above ground).

6.4.1.2 Recommendations

Given historical evidence of the species within the scheme area, it is recommended that a full specialist otter survey is carried out as precaution. This is recommended for Survey Area A only, as works are not proposed in Survey Area B. Otter surveys can be conducted throughout the year but are most effective following a long period of dry weather. The NRA guidelines recommend that mammal surveys are best undertaken during the period November to April when vegetation cover is low and does not obscure holts/dens (NRA, 2006). Methodologies for a standard otter survey are outlined in the sections below.

If any evidence of otter activity/habitat are observed during the above-mentioned survey, appropriate mitigation measures/guidance should be adhered to ensure any potential disturbances are avoided. If otters are found to be present and disturbance is likely, then a derogation licence will be required to allow proposed development works that might affect otters to proceed. The potential impacts on otter will be assessed and reported in the EIA.

Any otter mitigation works can potentially be conducted at any time of year but must avoid the breeding season (usually Spring but can be any time of year) if holts are present where works are proposed.

The most commonly applied monitoring method for otter surveys used within Europe follow the 'Standard Otter Survey' method. This involves the search for droppings (spraints), footprints, feeding remains, lying-up areas, holts (permanent places of rest and shelter) and areas of habitat considered suitable for the species. Nocturnal and elusive species are difficult to count directly and thus population trajectories are inferred by variation in the incidence of field signs and therefore indirect survey methods that record species presence using tracks, faeces or scent markings have become standard protocol for many species (Reid *et al*., 2008 (NPWS), and references therein.

If camera trapping is determined as a suitable method to monitor the identified holt (or any other identified in future surveys), a licence from NPWS should be sought ahead of the survey commencing.

6.4.2 Pine Marten

6.4.2.1 Summary

No evidence of pine marten (habitat or activity) was observed by the ecologists during the field survey. However, on review of Article 17 data (NPWS) of the pine marten within and surrounding the scheme area (containing 8 records), the presence of pine marten within the scheme area is likely.

6.4.2.2 Recommendations

Further surveys are not considered a requirement at the AA/EIA stage of the Project.

However, pre-construction surveys should be carried out to confirm the presence of the species within the construction area. If any evidence of Pine Marten activity/habitat are observed during the survey, additional surveys may be required and should be appropriately scoped. Further, appropriate mitigation should be adhered to ensure any potential disturbances are avoided during construction.

6.4.3 Irish Stoat

6.4.3.1 Summary

No evidence of Irish Stoat (habitat or activity) was observed by the ByrneLooby ecologists during the field surveys. However, on review of the desk study data, the presence of Irish Stoat within the scheme area is likely.

6.4.3.2 Recommendations

Further surveys are not considered a requirement at the AA/EIA stage of the Project.

However, pre-construction surveys should be carried out to confirm the presence of the species within the construction area. If any evidence of Irish Stoat activity/habitat are observed during the survey, additional surveys may be required and should be appropriately scoped. Further, appropriate mitigation should be adhered to ensure any potential disturbances are avoided during construction.

6.4.4 Hedgehog

6.4.4.1 Summary

No evidence of the hedgehog (habitat or activity) was observed by the ByrneLooby ecologists during the field surveys. However, on review of the desk study data, the presence of hedgehog within the scheme area is likely.

6.4.4.2 Recommendations

Further surveys are not considered a requirement at the AA/EIA stage of the Project.

However, pre-construction surveys should be carried out to confirm the presence of the species within the construction area. If any evidence of hedgehog activity/habitat are observed during the survey, additional surveys may be required and should be appropriately scoped. Further, appropriate mitigation should be adhered to ensure any potential disturbances are avoided during construction.

6.4.5 Red Squirrel

6.4.5.1 Summary

No evidence of red squirrel (habitat or activity) was observed during the field surveys. However existing records show the presences of red squirrel within the proposed scheme area.

6.4.5.2 Recommendations

Further surveys are not considered a requirement at the AA/EIA stage of the Project.

However, pre-construction surveys should be carried out to confirm the presence of the species within the construction area. If any evidence of Red Squirrel activity/habitat are observed during the survey, additional surveys may be required and should be appropriately scoped. Further, appropriate mitigation should be adhered to ensure any potential disturbances are avoided during construction.

6.4.6 Badger

6.4.6.1 Summary

Evidence of badger (badger run or faeces/latrines) was observed during the field survey, and badgers were previously recorded at high densities within the footprint of the proposed scheme area.

6.4.6.2 Recommendations

Further surveys are considered a requirement at the EIA/NIS stage of the Project. This can be coupled with the survey for otter activity. This is recommended for Survey Area A only, as works are not proposed in Survey Area B.

Badger surveys are significantly constrained by vegetational cover and season and are best conducted from November to April. All areas have to be systematically searched for setts and both sides of hedgerows and boundaries checked. Badger territorial activity is high from mid-January to March and surveys at this time are most efficient in identification of badger paths, latrines and feeding signs (NRA, 2006a). If any evidence of Badger activity/habitat are observed during the survey, additional surveys may be required and should be appropriately scoped. Further, appropriate mitigation should be adhered to ensure any potential disturbances are avoided during construction. The NRA guidelines recommend that mammal surveys are best undertaken during the period November to April when vegetation cover is low and does not obscure setts (NRA, 2006). However, it should be noted, until mid-January, badgers are less active during colder weather and setts can appear less well-used.

Should a sett be recorded within the scheme extents prior to construction, a derogation licence for works will be required and appropriate mitigation strategies will need to be devised and

implemented. Should existing setts require blocking and/or destruction, this should be completed in Autumn/early winter, and if any are being reconstructed, this should be completed in Spring/Summer. Alternative locations for artificial setts should be appropriately scoped ahead of any reconstruction. All surveys and mitigation should be carried out in accordance with best practice guidance (NRA, 2006a).

The following appropriate measures will be implemented in order to mitigate construction impacts on badgers potentially commuting and foraging in the works area:

- Minimise the potential for badgers becoming trapped, i.e., excavations will be left open for the minimum possible time, and not over-night. An escape ramp will be fitted (no more than 45°) if excavations are required to be left open over-night/extended periods to allow accidental incidents of trapped animals to escape. The materials required to cover excavations or create escape ramps will be on site at all times.
- Materials stored on site will be stacked securely so as to prevent accidental collapse if investigated by badgers, or any other large mammals.
- Prior to commencement, all works areas, site compounds and access routes will be re-surveyed to ensure that new Badger setts have not been established. Appropriate mitigation strategies (as mentioned above) will be implemented if a sett is found.

6.4.7 Irish Hare

6.4.7.1 Summary

No evidence of Irish Hare (habitat or activity) was observed during the field survey. However, on review of the desk study data, the presence of Irish hare in the surrounding landscape of the scheme area is likely.

The Irish Hare is the only native lagomorph and is legally protected under the Wildlife Acts (1976 and Amendments). Any scheme option that may have the potential to disturb the Irish Hare must be assessed.

6.4.7.2 Recommendations

Further surveys are not considered a requirement at the AA/EIA stage of the Project.

However, pre-construction surveys should be carried out to confirm the presence of the species within the construction area. If any evidence of Irish Hare activity/habitat are observed during the survey, additional surveys may be required and should be appropriately scoped. Further, appropriate mitigation should be adhered to ensure any potential disturbances are avoided during construction.

6.4.8 Bats

6.4.8.1 Summary

The ecologist observed potential bat roosts (PBRs) of densely covered trees and derelict buildings during the field survey in survey section A and B. Further detail is provided in Section 5.4.

6.4.8.2 Recommendations

A dedicated bat survey is recommended to be carried out to confirm the presence of bat species within the area for the proposed upstream storage. This is recommended for Survey Area A only, as works are not proposed in Survey Area B.

The scattered mature trees and areas of low water flow in the proposed upstream storage area provide good foraging, roosting and commuting routes for bat species. Options that require the removal of mature trees with the potential to support roosting bats shall be assessed for bat roosting potential.

Bat surveys should be conducted on any features with medium or high potential for roosting bats.

Once more detail becomes available pertaining to the proposed structural alterations to the site (including the proposed methods of construction), the site should be re-visited for the purpose of:

- Surveying key locations (e.g., where it is known that potential roosting habitat will be removed or disturbed); and
- Obtaining more detailed information about any potential bat roosts (i.e. whether it is a maternity roost, hibernaculum etc.)

This information will inform any considerations of mitigation measures that may need to be implemented. The optimal time to conduct bat surveys are between May and August, when bats are most active.

All bats, and trees that are identified as bat roosts, are afforded legal protection by the Wildlife Acts, 1976 and 2000, and the EU Habitats Directive (Under S.I. 94 of 1997). The most common and effective method of avoiding these offences is to carry out the work at an appropriate time of the year. The great majority of roosts are used only seasonally, so there is usually some period when bats are not present. Although there are differences between species, maternity sites are generally occupied between May and September and hibernation sites between October and March, depending on the weather. An adequate survey and good understanding of the seasonal activity patterns of the particular species involved will help in determining the optimum time to carry out the proposed work (Marnell et al., 2022). To proceed with the felling of trees in which bat roosts are confirmed, it is necessary to obtain a derogation licence from the National Parks and Wildlife Service. Removal of roosts should be carried out during the summer months for hibernation roosts and during the winter months for maternity roosts.

6.5 Herpetofauna

6.5.1 Summary

Ireland is home to a relatively limited range of native herpetofauna (amphibians and reptiles) compared to the UK and the mainland Europe; the common frog, smooth newt and common lizard are all protected under the Wildlife Acts (as amended). While the Common Frog and Newt were not observed during the walkover field survey, it is highly likely that the species are present in the area. Suitable habitat to support breeding amphibians on site and in the immediate area were identified. In particular, vegetation and wet grassland/riparian habitats adjacent to the River Duiske and the Old Millrace are likely to support these species.

The field survey was conducted the beginning of January, outside the breeding season for amphibians (i.e., February to June), therefore further observations are considered likely in the study area given the presence of standing water habitats and slow-moving streams. All three species of amphibians hibernate during the winter and are restricted by their biology to return to waterbodies to breed in spring/early summer.

The desk study returned records of common frog within the surrounding areas of the proposed works, the most recent from 2020 (NBDC and Article 17 – NPWS). There were no records of any amphibian found within the boundary of the proposed upstream storage area.

6.5.2 Recommendations

As the species are fairly widespread in Ireland and are highly likely to be located in the scheme area, further surveys are recommended at the EIA/NIS stage of the Project. This is recommended for Survey Area A only, as works are not proposed in Survey Area B.

On completion of the survey and identification of likely frog habitat/breeding sites, it may be possible to identify areas recommended to be avoided during construction to ensure impacts to frogs are minimised as much as possible.

Notwithstanding this, as the species adopt a more terrestrial lifestyle outside the breeding season, it is additionally recommended that a pre-construction survey is completed of the areas identified as works zones or construction compounds, particularly where standing water bodies are noted. This will reiterate the findings of the initial survey and confirm presence/absence of herpetofauna in the works areas. Areas of nearby lakes, ponds and standing water are considered suitable breeding habitats for amphibians and their presence is considered likely throughout the study area.

It should be noted, if evidence of breeding amphibians is observed within the proposed work areas best practice mitigation measures should be implemented to ensure continuance of these species on site after construction. Both the common frog and smooth newt are protected species under current Irish Wildlife legislation.

Where frogs are observed, or where frog breeding sites are identified, and have the potential to be impacted on site, translocation is a common practice in such circumstances and wildlife licences

need to be obtained from NPWS. Detailed proposals should be agreed with NPWS prior to construction/disturbance taking place.

6.6 Aquatic Fauna

Survey recommendations for aquatic sensitivities have been established by the appointed aquatic specialist, APEM, and are outlined in Appendix D.

6.7 Avifauna

6.7.1 Summary

The R. Barrow and R. Nore SAC is a site of high ornithological importance for several EU Birds Directive Annex I species, nationally important numbers of species found during the winter, and wintering flocks of migratory species, while providing extensive autumnal roosting sites in the reedbeds of the Barrow Estuary. The River Nore SPA is of high ornithological importance as it supports a nationally important population of Kingfisher (*Alcedo atthis*), a species that is listed on Annex I of the EU Birds Directive, while also supporting other species of national and international importance.

No BOCCI red-listed species or species listed in Annex I of the EU Birds Directive were recorded during the surveys. During the field surveys the ecologists observed the mallard duck (*Anas platyrhynchos*) and Woodpigeon (*Columba palumbus*), both of whom are designated under Annex II and Annex III species. On review of the desk study data, there are existing records of several national (i.e., Kingfisher (Annex I)) and internationally important bird populations, whose presence in the area is assumed to persist despite not having been detected during the surveys. In addition, the Yellowhammer and the Red Grouse, both BOCCI Red Listed, have been previously recorded within the proposed upstream storage location (NBDC).

The habitat(s) observed during the walkover survey are considered suitable breeding sites for the protected species documented on NBDC records within the area (grid cell reference S64X, where Survey Area A is located) and observed during the site walkover, namely the QI species the kingfisher, the house martin (*Delichon urbicum*), the BoCCI's Red listed yellowhammer (*Emberiza citrinella*), house sparrow (*Passer domesticus*), kestrel (*Falco tinnunculus*), and common pheasant (*Phasianus colchicus*).

6.7.2 Recommendations

Given the significance of certain areas of the site for breeding birds and recorded counts of those listed in Annex II and Annex III of the Birds Directive and BoCCI's Amber and Red List, a specialist bird breeding survey is recommended to confirm the presence of species within the area for the proposed upstream storage. This is recommended for Survey Area A only, as works are not proposed in Survey Area B, and should be undertaken at the EIA/NIS stage of the Project to inform these documents.

Any works involving the clearance of vegetation will need to be cognisant of the potential impacts to breeding passerines, as well as the potential disturbance of breeding birds by noise.

6.8 Molluscs – Desmoulin's Whorl Snail

6.8.1 Summary

No evidence of the Desmoulin's whorl snail was observed during the field survey. On review of the desk study data, the presence of the whorl snail in the surrounding landscape of the scheme area is unlikely. Online records from NBDC were historical observations dating from 1901-1940, and Article 17 spatial distribution data showed no records downstream of the proposed works, or within the surrounding areas of the proposed upstream storage location.

6.8.2 Recommendations

No further mollusc surveys are recommended.

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Appendix A – Habitat Maps

Figure A.1 Survey section A habitat map

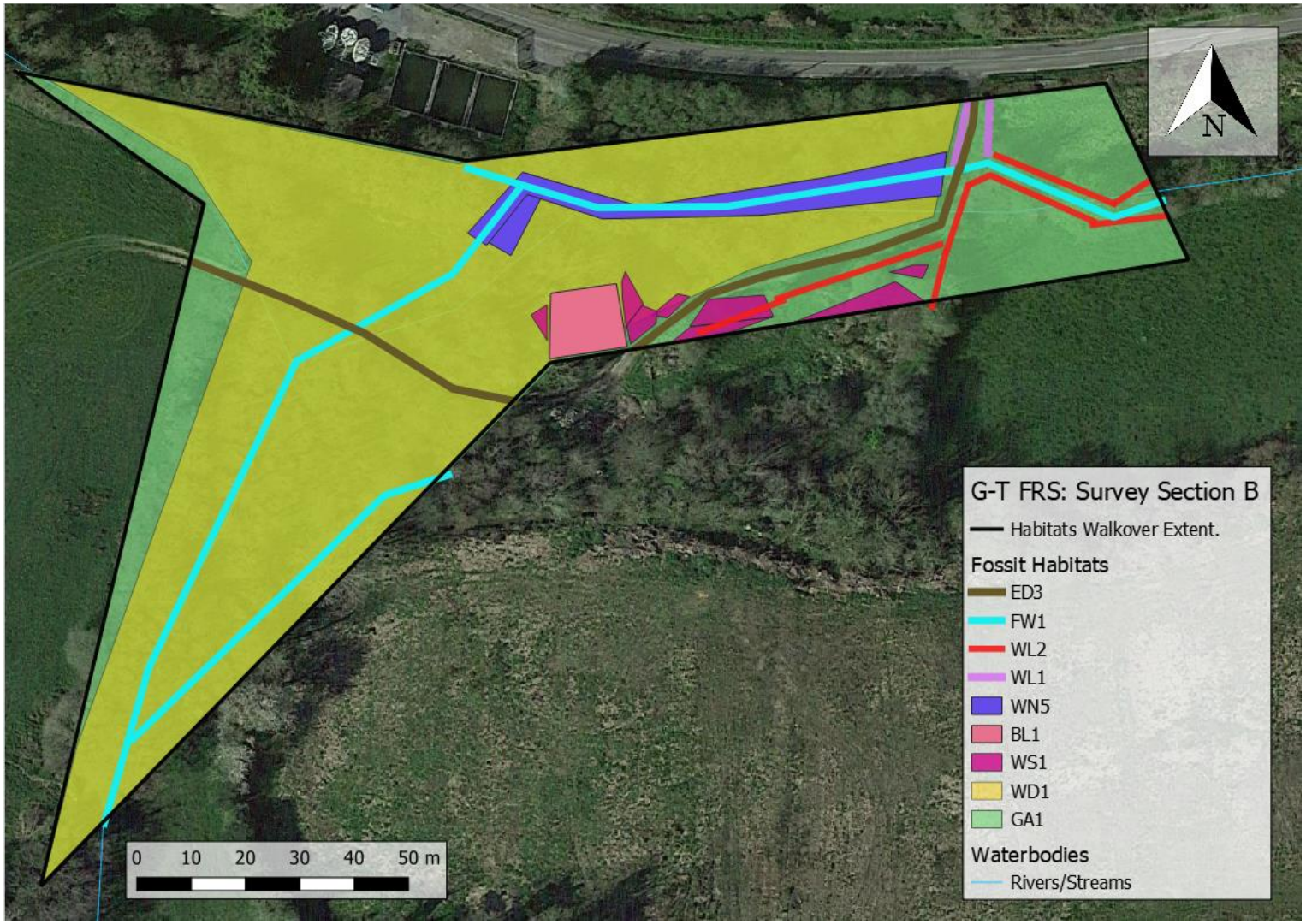


Figure A.2 Survey section B habitat map.

Appendix B – Flora Records

Species Type	Species Name	Record Count	Date of Last Record	Designation
fern	Bracken (Pteridium aquilinum)	1	22/08/2012	N/A
fern	Hard-fern (Blechnum spicant)	1	20/04/2019	N/A
fern	Hart's-tongue (Phyllitis scolopendrium)	2	15/07/2021	N/A
fern	Lady-fern (Athyrium filix-femina)	1	20/04/2019	N/A
fern	Soft Shield-fern (Polystichum setiferum)	2	01/05/2021	N/A
flowering plant	Alder (Alnus glutinosa)	3	01/05/2021	N/A
Flowering plant	Alexanders (Smyrnium olusatrum)	2	04/04/2020	N/A
flowering plant	Annual Meadow-grass (Poa annua)	1	15/07/2021	N/A
flowering plant	Ash (Fraxinus excelsior)	2	20/04/2019	N/A
flowering plant	Beech (Fagus sylvatica)	2	20/04/2019	N/A
flowering plant	Bittersweet (Solanum dulcamara)	1	22/08/2012	N/A
flowering plant	Blackthorn (Prunus spinosa)	2	20/04/2019	N/A
flowering plant	Bluebell (Hyacinthoides non-scripta)	3	01/05/2021	N/A
flowering plant	Bramble (Rubus fruticosus agg.)	4	15/07/2021	N/A
flowering plant	Broad-leaved Dock (Rumex obtusifolius)	2	20/04/2019	N/A
flowering plant	Bush Vetch (Vicia sepium)	3	01/05/2021	N/A
flowering plant	Cat's-ear (Hypochaeris radicata)	1	15/07/2021	N/A
flowering plant	Cleavers (Galium aparine)	2	20/04/2019	N/A
flowering plant	Cock's-foot (Dactylis glomerata)	1	22/08/2012	N/A
flowering plant	Common Bent (Agrostis capillaris)	1	20/04/2019	N/A
flowering plant	Common Chickweed (Stellaria media)	2	15/07/2021	N/A
flowering plant	Common Comfrey (Symphytum officinale)	1	22/08/2012	N/A
flowering plant	Common Dog-violet (Viola riviniana)	1	20/04/2019	N/A
flowering plant	Common Duckweed (Lemna minor)	1	22/08/2012	N/A
flowering plant	Common Knapweed (Centaurea nigra)	1	22/08/2012	N/A

flowering plant	Common Nettle (Urtica dioica)	3	01/05/2021	N/A
flowering plant	Common Ragwort (Senecio jacobaea)	2	15/07/2021	N/A
flowering plant	Common Sorrel (Rumex acetosa)	2	20/04/2019	N/A
flowering plant	Common Valerian (Valeriana officinalis)	1	22/08/2012	N/A
flowering plant	Cow Parsley (Anthriscus sylvestris)	2	20/04/2019	N/A
flowering plant	Creeping Bent (Agrostis stolonifera)	1	22/08/2012	N/A
flowering plant	Creeping Thistle (Cirsium arvense)	2	15/07/2021	N/A
flowering plant	Cuckooflower (Cardamine pratensis)	1	20/04/2019	N/A
flowering plant	Daisy (Bellis perennis)	1	20/04/2019	N/A
flowering plant	Elder (Sambucus nigra)	3	01/05/2021	N/A
flowering plant	False Oat-grass (Arrhenatherum elatius)	1	22/08/2012	N/A
flowering plant	False-brome (Brachypodium sylvaticum)	1	22/08/2012	N/A
flowering plant	Festuca ovina agg.	1	22/08/2012	N/A
flowering plant	Field Forget-me-not (Myosotis arvensis)	1	15/07/2021	N/A
flowering plant	Field Wood-rush (Luzula campestris)	1	20/04/2019	N/A
flowering plant	Fool's-water-cress (Apium nodiflorum)	1	22/08/2012	N/A
flowering plant	Gorse (Ulex europaeus)	1	20/04/2019	N/A
flowering plant	Great Willowherb (Epilobium hirsutum)	1	22/08/2012	N/A
flowering plant	Great Wood-rush (Luzula sylvatica)	1	20/04/2019	N/A
flowering plant	Greater Bird's-foot-trefoil (Lotus pedunculatus)	1	22/08/2012	N/A
flowering plant	Greater Plantain (Plantago major)	1	15/07/2021	N/A
	Greater Stitchwort (Stellaria holostea)	1	10/04/2012	N/A
flowering plant	Ground-ivy (Glechoma hederacea)	1	20/04/2019	N/A
flowering plant	Hawthorn (Crataegus monogyna)	3	20/04/2019	N/A
flowering plant	Hazel (Corylus avellana)	1	20/04/2019	N/A
flowering plant	Hedge Bindweed (Calystegia sepium)	2	12/07/2014	N/A
flowering plant	Hemlock Water-dropwort (Oenanthe crocata)	1	22/08/2012	N/A
flowering plant	Herb-Robert (Geranium robertianum)	2	15/07/2021	N/A

flowering plant	Himalayan Honeysuckle (Leycesteria formosa)	1	15/07/2021	Invasive Species: Invasive Species || Invasive Species: Invasive Species >> Medium Impact Invasive Species
flowering plant	Hogweed (Heracleum sphondylium)	1	22/08/2012	N/A
flowering plant	Holly (Ilex aquifolium)	2	01/05/2021	N/A
flowering plant	Honeysuckle (Lonicera periclymenum)	2	01/05/2021	N/A
flowering plant	Horse-chestnut (Aesculus hippocastanum)	1	01/05/2021	N/A
flowering plant	Indian Balsam (Impatiens glandulifera)	3	01/05/2021	High Impact: Regulation S.I. 477 (Ireland)
flowering plant	Ivy (Hedera helix)	3	15/07/2021	N/A
flowering plant	Ivy-leaved Toadflax (Cymbalaria muralis)	1	15/07/2021	N/A
flowering plant	Knotgrass (Polygonum aviculare)	1	15/07/2021	N/A
flowering plant	Lesser Celandine (Ranunculus ficaria)	4	01/05/2021	N/A
flowering plant	Lords-and-Ladies (Arum maculatum)	2	01/05/2021	N/A
flowering plant	Marsh Thistle (Cirsium palustre)	1	22/08/2012	N/A
flowering plant	Marsh Woundwort (Stachys palustris)	1	22/08/2012	N/A
flowering plant	Marsh-bedstraw (Galium palustre)	1	20/04/2019	N/A
flowering plant	Marsh-marigold (Caltha palustris)	2	01/05/2021	N/A
flowering plant	Meadow Buttercup (Ranunculus acris)	1	22/08/2012	N/A
flowering plant	Meadow Fescue (Festuca pratensis)	1	22/08/2012	N/A
flowering plant	Meadow Vetchling (Lathyrus pratensis)	1	22/08/2012	N/A
flowering plant	Meadowsweet (Filipendula ulmaria)	2	20/04/2019	N/A
flowering plant	Pedunculate Oak (Quercus robur)	1	22/08/2012	N/A
flowering plant	Petty Spurge (Euphorbia peplus)	1	15/07/2021	N/A
flowering plant	Pineappleweed (Matricaria discoidea)	1	15/07/2021	N/A
flowering plant	Primrose (Primula vulgaris)	1	02/04/2016	N/A
flowering plant	Procumbent Pearlwort (Sagina procumbens)	1	15/07/2021	N/A

flowering plant	Purple-loosestrife (Lythrum salicaria)	1	22/08/2012	N/A
flowering plant	Ramsons (Allium ursinum)	2	01/05/2021	N/A
flowering plant	Red Clover (Trifolium pratense)	1	22/08/2012	N/A
flowering plant	Red Valerian (Centranthus ruber)	1	15/07/2021	N/A
flowering plant	Reed Canary-grass (Phalaris arundinacea)	1	22/08/2012	N/A
flowering plant	Reed Sweet-grass (Glyceria maxima)	1	22/08/2012	N/A
flowering plant	Ribwort Plantain (Plantago lanceolata)	2	20/04/2019	N/A
flowering plant	Rosa canina agg.	1	22/08/2012	N/A
flowering plant	Sessile Oak (Quercus petraea)	1	20/04/2019	N/A
flowering plant	Smooth Sow-thistle (Sonchus oleraceus)	1	15/07/2021	N/A
flowering plant	Soft-rush (Juncus effusus)	2	20/04/2019	N/A
flowering plant	Sweet Vernal-grass (Anthoxanthum odoratum)	1	22/08/2012	N/A
flowering plant	Sycamore (Acer pseudoplatanus)	2	20/04/2019	Invasive Species: Medium Impact
flowering plant	Taraxacum aggregate	1	20/04/2019	-
flowering plant	Timothy (Phleum pratense)	1	22/08/2012	N/A
flowering plant	Tufted Vetch (Vicia cracca)	1	22/08/2012	N/A
flowering plant	Tutsan (Hypericum androsaemum)	1	01/05/2021	N/A
flowering plant	White Clover (Trifolium repens)	1	22/08/2012	N/A
flowering plant	Wild Angelica (Angelica sylvestris)	1	22/08/2012	N/A
flowering plant	Wild Strawberry (Fragaria vesca)	2	20/04/2019	N/A
flowering plant	Wood Anemone (Anemone nemorosa)	2	03/04/2022	N/A
flowering plant	Wych Elm (Ulmus glabra)	2	01/05/2021	N/A
flowering plant	Yellow Iris (Iris pseudacorus)	1	22/08/2012	N/A
flowering plant	Yorkshire-fog (Holcus lanatus)	2	15/07/2021	N/A
horsetail	Field Horsetail (Equisetum arvense)	1	22/08/2012	N/A
horsetail	Marsh Horsetail (Equisetum palustre)	1	20/04/2019	N/A
horsetail	Water Horsetail (Equisetum fluviatile)	1	22/08/2012	N/A

Appendix C – Avifauna Records

Table C1 Bird species recorded within the 2km grid cells as shown in Figure 5.1 (NBDC).

Species Name	Record Count	Date of Last Record	Designation
Barn Swallow (Hirundo rustica)	2	01/05/2021	Wildlife Acts Birds of Conservation Concern - Amber List
Black-billed Magpie (Pica pica)	2	31/12/2011	N/A
Blackcap (Sylvia atricapilla)	1	03/06/2015	N/A
Blue Tit (Cyanistes caeruleus)	3	31/12/2011	N/A
Chaffinch (Fringilla coelebs)	2	31/12/2011	N/A
Coal Tit (Periparus ater)	2	31/12/2011	N/A
Common Blackbird (Turdus merula)	5	01/05/2021	N/A
Common Bullfinch (Pyrrhula pyrrhula)	2	18/05/2013	N/A
Common Buzzard (Buteo buteo)	2	30/08/2020	N/A
Common Chiffchaff (Phylloscopus collybita)	3	01/05/2021	N/A
Common Kestrel (Falco tinnunculus)	1	31/12/2011	Wildlife Acts. Birds of Conservation Concern - Amber List.
Common Kingfisher (Alcedo atthis)	1	25/05/2010	Wildlife Acts. EU Birds Directive: Annex I. Birds of Conservation Concern - Amber List.
Common Pheasant (Phasianus colchicus)	4	01/05/2021	Wildlife Acts. EU Birds Directive: Annex II, Annex III.
Common Raven (Corvus corax)	2	03/06/2015	N/A
Common Starling (Sturnus vulgaris)	1	31/12/2011	Wildlife Acts. Birds of Conservation Concern - Amber List.
Common Whitethroat (Sylvia communis)	1	31/12/2011	N/A
Common Wood Pigeon (Columba palumbus)	2	01/05/2021	Wildlife Acts. EU Birds Directive: Annex II, Annex III.
Eurasian Collared Dove (Streptopelia decaocto)	3	01/05/2021	N/A
Eurasian Jackdaw (Corvus monedula)	3	31/12/2014	N/A
Eurasian Jay (Garrulus glandarius)	1	31/12/2014	N/A
Eurasian Siskin (Carduelis spinus)	2	31/12/2011	N/A

Eurasian Sparrowhawk (Accipiter nisus)	2	09/07/2017	N/A
European Goldfinch (Carduelis carduelis)	5	04/04/2020	N/A
European Greenfinch (Carduelis chloris)	3	31/12/2011	N/A
European Robin (Erithacus rubecula)	3	01/05/2021	N/A
Great Cormorant (Phalacrocorax carbo)	1	31/12/2011	Wildlife Acts. Birds of Conservation Concern - Amber List
Great Tit (Parus major)	4	01/05/2021	N/A
Hedge Accentor (Prunella modularis)	3	31/12/2011	N/A
Hooded Crow (Corvus cornix)	1	31/12/2011	N/A
House Martin (Delichon urbicum)	2	25/04/2020	Wildlife Acts. Birds of Conservation Concern - Amber List
House Sparrow (Passer domesticus)	2	31/12/2011	Wildlife Acts. Birds of Conservation Concern - Amber List
Lesser Redpoll (Carduelis cabaret)	1	07/03/2015	N/A
Long-tailed Tit (Aegithalos caudatus)	1	31/12/2011	N/A
Mallard (Anas platyrhynchos)	1	09/04/2010	Wildlife Acts. EU Birds Directive: Annex II, Annex III.
Mistle Thrush (Turdus viscivorus)	2	31/03/2013	N/A
Red Grouse (Lagopus lagopus)	1	31/12/2011	Wildlife Acts. EU Birds Directive: Annex II, Annex III. Birds of Conservation Concern - Red List
Rook (Corvus frugilegus)	2	31/12/2014	N/A
Sand Martin (Riparia riparia)	1	25/05/2010	Wildlife Acts. Birds of Conservation Concern - Amber List
Song Thrush (Turdus philomelos)	3	01/05/2021	N/A
White Wagtail (Motacilla alba)	1	31/12/2011	N/A
Willow Warbler (Phylloscopus trochilus)	2	31/12/2011	N/A
Winter Wren (Troglodytes troglodytes)	4	01/05/2021	N/A
Yellowhammer (Emberiza citrinella)	3	04/04/2020	Wildlife Acts. Birds of Conservation Concern - Red List

Table C2. Protected bird species recorded within the 2km grid cells as shown in Figure 5.1 (NBDC).

Species Name	Record Count	Date of Last Record	Designation
Barn Swallow (Hirundo rustica)	2	01/05/2021	Wildlife Acts Birds of Conservation Concern - Amber List
Common Kestrel (Falco tinnunculus)	1	31/12/2011	Wildlife Acts. Birds of Conservation Concern - Amber List.
Common Kingfisher (Alcedo atthis)	1	25/05/2010	Wildlife Acts. EU Birds Directive: Annex I. Birds of Conservation Concern - Amber List.
Common Pheasant (Phasianus colchicus)	4	01/05/2021	Wildlife Acts. EU Birds Directive: Annex II, Annex III.
Common Starling (Sturnus vulgaris)	1	31/12/2011	Wildlife Acts. Birds of Conservation Concern - Amber List.
Common Wood Pigeon (Columba palumbus)	2	01/05/2021	Wildlife Acts. EU Birds Directive: Annex II, Annex III.
Great Cormorant (Phalacrocorax carbo)	1	31/12/2011	Wildlife Acts. Birds of Conservation Concern - Amber List
House Martin (Delichon urbicum)	2	25/04/2020	Wildlife Acts. Birds of Conservation Concern - Amber List
House Sparrow (Passer domesticus)	2	31/12/2011	Wildlife Acts. Birds of Conservation Concern - Amber List
Mallard (Anas platyrhynchos)	1	09/04/2010	Wildlife Acts. EU Birds Directive: Annex II, Annex III.
Red Grouse (Lagopus lagopus)	1	31/12/2011	Wildlife Acts. EU Birds Directive: Annex II, Annex III. Birds of Conservation Concern - Red List
Sand Martin (Riparia riparia)	1	25/05/2010	Wildlife Acts. Birds of Conservation Concern - Amber List
Yellowhammer (Emberiza citrinella)	3	04/04/2020	Wildlife Acts. Birds of Conservation Concern - Red List

Appendix D – Aquatics Desk-based Study (GTFRS proposed upstream storage area)

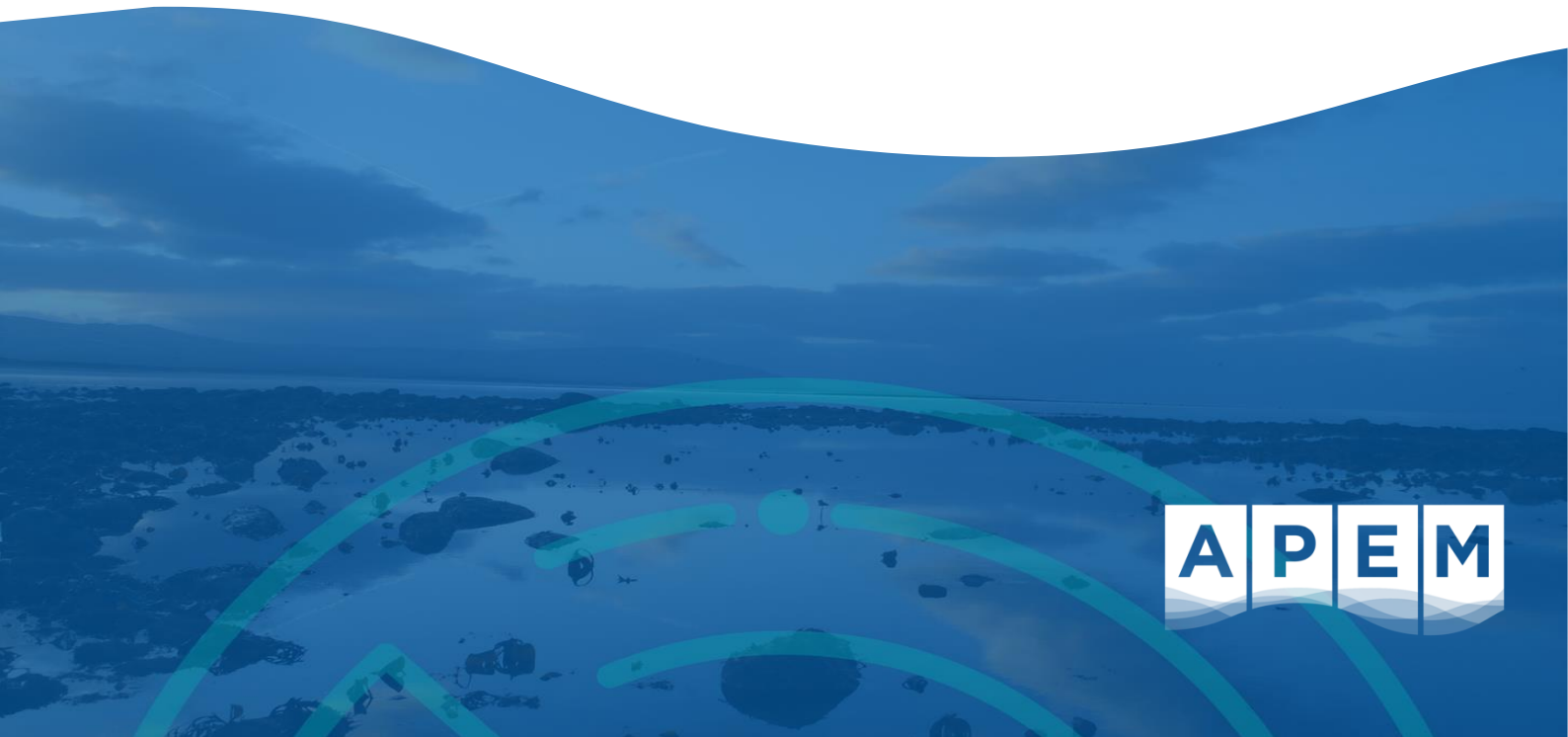
ByrneLooby

Graiguenamanagh–Tinnahinch Flood Relief Scheme

Desk Study Baseline Report

P00010978

March 2023



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1. Introduction

APEM Ireland Ltd was commissioned by ByrneLooby to carry out a desk study and site visit in order to prepare a baseline ecological report for the flood storage area proposed on the Duiske River as part of the Graiguenamanagh and Tinnahinch Flood Relief Scheme.

1.1. Site Description

The proposed development site ("the Site") is located at Graiguenamanagh, Co. Kilkenny and is centred at Irish Transverse Mercator (ITM) 669328 644387 (Figure 1). The Site covers a ca. 750m stretch of the lower reaches of the Duiske River which lies within the River Barrow and River Nore SAC. The Site is located in an agricultural setting, surrounded by grazing farmland.

The Duiske River is formed by the confluence of several smaller streams around Graiguenamanagh. It drains approximately 24km^2 and discharges into the River Barrow immediately downstream of Graiguenamanagh Bridge, Co. Kilkenny on the upstream side of a major weir.

1.2. Brief Description of the Project

The following project description was provided by ByrneLooby for the proposed raised defences and Duiske River storage area.

"The aim of this proposed project is to construct raised defences on the River Barrow along with raised defences and an upstream storage area on the Duiske River to prevent flooding. The proposed works involves upstream storage of flood waters, which facilities a reduced extent of flood walls downstream in the built-up area of Graiguenamanagh. Online storage requires a sluice gate but does not require a channel diversion culvert and associated weir structure. Additionally, the proposed works contains a series of walls on the existing channel instead of a channel diversion on the Duiske River. The maximum increase in water level associated with the proposed works is 110mm, this flood level increase upstream of the storage area, occurs in areas composed of agricultural pasture containing between 5-10 landholdings

Construction of the flood storage area results in significant ground disturbance (excavation & ground shifting) and land take. Additionally, the volume of imported material to construct the impoundment at the storage areas is significant."

1.3. Purpose of this Report

The overall purpose of this desk study baseline report is to determine which aquatic species or habitats of conservation importance may be present at the Site and to then determine any field survey needs in the future.

1.4. Project Personnel

Summaries of the qualifications and experience of the personnel involved in the work, and their role in delivering it, are outlined below. Adon McFarlane carried out the field survey. The desk study baseline report was prepared by Adon McFarlane and technically reviewed by Michael Dobson.

Dr Adon McFarlane is a freshwater biologist, specialising in protected species. He is an experienced field scientist, with extensive skills in the fields of freshwater habitat assessment; freshwater pearl mussel survey; white-clawed crayfish survey, macroinvertebrate survey, fish habitat assessment and electrofishing survey. He has built up skills in the collection of data both in the field and laboratory, analysis of data using statistical software programs such as R, BORIS, RAVEN and Minitab, creation of distribution maps using GIS. Adon has very strong technical skills in both freshwater and marine laboratory and fieldwork instrumentation and equipment usage. Adon has worked on a number of ecological reports, including Appropriate Assessments, Ecological Impact Assessments (EcIA), Preliminary Ecological Appraisal Reports (PEAR) and Invasive Species Reports.

Dr Michael Dobson FLS MCIEEM is a freshwater biologist with over 35 years' experience. He spent 20 years as a research scientist, specialising in ecology and management of rivers and freshwater wetlands throughout Europe and East Africa, along with developing biotic indices for river quality assessment in Central America. He was Director of the Freshwater Biological Association for six years before joining APEM in 2013, working initially in the limnology and water quality team before setting up its dedicated invasive species team in 2019 and moving to APEM Ireland in 2022. Mike has written many peer- reviewed papers in ecology and biogeography, along with two undergraduate textbooks for Oxford University Press (both in their second editions) and seven identification guides to freshwater invertebrates of Britain and Ireland. He has extensive experience of survey design, data analysis and reporting, including publication and verbal reporting for non-technical audiences. He has written and reviewed Habitats Directive assessments in both Ireland and the UK.

2. Methods

The approach used in this report is based on the Chartered Institute of Ecology and Environmental Management (CIEEM) publication "Guidelines for Preliminary Ecological Appraisal" (CIEEM, 2017). To ascertain the current baseline conditions at the Site, a desk study and field survey have been undertaken. The methods for these are described below.

2.1. Desk Study

A desk study was carried out to collate the available existing ecological information for the Site. The Site and the surrounding area were viewed online using existing available satellite imagery such as Google maps[1] to aid in determining the habitats surrounding and nearby the proposed site.

Documents relating to previous aquatic surveys by Aquafact were provided by the client and were reviewed for background detail on the Site.

The National Parks and Wildlife Service (NPWS)[2] and National Biodiversity Data Centre (NBDC)[3] websites were accessed for information on sites designated for nature conservation and on protected habitat and species. Species recorded in the last ten years were considered to be relevant for this report as older records are unlikely to still be relevant given their age and the changes in land management that have occurred in the intervening period. Any available literature on the Site was reviewed to inform the field survey and recommendations.

The absence of rare or protected species from the NPWS and NBDC databases does not necessarily imply that it does not occur within the area, but rather that it has not formally been recorded as present. Similarly, the presence of a recent record does not imply it is present within the Site, rather it is known to be present within the wider study area chosen for desk study.

Given the location of the Site, the size and scale of the proposed works, a data search of 2 km radius from the Site was considered sufficient for the purposes of this report.

2.2. Field Survey

The Site was visited on 24 January 2023 by Adon McFarlane, Consultant Freshwater Ecologist, APEM Ireland. The weather conditions at the time of the survey were overcast and dry with a light breeze, 100% cloud cover and approximately 10°C air temperature.

A fish habitat walkover was conducted according to the methodology by Hendry & Cragg-Hine (1997). The riverbank was walked, noting habitat features in the river channel which may be suitable for conservation species within the area.

Incidental sightings of birds, mammals or amphibians were noted during the survey.

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[1] https://www.google.com/maps (last accessed 12 January 2023)

[2] https://www.npws.ie/ (last accessed 12 January 2023)

[3] https://maps.biodiversityireland.ie/Map (last accessed 12 January 2023)

2.3. Limitations

Weather conditions were adequate to carry out a site walkover and there was no constraint to accessing the Site. The entire Site was accessible and surveyed. Conditions were not ideal for the fish habitat survey due to high water levels; however, the broad habitat could be described from the field visit as water clarity was high and water depth was less than 0.5 m in most places.

3. Nature Conservation Designations

3.1. Natura 2000 sites

The proposed works area is located within the River Barrow and River Nore Special Area of Conservation (SAC) 002162 (Figure 2). The River Barrow and River Nore SAC extends throughout and ca. 550m above the proposed works area and consists of most of the freshwater stretches of the Barrow/Nore River catchments. There are no other Natura 2000 sites that have the potential to be impacted by the project. A Natura 2000 site description of River Barrow and River Nore SAC is outlined in Appendix A.

The aquatic Qualifying Interests (QI) of the River Barrow and River Nore SAC are:

- *Petromyzon marinus* (Sea Lamprey) [1095], *Lampetra planeri* (Brook Lamprey) [1096] and *Lampetra fluviatilis* (River Lamprey) [1099]
- *Salmo salar* (Salmon) [1106]
- *Alosa fallax fallax* (Twaite Shad) [1103]
- *Austropotamobius pallipes* (White-clawed Crayfish) [1092]
- *Lutra lutra* (Otter) [1355]
- Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260]
- *Margaritifera margaritifera* (Freshwater Pearl Mussel) [1029]
- *Margaritifera durrovensis* (Nore Pearl Mussel) [1990]

3.2. Natural Heritage Areas

There are no natural heritage areas (NHA) or Proposed Natural Heritage Areas (pNHA) recorded within 2km of the Proposed Development.

3.3. Notable and Protected Species

The NBDC returned four notable and protected species within 2km of the Site. Those relevant to the Site are described in Table 4, Appendix B. Note that none of these species are aquatic or dependent upon aquatic habitats.

4. Existing biological data

4.1. Fish species

Electrofishing surveys have been conducted upstream and downstream of the proposed works area on the Duiske River by Inland Fisheries Ireland (IFI) for the Water Framework Directive fish ecological status 2008-2021 project. The newly published dataset river layer shows river fish status and fish distribution from surveys carried out from 2008 to 2021, as well as the species recorded and the dates the surveys were conducted[4]. Electrofishing surveys conducted ca. 550m upstream and ca. 1.5 km downstream of the proposed work site on 20 July 2015 and 09 July 2020 by IFI identified the presence of salmon, brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*) and lamprey spp. IFI simply recorded the ammocoetes they encountered as Lamprey sp. and did not determine species level.

Aquafact Ltd conducted electrofishing surveys on the Duiske River in 2021 ca. 1.4 km downstream of the proposed works area and identified the presence of Atlantic salmon, brown trout, European eel, and Brook lamprey (Aquafact, 2021). During this survey optimal salmonid nursery and spawning habitat was observed along with optimal lamprey ammocoete habitat. The Duiske River has also been identified as a potentially important nursery ground for Atlantic salmon by Delanty *et al.* (2017) and for Lamprey by King (2006).

No observations of Twaite Shad have been recorded within the Duiske River.

Table 1 below identifies the fish species recorded both above and below the proposed works area during electrofishing surveys.

Table 1. Fish species recorded by IFI and Aquafact on River Duiske with potential to reside within works area

Fish Species	2015 IFI Survey (Upstream of proposed works)	2020 IFI Survey (Upstream of proposed works)	2021 Aquafact Survey (Downstream of proposed works)
Salmon	X	X	X
Brown Trout	X	X	X
European eel		X	X
Lamprey sp.	X		X

4.2. White-clawed crayfish

White-clawed Crayfish were previously recorded at the confluence of the Duiske River and the River Barrow in 2006 by the EPA. However, high mortality crayfish was reported in the stretch of the River Barrow from Carlow to Graiguenamanagh in 2017, caused by crayfish plague *Aphanomyces astaci*.

Triturus Environmental Ltd conducted white-clawed crayfish surveys and eDNA sampling on the Duiske River in April 2021 ca. 350m downstream of the proposed works area. No white-

[4] Water Framework Directive Fish Ecological Status 2008-2021 | Water Framework Directive Fish Ecological Status 2008-2021 | Inland Fisheries Ireland Data Hub (arcgis.com)

clawed crayfish were recorded via hand-searching/sweep netting, eDNA samples returned a negative for white-clawed crayfish and crayfish plague eDNA (Triturus, 2021b).

4.3. Otter

Although Otter were not recorded within the 2km grid square of the Site, they were recorded on the River Barrow during the National Otter Survey 2012.

4.4. Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation

There are no records of the *Ranunculion fluitantis* and *Callitricho-Batrachion* habitat being identified on the Duiske River.

4.5. Freshwater Pearl Mussel and Nore Pearl Mussel

Freshwater pearl mussel populations in the River Barrow and River Nore SAC are located upstream of Graiguenamanagh on the River Barrow, and therefore there is no potential for them to be located within the proposed works area on the Duiske River or to be affected by the proposed works.

Triturus Environmental Ltd conducted stage 1 pearl mussel surveys and eDNA sampling on the Duiske River in April 2021 ca. 350m downstream of the proposed works area. No live or dead freshwater pearl mussels were recorded via bathyscope survey or snorkelling, eDNA samples returned a negative for freshwater pearl mussel eDNA (Triturus, 2021a).

4.6. Macroinvertebrate assessments (Q-value)

Aquafact Ltd conducted a Q-value survey on the lower reaches of the Duiske River in February 2021 and noted that the Duiske River achieved a Q-value score of Q4 indicating the river was unpolluted as it entered Graiguenamanagh at Station 1 (Aquafact, 2021). This was of particular interest for this report as it was this was the nearest downstream survey conducted to the proposed works area, being located ca. 1.2 km downstream.

The only upstream record for Q-value is an EPA Q-value sampling site located ca. 560m upstream of the proposed works area; a Q-value of Q4-5 was recorded in 2020 indicating the river is unpolluted at this point.

According to the EPA's Report on River Water Quality in Co. Kilkenny (2013), the Q values of the Duiske River were Q3-4 overall and the water chemistry was satisfactory other than slightly elevated nitrate levels.

5. Field survey results

The entire ca. 750m section of the Duiske River within the site boundary was walked and habitat suitability for salmonids, lamprey sp., white-clawed crayfish, otter and *Ranunculion fluitantis* and *Callitricho-Batrachion* habitat was assessed. Any evidence of presence/absence of these features was recorded.

The proposed works area section of the Duiske River is characterised by areas of riffle, run, glide and pool habitat with a gravel, cobble and boulder substrata present. Water depth ranged from 0.2m – 0.5m, with the majority being ca. 0.3m. Water clarity was good with flows ranging from ca. 0.5 m/s – 1.5 m/s.

Suitable habitat for both salmon or brown trout fry and parr was observed with riffle and glide habitat with adequate shading, turbulent surface and a gravel, cobble and boulder substrate being abundant along the proposed works area (Plate 1 and Plate 2). Salmonoid parr were observed during the walkover within pool and glide habitat (Plate 3).

Suitable lamprey ammocoete habitat was observed with silt and sand beds containing loosely compacted, fine grained, organic rich material in pool and slow glide being abundant along the proposed works area (Plate 4).

Suitable white-clawed crayfish habitat was abundant throughout the proposed works area in the form of a wide range of refuges including cobble and boulders, undercut banks, tree roots within the river and overhanging vegetation (Plate 1).

Possible evidence of Otter presence was observed along the length of the 750m stretch of riverbank, by way of slides into the Duiske River from the riverbank (Plate 2). No spraint or tracks were observed but this may have been due to recent high-water levels washing these away.

No evidence of *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation was observed during site walkover.

6. Key findings

The proposed development is located on the lower reaches of the Duiske River which is within the River Barrow and River Nore SAC. The baseline aquatic ecology desk study and field survey identified that six QI for this SAC may be noted within the proposed works area, as summarised below.

6.1. Salmon

- Suitable habitat for Salmon parr and fry was observed during the field survey within the proposed works area.
- Juvenile salmonids were observed during the field survey within the proposed works area.
- Previous electrofishing surveys upstream and downstream of the proposed works have identified the presence of Salmon in 2015, 2020 and 2021.

6.2. Lamprey sp. (Sea lamprey, Brook lamprey and River lamprey)

- Suitable habitat for lamprey ammocoetes was observed during the field survey within the proposed works area.
- Previous electrofishing surveys upstream and downstream of the proposed works have identified the presence of Lamprey sp. in 2015 and 2021. Lamprey ammocoetes are extremely difficult to determine species level during field surveys, however, Aquafact identified that the ammocoetes they observed were Brook Lamprey. IFI simply recorded the ammocoetes they encountered as Lamprey sp.

6.3. Other fish species

- Although not defined as QI within the River Barrow and River Nore SAC, brown trout and European eel were observed both above and below the proposed works area by IFI and Aquafact during electrofishing surveys. Both these species are protected, with European eel being protected by EU legislation.

6.4. White-clawed crayfish

- Suitable habitat for white-clawed crayfish was observed during the field survey within the proposed works area.
- Prior to the outbreak of crayfish plague in 2017, white-clawed crayfish had been observed at the confluence of the River Barrow and the Duiske River, therefore, the Duiske River provides a suitable tributary for which white-clawed crayfish may reside and may have survived the outbreak of the crayfish plague.
- Although there was no white-clawed crayfish recorded during hand-searching/sweep netting and a negative eDNA result was recorded 350m downstream of the proposed works area in April 2021 this does not necessarily confirm species absence within the proposed works area upstream.
- False negatives (failures to detect a species despite its presence), occur due to a highly stochastic distribution of eDNA in the field emerging from environmental and ecological drivers. Risk of false negatives can occur during time periods with lower species activity, or an increase in adverse weather. Environmental factors and species

habitat preference can also lead to heterogenous distribution of eDNA causing risk of false negatives (Troth *et al.,* 2021).

- Active searching for white-clawed crayfish within the proposed works area would therefore still be recommended.

6.5. Otter

- Possible evidence of Otter presence was observed within the proposed works area during the field survey, by way of slides into the Duiske River from the riverbank.
- Otter have been previously recorded on the River Barrow during the National Otter Survey in 2012.
- Therefore, it is possible that otter are using the proposed works area for foraging and passage.

7. Proposed surveys required and costs

The proposed flood storage works requires land take and works within the Natura 2000 site during construction of flow control structure and soft defences. There is therefore a risk of habitat damage, loss or fragmentation within this part of the River Barrow and River Nore SAC, which would have detrimental impact on any QI species present in the Duiske River. It is therefore recommended that aquatic ecological surveys be carried out prior to any potential in-river works in order to determine the presence/absence of the QIs outlined above.

Below we provide proposals for surveys that would be of benefit. We have given an estimate of the cost of each of these surveys, based on the specific method we propose.

7.1. Fish

A quantitative electrofishing survey should be conducted (as per Inland Fisheries Ireland standards on sampling fish with electricity), in order to determine the species present and estimated population density. This will also help to inform the requirements if a fish removal is required prior to works taking place.

Fish Habitat walkover allows for the recording of locations of the areas of individual habitat types encountered within the proposed works area, such as salmonid spawning habitat, salmonid nursery habitat, lamprey spawning and lamprey nursery habitat. The methodology applied to the habitat survey follows Hendry and Cragg-Hine (1997), Harvey and Cowx (2003) and Maitland (2003). The fish habitat survey involves mapping hand drawings onto a high-resolution map (OS 1 km tiles) at a scale of 1:10,000 using a field tablet. This allows exact representation of the areas of individual habitat types encountered. The drawings of the habitat types along the section of the river are then digitised using GIS. In this manner, a mosaic of the different habitat types can be drawn along the whole section of the river.

This is important as a baseline to understand if the works and the alterations to the channel have any impact on habitat location and availability.

7.2. White-clawed crayfish

White-clawed crayfish surveys should be carried out according to the standard methodology used by Peay (2003) and Gammell *et al.* (2021). Both active and passive sampling techniques are be carried out by conducting hand searches of potential refuges and setting baited traps overnight.

7.3. Otter

Otter surveys should be carried out as per TII guidelines (Transport Infrastructure Ireland, 2008), and Chanin (2003). Walkover surveys involve systematically checking the proposed works area for otter activity, otter signs and identifying potential holt locations within the vicinity of the Duiske River.

7.4. Macroinvertebrate and water quality sampling

A macroinvertebrate survey allows for the recording of a biological feature that will react to the full range of physicochemical conditions experienced in the river. Macroinvertebrates, a varied group of aquatic species including insects, shrimps, snails and leeches, are collectively used to determine overall conditions in a river, based on the types present and their known

tolerances of different water quality conditions. This is, for example, the basis of the Q-value system used by the Environmental Protection Agency to classify rivers. Therefore, although none of the species recorded is a QI in its own right, collectively they give valuable information that is also useful as a baseline, to enable comparison of the habitat before and after works take place. The macroinvertebrates present are typically identified to different levels, depending on the type, and the collective term for the types determined is taxa (singular: taxon).

Kick-sampling should be conducted at a number of sites according to the standard methodology used by the EPA (Toner *et al*., 2005). To ensure a comprehensive record of taxa, each sample would be preserved on site and returned to the laboratory for identification and counts of invertebrates present.

Water samples should also be taken at each site and transported to an accredited laboratory for analysis for the required water quality parameters. Measurements of dissolved oxygen concentration, temperature, conductivity and pH are taken *in situ* using a multimeter probe at each site.

By taking samples and readings at different locations upstream, within and downstream of the proposed works, this will provide a baseline of water chemistry and habitat quality for comparison to future monitoring during and after the proposed works.

7.5. Indicative survey costs

Table 2 below shows an indicative idea of the cost and survey window for each suggested survey. The costs presented are for conducting surveys individually, if surveys are completed simultaneously this will give an economy of scale.

Each cost given is per survey visit and includes all components including reporting. Any further survey, for example as a follow up after completion of work, would be a similar cost.

Table 2 Suggested surveys timeframe and indicative cost

Survey	Optimal Survey window	Sub-Optimal Survey Window	Indicative Cost (excl. VAT)
Fish	July - September	N/A can only survey under licence between July and September	€5500-6500 (€7500-8500 if a fish habitat survey is also carried out)
White-clawed crayfish	July - September	June – Mid-October	€5000-€5500
Otter	Throughout the year		€4500-€5000
Macroinvertebrate and water quality sampling	June - September	Throughout the year	€6000-€6500

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Plates

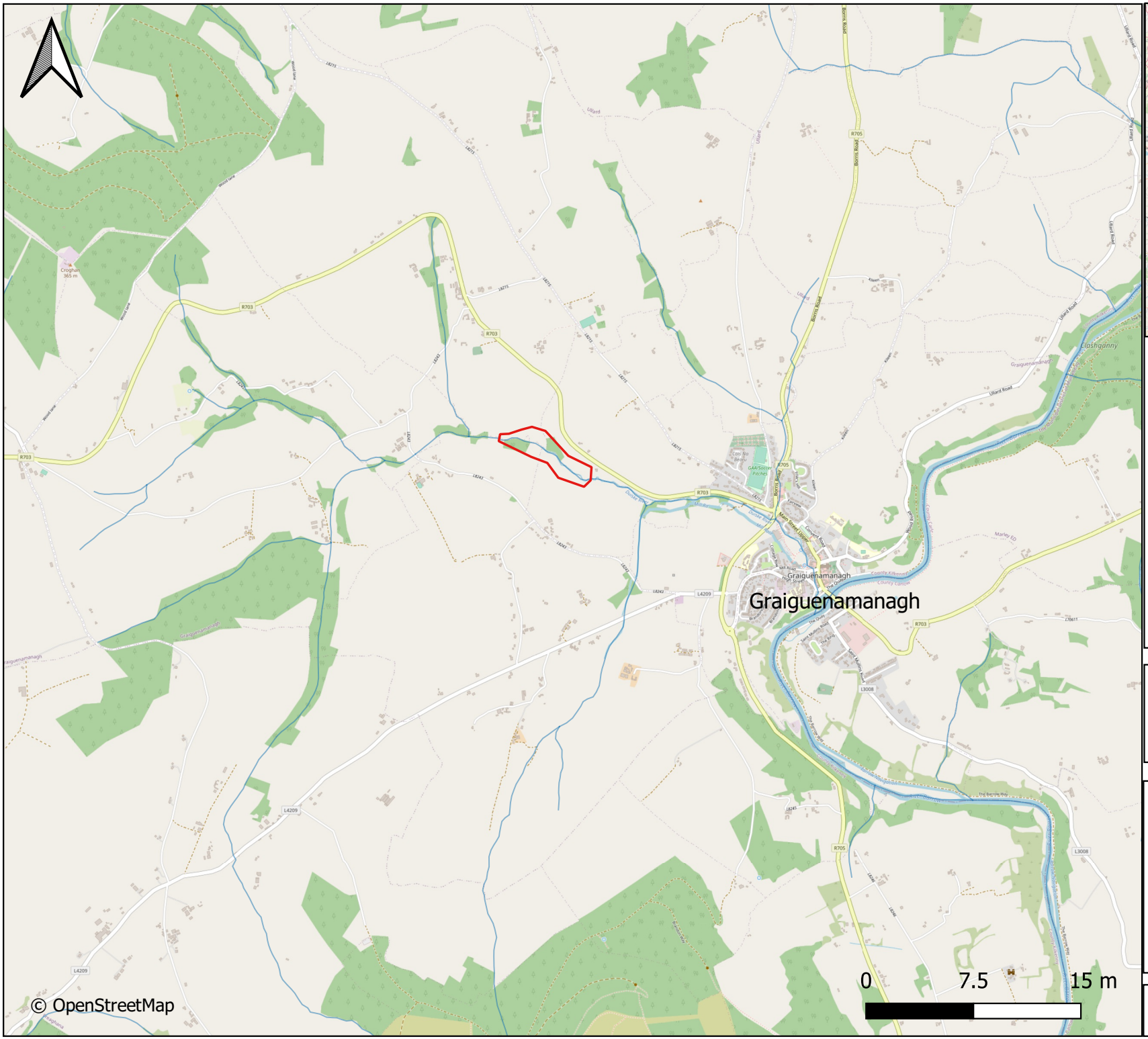
Plate 1 Riffle and Glide habitat with abundant refuges for white-clawed crayfish.

Plate 2 Mixed juvenile salmonid habitat with possible otter slide

Plate 3 Pool habitat where salmonid parr were observed

Plate 4 Silt bed and possible juvenile lamprey habitat

Figures



Site Boundary

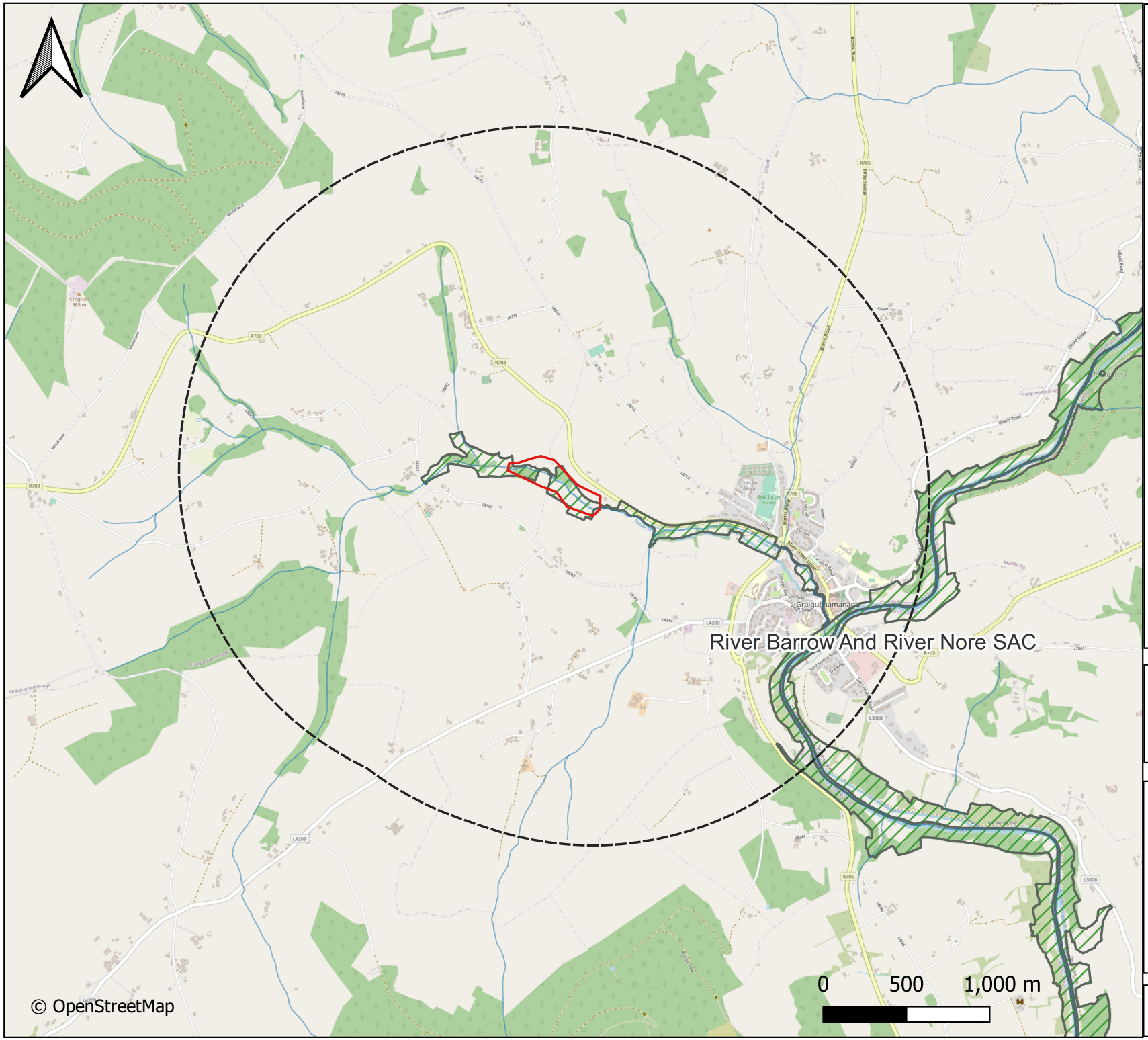
APEM

Client
ByrneLooby

Project
Graiguenamanagh–Tinnahinch FRS

Title
Fig 1. Location of Proposed Works Area Map

Created	Checked	Date
AMcF	MD	12 Jan 23



Site Boundary

Special Area of Consrvation

2km Boundary

River Network

APEM

Client

ByrneLooby

Project

Graiguenamanagh–Tinnahinch FRS

Title

Fig 2. Natura 2000 Sites within 2km of Site

Created	Checked	Date
AMcF	MD	03 Mar 2023

Appendix A – River Barrow and River Nore SAC

The following Natura 2000 site description of River Barrow and River Nore SAC have been prepared using the supporting information available on the NPWS website[5].

River Barrow and River Nore SAC 002162

> "River Barrow and River Nore SAC consists of most of the freshwater stretches of the Barrow/Nore River catchments. Both rivers rise in the old red sandstone of the Slieve Bloom Mountains. They traverse limestone bedrock for a good proportion of their routes. A wide range of habitats associated with the rivers are included within the site, including substantial areas of woodland (deciduous, mixed), dry heath, wet grassland, swamp and marsh vegetation, salt marshes, a small dune system, biogenic reefs and intertidal sand and mud flats. Areas of improved grassland, arable land and coniferous plantations are included in the site for water quality reasons. The site supports many annexed habitats including the priority habitats of alluvial woodland and petrifying springs. Quality of habitat is generally good. The site is very important for the presence of a number of E.U. Habitats Directive Annex II animal species including Freshwater Pearl Mussel (both *Margaritifera margaritifera* and *M. m. durrovensis*), White-clawed Crayfish, Salmon, Twaite Shad, three lamprey species – Sea Lamprey, Brook Lamprey and River Lamprey, the tiny whorl snail *Vertigo moulinsiana* and Otter. This is the only site in the world for the hard water form of the Freshwater Pearl Mussel, *M. m. durrovensis*, and one of only a handful of spawning grounds in the country for Twaite Shad. The freshwater stretches of the River Nore main channel is a designated salmonid river. The Barrow/Nore is mainly a grilse fishery though spring salmon fishing is good in the vicinity of Thomastown and Inistioge on the Nore. A range of rare plants and invertebrates are found in the woods along these rivers and rare plants are also associated with the saltmarsh. Land use at the site consists mainly of agricultural activities – mostly intensive in nature and principally grazing and silage production. Slurry is spread over much of the area. Arable crops are also grown. The spreading of slurry and fertiliser poses a threat to the water quality of the salmonid river and to the populations of E.U. Overall, the site is of considerable conservation significance for the occurrence of good examples of habitats and of populations of plant and animal species that are listed on Annexes I and II of the E.U. Habitats Directive. Furthermore, it is of high conservation value for the populations of bird species that use it. The occurrence of several Red Data Book plant species including three rare plants in the salt meadows add further interest to this site."

The qualifying interests and conservation objectives for Great Island Channel SAC and Cork Harbour SPA are listed in Table 2 below:

[5] https://www.npws.ie/protected-sites (last accessed 12 January 2023)

Table 3. Natura 2000 Sites within the Proposed Works Area

Natura 2000 site	Qualifying Interests	Conservation Objectives
River Barrow and River Nore SAC - 002162	• Estuaries [1130] • Mudflats and sandflats not covered by seawater at low tide [1140] • Reefs [1170] • Salicornia and other annuals colonising mud and sand [1310] • Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330] • Mediterranean salt meadows (*Juncetalia maritimi*) [1410] • Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260] • European dry heaths [4030] • Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430] • Petrifying springs with tufa formation (*Cratoneurion*) [7220] • Old sessile oak woods with Ilex and Blechnum in the British Isles [91A0] • Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0] • *Trichomanes speciosum* (Killarney Fern) [1421] • *Vertigo moulinsiana* (Desmoulin's Whorl Snail) [1016] • *Margaritifera margaritifera* (Freshwater Pearl Mussel) [1029] • *Margaritifera durrovensis* (Nore Pearl Mussel) [1990] • *Austropotamobius pallipes* (White-clawed Crayfish) [1092] • *Petromyzon marinus* (Sea Lamprey) [1095] • *Lampetra planeri* (Brook Lamprey) [1096] • *Lampetra fluviatilis* (River Lamprey) [1099] • *Alosa fallax fallax* (Twaite Shad) [1103] • *Salmo salar* (Salmon) [1106] • *Lutra lutra* (Otter) [1355]	The conservation objectives of this site are set out in full here: https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO002162.pdf In summary, the conservation objective for the SAC is to maintain the favourable conservation condition of the species and wetland habitat for which the SAC has been selected. The conservation condition of each qualifying interest is defined by a list of specific attributes and targets.

Appendix B – Notable and Protected Species Records

Table 4. Relevant Species Recorded from NBDC 2km grid square S64X

Species Name	Record Count	Date of last record	Status
West European Hedgehog *Erinaceus europaeus*	2	25/07/2016	Protected Species: Wildlife Acts
Common Pheasant Phasianus colchicus	2	01/12/2020	Protected Species: Wildlife Acts, Annex III, Section I Bird Species
House Martin *Delichon urbicum*	1	25/04/2020	Protected Species: Wildlife Acts, Birds of Conservation Concern - Amber List
Yellowhammer Emberiza citrinella	2	04/04/2020	Protected Species: Wildlife Acts, Birds of Conservation Concern - Red List

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Appendix 10-3 Bat Survey Report CFRAM Scheme Area 2020

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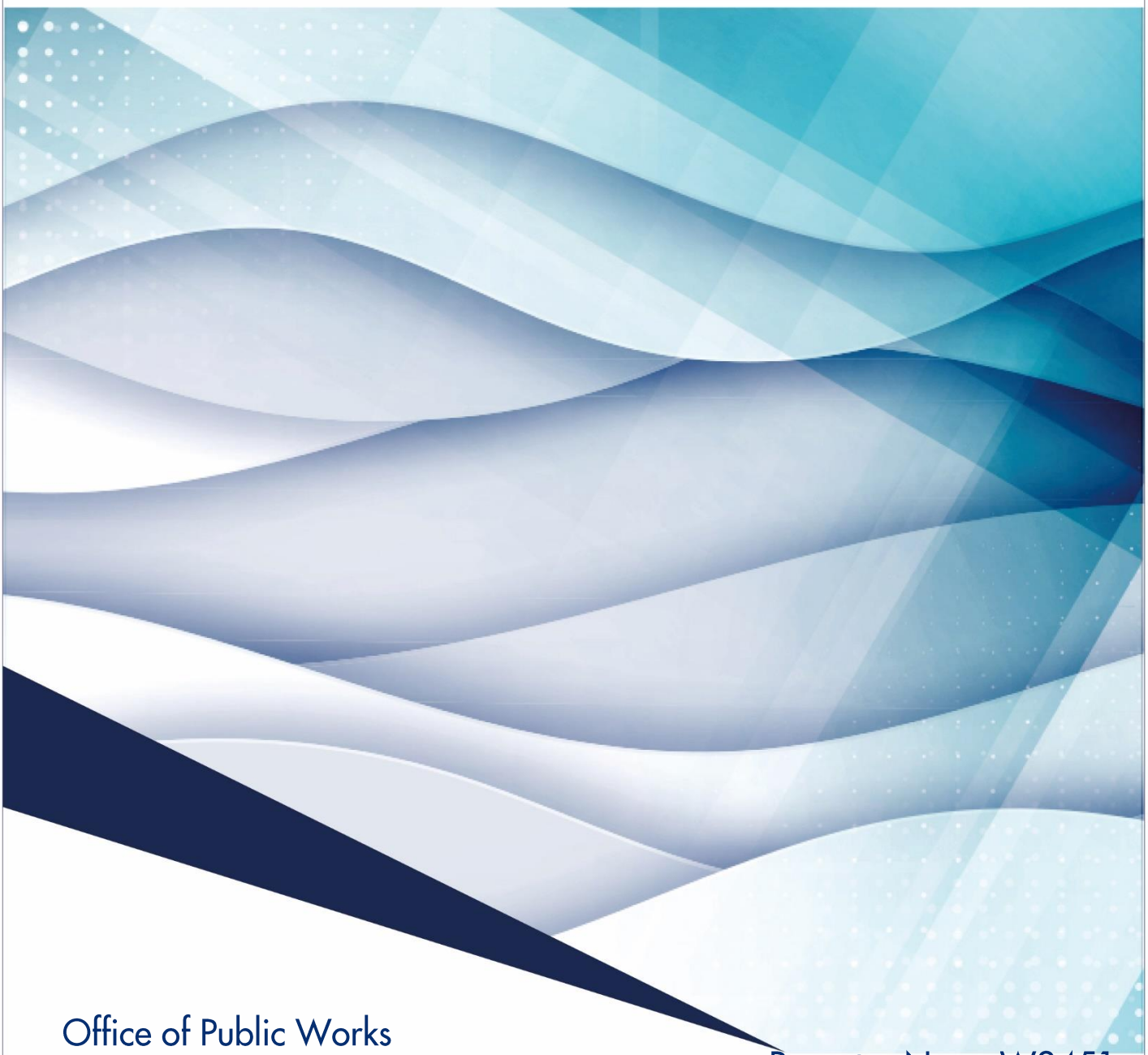

Office of Public Works

Graiguenamanagh/Tinnahinch Flood Relief Scheme

Bat Survey Report

Report No. W3451-ENV-R001

20 October 2020

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			Prepared By	Checked By	Approved By
00	20 October 2020	For Approval	Steven Tooher	Fiona Symes	Fiona Symes
Disclaimer: Please note that this report is based on specific information, instructions and information from our Client and should not be relied upon by third parties.					

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1 Introduction

1.1 Overview

ByrneLooby has been appointed by The Office of Public Works (OPW) for the development and implementation of a flood relief scheme (FRS) for a section of the River Barrow that flows through Graiguenamanagh-Tinnahinch. Periods of high rainfall have resulted in parts of the town being flooded frequently in recent years. Graiguenamanagh (Co. Kilkenny) is situated on the northern side of the Barrow, while Tinnahinch (Co. Carlow) is situated on the southern side. For the purpose of this report, and in line with the nomenclature used for the FRS as a whole, the locality is referred to as Graiguenamanagh-Tinnahinch. The overall scheme study area is shown in Figure 1.1.

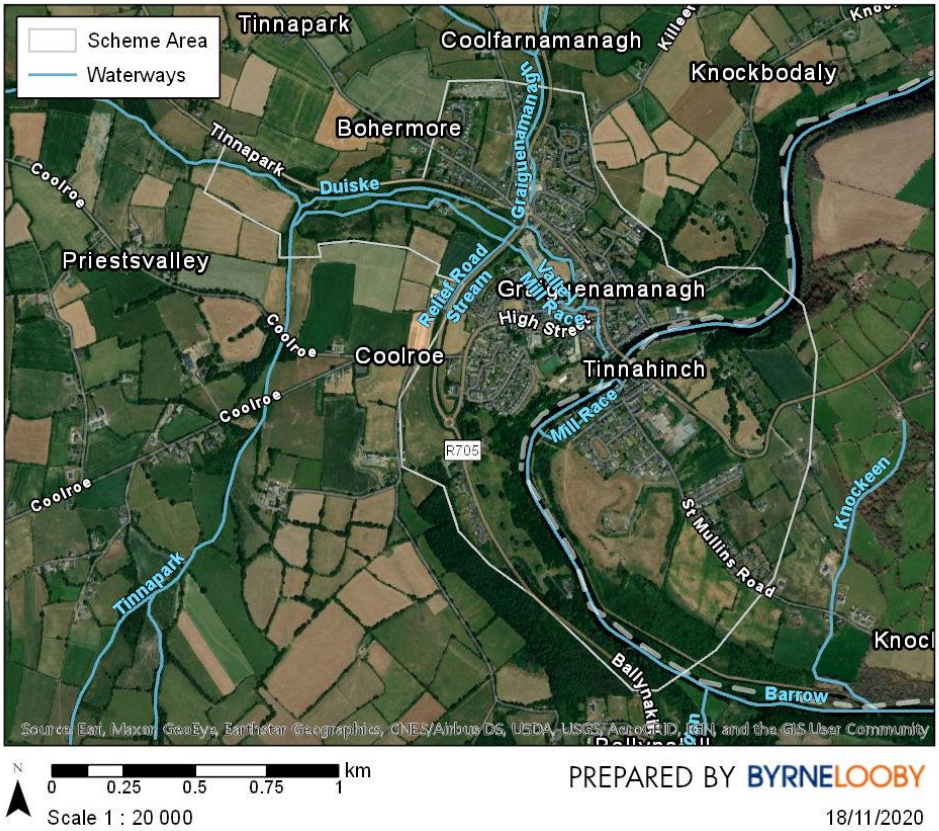

Figure 1.1. Overall Scheme Study Area

All Irish bats are protected under national and EU legislation. Both the animals themselves and their roosts are protected and it is an offence to disturb or interfere with them without a licence. Such a derogation (which must be given by the Minister for the Environment, Heritage and Local Government) can only be sanctioned where there is no satisfactory alternative and where it will not be detrimental to the favourable conservation status of the species concerned.

With due cognisance of the protection of all bat species, ByrneLooby were requested to carry out a survey of the development area to ascertain if the proposed development area was being used, or had the potential to be used, by bats. See Figure 1.2 for an overview of the survey area. The results of this survey will form part of a constraints study for the proposed project.

This report details the findings of a bat survey of the development area carried out in September 2020 by Steven Tooher MSc.

1.2 Statement of Authority

Steven Tooher has been working as a professional ecologist since July 2015. He has experience in a wide variety of aquatic and terrestrial surveys. He has a BSc. (Hons.) in Zoology from University College Cork, and a MSc. In Environmental Resource Management from University College Dublin.

He has considerable experience undertaking protected species surveys in Ireland, including plants, bats and bird surveys for a variety of public and private entities.

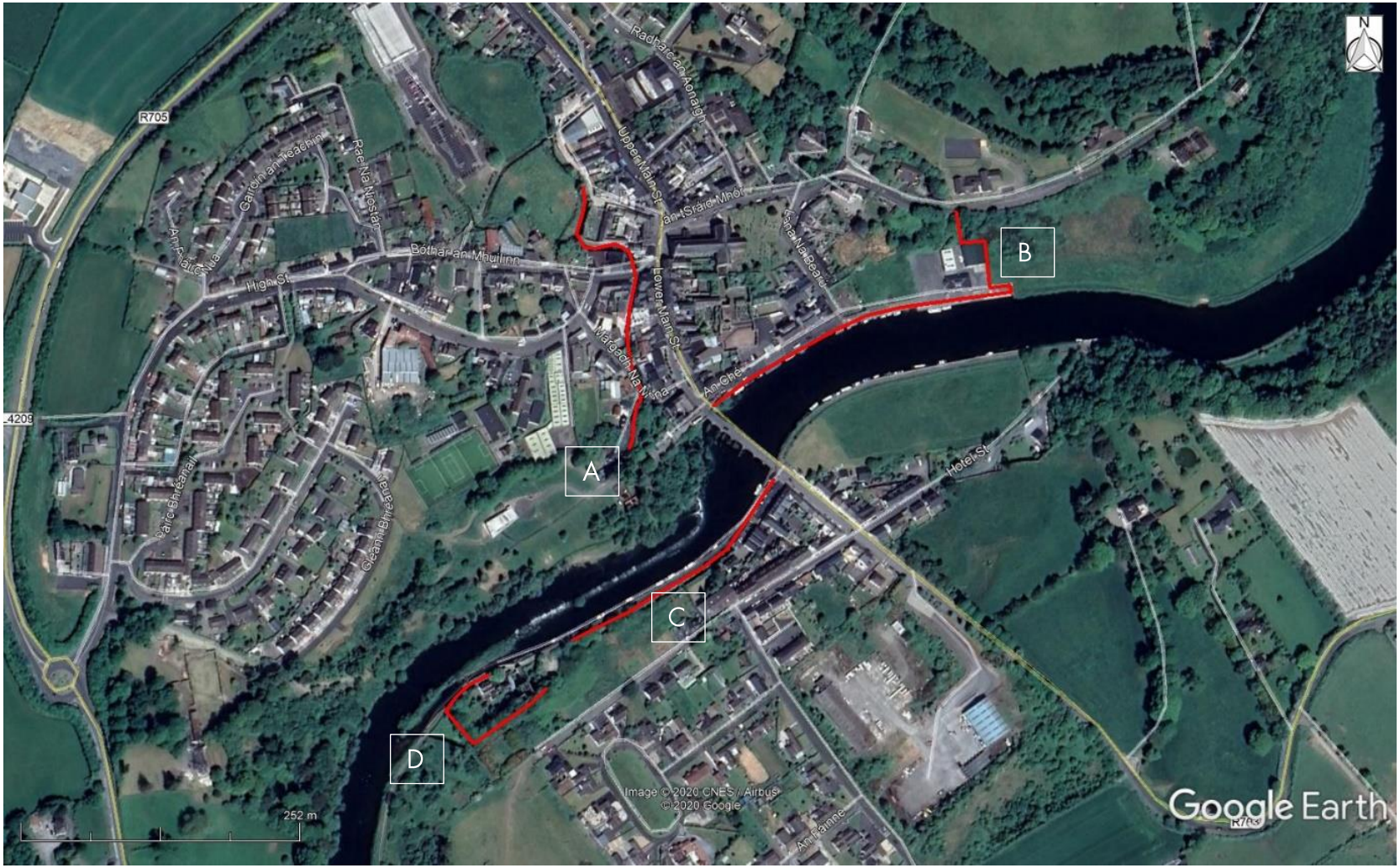

Figure 1.2. Graiguenamanagh-Tinnahinch Bat Survey Routes (shown as red lines)

2 Methodology

2.1 Guidance and background information

This report has been prepared with reference to the following European Directives, national legislation and guidance on bat mitigation.

- Bat Conservation Trust (2015). Bat Surveys for Professional Ecologists – Good Practice Guidelines (3rd edition).
- Council Directive (92/43/EEC) of 21 May 1992 on the conservation of natural habitats and of wild flora and fauna.
- Kelleher, C. & Marnell, F. (2006) Bat Mitigation Guidelines for Ireland. Irish Wildlife Manuals, No. 25. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.
- National Roads Authority (2005). Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes. National Roads Authority, Dublin.
- Wildlife Acts 1976 to 2018.

2.2 Study Area

The survey area focused on the areas shown in Figure 1.2 where works are proposed to be implemented (as per correspondence from the OPW).

2.3 Survey Methodology

A desk assessment of potential bat habitats in the wider geographical area was conducted. Existing records of historical bat sightings were obtained from the National Bat Database of Ireland, which is maintained by Bat Conservation Ireland (BCI) and available from the National Biodiversity Data Centre (NBDC).

An initial survey of the site was carried out during daylight hours on 14th of September 2020 to gain an overview of the site with regard to its potential use by bats. Sites deemed to be suitable for roosting bats were noted and recorded on a handheld GPS device (Garmin GPSMAP 64S). Notes were taken on the habitats and general appearance of the environment along the entire survey route. The information gathered during the daytime survey is presented in Section 4.

Potential roost sites were revisited at dawn and dusk on the following two nights/mornings to establish whether they were being used as roosts by bats. Bat activity was monitored using a heterodyne bat detector (Magenta Bat5), with which it was possible to identify species based on their echolocation frequency. The results of this survey are presented in Section 5.

3 Description of the Study Area and Survey Routes

Graiguenamanagh-Tinnahinch is located on the border between counties Kilkenny and Carlow, where the River Barrow and the River Duiske converge. The town is known for its attractive examples of 18th and 19th-Century civil engineering structures and architecture. The survey routes A, B, C and D (as shown in Figure 1.2) are described below. All potential roost locations are shown in Figure 3.1 at the end of this section.

3.1 Survey Route A

This route starts at the southern end of a lane known as Turf Market. Further south is a recreational area that is frequently occupied by caravans. At the bottom of Turf Market there is a pair of old stonework buildings that were erected c. 1800. They are separated by a narrow passageway known as Peg Washington's Lane, which connects Turf Market to a narrow footpath alongside the River Duiske. Both buildings were considered to have potential as bat roosts, due to their old stonework and abandoned appearance. There were potential entry/exit points on both buildings. These potential roosts were labelled PR1 and PR2 respectively.

The River Duiske at this location is approximately 2 metres wide and flows over cobbles and boulders. Flow at the time of surveying was considered to be moderate. Immediately upstream there is some mixed broadleaved woodland, which has foraging potential. No obvious potential bat roosting sites were observed in this area.

Further upstream, Route A passes by some modern bridges and a weir before encountering another old stone building with an abandoned appearance. From examining the 25-inch OSI maps available online, it appears that this building may have been a smithy. It is partially-overgrown with *Hedera helix* (ivy) and *Parthenocissus quinquefolia* (Virginia creeper). This was also considered a potential roost site (PR3).

Further north, domestic dwellings are crowded along both sides of the River Duiske. One of the buildings appeared to be in disuse - window panes were absent and the interior appeared to have been undisturbed for some time. A stockpile of refuse bags and other miscellaneous items were being stored inside, and there appeared to be sufficient shelter so as to be another potential roost site (PR4). Some bramble and willow scrub was noted along the opposite side of the river.

It is possible to access the Duiske further upstream via a historic feature known as the Bianconi Archway. This leads to a small patio, flowerbed and a small assembly of chairs and tables. It has the appearance of belonging to the adjacent pub (Mick Doyle's). This area looks out onto the Duiske, and to its rear is another old building with similarly old stonework. It is unclear what the present use of the building is, but it is suggested that stables existed here when Mick Doyle's pub used to be a hotel and stopping point for horse-drawn 'Bianconi Cars' in the 19th and early

20th Century. Some slit openings exist along the riverside wall, which along with its disused appearance, contributes to the building's potential as another roost site (PR5).

3.2 Survey Route B

Starting at the northern end of the bridge, travelling east.

The majority of this route consists of a tarmacked road, with buildings on one side and a quay on the other. The quay was populated with pleasure craft (barges etc.) at the time of the site visit. The quay wall dates from c. 1900[1] and is constructed with stone blocks. Concrete bollards line the edge of the quay. There is very little vegetation along this stretch, with the exception of a small marshy/grassy area by the bridge. This area is fringed by *Typha latifolia*, but grades into grasses towards the roadside. Several specimens of *Impatiens glandulifera* (Himalayan balsam) were noted. A couple of *Salix cinerea* (grey willow) shrubs were also noted.

At the eastern end of Route B, the survey route winds its way up a hill behind a scout hall and rowing club. The low-lying parts of this section are occupied by semi-natural grassland and bramble scrub, but a mixed broadleaved woodland sits at the top of the hill. The woodland was easiest accessed from Chapel Street to the north. It is home to several large specimens of *Fraxinus excelsior* (ash) and *Acer pseudoplatanus* (sycamore), and had a notable coverage by *Clematis vitalba*.

The riverside portion of Survey Route B is considered generally unsuitable for roosting bats. Whilst there may be crevices etc. in old stonework along the quay walls, the frequent boat activity in this area is sufficient to deter bats from roosting. The willow shrubs are too young to have any of the characteristics that make an attractive vegetative roost (cracks, hollows etc.). The woodland up the hill behind the scout centre and rowing club contains some large trees that may have these physical properties (cracks, hollows etc.). This site was therefore noted as a potential roost (PR6).

3.3 Survey Route C

Starting at the southern end of the bridge, moving west.

Much like Route B above, the southern embankment of the river along Route C is tarmacked and built up as a quayside. Pleasure craft lined much of Route C at the time of the survey. It is the site of a former towpath; a canal exists further west. The height of the quay wall has been recently increased in this area to provide some degree of flood protection to the adjacent residential properties. The landward side of Route C is at first residential, comprising mostly modern buildings. After ~150 metres a small stream is apparent – this may have been a mill race for an old starch works that operated on the quayside between 1842-1919. The landward

[1] https://www.buildingsofireland.ie/buildings-search/building/12318002/graiguenamanagh-county-kilkenny

habitat from this point on along Route C is dominated by a hedgerow, which can be called a treeline in some areas where trees are >5m in height. Species noted were:

Acer pseudoplatanus (Sycamore)
Salix cinerea (Grey willow)
Crataegus monogyna (Hawthorn)
Impatiens glandulifera (Himalayan balsam)
Fraxinus excelsior (Ash)
Hedera helix (Ivy)
Lonicera periclymenum (Honeysuckle)
Sambuca nigra (Elder)

This area was noted as potential foraging habitat, but was not considered a likely roosting area for bats. There were no potential roost sites noted along Survey Route C.

3.4 Survey Route D

Continuing west from the end of Route C and looping around Tinnahinch Castle.

The former towpath approaches small group of buildings; one of these is Tinnahinch Castle, which was constructed in 1615 and has been in ruins since approximately 1700. It is possible to access the interior of the castle walls, which are all that remains of the structure. Several ash shrubs form a partial canopy 3-4 metres in height. The old stonework and abandoned nature of the building suggest that this is a potential roost (PR9).

A canal lock exists further west along the former towpath. The bankside wall was lined with 1m^2-sandbags in this area. A ~1m-wide strip of common reeds (*Phragmites australis*) extends into the watercourse along the bankside wall – this is no longer a mooring point for boats. A grey heron (*Ardea cinerea*) was observed standing in this area. A treeline begins opposite the lock on the landward side of the towpath. A large cypress tree (*Cupressus* sp.) was considered large enough to have features compatible with potential bat roosts (cracks, hollows etc. inside which bats can crawl) (PR7). Approximately 25 metres further west, a mature horse chestnut was observed (*Aesculus hippocastanum*), the top of which appears to have fallen or broken off (evidenced by a jagged break line, distinct from a clean chainsaw cut). This was also considered a potential bat roost (PR8). The proximity of PR7 and PR8 to each other meant that it would later be possible to survey this small stretch of treeline as one potential roost site (i.e. PR7/8).

The remainder of this treeline, which extends south and east around Tinnahinch castle, was not accessible on foot. This treeline does contain other examples of large mature trees, all of which have potential as foraging grounds or commuting routes for bats, and some of which may also have features attractive to roosting bats.

All potential roost locations identified during the daytime walkover are shown in Figure 3.1 overleaf.

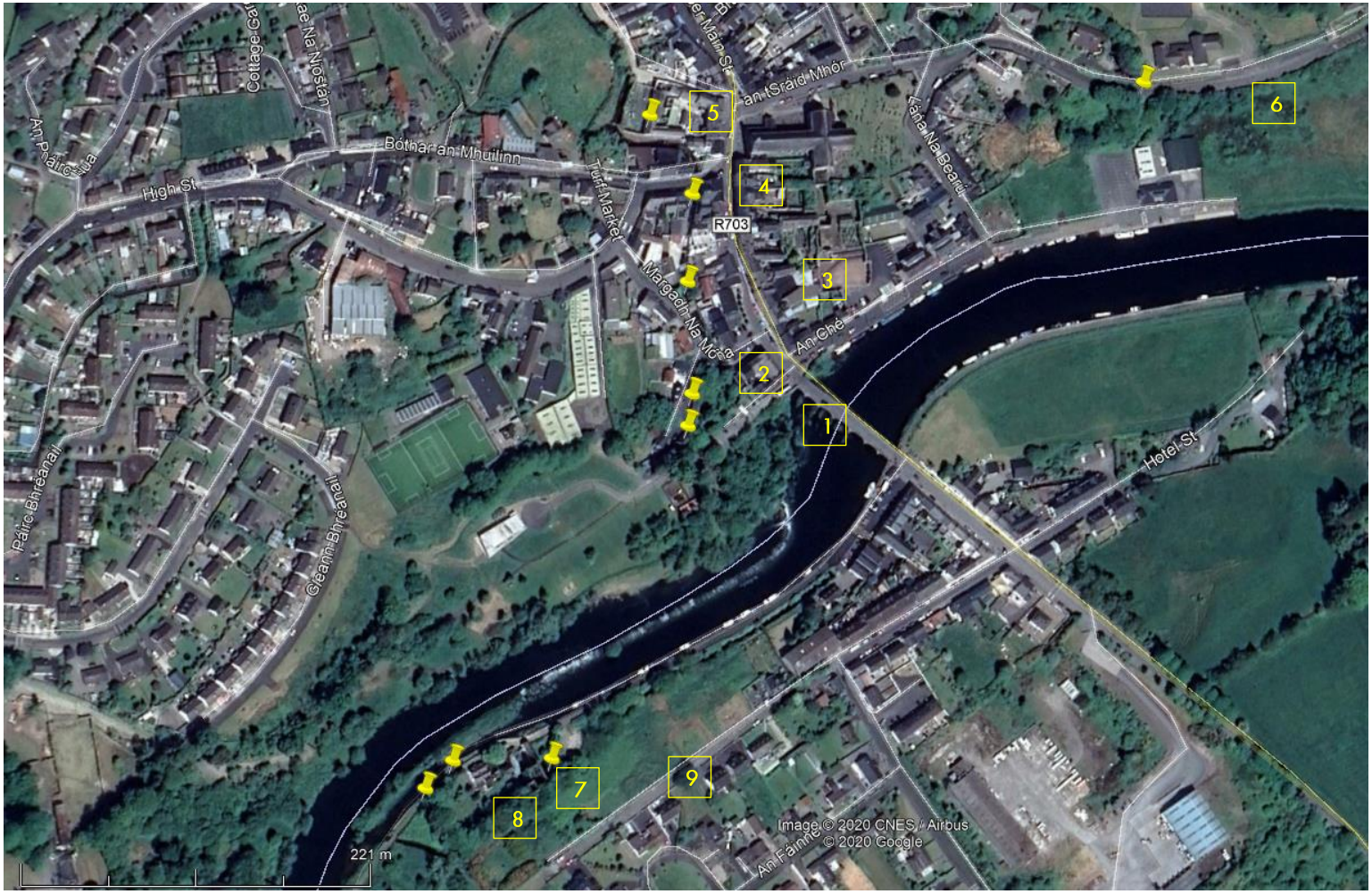

Figure 3.1. Potential Roost Sites

4 Results

This section provides the results of the desk-based study exercise and the site surveys.

4.1 Existing Data

4.1.1 Habitat Suitability

The National Biodiversity Data Centre (NBDC) has compiled data on the suitability of areas as habitats for bats. The table below provides a 'suitability index' for all bats, as well as each individual species known in Ireland. The suitability index is a number between 0 and 100, with 0 being least suitable and 100 being most suitable. The data in Table 4.1 pertains to a 6 x 6 km square, as shown in Figure 4.1.

Table 4.1. Suitability Indeces for bats in the 6km square in which the study area is located

Scientific Name	Common Name	Suitability Index
All bats		31.67
Pipistrellus pygmaeus	Soprano pipistrelle	38
Plecotus auritus	Brown long-eared bat	47
Pipistrellus pipistrellus	Common pipistrelle	48
Rhinolophus hipposideros	Lesser horseshoe bat	5
Nyctalus leisleri	Leisler's bat	38
Myotis mystacinus	Whiskered bat	33
Myotis daubentonii	Daubenton's bat	29
Pipistrellus nathusii	Nathusius' pipistrelle	1
Myotis nattereri	Natterer's bat	46

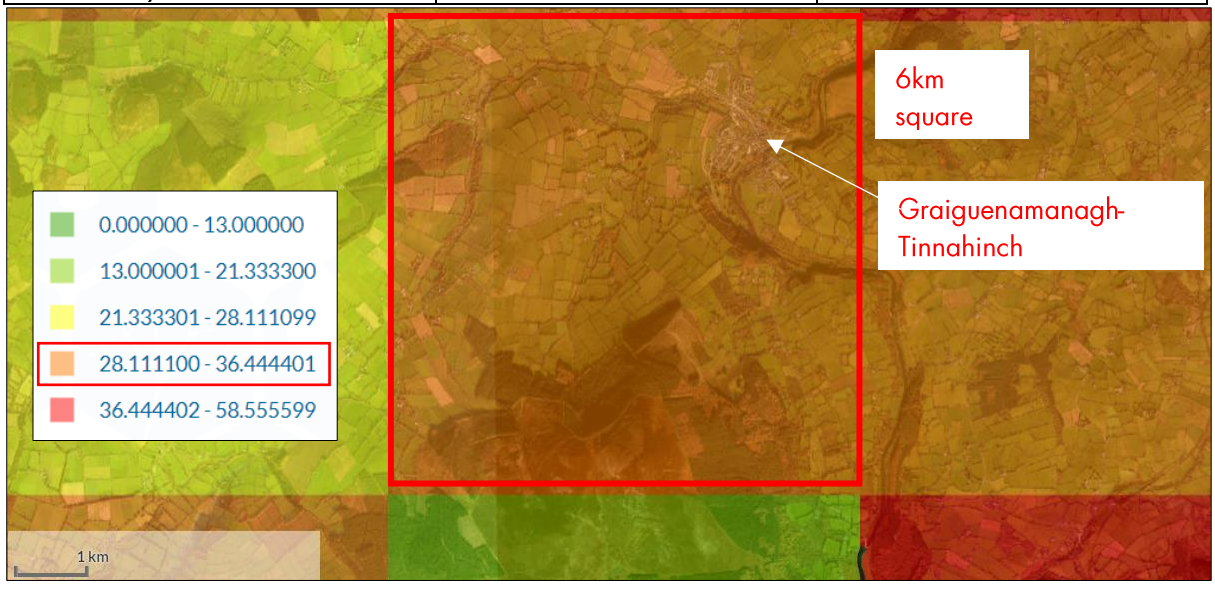

Figure 4.4.1. Location of the NBDC's 6-km square, to which the data in Table 4.1 relates

The above data suggests that the site and its surroundings generally have a moderate-to-high habitat suitability for bat usage. The area is deemed most suitable for brown long-eared bats and common pipistrelles. The surrounding landscape is reasonably diverse, comprising a mixture of agricultural grassland, silviculture and urban land-uses, which are punctuated by a network of criss-crossing treelines/hedgerows and a river system. The diverse landscape, as well as the presence of ecological corridors (in the form of hedgerows/treelines and rivers) are what drives the high habitat suitability index for bats in this area.

4.2 National Bat Database of Ireland

Nationwide records of bat observations are collected and maintained by Bat Conservation Ireland. The data come from a number of different surveys, some of which have been undertaken by BCI and their members. With regard to Graiguenamanagh-Tinnahinch, bats have been recorded in the locations shown in Figure 4.2. For the purpose of this report, the locations have been labelled A-D. The data are summarised in the table below.

Table 4.2. Existing records

Location	Species	Date(s) recorded
A	*Myotis daubentonii*	27 times between 2006-2014
B	*Myotis daubentonii*	07/03/2003
C	*Pipistrellus pygmaeus*	08/04/2000
		04/06/2012
	Pipistrellus pipistrellus	04/06/2012
	Nyctalus leisleri	04/06/2012
	Plecotus auritus	04/06/2012
D	*Nyctalus leisleri*	08/03/2000
	Pipistrellus pipistrellus	08/03/2000

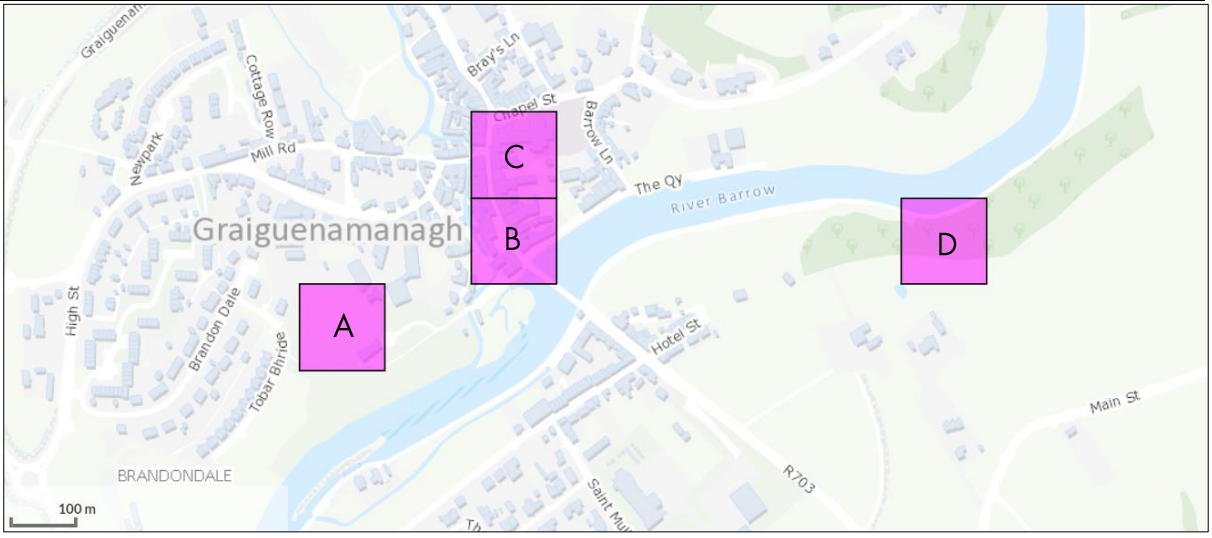

Figure 4.4.2. Locations of existing bat records (Source: NBDC, 2020)

4.3 Dawn/Dusk Surveys

Dawn and dusk surveys were carried out during September 2020 as summarised in Table 4.3.

Table 4.3 Survey dates and times

Survey and Date	Sunrise/Sunset	Start time	End time	Weather
Dusk (14/09/2020)	19:44 (Sunset)	19:25	21:29	Overcast, dry
Dawn (15/09/2020)	07:03 (Sunrise)	05:10	07:05	Overcast, dry
Dusk (15/09/2020)	19:43 (Sunset)	19:30	21:25	Clear, dry
Dawn (16/09/2020)	07:05 (Sunrise)	05:12	07:09	Clear, dry

The first two surveys focused on potential roost sites PR1-PR6. The ecologist moved between them continuously for the duration of the survey. Five minutes were spent at each site before moving onto the next one, where the process was repeated. The bat detector was used to detect evidence of bats emerging from or returning to a roost. Records of any foraging or commuting bats were also made. The last two surveys focused on potential roost sites PR7-PR9. The results are presented in Table 4.4 below.

Table 4.4 Dawn/Dusk Survey Results

Potential Roost ID	GPS		Surveys (Dawn/Dusk) – Positive or Negative for Emerging or Returning Bats				Comments – species etc.
	X	Y	Dusk 14/09/20	Dawn 15/09/20	Dusk 15/09/20	Dawn 16/09/20	
PR1	-6.955894	52.539381	-ve	-ve			No bats observed in, emerging from or returning to this structure. Fly-bys of foraging Soprano Piipstrelles and Daubenton's bat.
PR2	-6.955857	52.539562	+ve	+ve			See comments overleaf. Fly-bys of foraging Soprano Pipistrelles
PR3	-6.955904	52.540196	-ve	-ve			No bats observed in, emerging from or returning to this structure. Fly-by of foraging Common Pipistrelle
PR4	-6.955866	52.540692	-ve	-ve			No bats observed in, emerging from or returning to this structure. Fly-bys of foraging Soprano Pipistrelles
PR5	-6.956265	52.541137	-ve	-ve			No bats observed in, emerging from or returning to this structure. Fly-bys of foraging Soprano Pipistrelles and Daubenton's bat.
PR6	-6.951671	52.541341	-ve	-ve			No bats observed in, emerging from or returning to this structure. Fly-bys of foraging Soprano Pipistrelles
PR7	-6.958062	52.537479			-ve	-ve	7 and 8 are close enough so that they can be observed simultaneously from the same vantage point. No bats observed in, emerging from or returning to these structures.
PR8	-6.958316	52.537321			-ve	-ve	

							Almost constant foraging activity from Soprano Pipistrelle. Fly-bys of Daubenton's bats also observed.
PR9	-6.957142	52.537495			+ve	+ve	See comments overleaf.

4.4 Evidence of Roosting Bats

There was sufficient evidence to suggest that bat species (Soprano Pipistrelles) were roosting at PR 2 and PR 9 as follows:

PR2 – During the dusk survey, soprano pipistrelles appeared to be circling inside the building (frequent pulses were recorded on detector, suggesting bats were flying past the window). During the dawn survey the following morning, a number of Soprano Pipistrelles (clearest at ~55 kHz, erratic flight patterns) were observed circling before disappearing from view towards the northern end of the building. The exact point of exit/entry was not observed.

PR9 – During the dusk survey (observing from inside the castle walls), Soprano Pipistrelles were observed emerging over the top of the northern wall. Some descended into the castle and circled for a short time before leaving. The dawn survey yielded a similar pattern, with Soprano Pipistrelles circling before disappearing from view over the northern wall. The exact point of exit/entry was not observed.

5 Discussion

5.1 Overview of the Species Recorded

The **common pipistrelle** (*Pipistrellus pipistrellus*) is widespread throughout the country and commonly encountered during bat surveys. The most recent estimates suggest a population size in the order to 1-2 million animals, making it one of the most common mammals in Ireland. It is very general in its habitat preference, foraging in woodland, riparian habitats and parkland, along linear features in farmland, and in towns and cities. Maternity roosts of this species are often in buildings, typically in the attics of dwelling houses, although it is occasionally found roosting under bridges and in trees. Recent monitoring by NPWS has reported that there is no evidence of any decline in the range or habitat for this species in Ireland and that the population is increasing. The available NPWS reporting notes that there is no indication of any major pressures currently impacting populations of this species. Overall, the species is assessed as "Favourable" and the overall trend is demonstrating an on-going increase (NPWS, 2019).

The **soprano pipistrelle** (*Pipistrellus pygmaeus*) is the most widespread bat species on the island of Ireland, occurring in all counties including the extreme north, west and south. It is the second most commonly encountered species in the national bat monitoring programme, although its abundance is variable across the island with no particular north-south or east-west pattern apparent. Summer roosts are usually in buildings, including modern suburban houses, old abandoned mansions, churches, amenity buildings and farm sheds. Soprano pipistrelles normally roost in very confined spaces, such as behind window sashes, under tiles and weather-boards, behind fascia and soffits, and within the cavities of flat roofs. Roosts of >1,500 individuals are known. The species is thought to hibernate in buildings and trees, but has seldom been recorded in winter. Although this bat is known to forage in a broad range of habitats, it shows some preference for aquatic habitats – riparian woodland, rivers and lakes. The population of this species has been increasing significantly and steadily in recent years. Given the widespread distribution and very large population present in the country, no threats or pressures are considered significant (NPWS, 2019).

The **Daubenton's bat** (*Myotis daubentonii*) is found throughout Ireland. It forages over water and is particularly associated with slow-moving rivers and with lakes. It favours waterways with riparian vegetation, particularly broadleaf woodlands, and is positively associated with good water quality and invertebrate diversity. It is less likely to be present where there are street lights. This species forages over the surface of water bodies, gaffing aquatic insects such as non-biting midges, caddis-flies and mayflies. The majority of roosts known for this species are in masonry bridges and stone buildings such as castles and ruins. The Daubenton's bat is widespread across Ireland and its population is showing signs of increase. The species exploits a habitat niche which is widely available in Ireland and despite some local reductions in quality (e.g. due to light pollution) there appears to be sufficient suitable habitat going forward. The NPWS reporting notes that Light pollution is a particular concern for Myotis bats such as Daubenton's

bat. Removal of riparian vegetation, bridge repairs and drainage works may also provide some cause for concern for this species and these issues merit further study.

However, there is no current evidence to date of an impact on Daubenton's bat distribution due to these issues (NPWS, 2019).

5.2 Overview of Bat Use of the Survey Site

Graiguenamanagh-Tinnahinch is an old town that has retained much of its centuries-old stonework. The presence of the Rivers Barrow and Duiske, as well as numerous patches of scrub, hedgerows, treelines and woodland, cumulatively offer attractive foraging and commuting habitats for several species of bats. These observations are supported by the existing data available online from the National Biodiversity Data Centre and Bat Conservation Ireland.

Two of the potential roost sites identified during the daytime survey showed evidence of roosting soprano pipistrelles. Bat activity (in the form of fly-bys) was recorded at all potential roost sites, which indicates that the area as a whole is an important resource for foraging and/or commuting bats. Light pollution is more notable on the northern side of the River Barrow (i.e. PR1-6), which is where the bulk of the town centre is located.

It is noted that the project is in early stages of planning, and specific structural details of the proposed flood defence measures are not yet available. The significance of these potential roost sites in relation to the proposed works is therefore currently unclear.

5.2.1 Recommendations for Further Study

Once more detail becomes available pertaining to the proposed structural alterations to the site (including the proposed methods of construction), the site should be re-visited for the purpose of:

- Surveying key locations (e.g. where it is known that potential roosting habitat will be removed or disturbed)
- Obtaining more detailed information about any potential bat roosts (i.e. whether it is a maternity roost, hibernaculum etc.)

This information will inform any considerations of mitigation measures that may need to be implemented.

As all Irish bats and their roosts are protected under national and EU legislation it is an offence to disturb or interfere with them without a licence. Such a derogation (which must be given by the Minister for the Environment, Heritage and Local Government) can only be sanctioned where there is no satisfactory alternative and where it will not be detrimental to the favourable conservation status of the species concerned. Therefore, any falling of trees or work on bridges

which provide suitable roost habitat for bats should be sought in advance of any development that may interfere with such roost sites.

6 References

Bat Conservation Trust (2015). *Bat Surveys for Professional Ecologists – Good Practice Guidelines* (3rd edition). London.

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Wildlife Acts 1976 to 2018.

7 Appendix I - Photographs

Survey Route A

Figure 7.1. PR1 – note potential entry/exit point near top of gable end (14/09/20).

Figure 7.2. Laneway between PR1 (right) and PR2 (left) (14/09/20)

Figure 7.3. PR3 (14/09/20)

Figure 7.4. PR4 (14/09/20)

Figure 7.5. PR5 (14/09/20)

Survey Route B

Figure 7.6. Survey Route B - looking east from the bridge (14/09/20)

Figure 7.7. Survey Route B - Looking west from Scout Hall. (14/09/20)

Figure 7.8. Scout hall and rowing club (14/09/20)

Figure 7.9. Mixed broadleaved woodland (from Chapel St.) (PR6) (14/09/20)

Survey Route C

Figure 7.10. Looking west from bridge (14/09/20)

Figure 7.11. Looking east approximately halfway along Route C (14/09/20)

Survey Route D

Figure 7.12. PR7/8 (14/09/20)

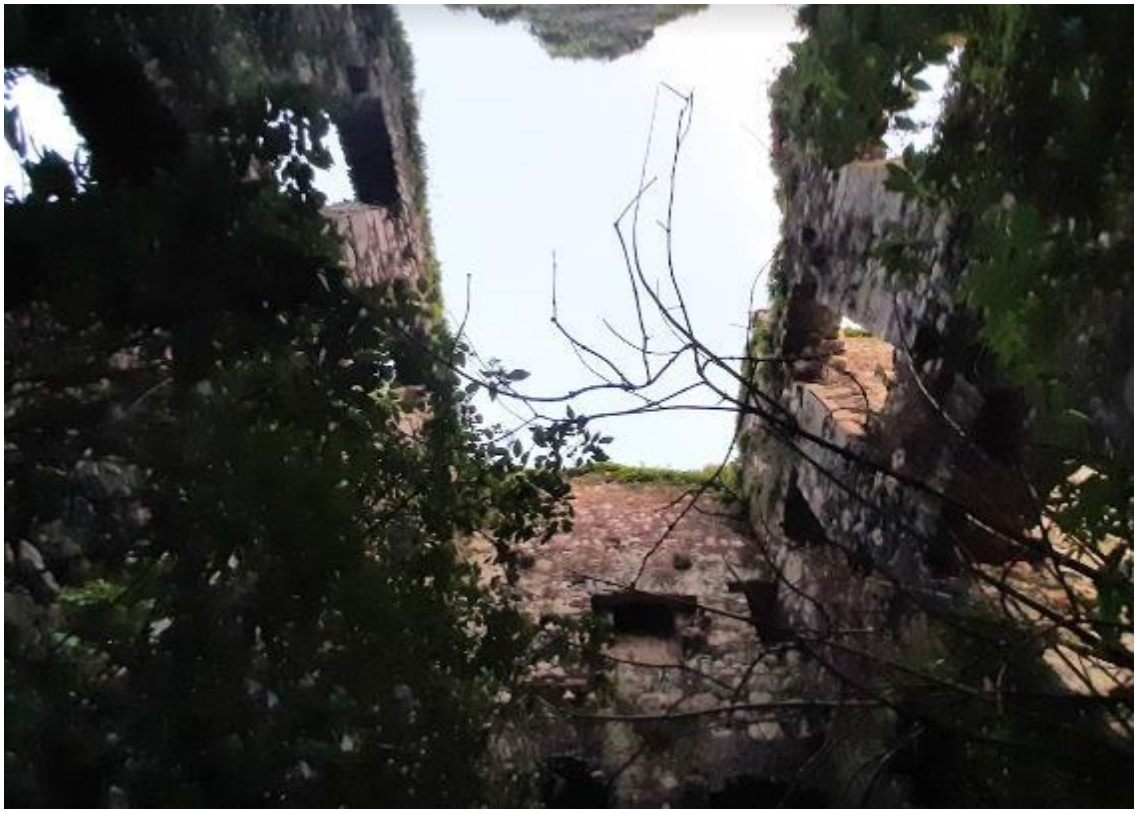

Figure 7.13. PR9 - Tinnahinch Castle (14/09/20)

Figure 7.14. Treeline along western edge of Route D. (14/09/20)

Appendix 10-4 Bat Survey Report Upstream Storage Area 2023

Forestry, Ecology & Environment

Bat Survey Report

Proposed Graiguenamanagh-Tinnahinch Upstream Storage Area

Compiled by: Veon Ecology

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SUMMARY

Site: Townlands of Graiguenamanagh in County Kilkenny. Part of the settlement, known as Tinnahinch, is on the County Carlow side of the river, and Carlow County Council refers to the whole village as "Graiguenamanagh-Tinnahinch.

Proposed works:

Due to repeated and increasingly common flood events, a Flood Relief Scheme (FRS) for Graiguenamanagh town, is proposed. The objective of the Graiguenamanagh-Tinnahinch Flood Relief Scheme project is the identification, design, and construction of a Flood Relief Scheme, that is technically, socially, environmentally, and economical acceptable, to alleviate the risk of flooding to the community of Graiguenamanagh.

As part of the constraints study, a number of options in relation to flood relief works have been proposed. These flood relief route options were used to form the basis for the bat survey. The flood relief measures put forward for Graiguenamanagh included a combination of hard defences (both flood walls and embankments), flood gates, debris traps, and alterations/removal of bridges. These are proposed on the River Barrow and the River Duiske within the towns of Graiguenamanagh and Tinnahinch. It additionally includes for the attenuation of flood waters within an upstream storage area, located approximately 2km upstream on the River Duiske from the confluence with the River Barrow in the town of Graiguenamanagh and Tinnahinch.

Considering the nature of project, potential significant effects on ecologically sensitive receptors such as bats cannot be ruled out. Large-scale development entailing changes to, or removal of existing vegetation and structures may adversely affect bats through loss of breeding/resting places or commuting/foraging features, displacement, and injury. It is essential therefore that a study of protected species such as bats is undertaken in such cases to identify any conflict zones and hence to avoid and/or reduce impacts to bats through mitigation.

Surveyed by: Donnachadh Powell, BSc (Hons) Ecology and Environmental Biology, CIEEM, Lead Ecologist, David McGillycuddy, BSc (Hons) Wildlife Biology, CIEEM, Ecologist, Jason Cahill, BSc (Hons) Wildlife Biology, Ecologist, Sara Sheridan MSc BSc CIEEM, Ecologist and Anna Paula Moreira B.Sc. (Hons) in Environmental Science, Ecologist, Veon Ecology.

Survey effort:

As part of a wider ecological constraints assessment of the proposed flood relief scheme, Veon Ecology was commissioned to undertake a specific assessment of bat activity within the study area. Preliminary Roost Assessments were carried out on the relevant trees within the survey area where possible to determine the presence of roosting bats. Transect walks were conducted on and around the proposed works locations to further characterise bat activity levels and species present. A low to moderate level of bat activity was recorded on site.

Potential bat corridors in the vicinity of the area were also assessed. The bat activity surveys involved active acoustic sampling using handheld bat detectors at predetermined points. To ensure there is no negative impact on bats as a result of the proposed works, surveys were undertaken in all areas identified as having bat roosting, commuting and foraging potential.

Activity surveys were carried out on site on the following dates in 2023, August 2nd, August 15th, August 16th, September 1st, September 5th, September 7th, September 12th and September 22nd. These surveys involved dusk emergence surveys and transect surveys. Daytime inspection of trees for potential bat roosts were also carried out prior to bat activity surveys.

Section 1: INTRODUCTION

1.1 Aims of the Report

Veon Ltd. (Veon Ecology) was commissioned by ByrneLooby (BL) on behalf of Kilkenny County Council (KCC) to undertake a survey for bats within a Survey Area affected by the proposed Graiguenamanagh -Tinnahinch Upstream Storage Area hereafter referred to as the proposed Scheme. The Survey Area for bat activity surveys can be seen in Figure 2.1 below.

The overarching aims of the bat surveys were as follows:

- To identify the areas and habitats within the Survey Area that are being used by bats (including flight paths/commuting routes and foraging areas).
- Collect robust data following good practice guidelines to allow an assessment of the potential impacts of the proposed project on local bat populations, both on and off-site (where possible).
- To identify the species of bats using the Survey Area.
- Provide baseline information with which the results of post-construction monitoring surveys can be compared to, where appropriate.
- To identify, where possible, any bat roosts within the Survey Area and the environs of the scheme;
- Facilitate the design of mitigation, enhancement and monitoring strategies for local bat populations recorded; and,
- Facilitate the conservation of local bat populations.

The bat surveys were completed during August to September 2023. This also informed the assessment of potential roost sites for bats. The Survey Area for this baseline assessment focussed within a 200m – 400m wide corridor of suitable habitat which encompasses the location of the proposed Scheme. Bat surveys focussed on suitable roosting and foraging habitat within the Zone of Influence (ZoI) such as watercourses, woodlands, treelines, hedgerows, grasslands and Riparian woodland along sections of the DUISKE_020 and BARROW_230 and tributaries which shall be directly impacted by the proposed works.

1.2 Relevant Legislation

All Irish bat species are protected under the Wildlife Act (1976) and Wildlife Amendment Acts (2000 and 2010). Also, the EC Directive on The Conservation of Natural habitats and of Wild Fauna and Flora (Habitats Directive 1992), seeks to protect rare species, including bats, and their habitats and requires that appropriate monitoring of populations be undertaken.

All Irish bats are listed in Annex IV of the Habitats Directive and the Lesser horseshoe bat (*Rhinolophus hipposideros*) is further listed under Annex II.

Across Europe, they are further protected under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention 1982), which, in relation to bats, exists to conserve all species and their habitats.

The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention 1979, enacted 1983) was instigated to protect migrant species across all European boundaries. The Irish government has ratified both these conventions.

Also, under existing legislation, the destruction, alteration, or evacuation of a known bat roost is a notifiable action, and a derogation licence must be obtained from the National Parks and Wildlife Service (NPWS) before works can commence.

Any works interfering with bats and especially their roosts, may only be carried out under a licence to derogate from Regulation 23 of the Habitats Regulations 1997 and Regulation 54 of the European Communities (Birds and Natural Habitats) Regulations 2011 (which transposed the EU Habitats Directive into Irish law), issued by NPWS.

The details with regards to appropriate assessments, the strict parameters within which derogation licences may be issued and the procedures by which and the order in relation to the planning and development regulations such licences should be obtained, are set out in Circular Letter NPWS 2/07 "Guidance on Compliance with Regulation 23 of the Habitats Regulations 1997 - strict protection of certain species/applications for derogation licences" issued on behalf of the Minister of the Environment, Heritage and Local Government on the 16th of May 2007.

1.3 Bat Species in Ireland

There are eleven recorded bat species in Ireland, nine of which are considered Resident, two as Vagrant, namely:

1. Common pipistrelle (*Pipistrellus pipistrellus*)
2. Soprano pipistrelle (*Pipistrellus pygmaeus*)
3. Nathusius' pipistrelle (*Pipistrellus nathusii*)
4. Leisler's bat (*Nyctalus leisleri*)
5. Brown long-eared bat (*Plecutus auratus*)
6. Natterer's bat (*Myotis nattereri*)
7. Whiskered bat (*Myotis mystacinus*)
8. Daubenton's bat (*Myotis daubentonii*)
9. Lesser horseshoe bat (*Rhinolophus hipposideros*)
10. Brandt's bat (*Myotis brandtii*) (**Vagrant**)
11. Greater horseshoe bat (*Rhinolophus ferrumerquinum*) (**Vagrant**)

Eight of the nine resident bat species and one of the vagrant bat species are 'Vesper' bats. All vespertilionid bats have a tragus (cartilaginous structure inside the pinna of the ear). Vesper bats are distributed throughout the island.

The Lesser horseshoe bat (*Rhinolophus hipposideros*), belongs to the Rhinolophidea and has a complex nose leaf structure on the face, distinguishing it from the Vesper bats. This species' current distribution is confined to the western seaboard counties of Mayo, Galway, Clare, Limerick, Kilkenny, and Cork.

Only one confirmed record (corroborated by DNA testing) of the Brandt's bat (*Myotis brandtii*) has occurred in Ireland to-date. All other records have not been genetically confirmed. The Brandt's bat is very similar to the Whiskered bat (*Myotis mystacinus*), so it remains possible that the two have been confused in Ireland in the past. As such, the Brandt's bat is considered a vagrant.

The Greater horseshoe bat (*Rhinolophus ferrumerquinum*) was only recorded for the first time in February 2013 in County Wexford and is therefore also considered to be a vagrant species.

1.4 Guidance Documents

This report will draw on guidelines already available in Europe and will use the following documents:

- National Roads Authority (2006) Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes.
- National Roads Authority Guidelines for the Protection and Preservation of Trees, Hedgerows and Scrub Prior to, and During the Construction of National Road Schemes.
- Kelleher, C & Marnell, F. (2006). Bat Mitigation Guidelines for Ireland. Irish Wildlife Manuals, No. 25. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.
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- The status of EU protected habitats and species in Ireland: Conservation status in Ireland of habitats and species listed in the European Council Directive on the Conservation of Habitats, Flora, and Fauna 92/43/EEC. National Parks and Wildlife Service, Department of Environment, Heritage, and Local Government.

Collins (2016) is the principal document used to provide guidance in relation to survey effort required however the level of surveying is assessed on a case-by-case basis taking into consideration the historical bat records for the survey area, presence of built structures and trees potentially suitable for roosting bats.

Impacts on bats can arise from activities that may result in the following:

- Lighting disturbance.
- Noise disturbance e.g. use of machinery, increase human presence etc.
- Physical disturbance of bat roosts e.g. destruction or renovation of buildings.
- Loss of roosts e.g. destruction or renovation of buildings.
- Loss of foraging habitats.
- Modifications of commuting or foraging habitats.
- Severance or fragmentation of commuting routes.

It is recognised that any development may have an impact on the receiving environment, but the significance of the impact will depend on the value of the ecological features that would be affected. Such ecological features will be those that are important and potentially affected by the proposed development.

The guidelines consulted recommend that the potential impacts of a proposed development on bats are assessed as early as possible in the design stage to determine any areas of conflicts.

Section 2: PROJECT DESCRIPTION

2.1 Site Location

The surveyed area is located approximately 2km from Graiguenamanagh town and specifically encompasses a proposed upstream storage area. The study area, which served as the foundation for the bat surveys, includes the river BARROW_230 and waterbody DUISKE_020. Figure 2.1 below illustrates a map of the proposed works locations and the survey area. The waterbody DUISKE_020 flows in a south-eastward direction towards Graiguenamanagh town, ultimately meeting river BARROW_230 at the coordinates 52.538580, -6.955742.

The River Barrow is considered a Freshwater Pearl Mussel (FPM) sensitive area. Water quality in the River Barrow is generally classified as poor under the WFD. There are significant polluting sources within the survey area including Benzo(g,h,i)perylene and Benzo(k)fluoranthene.

The survey area supports a variety of habitats including hedgerows, treelines, grasslands, woodland, and scrub. Land-usage in the wider landscape is primarily for livestock agriculture, residential and forestry. of these habitats provide suitable foraging areas for bats, as well as opportunities for roosting sites.

The survey area overlaps or is in close proximity to the following Natura 2000 sites (Figure **2.2**):

- River Barrow and River Nore SAC (002162)
- Thomastown Quarry SAC (002252)
- Slaney River Valley SAC (000781)
- Blackstairs Mountains SAC (000770)
- River Nore SPA (004233)

River Barrow and River Nore SAC (002162) is very important for the presence of a number of E.U. Habitats Directive Annex II animal species including Freshwater Pearl Mussel (both *Margaritifera margaritifera* and *M. m. durrovensis*), White-clawed Crayfish, Salmon, Twaite Shad, three lamprey species – Sea Lamprey, Brook Lamprey and River Lamprey, the tiny whorl snail Vertigo moulinsiana and Otter. This is the only site in the world for the hard water form of the Freshwater Pearl Mussel, *M. m. durrovensis*, and one of only a handful of spawning grounds in the country for Twaite Shad.

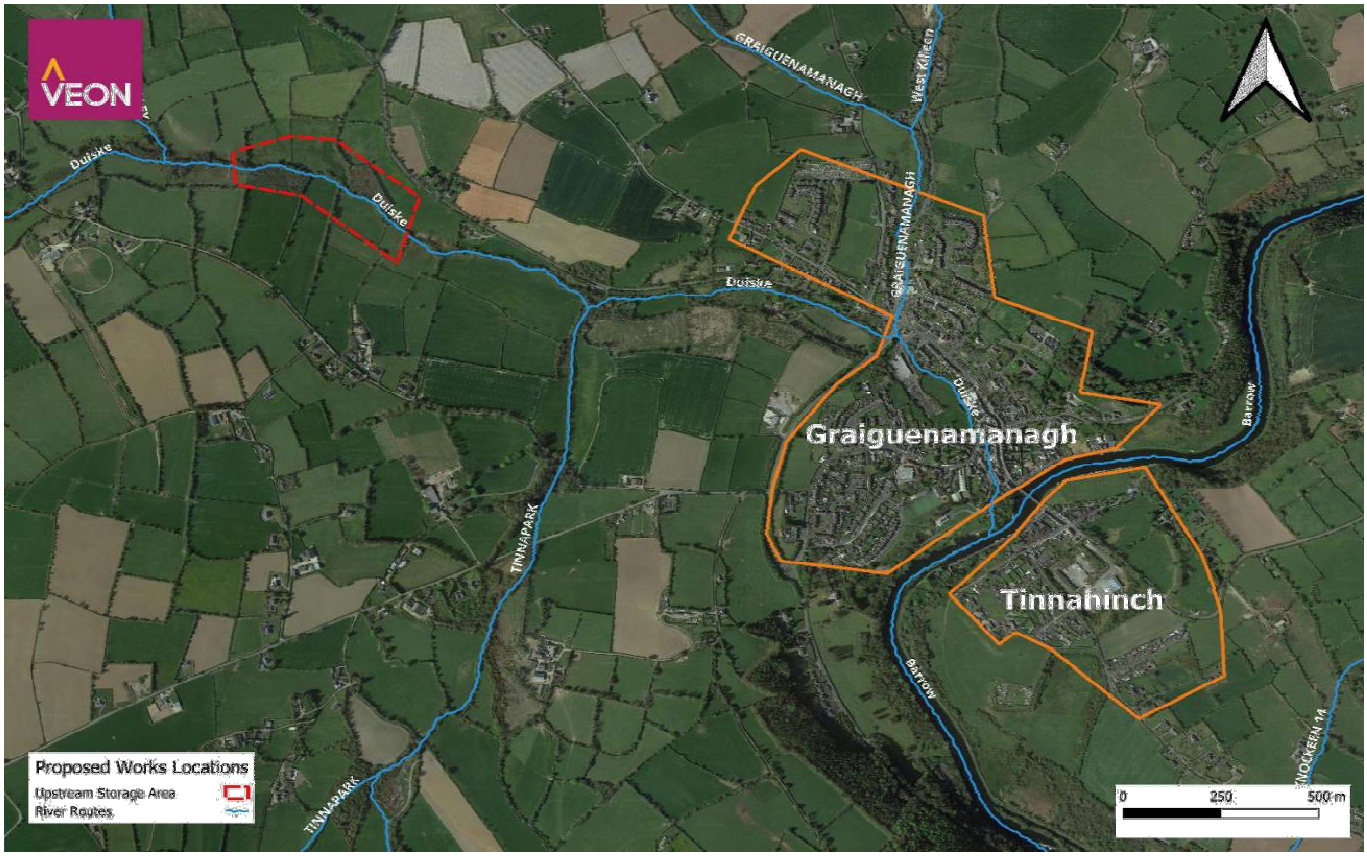

Figure 2.1: Proposed Works Locations/ Bat Survey Area and relevant watercourses Map.

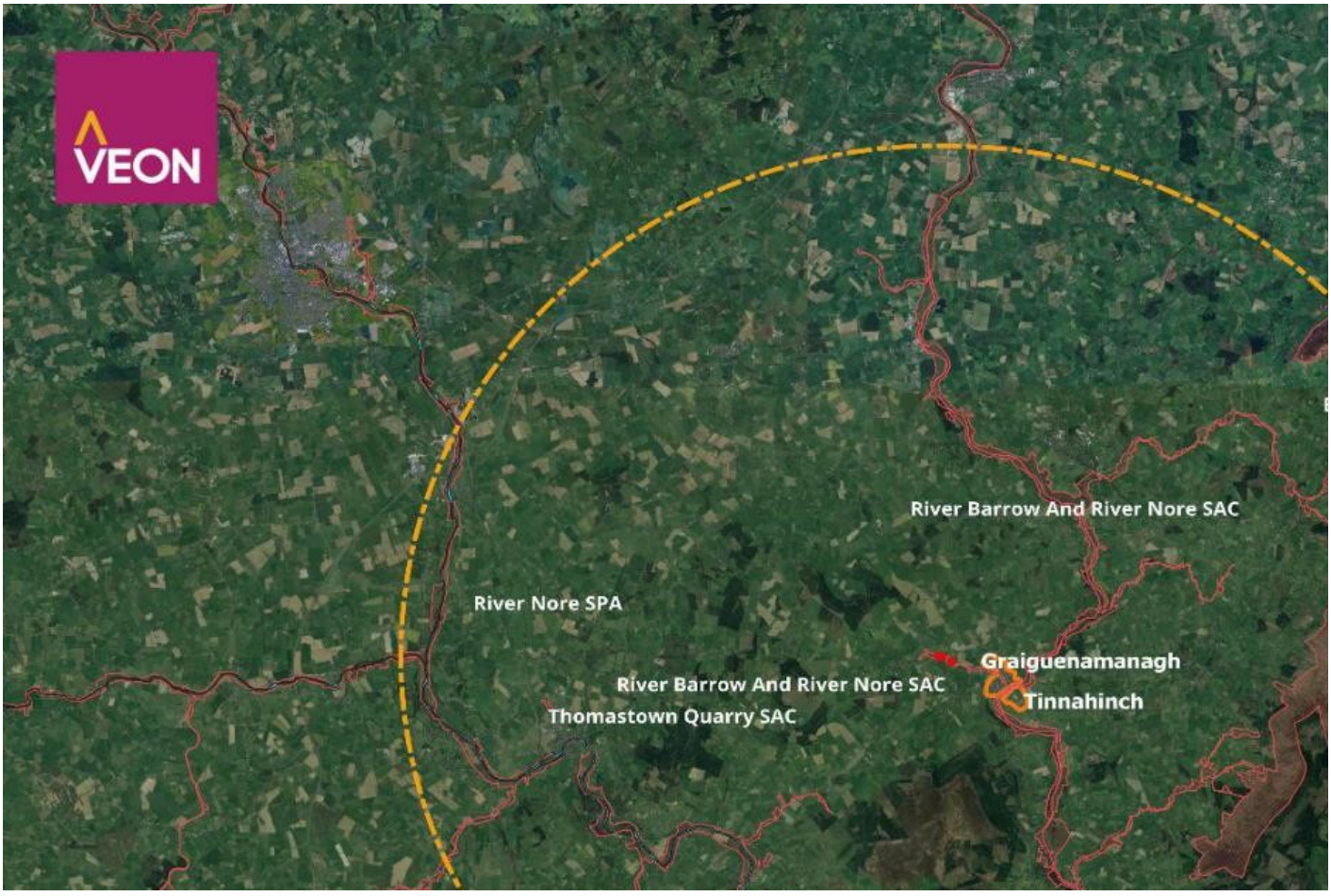

Figure 2.2: Natura Sites within 15km

2.2 Project Description

The Office of Public Works (OPW) completed Catchment Flood Risk Assessment and Management (CFRAM) studies covering the entire country reviewing flood-prone sites. Graiguenamanagh-Tinnahinch was identified during the study as one of the areas at risk to flooding. The plan set out the measures and policies to be pursued in order to achieve the most cost effective and sustainable management of flood risk.

The objective of the Graiguenamanagh-Tinnahinch Flood Relief Scheme project is the identification, design and construction of a Flood Relief Scheme, that is technically, socially, environmentally and economical acceptable, to alleviate the risk of flooding to the community of Graiguenamanagh-Tinnahinch (Source: floodinfo.ie).

The proposed project is at an early stage of the planning process, so detailed designs have not yet been prepared. As part of the constraints study, a number of options in relation to flood relief works have been proposed. These flood relief route options were used to form the basis for the bat survey.

The flood relief measures put forward for Graiguenamanagh-Tinnahinch included a combination of hard defences (both flood walls and embankments), flood gates, debris traps, and alterations/removal of bridges. These are proposed on the River Barrow and the River Duiske within the towns of Graiguenamanagh and Tinnahinch. It additionally includes for the attenuation of flood waters within an upstream storage area, located approximately 2km upstream on the River Duiske from the confluence with the River Barrow in the town of Graiguenamanagh.

Section 3: METHODOLOGY

Initially, a desktop assessment of aerial photographs along the route of the proposed flood relief scheme was undertaken to identify existing habitats, buildings and structures which may be favourable for bat use within the potential works locations.

Bat surveys are comprised of many different types and may differ from site to site depending on the aims of the survey. The surveys deemed suitable for a particular project is determined on a case-by-case basis.
To fulfil the Survey brief, the following activities were carried out:

- Daytime walkover survey of the site and immediate area.
- Daytime inspection of the relevant building(s)/structure(s) directly.
- Active acoustic surveys in the study area during night hours.
- Review of historical bat surveys conducted within the vicinity of the site.
- Desktop study of the National Biodiversity Data Centre (NBDC) Bat Suitability Index.

3.1 Bat Habitat and Commuting Routes

The survey site was assessed during daytime walkover surveys, in relation to potential bat foraging habitat and potential bat commuting routes. Bat habitats and commuting routes identified are considered in relation to the wider landscape to determine landscape connectivity for local bat populations through the examination of aerial photographs.

All areas were surveyed on foot, mainly along hard-surfaced roads, grassland, built land and along the river corridor.

3.2 Survey for presence/absence of Bat roosts

A preliminary roost assessment (PRA) was carried out during daylight hours (exterior and interior) to identify any evidence of roosting bats, current or historic. Potential roosting features (PRFs) were recorded at these buildings/structures during daytime visual inspections. A bat activity survey was carried out to confirm the presence or absence of roosting bats at these buildings/structures. Surveys followed guidelines outlined in Collins (2016).

3.2.1 Preliminary Roost Assessment

The relevant buildings, structures and trees within the survey area were investigated during daylight hours to record any signs of current and/or historic bat presence, such as droppings, brown staining from urine, feeding remains and surfaces smoothed around entrance holes. Kelleher & Marnell (2006) provide guidance on assessing the potential for structures to support roosting bats. This guidance identifies a variety of factors that increase or decrease the potential of a structure to function as a bat roost, namely:

Increase Potential

Disused or little used; largely undisturbed; Large roof void with unobstructed flying spaces; Large dimension roof timbers with cracks, joints, and holes; Uneven roof covering with gaps, though not too draughty; Entrances that bats can fly in through; Hanging tiles or wood cladding, especially on south-facing walls; Rural setting; Close to woodland and/or water; Pre-20th century or early 20th century construction; Roof warmed by the sun.

Decrease Potential

Urban setting or highly urbanised area with few feeding places; Small or cluttered roof void; Heavily disturbed; Modern construction with few gaps around soffits or eaves; Prefabricated with steel sheet materials; Active industrial premises; Roof shaded from the sun; High internal day time light levels.

The day-time inspections focused on identifying any suitable ingress and egress points for bats into any relevant structures and a thorough search of all exterior areas of the relevant buildings. Internal inspections of buildings including the roof and attic spaces are also completed, where safe access is possible.

The following equipment was used during the PRA and activity surveys:

- Wildlife Acoustics Echometer Touch 2 Bat Detector (Android).
- High-powered Maglite© hand torch and LED head torch.
- Endoscope (Explorer Premium) Wireless inspection camera.

3.2.2 Activity Surveys

Bat emergence/re-entry surveys are typically undertaken at dusk or dawn between April and September to identify whether bats are present within a structure and provide additional confidence in any negative survey results from preliminary roost assessment surveys conducted if the buildings, structures and/or trees are identified as medium or high potential for a roost to be present.

Activity surveys were carried out on site on the following dates in 2023, August 2nd, August 15th, August 16th, September 1st, September 5th, September 7th, September 12th and September 22nd. These surveys involved dusk emergence surveys and transect surveys.

Dusk surveys were started from 10 minutes before sunset to at least 100 minutes post sunset (extended survey period times occurred in relation to walking transects).

Conducting an Emergence Bat survey allows surveyors to identify:

- Whether bats are present in a structure, the species, and number involved.
- Entrance and exit points for the roost.

- Any actions needed to be taken to ensure legal compliance.
- The type of roost, i.e.:

    - Day roosts: individual bats, or small groups of males, are using the area for shelter during daylight hours.
    - Feeding roosts: whereby bats, particularly Brown Long-Eared and Horseshoe species feed during the night.
    - Night roost: where bats rest or shelter between feeding sessions.
    - Hibernation roost: where bats hibernate over the winter periods.
    - Transitional or occasional roost: where bats gather at a temporary site before and after hibernation.
    - Mating site: Males and females gather in late summer to early winter.
    - Maternity roost: where babies are born and raised until they're independent.
    - Satellite roost: where breeding females roost close to the main nursery colony in the breeding season.
    - Swarming site: where bats gather in large numbers from late summer to autumn.

Bats rely heavily on buildings for roosting. Average maternity colony sizes are about 50 bats although most roosts are much smaller. Larger roosts are not uncommon among particular species. A maternity or nursery roost is where females gather to give birth in the summer. Bats typically roost in buildings during the summer months, leaving in autumn to seek a site with a more stable temperature regime for hibernation.

As a standard approach, all emerging or re-entering bats observed at a structure are recorded along with their flight path, their species, and the time of flight. Vegetation, habitat, and relevant environmental factors are also detailed, where applicable and appropriate.

Walking transects involve the surveyor(s) walking the survey area, noting the time, location and bat species encountered. The Wildlife Acoustics Echo Meter Touch 2 (Android) recordings are mapped using QGIS with the produces WAV files. The validation of bat records is completed by the principal bat surveyor prior to mapping.

3.2.3 Tree Potential Bat Roost (PBRs) Inspection

Trees that may provide a roosting space for bats are classified using the Bat Tree Habitat Key (BTHK, 2023)1 and the classification system used is from Collins (2016). The Potential Roost Features (PRFs) listed in this guide are used to determine the PBR value of trees.

It can be challenging to ascertain the absence of roosts in trees, even if no bats are detected. Therefore, precautionary measures may be necessary during tree felling and pruning activities. If a tree is deemed to be a roost site, then further surveying involving dusk and dawn surveys of the actual trees may be recommended to determine what bat species are present etc. If bats or a bat roost is identified, it is imperative to contact the NPWS (National Parks and Wildlife Service). Before commencing felling activities, obtaining a derogation license from NPWS is mandatory.

Table 3.1: Tree Bat Roost Category Classification System (Collins, 2016).

	Tree Bat Roost Classification System:
Tree Category	**Description**
1 (High)	Trees with multiple, highly suitable features (Potential Roosting Features = PRFs) capable of supporting larger roosts.
2 (Moderate)	Trees with definite bat potential but supporting features (PRFs) suitable for use by individual bats.
3 (Low)	Trees have no obvious potential although the tree is of a size and age that elevated surveys may result in cracks or crevices being found or the tree supports some features (PRFs) which may have limited potential to support bats.
4 (Negligible)	Trees have no potential.

3.3 Desk Study

In addition to surveys carried out on site, a detailed desktop study was carried out using information from publicly available databases such as NWPS and NBDC to further characterise the local bat ecology and potential significant effects on bat communities which may be present in the area but were not recorded during on site surveys.

3.3.1 National Biodiversity Data Centre (NBDC)

A review of National Biodiversity Data Centre (NBDC) historical records was undertaken. The proposed development site area falls within No. 2 separate 10km^2 data grid squares (S64 & S74) (See **Figure 3.1**). The NBDC Map Viewer has a 'Bat Suitability Index' (Source: NBDC & Lundy et al. 2011). This will be referred to where applicable and appropriate in this current survey.

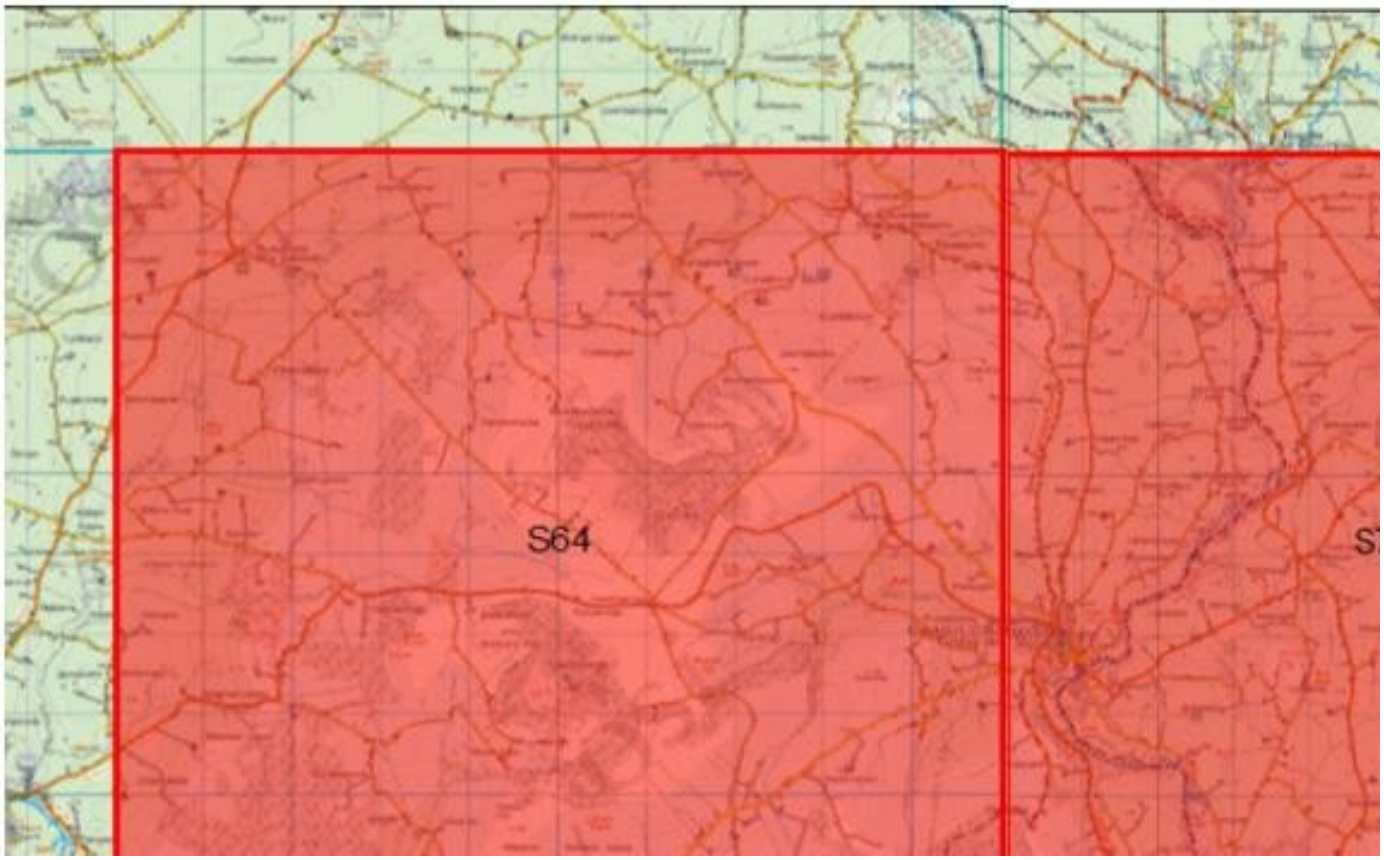

Figure 3.1: The 10km^2 data grid squares (S64 & S74) overlapping the survey area (Source: NBDC).

[1] BTHK (2023) Bat Roosts in Trees – A Guide to Identification and Assessment for Tree-Care and Ecology Professionals.

Section 4: SURVEY RESULTS

The surrounding landscape of Graiguenamanagh, Co. Kilkenny is primarily agricultural land with treelines and hedgerows. There is a high level of connectivity in the landscape which makes it suitable for commuting and foraging bat populations.

The town of Graiguenamanagh has extensive streetlights which reduces its suitability for foraging and commuting bats considered to be light sensitive (e.g. Daubenton's bats).

4.1 Preliminary Roost Assessment

The daytime Preliminary Roost Assessment (PRA) survey was carried out on the relevant buildings and structures.

Signs of roosting bats, i.e. visible bats and droppings were not identified within the upstream storage area. PRFs were identified within some trees which have the potential to support at least small numbers or individual roosting bats. Examples of PRFs recorded on site include:

- Bark tear outs and small cavitites.
- Thick interweaving ivy steams.

4.1.1 Buildings & Structures Inspection Results

The semi-mature trees within the study area provide some potential roosting opportunities for. Trees were surveyed where possible and no roosting bats or signs of roosting bats, current or historic, were recorded. On no occasion were any species of bats seen re-entering or emerging from trees during surveys.

Mature trees within the survey area were inspected to determine their Potential Bat Roost (PBR) value. An initial BS tree survey report was undertaken by Veon and identified a number of trees that had bat roost potential. The following trees listed in **Table 4.1** were deemed to have a PBR. All of the trees/tree groups listed below have a Category 2 PBR rating because they have some suitable features that can provide roosting sites for bats.

Table 4.1: Tree PBR inspection results.

Tree PBR inspection results:				
Tree Code	**Tree Species**	**PRFs**	**Bat Usage**	**Value**
T1	Oak, Beech	Moderate number crevices and spilt limbs.	bats recorded foraging in vicinity of this treeline.	Moderate Value
T2	Beech, Sycamore, Oak	Moderate number crevices and spilt limbs.	bats recorded commuting and foraging in vicinity of this woodland.	Moderate Value
T3	Oak, Holly, Birch	Moderate number of tree holes and dead wood.	bats recorded foraging in vicinity of this woodland.	Moderate Value
T4	Oak, Ash, Sycamore	Moderate number of tree holes and dead wood.	bats recorded foraging in vicinity of this treeline.	Moderate Value
T5	Ash, Birch, Holly	Moderate number of tree holes and dead wood.	bats recorded foraging in vicinity of this treeline.	Moderate Value

4.2 Activity Surveys

Where it was safe to do so, transects were walked along the study area to identify any bat hot spots and corridors. No bats were recorded emerging from any structures during any of the activity surveys.

The Transect surveys involved Active acoustic sampling using handheld bat detectors (Wildlife Acoustics Echometer Touch 2 Bat Detector). Hot spots of bat activity were found south of the study area. Common

pipistrelles and soprano pipistrelles were recorded frequently commuting along hedgerows that form the border of fields south of the study area.

Foraging opportunities within the townland were sparse in sections and of low suitability (low insect abundance) which lowers the ecological value of certain sections of the site to Irish bat species.
No. 3 species of bat were recorded foraging in the vicinity of the study area. These include the following: Soprano pipistrelle, Common pipistrelle and Leisler's bat.

Common pipistrelle and Leisler's bats were the most frequently recorded bat species. Leisler's bats were particularly recorded foraging at height in the hot spot areas south of the redline boundary of the study area. The Common Pipistrelles were more associated with dense trees.

In summary, little bat activity was recorded associated with the Duiske river running through the study area. The majority of bat activity was associated with the hedgerows and open fields outside the study area, with a low to moderate level of activity recorded within the study area.

4.2.1 Bat Activity Indices

During transects, the number of times a bat was encountered is described as the number of bat passes. The number of bat passes recorded are used as the standard measure to create a relative index of bat activity. This is either expressed as the number of bat passes per hour or per survey night. A contact ("bat pass"), as recorded in the results from these surveys, describes a bat observed by the surveyor.

This contact can range from a commuter passing quickly to a foraging bat circling a feature lasting for several minutes. Bat contacts do not equate to numbers of bats as individual bats of the same species cannot be differentiated. A single bat continuously foraging in proximity to the detector can generate a large number of contacts in one night. In addition, variability occurs in the likelihood of detection between species.

The same bat may be recorded in several contacts throughout the night. This survey type cannot estimate abundance of bats, rather activity; the amount of uses bats make of an area/feature. Where multiple visits for a transect are required, the start and end points of transect walks were alternated between visits to intersperse time and location (i.e., to prevent bias due to certain areas always being surveyed close to dusk).

During the walked transect surveys a low–moderate level of bat activity was observed within the survey area, with a total of No. 558 bat passes, from three different bat species, being recorded. These included common pipistrelle (n = 355), soprano pipistrelle (n = 103), Leisler's bat (n = 100).

4.3 Local Bat Records

The desk and field-based assessments undertaken of the habitats within the proposed development area revealed High potential for bat roosting features.

The woodland habitats within the survey area provide foraging and commuting potential for bats. The majority of trees within the survey area were semi-mature. The majority of these trees did not support large crevices, apertures or dense ivy growth that could provide suitable roosting habitat for bats. Some trees did however support ivy growth, suggesting moderate suitability to support roosting bats.

The review of existing bat records within the study area (sourced from NBDC) reveals that No. 8 of the No. 9 recorded Irish species have been observed locally. The overall suitability of the area for bat activity was

High (31.67). The habitat suitability index for 'All bats' and for each individual species of bat is presented below (**See Table 4.2 below**). The index ranges from 0 to 100, with 100 being most suitable for bats.

Table 4.2: Bat Suitability Index for the site and its surrounding area (NBDC, 2023).

Suitability index for different bat species:		
Common Name	**Scientific Name**	**Suitability Score**
Soprano pipistrelle	*Pipistrellus pygmaeus*	38
Brown long-eared bat	*Plecotus auritus*	47
Common pipistrelle	*Pipistrellus pipistrellus*	48
Lesser horseshoe bat	*Rhinolophus hipposideros*	5
Leisler's bat	*Nyctalus leisleri*	38
Whiskered bat	*Myotis mystacinus*	33
Daubenton's bat	*Myotis daubentonii*	29
Nathusius' pipistrelle	*Pipistrellus nathusii*	1
Natterer's bat	*Myotis nattereri*	46
Total Score for All Bat Species		31.67

The area is deemed as favourable for bat activity with local areas of abundance present due to the suitable habitats surrounding and within the survey area. Thus, bats use the site for foraging and/or commuting through the site or along its boundaries, particularly along the hedgerows and treelines.

Table 4.3: Records of all bats available from the NBDC within 2km^2 grid squares S64X, S64W, S74B and S74C.

Species	Record Count	Date of Last Record	Designation
Brown Long-eared Bat (*Plecotus auritus*)	2	04/06/2012	EU Habitats Directive - Annex IV Protected Species: Wildlife Acts
Daubenton's Bat (*Myotis daubentonii*)	28	22/08/2014	EU Habitats Directive - Annex IV Protected Species: Wildlife Acts
Leisler's bat (*Nyctalus leisleri*)	2	04/06/2012	EU Habitats Directive - Annex IV Protected Species: Wildlife Acts
Pipistrelle (*Pipistrellus pipistrellus sensu lato*)	2	04/06/2012	EU Habitats Directive - Annex IV Protected Species: Wildlife Acts
Soprano Pipistrelle (*Pipistrellus pygmaeus*)	2	04/06/2012	EU Habitats Directive - Annex IV Protected Species: Wildlife Acts

Historic records of bats were recorded within the 10km^2 grid squares (S64 & S74) in which the study area is located and includes the following species: Brown Long-eared Bat (*Plecotus auritus*), Daubenton's Bat (*Myotis daubentonii*), Leisler's bat (*Nyctalus leisleri*), Nathusius's Pipistrelle (*Pipistrellus nathusii*), Natterer's Bat (*Myotis nattereri*), Common Pipistrelle (*Pipistrellus pipistrellus sensu lato*) and Soprano Pipistrelle (*Pipistrellus pygmaeus*).

4.4 Summary of Results

Surveys were undertaken using a range of techniques and covered the peak period of bat activity between May and September. This provides a robust dataset to support a future impact assessment.

Table 4.4: Bat Surveys Completed (Indicated by ticked box).

Surveys Completed:			
Endoscope Inspection	☑	Daytime Building Inspection	☑
Walking Transect	☑	Daytime Bridge Inspection	☑
Dusk Bat Survey	☑	Trapping / Mist Netting	☐
Dawn Bat Survey	☑	Driving Transect	☐
Static Detector Survey	☐	IR Camcorder filming	☐
Tree PBR Survey	☑	Trapping / Mist Netting	☐
Emergence Survey	☑	Other	☐

The survey area and its environs offer foraging and commuting habitat for bats. A total of No. 3 bat species have been recorded foraging across the survey area on a regular basis. The habitats of highest value to bats within the survey area were considered to be the mature woodlands, the Duiske and tributaries, hedgerows, treelines, grassland and

scrub. The spatial distribution of all species recorded was not uniform: bats were recorded in highest numbers in the vicinity of trees and hedgerows, and lowest in areas of built land with artificial lighting. This is unsurprising, as bats often prefer to feed along linear habitats such as woodland edges or hedgerows. Overall, the survey results demonstrate the value of the study area as a foraging and commuting habitat for bats. No bat roosts were recorded within the survey area.

Table 4.5: Bat Survey Results Overview.

Overview of Results:			
Bat Species	**Commuting**	**Foraging**	**Roosts**
Soprano pipistrelle *Pipistrellus pygmaeus*	☑	☑	
Brown long-eared bat *Plecotus auritus*			
Common pipistrelle *Pipistrellus pipistrellus*	☑	☑	
Lesser horseshoe bat *Rhinolophus hipposideros*			
Leisler's bat *Nyctalus leisleri*	☑	☑	
Whiskered bat *Myotis mystacinus*			
Daubenton's bat *Myotis daubentonii*			
Nathusius' pipistrelle *Pipistrellus nathusii*			
Natterer's bat *Myotis nattereri*			

Section 5: IMPACT ASSESSMENT & MITIGATION

5.1 Potential Impacts

Bat species within the area of the proposed development will likely be affected by both the construction phase and subsequent existence of new structures such as embankments and walls which may require the removal of mature trees.

Surveys of bats in the immediate area indicate that a diverse range of bat species use the site and surrounding area. The key impacts on bats as part of the proposed works arise through potential roost loss, loss of feeding areas and disruption of commuting routes.

5.2 Mitigation Measures

As the Graiguenamanagh -Tinnahinch Upstream Storage Area project is still in the early stages, the current information on the proposed works is limited and therefore detailed mitigation measures are not provided. The following general measures should be adhered to when selecting the preferred route and for the detailed design and construction of any flood relief scheme:

- Minimise the potential impact of proposed works on mature trees, treelines, and hedgerows.
- Retain trees where possible and protect trees and their roots from proposed works.
- Any trees that required to be felled should be assessed for the Potential Bat Roost (PBR) level prior to felling and alternative roosting sites should be provide (e.g. bat boxes).
- Undertake additional bat survey work on any buildings that may be impacted by proposed works.
- Any works undertaken on bridges/culverts requires bat mitigation measures.
- Restrict the usage of artificial lighting in work zones and ensure that such are turned off during the hours of darkness.
- Any removal of hedgerows and treelines requires landscape replacement (native tree and shrub species).

Standard mitigation measures as would apply to any large-scale development, should be adopted in the construction of the proposed Graiguenamanagh Upstream Storage Area. These include limiting season of disturbance to trees and vegetation to reduce impacts on breeding species, to provide for habitat replacement and to implement measures to avoid and/or control pollution and sedimentation into watercourses during construction and operation phases. Specific measures will be required to protect bats onsite, and these are detailed further below.

5.2.1 Lighting

All European bat species, including Irish bat species, are nocturnal. They usually hide in roosts during the daytime, while fly to feeding areas or drinking sites using commuting routes during the night. Annually bats will hibernate in the winter, swarm in the autumn, and give birth in the summer months.

In all aspects of the bat lifestyle, Artificial Light at Night (ALAN) may significantly change their natural behaviour in relation to roosting, commuting, and feeding. While bats are naturally exposed only to very low lighting levels produced by moonlight, starlight and low intensity twilight, light levels greater than natural light levels can impact on the lifestyle of bats.

Construction Phase Lighting

Where construction lighting is required, light spill should be minimised as much as possible. This can be achieved by the use of directional lighting (i.e. lighting which only shines on the proposed works and not nearby countryside) to prevent overspill. This should be achieved by the design of the luminaire and by using accessories such as hoods, cowls, louvres, and shields to direct the light to the intended area only. Lighting should be minimised in potential foraging

and commuting areas, and the times during which the lighting is on should be limited to provide some dark periods. Lights should be positioned to avoid sensitive areas and restricted so that there are dark areas. The timing of lights should be restricted to avoid bat activity (i.e. from dusk until dawn).

Operational Phase Lighting

The following specifications have been recommended for the lighting to be installed:

- 4000k colour temperature
- 0% ULR
- Full cut off visor

5.2.2 Trees to be retained

Where possible, mature trees and treelines that are located immediately adjacent to planned work areas or are not directly impacted should be avoided and retained intact. Overall impacts on these sites should be reduced through modified design and sensitivity during works. Retained trees should be protected from root damage by machinery by an exclusion zone of at least c. 7 metres or equivalent to canopy height. Such protected trees should be fenced off by adequate temporary fencing prior to other works commencing.

5.2.3 Removal of Trees

Should any mature broadleaved tree(s) be scheduled for removal as part of the proposed development plans, it should be surveyed for bat presence by a suitably experienced specialist immediately prior to felling. If bats are found, an application for a derogation licence should be made to the National Parks and Wildlife Service to allow its legal removal. Such trees should ideally be felled in the period late August to late October, or early November, in order to avoid disturbance of any roosting bats as per National Roads Authority (NRA) guidelines and also to avoid the bird breeding seasons. Tree felling should be completed by mid-November at the latest as bats roosting in trees are vulnerable to disturbance during their hibernation period (November - April). If trees are to be removed outside of these periods extra care should be taken prior to felling to ensure no protected species are present. Trees with ivy-cover, once felled, should be left intact onsite for 24 hours prior to disposal to allow any bats beneath foliage to escape overnight.

5.2.4 Boundary Vegetation

Linear features such as treelines and hedgerows serve as commuting corridors for bats (and other wildlife). The onsite boundary vegetation especially that bordering the Finnihy River should be retained and/or replaced once construction ends. Native species should be chosen in all landscaping schemes. Planting schemes should attempt to link in with existing wildlife corridors (hedgerows and treelines) to provide continuity of wildlife corridors.

5.3 Residual Impact

The construction phase of the proposed Graiguenamanagh -Tinnahinch Upstream Storage Area may displace certain bat species through disruption of commuting routes however, this is expected to be temporary. If the recommended mitigation measures outlined above to safeguard bats are implemented, preserving the present nature of the site and river corridor, the residual impact of the development on bats is expected to be negligible and all bat species recorded in the area should persist.

Section 6: SURVEY CONCLUSION

In general (according to Lundy *et al,* 2011), the landscape in which the proposed project is situated is of high suitability for common pipistrelle, soprano pipistrelle, brown long-eared bat, lesser horseshoe bat, leisler's bat and Natterer's bat, moderate suitability for, daubenton's bat and whiskered bat, and low for nathusius' Pipistrelle.

A total of No. 3 species of bat were recorded commuting and foraging within the survey area. The following bat species were recorded during this bat survey: common pipistrelles, soprano pipistrelles and Leisler's bats. This represents No. 3 of the No. 9 resident bat species known to Ireland.

The most abundant species was common pipistrelle, followed by Leisler's bat and soprano pipistrelle, this is a typical species assemblage for rural sites in Ireland. Bat activity was broadly distributed throughout the Site, with no obvious clustering of activity at any specific locations. Activity levels appeared to be slightly higher at some of the sampling points that were near linear habitat features (e.g. a road lined with treelines, or a partial hedgerow).

The ecological value of the Site can be categorised using the valuation system of the CIEEM Guidelines (2018). As the majority of the study area is used on a regular basis by common bat species, it is considered to be of *Local Ecological Value*. Nonetheless, it is noted that all bats and their roosts receive legal protection from destruction or disturbance under the *European Communities (Birds and Natural Habitats) Regulations 2011* (as amended).

The Overriding Purpose of the project is to provide flood defences in Graiguenamanagh Town to the standards of the EU Directive on the Assessment and Management of Flood Risk (Floods Directive 2007/60/EC) transposed into Irish Law as SI 122 of 2010. The proposed flood defences to include an allowance for freeboard (300mm for walls, 500mm for embankments) as per the OPW guidelines and to address Environmental, Social and Health and Safety concerns.

The Graiguenamanagh -Tinnahinch Upstream Storage Area was assessed in relation to potential impact on local bat populations. Due to the fact that the majority of bat activity was recorded along linear features such as treelines and hedgerows within the study area, any works which involve loss of treelines and hedgerows will impact on local bat populations due to the removal of commuting routes and foraging habitat.

Therefore, in consideration of the conservation of local bat populations, the application of the proposed mitigation measures outlined above in **Section 5** aims to ensure the implementation of safeguards for bats. By preserving the current nature of the site and river corridor, it is anticipated that the impacts of the development on bats will be negligible, and all bat species recorded in the area should persist.

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Section 8: APPENDICES

Appendix 1. MAPS & FIGURES

Figure 8.1: Site Location Map.

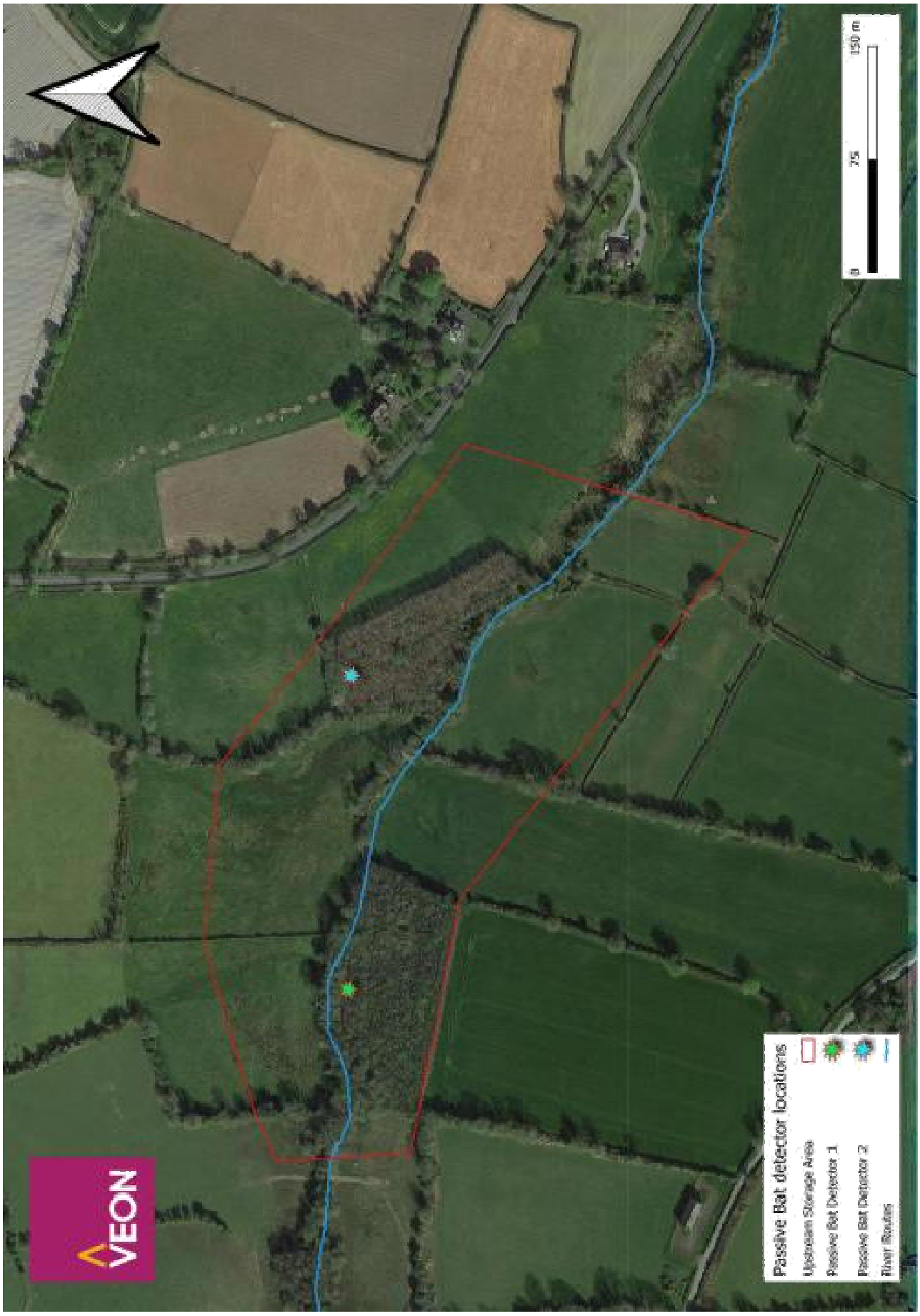

Figure 8.2: Passive Bat detector locations within the study area.

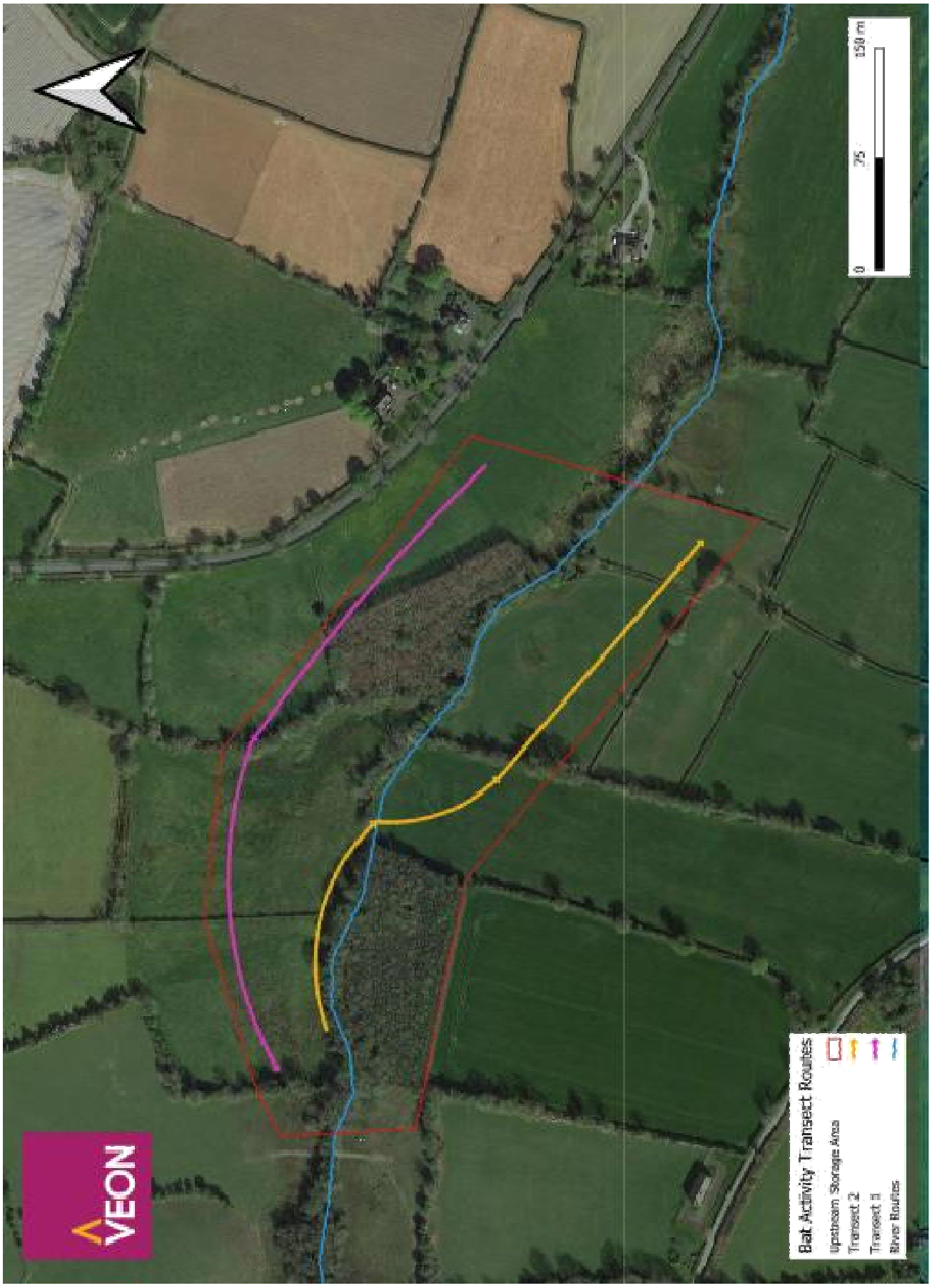

Figure 8.3: Bat Activity Transect Route.

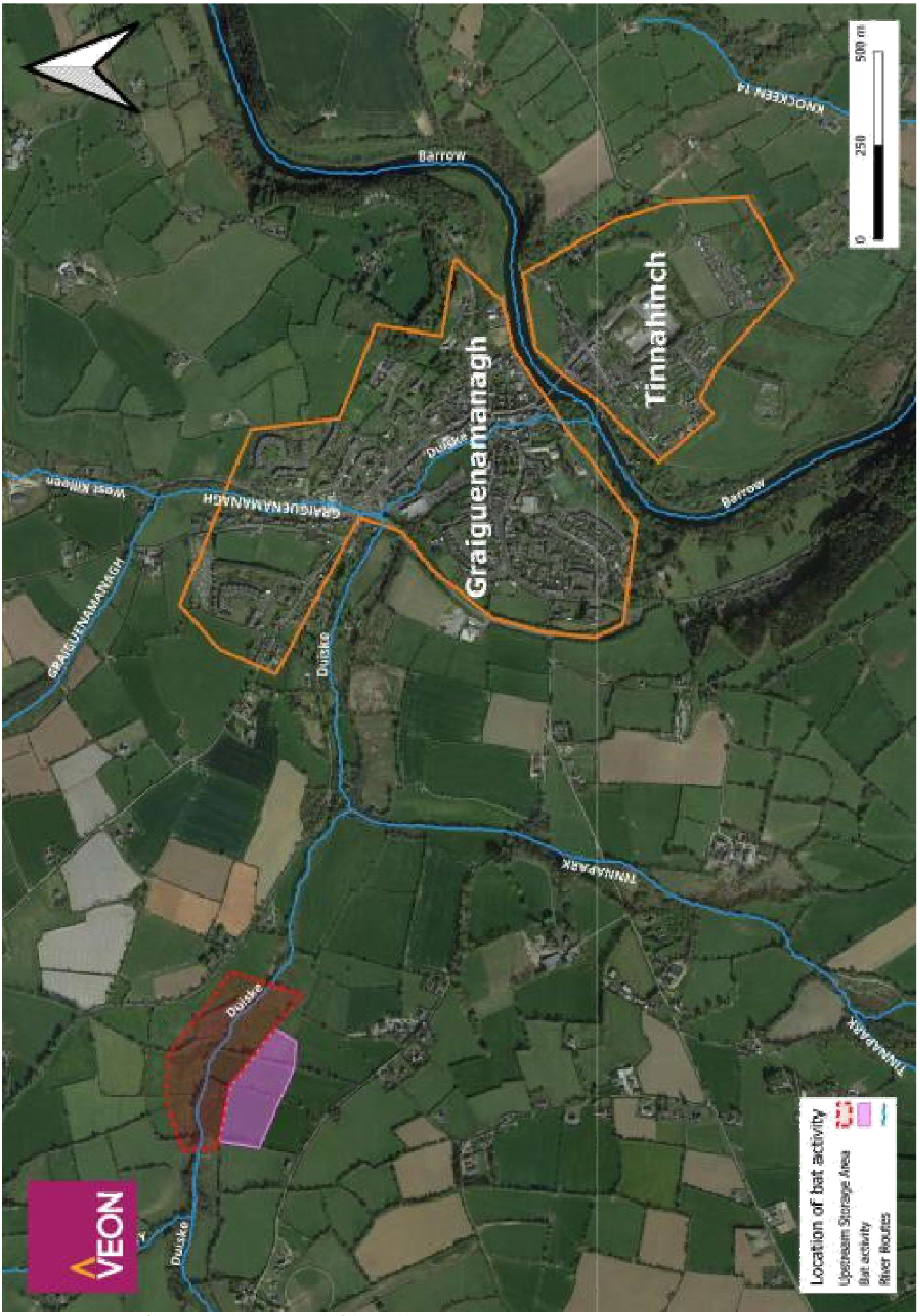

Figure 8.4: Location of bat activity hot spot south of the study area.

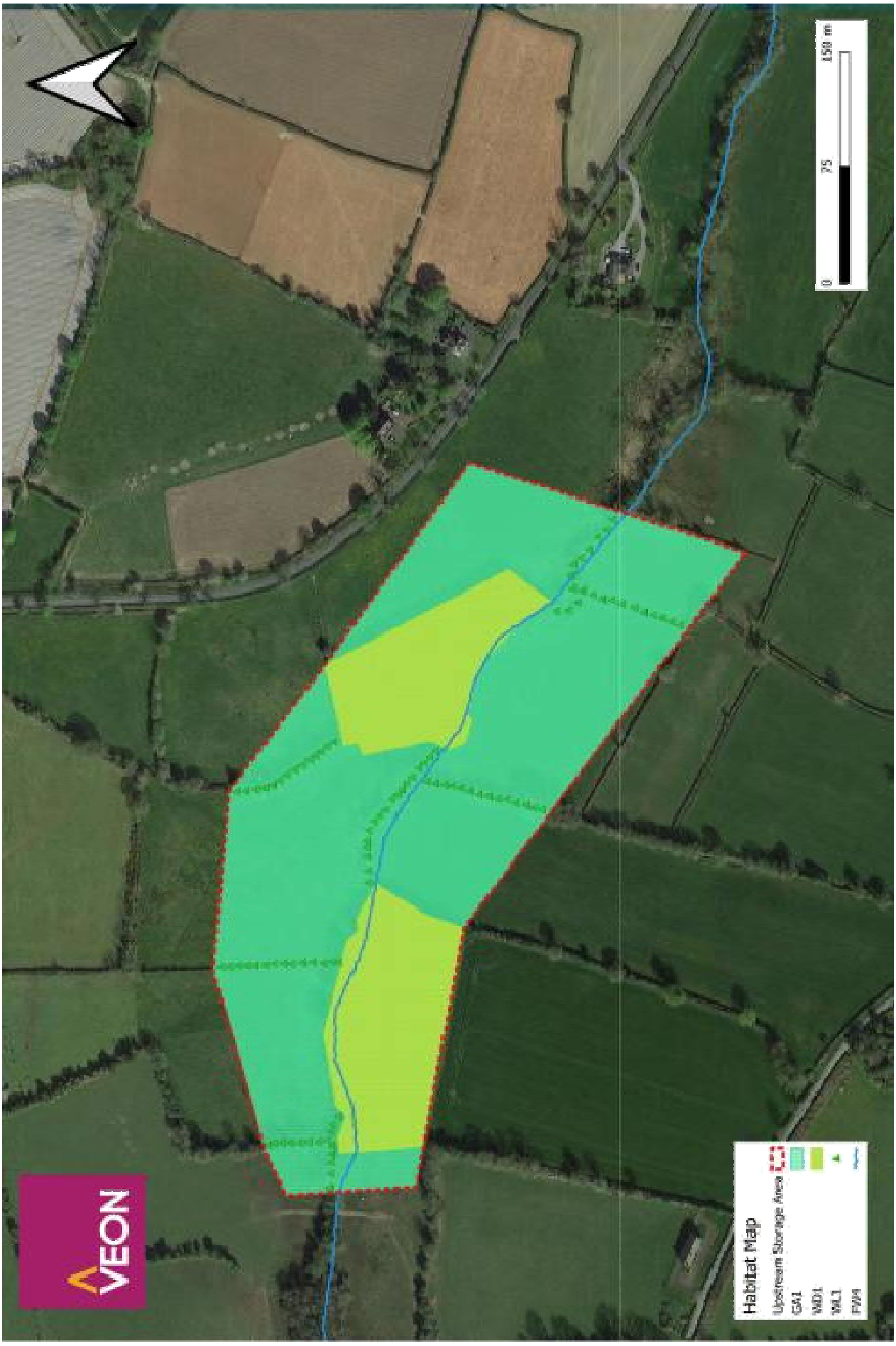

Figure 8.5: Habitats recorded on site.

Appendix 2. BAT SPECIES PROFILES

Ireland has No. 9 known established bat species from two distinct families. Each is briefly described below. For a more comprehensive overview see Roche et al (2014). The conservation status of each species is derived from NPWS (2019).

Vespertilionidae:

Leisler's bat (*Nyctalus leisleri*)

This species is Ireland's largest bat, with a wingspan of up to 320mm; it is also the third most common bat, preferring to roost in buildings, although it is sometimes found in trees and bat boxes. It is the earliest bat to emerge in the evening, flying fast and high with occasional steep dives to ground level, feeding on moths, caddisflies and beetles. The echolocation calls are sometimes audible to the human ear being around 15 kHz at their lowest. The audible chatter from their roost on hot summer days is sometimes an aid to location. The conservation status of this species is Favourable.

Ireland's population is deemed of international importance and the paucity of knowledge of roosting sites, makes this species vulnerable. However, it is widespread across the island. The modelled Core Area for Leisler's bats is a relatively large area that covers much of the island of Ireland (52,820km^2). The Bat Conservation Ireland Irish Landscape Model indicated that the Leisler's bat habitat preference has been difficult to define in Ireland. Habitat modelling for Ireland shows an association with riparian habitats and woodlands (Roche *et al.,* 2014). The landscape model emphasised that this is a species that cannot be defined by habitats preference at a local scale compared to other Irish bat species but that it is a landscape species and has a habitat preference at a scale of 20.5km. In addition, of all Irish bat species, Leisler's bats have the most specific roosting requirements. It tends to select roosting habitat with areas of woodland and freshwater.

The principal concerns for Leisler's bats are poorly known in Ireland but those that are relevant for this survey area are as follows:

- Selection of maternity sites is limited to specific habitats.
- Relative to the population estimates, the number of roost sites is poorly recorded.
- Tree felling, especially during autumn and winter months.
- Increasing urbanisation.

Common pipistrelle (*Pipistrellus pipistrellus*)

The common pipistrelle's echolocation calls peak at 45 kHz. The species forages along linear landscape features such as hedgerows and treelines as well as within woodland. This species is generally considered to be the most common bat species in Ireland. The species is widespread and is found in all provinces. The modelled Core Area for common pipistrelles is a large area that covers much of the island of Ireland (56,485km^2) which covers primarily the east and southeast of the area (Roche *et al.,* 2014). The Bat Conservation Ireland Irish Landscape Model indicates that the Common pipistrelle selects areas with broadleaf woodland, riparian habitats and low-density urbanization (<30%) (Roche *et al.,* 2014). The conservation status of this species is Favourable.

Principal concerns for Common pipistrelles in Ireland that are relevant for this survey area are as follows:

- Lack of knowledge of roosting requirements.
- This species has complex habitat requirements in the immediate vicinity of roosts. Therefore, careful site-specific planning for this species is required in order to ensure all elements are maintained.
- Renovation or demolition of derelict buildings.
- Tree felling .
- Increasing urbanisation (e.g. increase in lighting).

Soprano pipistrelle (*Pipistrellus pygmaeus*)

The soprano pipistrelle's echolocation calls peak at 55 kHz, which distinguishes it readily from the common pipistrelle on detector. The pipistrelles are the smallest and most often seen of our bats, flying at head height, and taking small prey such as midges and small moths. Summer roost sites are usually in buildings, but tree holes and heavy ivy are also used. Roost numbers can exceed 1,500 animals in mid-summer. The conservation status of this species is Favourable.

This species is generally considered to be the second most common bat species in Ireland. The species is widespread and is found in all provinces, with concentration along the western seaboard. The modelled Core Area for soprano pipistrelle is a large area that covers much of the island of Ireland (62,020km^2). The Bat Conservation Ireland Irish Landscape Model indicates that the soprano pipistrelle selects areas with broadleaf woodland, riparian habitats and low-density urbanisation (Roche *et al.,* 2014).

Principal concerns for Soprano pipistrelles in Ireland that are relevant for this survey area are as follows:

- Lack of knowledge of roosts.
- Renovation or demolition of structures.
- Tree felling.
- Increasing urbanisation (e.g. increase in lighting).

Nathusius' pipistrelle (*Pipistrellus nathusii*)

Nathusius' pipistrelle is a recent addition to the Irish fauna and has mainly been recorded from the north-east of the island in Counties Antrim and Down (Richardson, 2000) and in Fermanagh, Longford and Cavan. It has also been recorded in Counties Cork and Kilkenny (Kelleher, 2005). However, the known resident population is enhanced in the autumn months by an influx of animals from Scandinavian countries. It is not known whether the Irish population migrates within or from Ireland to another country to overwinter, although there is evidence that Nathusius' pipistrelle bats migrate from Britain to overwinter on continental Europe. The Nathusius' pipistrelle often forages over water or along forest tracks. The conservation status of this species is Favourable.

Natterer's bat (*Myotis nattereri*)

There are three species included in the Myotis species family and their echolocation calls are very similar across these three species. One of the rarer Irish bat species, the Natterer's bat likes woodland, mature hedgerow and pasture habitats. The Natterer's bat has broad wings so it can fly with great manoeuvrability among trees and around hedgerows. It sometimes gleans insects or even spiders from foliage and may eat larger prey at a feeding perch. Its usual roost sites are in tree holes, old stone buildings such as churches and barns, and under bridges. This species has a fringe of stiff bristles along the trailing edge of its tail membrane, which may help to hold or trap its prey.

This species has a slow to medium flight, usually over trees but sometimes over water. It usually follows hedges and treelines to its feeding sites, consuming flies, moths, caddisflies and spiders. The Natterer's bat is one of our least studied species and further work is required to establish its status in Ireland. The conservation status of this species is Favourable.

The modelled Core Area for Natterer's bats is a relatively large area that covers much of the island of Ireland (52,864km^2). The Bat Conservation Ireland Irish Landscape Model indicates that the Natterer's bat selects areas with broadleaf woodland, riparian habitats, and areas with larger scale provision of mixed forest (Roche et al., 2014).

Brown long-eared bat (*Plecotus auritus*)

This species of bat is a 'gleaner', hunting amongst the foliage of trees and shrubs, and hovering briefly to pick a moth or spider off a leaf, which it then takes to a sheltered perch to consume. They often land on the ground to capture

their prey. Using its nose to emit its echolocation, the long-eared bat 'whispers' its calls so that the insects, upon which it preys, cannot hear its approach (and hence, it needs oversize ears to hear the returning echoes). As this is a whispering species, it is extremely difficult to monitor in the field as it is seldom heard on a bat detector. Furthermore, keeping within the foliage, as it does, it is easily overlooked. It prefers to roost in old buildings. The conservation status of this species is Favourable.

This species is generally considered to be widespread across the island. The modelled Core Area for Brown long-eared bats is a relatively large area that covers much of the island of Ireland (52,820km^2) with preference suitable areas in the southern half of the island. The Bat Conservation Ireland Irish Landscape Model indicates that the Brown long-eared bat habitat preference is for areas with broadleaf woodland and riparian habitats on a small scale of 0.5km emphasising the importance of local landscape features for this species (Roche *et al.,* 2014).

Principal concerns for brown long-eared bats are poorly known in Ireland, but those that are relevant for this survey area are as follows:

- Selection of maternity sites is limited to specific habitats.
- Lack of knowledge of winter roosts.
- Loss of woodland, scrub and hedgerows.
- Tree surgery and felling.
- Increasing urbanisation.
- Light pollution.

Daubenton's bat (*Myotis daubentonii*)

This bat species prefers feeding close to the surface of smooth water, either over rivers, canals, ponds, lakes, or reservoirs but it can also be found foraging in woodlands. Flying at 15 kilometres per hour, it gaffs insects with its over-sized feet as they emerge from the surface of the water - feeding on caddis flies, moths, mosquitoes, midges etc. It is often found roosting beneath bridges or in tunnels and makes use of hollows in trees. The conservation status of this species is Favourable.

The modelled Core Area for Daubenton's bats is a relatively large area that covers much of the island of Ireland (41,285km^2) reflecting the distribution of sizeable river catchments. The Bat Conservation Ireland Landscape Model indicates that the Daubenton's bat habitat preference is for areas with broadleaf woodland, riparian habitats and low-density urbanisation (Roche *et al.,* 2014).

Principal concerns for Daubenton's bats are poorly known in Ireland but those that are relevant for this survey area are as follows:

- Potential roost loss due to bridge works.
- Loss of woodland and forest clearance.
- Loss of woodland, scrub, and hedgerows.
- Tree surgery and felling.
- Increasing urbanisation.
- Light pollution.

Whiskered bat (*Myotis mystacinus*)

This species, although widely distributed, has been rarely recorded in Ireland. It is often found in woodland, frequently near water. Flying high, near the canopy, it maintains a steady beat and sometimes glides as it hunts. It also gleans spiders from the foliage of trees. Whiskered bats prefer to roost in buildings, under slates, lead flashing or exposed beneath the ridge beam within attics. However, they also use cracks and holes in trees and sometimes bat boxes. The conservation status of this species is Favourable.

Rhinolophidae:

Lesser horseshoe bat (*Rhinolophus hipposideros*)

This species is the only representative of the Rhinolophidae or horseshoe bat family in Ireland. It differs from our other species in both habits and looks, having a unique nose leaf with which it projects its echolocation calls. It is also quite small and, at rest, wraps its wings around its body. Lesser horseshoe bats feed close to the ground, gleaning their prey from branches and stones. It often carries its prey to a perch to consume, leaving the remains beneath as an indication of its presence.

The echolocation call of this species is of constant frequency and, on a heterodyne bat detector, sounds like a melodious warble. The species is confined to six counties along the Atlantic seaboard: Mayo, Galway, Clare, Limerick, Kilkenny and Cork. The current Irish national population is estimated at 12,500 – 14,000 individuals. This species is listed on Annex II of the EC Habitats Directive and 41 Special Areas of Conservation have been designated in Ireland for its protection, of which 9 have also been selected for the Annex I habitat 'Caves not open to the public'. Where it occurs, it is often found roosting within farm buildings. In Ireland, the overall conservation status of lesser horseshoe bat is assessed as Favourable.

Lesser horseshoe bats forage on flying insects predominantly in deciduous woodland and riparian vegetation normally within a couple of kilometres of their roosts. The bats rely on linear landscape features (e.g. treelines, stonewalls and hedgerows) to navigate and commute from roosts to feeding sites and they are reluctant to fly out in the open.

Lesser horseshoe bats are sensitive to disturbance and normally do not occupy the same buildings as humans. Loss of roosting sites due to deterioration or renovation of old buildings, loss of commuting routes linking roosts to foraging sites and unsympathetic management of foraging sites are the major threats to this species.

Lesser horseshoe bats are very sensitive to light pollution and will avoid brightly lit areas. Artificial light at night at or near roosts may impact bats in a number of ways, for example, delaying emergence time after dusk, causing abandonment of roosts when exits are lit at night and/or reducing reproductive success.

Appendix 10-5 Bat Survey Report Top-up Report 2023

VEON Forestry, Ecology & Environment

Bat Survey Report

Graiguenamanagh Tinnahinch Flood Relief Scheme
Graiguenamanagh, Co. Kilkenny

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SUMMARY

Site: Townlands of Graiguenamanagh in County Kilkenny. Part of the settlement, known as Tinnahinch, is on the County Carlow side of the river, and Carlow County Council refers to the whole village as "Graiguenamanagh-Tinnahinch.

Proposed works:

Due to repeated and increasingly common flood events, a Flood Relief Scheme (FRS) for Graiguenamanagh town, is proposed. The objective of the Graiguenamanagh Flood Relief Scheme project is the identification, design and construction of a Flood Relief Scheme, that is technically, socially, environmentally and economical acceptable, to alleviate the risk of flooding to the community of Graiguenamanagh (Source: floodinfo.ie).

Considering the nature of project, potential significant effects on ecologically sensitive receptors such as bats cannot be ruled out. Large-scale development entailing changes to, or removal of existing vegetation and structures may adversely affect bats through loss of breeding/resting places or commuting/foraging features, displacement and injury. It is essential therefore that a study of protected species such as bats is undertaken in such cases to identify any conflict zones and hence to avoid and/or reduce impacts to bats through mitigation.

Surveyed by: Donnachadh Powell, BSc (Hons) Ecology and Environmental Biology, CIEEM, Lead Ecologist, David McGillycuddy, BSc (Hons) Wildlife Biology, CIEEM, Ecologist, Jason Cahill, BSc (Hons) Wildlife Biology, Ecologist, Sara Sheridan MSc BSc CIEEM, Ecologist and Anna Paula Moreira B.Sc. (Hons) in Environmental Science, Ecologist, Veon Ecology.

Survey effort:

As part of a wider ecological constraints assessment of the proposed flood relief scheme, Veon Ecology was commissioned to undertake a specific assessment of bat activity within the study area. Preliminary Roost Assessments were carried out on the relevant structures within the survey area and tree surveys were also conducted where possible to determine the presence of roosting bats. Transect walks were conducted on and around the proposed works locations to further characterise bat activity levels and species present. A moderate level of bat activity was recorded on site, likely due to a lack of foraging/roosting opportunities and high levels of sustained disturbances associated with anthropogenic activity such as artificial lighting.

Potential bat corridors in the vicinity of the area were also assessed. The bat activity surveys involved active acoustic sampling using handheld bat detectors at predetermined points. To ensure there is no negative impact on bats as a result of the proposed works, surveys were undertaken on all relevant buildings identified as having bat roosting potential.

Activity surveys were carried out on site. These surveys involved dusk emergence surveys and transect surveys.

Section 1: INTRODUCTION

1.1 Aims of the Report

Veon Ltd. (Veon Ecology) was commissioned by Ayessa on behalf of Kilkenny County Council (KCC) to undertake a survey for bats within a Survey Area affected by the proposed Graiguenamanagh Flood Relief Scheme hereafter referred to as the proposed Scheme. The Survey Area for bat activity surveys can be seen in **Figure 2.1** below.

The overarching aims of the bat surveys were as follows:

- To identify the areas and habitats within the Survey Area that are being used by bats (including flight paths/commuting routes and foraging areas);
- Collect robust data following good practice guidelines to allow an assessment of the potential impacts of the proposed project on local bat populations, both on and off-site (where possible);
- To identify the species of bats using the Survey Area;
- Provide baseline information with which the results of post-construction monitoring surveys can be compared to, where appropriate;
- To identify, where possible, any bat roosts within the Survey Area and the environs of the scheme;
- Facilitate the design of mitigation, enhancement and monitoring strategies for local bat populations recorded; and,
- Facilitate the conservation of local bat populations.

The bat surveys were completed during May to September 2024. This also informed the assessment of potential roost sites for bats. The Survey Area for this baseline assessment focussed within a 200m – 400m wide corridor of suitable habitat which encompasses the location of the proposed Scheme. Bat surveys focussed on suitable roosting and foraging habitat within the Zone of Influence (ZoI) such as watercourses, woodlands, treelines, hedgerows, grasslands and Riparian woodland along sections of the DUISKE_020 and BARROW_230 and tributaries which shall be directly impacted by the proposed works.

1.2 Relevant Legislation

All Irish bat species are protected under the *Wildlife Act (1976) and Wildlife Amendment Acts (2000 and 2010)*. Also, the EC Directive on *The Conservation of Natural habitats and of Wild Fauna and Flora (Habitats Directive 1992)*, seeks to protect rare species, including bats, and their habitats and requires that appropriate monitoring of populations be undertaken.

All Irish bats are listed in Annex IV of the Habitats Directive and the Lesser horseshoe bat (*Rhinolophus hipposideros)* is further listed under Annex II.

Across Europe, they are further protected under the *Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention 1982)*, which, in relation to bats, exists to conserve all species and their habitats.

The *Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention 1979, enacted 1983)* was instigated to protect migrant species across all European boundaries. The Irish government has ratified both these conventions.

Also, under existing legislation, the destruction, alteration, or evacuation of a known bat roost is a notifiable action, and a derogation licence has to be obtained from the National Parks and Wildlife Service (NPWS) before works can commence.

Any works interfering with bats and especially their roosts, may only be carried out under a licence to derogate from Regulation 23 of the Habitats Regulations 1997 and Regulation 54 of the European Communities (Birds and Natural Habitats) Regulations 2011 (which transposed the EU Habitats Directive into Irish law), issued by NPWS.

The details with regards to appropriate assessments, the strict parameters within which derogation licences may be issued and the procedures by which and the order in relation to the planning and development regulations such licences should be obtained, are set out in *Circular Letter NPWS 2/07 "Guidance on Compliance with Regulation 23 of the Habitats Regulations 1997 - strict protection of certain species/applications for derogation licences*" issued on behalf of the Minister of the Environment, Heritage and Local Government on the 16th of May 2007.

1.3 Bat Species in Ireland

There are eleven recorded bat species in Ireland, nine of which are considered Resident, two as Vagrant, namely:

1. Common pipistrelle (*Pipistrellus pipistrellus*)
2. Soprano pipistrelle (*Pipistrellus pygmaeus*)
3. Nathusius' pipistrelle (*Pipistrellus nathusii*)
4. Leisler's bat (*Nyctalus leisleri*)
5. Brown long-eared bat (*Plecutus auratus*)
6. Natterer's bat (*Myotis nattereri*)
7. Whiskered bat (*Myotis mystacinus*)
8. Daubenton's bat (*Myotis daubentonii*)
9. Lesser horseshoe bat (*Rhinolophus hipposideros*)
10. Brandt's bat (*Myotis brandtii*) (**Vagrant**)
11. Greater horseshoe bat (*Rhinolophus ferrumerquinum*) (**Vagrant**)

Eight of the nine resident bat species and one of the vagrant bat species are 'Vesper' bats. All *vespertilionid* bats have a tragus (cartilaginous structure inside the pinna of the ear). Vesper bats are distributed throughout the island.

The Lesser horseshoe bat (*Rhinolophus hipposideros)*, belongs to the *Rhinolophidea* and has a complex nose leaf structure on the face, distinguishing it from the Vesper bats. This species' current distribution is confined to the western seaboard counties of Mayo, Galway, Clare, Limerick, Kilkenny and Cork.

Only one confirmed record (corroborated by DNA testing) of the Brandt's bat (*Myotis brandtii*) has occurred in Ireland to-date. All other records have not been genetically confirmed. The Brandt's bat is very similar to the Whiskered bat (*Myotis mystacinus*), so it remains possible that the two have been confused in Ireland in the past. As such, the Brandt's bat is considered a vagrant.

The Greater horseshoe bat (*Rhinolophus ferrumerquinum)* was only recorded for the first time in February 2013 in County Wexford and is therefore also considered to be a vagrant species.

1.4 Guidance Documents

This report will draw on guidelines already available in Europe and will use the following documents:

- National Roads Authority (2006) Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes.
- National Roads Authority Guidelines for the Protection and Preservation of Trees, Hedgerows and Scrub Prior to, and During the Construction of National Road Schemes.
- Kelleher, C & Marnell, F. (2006). Bat Mitigation Guidelines for Ireland. Irish Wildlife Manuals, No. 25. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.
- Hundt, L. 2012 Bat Surveys: Best Practice Guidelines (2nd edition). Bat Conservation Trust, London.

- Collins, J. (Editor) 2016 Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edition). Bat Conservation Trust, London.
- McAney, K. (2006) A conservation plan for Irish vesper bats, Irish Wildlife Manual No. 20 National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.
- The status of EU protected habitats and species in Ireland: Conservation status in Ireland of habitats and species listed in the European Council Directive on the Conservation of Habitats, Flora and Fauna 92/43/EEC. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government.

Collins (2016) is the principal document used to provide guidance in relation to survey effort required however the level of surveying is assessed on a case-by-case basis taking into consideration the historical bat records for the survey area, presence of built structures and trees potentially suitable for roosting bats.

Impacts on bats can arise from activities that may result in the following:

- Lighting disturbance.
- Noise disturbance e.g. use of machinery, increase human presence etc.
- Physical disturbance of bat roosts e.g. destruction or renovation of buildings.
- Loss of roosts e.g. destruction or renovation of buildings.
- Loss of foraging habitats.
- Modifications of commuting or foraging habitats.
- Severance or fragmentation of commuting routes.

It is recognised that any development may have an impact on the receiving environment, but the significance of the impact will depend on the value of the ecological features that would be affected. Such ecological features will be those that are considered to be important and potentially affected by the proposed development.

The guidelines consulted recommend that the potential impacts of a proposed development on bats are assessed as early as possible in the design stage to determine any areas of conflicts.

Section 2: PROJECT DESCRIPTION

2.1 Site Location

The study area that formed the basis of the bat surveys includes the river BARROW_230 and waterbody DUISKE_020. Additional areas of Graiguenamanagh town were also surveyed. A map of the proposed works locations and survey area is illustrated in **Figure 2.1** below. The waterbody DUISKE_020 flows south-eastwards to Graiguenamanagh town and meets river BARROW_230 (Lat Lon coordinate: *52.538580, -6.955742*).

The River Barrow is considered a Freshwater Pearl Mussel (FPM) sensitive area. Water quality in the River Barrow is generally classified as poor under the WFD. There are significant polluting sources within the survey area including Benzo(g,h,i)perylene and Benzo(k)fluoranthene.

The survey area supports a variety of habitats including hedgerows, treelines, grasslands, woodland and scrub. Land-usage in the wider landscape is primarily for livestock agriculture, residential and forestry. The habitats within the survey area provide suitable foraging areas for bats, as well as opportunities for roosting sites.

The survey area overlaps or is in close proximity to the following Natura 2000 sites:

- River Barrow and River Nore SAC (002162)
- Thomastown Quarry SAC (002252)
- Slaney River Valley SAC (000781)
- Blackstairs Mountains SAC (000770)
- River Nore SPA (004233)

River Barrow and River Nore SAC (002162) is very important for the presence of a number of E.U. Habitats Directive Annex II animal species including Freshwater Pearl Mussel (both *Margaritifera margaritifera* and *M. m. durrovensis*), White-clawed Crayfish, Salmon, Twaite Shad, three lamprey species – Sea Lamprey, Brook Lamprey and River Lamprey, the tiny whorl snail Vertigo moulinsiana and Otter. This is the only site in the world for the hard water form of the Freshwater Pearl Mussel, *M. m. durrovensis*, and one of only a handful of spawning grounds in the country for Twaite Shad.

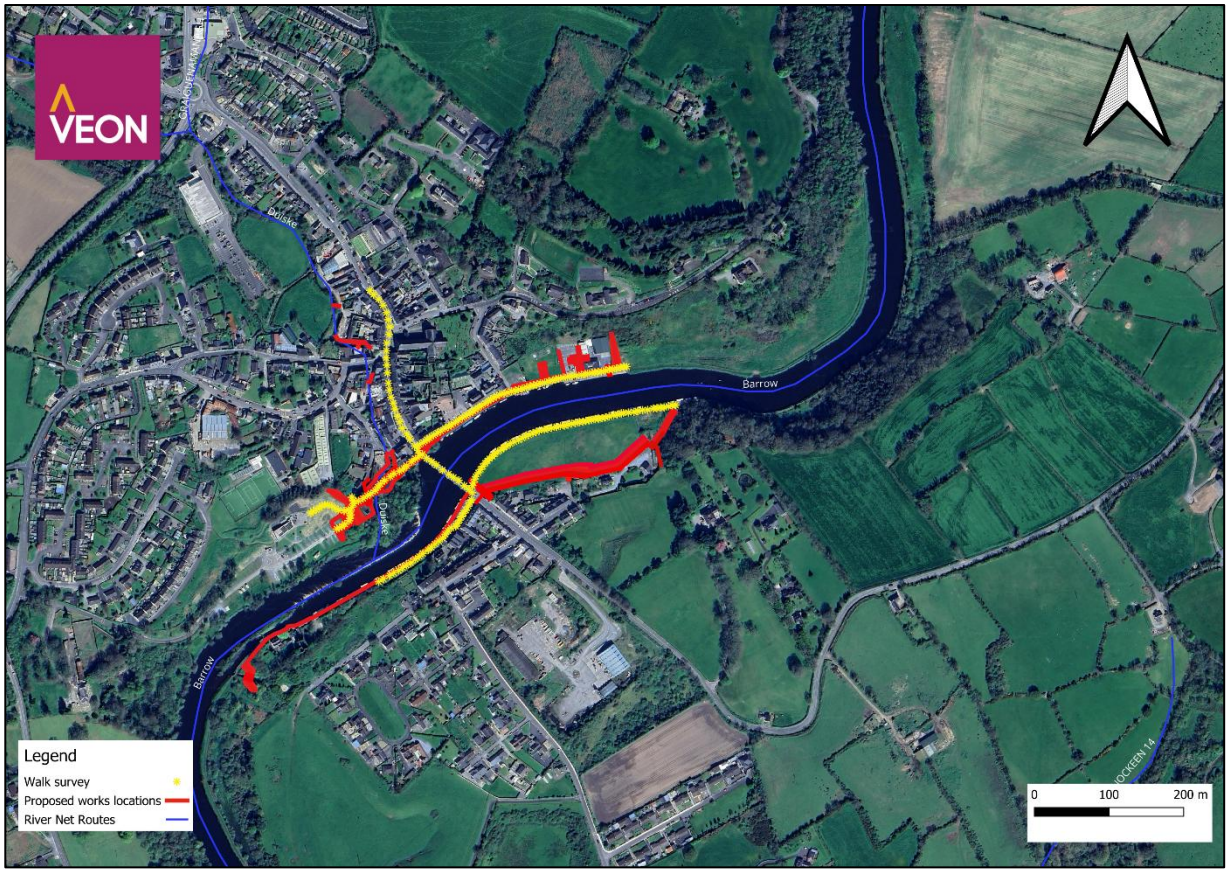

Figure 2.1: Proposed Works Locations/ Bat Survey Area and relevant watercourses Map.

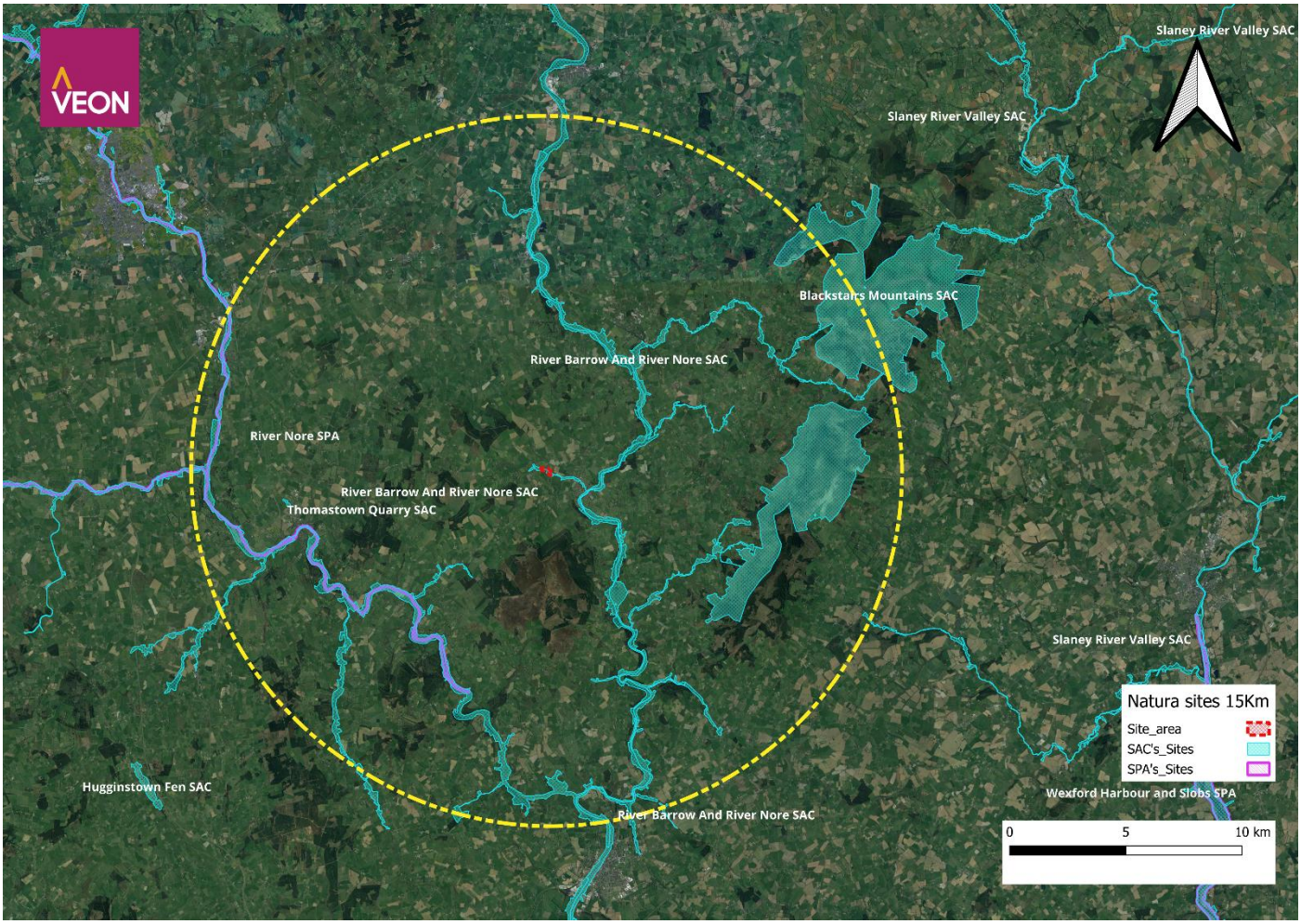

Figure 2.2: Natura Sites within 15km of the possible works locations.

2.2 Project Description

The Office of Public Works (OPW) completed Catchment Flood Risk Assessment and Management (CFRAM) studies covering the entire country reviewing flood-prone sites. Graiguenamanagh-Tinnahinch was identified during the study as one of the areas at risk to flooding. The plan set out the measures and policies to be pursued in order to achieve the most cost effective and sustainable management of flood risk.

The objective of the Graiguenamanagh Tinnahinch Flood Relief Scheme project is the identification, design and construction of a Flood Relief Scheme, that is technically, socially, environmentally and economical acceptable, to alleviate the risk of flooding to the community of Graiguenamanagh Tinnahinch (Source: floodinfo.ie).

Survey areas were based on the final preliminary design of the proposed flood defence works. The preliminary design is illustrated in **Figure 2.1**.

Section 3: METHODOLOGY

Initially, a desktop assessment of aerial photographs along the route of the proposed flood relief scheme was undertaken to identify existing habitats, buildings and structures which may be favourable for bat use within the potential works locations.

Bat surveys are comprised of many different types and may differ from site to site depending on the aims of the survey. The surveys deemed suitable for a particular project is determined on a case-by-case basis.

To fulfil the Survey brief, the following activities were carried out:

- Daytime walkover survey of the site and immediate area.
- Daytime inspection of the relevant building(s)/structure(s) directly.
- Active acoustic surveys in the study area during night hours.
- Review of historical bat surveys conducted within the vicinity of the site.
- Desktop study of the National Biodiversity Data Centre (NBDC) Bat Suitability Index.

3.1 Bat Habitat and Commuting Routes

The survey site was assessed during daytime walkover surveys, in relation to potential bat foraging habitat and potential bat commuting routes. Bat habitats and commuting routes identified are considered in relation to the wider landscape to determine landscape connectivity for local bat populations through the examination of aerial photographs.

All areas were surveyed on foot, mainly along hard-surfaced roads, grassland, built land and along the river corridor.

3.2 Survey for presence/absence of Bat roosts

A preliminary roost assessment (PRA) was carried out during daylight hours (exterior and interior) to identify any evidence of roosting bats, current or historic. Potential roosting features (PRFs) were recorded at these buildings/structures during daytime visual inspections. A bat activity survey was carried out to confirm the presence or absence of roosting bats at these buildings/structures. Surveys followed guidelines outlined in Collins (2016).

3.2.1 Preliminary Roost Assessment

The relevant buildings, structures and trees within the survey area were investigated during daylight hours to record any signs of current and/or historic bat presence, such as droppings, brown staining from urine, feeding remains and surfaces smoothed around entrance holes. Kelleher & Marnell (2006) provide guidance on assessing the potential for structures to support roosting bats. This guidance identifies a variety of factors that increase or decrease the potential of a structure to function as a bat roost, namely:

Increase Potential
Disused or little used; largely undisturbed; Large roof void with unobstructed flying spaces; Large dimension roof timbers with cracks, joints, and holes; Uneven roof covering with gaps, though not too draughty; Entrances that bats can fly in through; Hanging tiles or wood cladding, especially on south-facing walls; Rural setting; Close to woodland and/or water; Pre-20th century or early 20th century construction; Roof warmed by the sun.

Decrease Potential
Urban setting or highly urbanised area with few feeding places; Small or cluttered roof void; Heavily disturbed; Modern construction with few gaps around soffits or eaves; Prefabricated with steel sheet materials; Active industrial premises; Roof shaded from the sun; High internal day time light levels.

The day-time inspections focused on identifying any suitable ingress and egress points for bats into any relevant structures and a thorough search of all exterior areas of the relevant buildings. Internal inspections of buildings including the roof and attic spaces are also completed, where safe access is possible.

The following equipment was used during the PRA and activity surveys:

- Wildlife Acoustics Echometer Touch 2 Bat Detector (Android).
- High-powered Maglite© hand torch and LED head torch.
- Endoscope (Explorer Premium) Wireless inspection camera.

3.2.2 Activity Surveys

Bat emergence/re-entry surveys are typically undertaken at dusk or dawn between April and September to identify whether bats are present within a structure and provide additional confidence in any negative survey results from preliminary roost assessment surveys conducted if the buildings, structures and/or trees are identified as medium or high potential for a roost to be present.

Dusk surveys were started from 10 minutes before sunset to at least 100 minutes post sunset (extended survey period times occurred in relation to walking transects).

Conducting an Emergence Bat survey allows surveyors to identify:

- Whether bats are present in a structure, the species, and number involved.
- Entrance and exit points for the roost.
- Any actions needed to be taken to ensure legal compliance.
- The type of roost, i.e.:
    - Day roosts: individual bats, or small groups of males, are using the area for shelter during daylight hours.
    - Feeding roosts: whereby bats, particularly Brown Long-Eared and Horseshoe species feed during the night.
    - Night roost: where bats rest or shelter between feeding sessions.
    - Hibernation roost: where bats hibernate over the winter periods.
    - Transitional or occasional roost: where bats gather at a temporary site before and after hibernation.
    - Mating site: Males and females gather in late summer to early winter.
    - Maternity roost: where babies are born and raised until they're independent.
    - Satellite roost: where breeding females roost close to the main nursery colony in the breeding season.
    - Swarming site: where bats gather in large numbers from late summer to autumn.

Bats rely heavily on buildings for roosting. Average maternity colony sizes are about 50 bats although most roosts are much smaller. Larger roosts are not uncommon among particular species. A maternity or nursery roost is where females gather to give birth in the summer. Bats typically roost in buildings during the summer months, leaving in autumn to seek a site with a more stable temperature regime for hibernation.

As a standard approach, all emerging or re-entering bats observed at a structure are recorded along with their flight path, their species, and the time of flight. Vegetation, habitat, and relevant environmental factors are also detailed, where applicable and appropriate.

Walking transects involve the surveyor(s) walking the survey area, noting the time, location and bat species encountered. The Wildlife Acoustics Echo Meter Touch 2 (Android) recordings are mapped using QGIS with the produces WAV files. The validation of bat records is completed by the principal bat surveyor prior to mapping.

3.2.3 Building & Structure Inspection

Structures, buildings and other likely places that may provide a roosting space for bats were inspected during the daytime for evidence of bat usage. Evidence of bat usage is in the form of actual bats (visible or audible), bat droppings, urine staining, grease marks (oily secretions from glands present on stonework) and claw marks. Inspections were undertaken visually with the aid of a strong torch beam (High-powered Maglite© hand torch and LED head torch) and endoscope (Explorer Premium). Bat surveys should ideally be carried out during summer when bats are most active, unless the site is thought to be important for hibernating bats in which case a survey during cold weather in winter may be required.

Bridge structures and similar stone structures were assessed (where possible) using a 4-point classification system designed for bridges by Billington & Norman (1997)[1] as follows:

Table 3.1: Bridge and Stone Structure Bat Roost Classification System.

Bridge Bat Roost Classification System:	
Bridge Category	**Description**
0	No potential (i.e. no suitable crevices for roosting bats).
1	Low potential (i.e. crevices present that may be of use to bats).
2	High potential (i.e. crevices ideal for roosting bats but no evidence of usage during inspections).
3	Roost (evidence of bats roosting either because bats are present or other evidence is recorded during inspection (e.g. bat droppings).

3.2.4 Tree Potential Bat Roost (PBRs) Inspection

Trees that may provide a roosting space for bats are classified using the Bat Tree Habitat Key (BTHK, 2023)[2] and the classification system used is from Collins (2016). The Potential Roost Features (PRFs) listed in this guide are used to determine the PBR value of trees.

It can be challenging to ascertain the absence of roosts in trees, even if no bats are detected. Therefore, precautionary measures may be necessary during tree felling and pruning activities. If a tree is deemed to be a roost site then further surveying involving dusk and dawn surveys of the actual trees may be recommended to determine what bat species are present etc. If bats or a bat roost is identified, it is imperative to contact the NPWS (National Parks and Wildlife Service). Before commencing felling activities, obtaining a derogation license from NPWS is mandatory.

Table 3.2: Tree Bat Roost Category Classification System (Collins, 2016).

Tree Bat Roost Classification System:	
Tree Category	**Description**
1 (High)	Trees with multiple, highly suitable features (Potential Roosting Features = PRFs) capable of supporting larger roosts.
2 (Moderate)	Trees with definite bat potential but supporting features (PRFs) suitable for use by individual bats.
3 (Low)	Trees have no obvious potential although the tree is of a size and age that elevated surveys may result in cracks or crevices being found or the tree supports some features (PRFs) which may have limited potential to support bats.
4 (Negligible)	Trees have no potential.

[1] Billington, G.E. & Norman, G.M. (1997), The Conservation of Bats in Bridges Project.
[2] BTHK (2023) Bat Roosts in Trees – A Guide to Identification and Assessment for Tree-Care and Ecology Professionals.

3.3 Desk Study

In addition to surveys carried out on site, a detailed desktop study was carried out using information from publicly available databases such as NWPS and NBDC to further characterise the local bat ecology and potential significant effects on bat communities which may be present in the area but were not recorded during on site surveys.

3.3.1 National Biodiversity Data Centre (NBDC)

A review of National Biodiversity Data Centre (NBDC) historical records was undertaken. The proposed development site area falls within No. 2 separate 10km^2 data grid squares (S64 & S74) (See **Figure 3.1**). The NBDC Map Viewer has a 'Bat Suitability Index' (Source: NBDC & Lundy et al. 2011). This will be referred to where applicable and appropriate in this current survey.

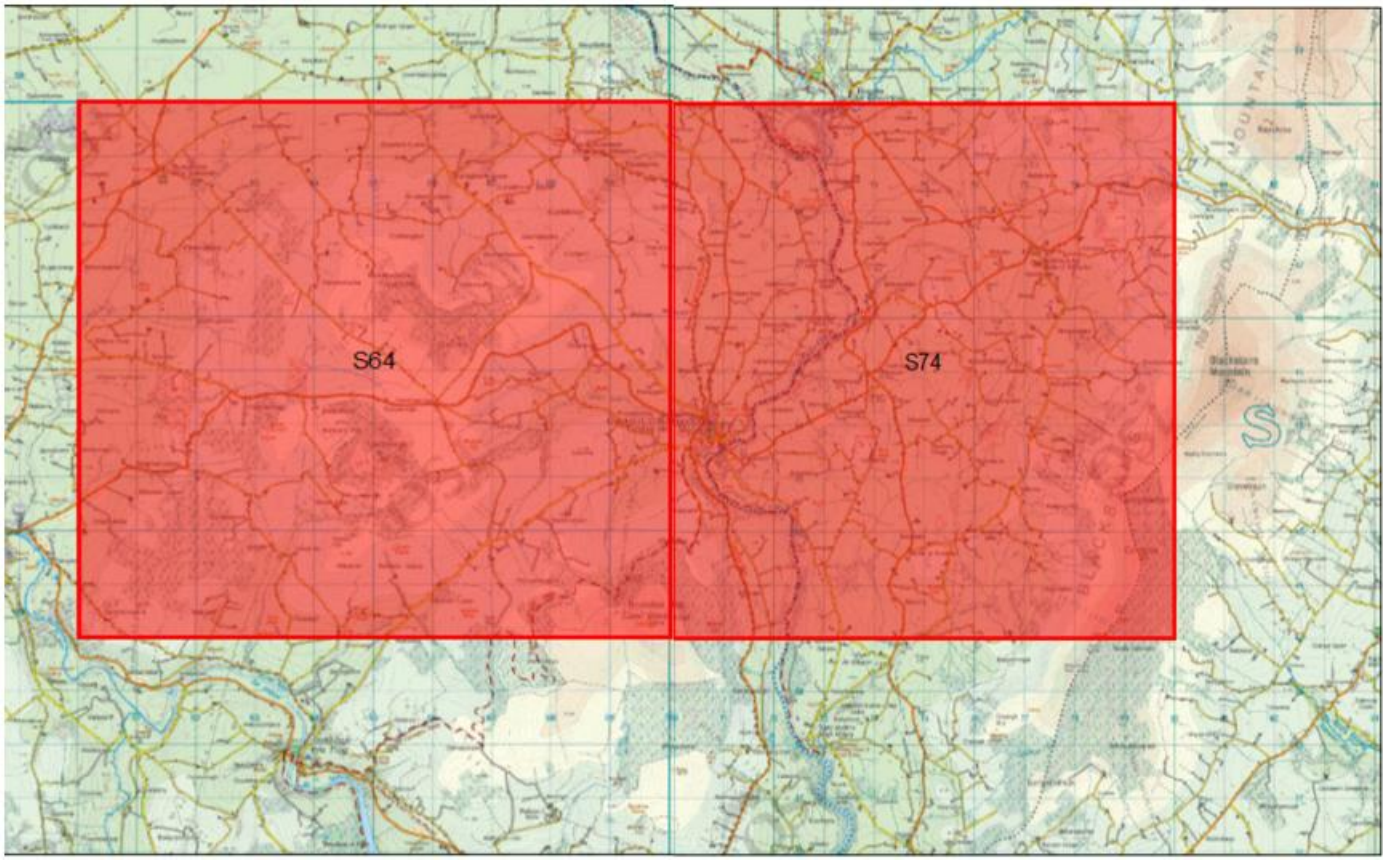

Figure 3.1: The 10km^2 data grid squares (S64 & S74) overlapping the survey area (Source: NBDC).

3.3.2 Photographic Record

A photographic record was completed for the survey and is presented throughout the text where applicable, and in **Section 8, Appendix 2**.

Section 4: SURVEY RESULTS

The surrounding landscape of Graiguenamanagh, Co. Kilkenny is primarily agricultural land with, treelines and hedgerows. There is a high level of connectivity in the landscape which makes it suitable for commuting and foraging bat populations.

The town of Graiguenamanagh is subjected to artificial lighting at night which reduces its suitability for foraging and commuting bats considered to be light sensitive (e.g. Daubenton's bats).

4.1 Preliminary Roost Assessment

The daytime Preliminary Roost Assessment (PRA) survey was carried out on the relevant buildings and structures.

Signs of roosting bats were not recorded during surveys. PRFs were identified on some trees and buildings which have the potential to support at least small numbers or individual roosting bats. Examples of PRFs recorded on site include:

- Gaps between brickwork.
- Small cavities within the walls of structures.
- Small cavities/bark tear-outs on trees

No roosts were identified site within the survey area.

4.1.1 Buildings & Structures Inspection Results

The relevant buildings/structures within the study area provide some potential roosting opportunities for bats. Structures were surveyed where possible, and signs of roosting bats were recorded. On no occasion were any species of bats seen re-entering or emerging from the buildings or structures during surveys. It should be noted that there are several buildings in the town have potential to support roosting bats. Common Pipistrelles were recorded at their average emergence time in close proximity to some buildings located near the river. Emergence surveys were carried out in areas where bats were recorded during their average emergence time. However, no bats were directly observed emerging from the target buildings. Several PRFs were observed on most buildings within the town, and bats may occupy these buildings occasionally.

Bridges and culverts within the survey area were inspected to determine their potential/ suitability for bat roosts. These structures surveyed have a Category 0 rating because they have no suitable features that can provide roosting sites for bats.

4.1.2 Tree Potential Bat Roost (PBRs) Inspection Results

The semi-mature trees within the study area provide some potential roosting opportunities for bats. Trees were surveyed where possible and no roosting bats or signs of roosting bats, current or historic, were recorded. On no occasion were any species of bats seen re-entering or emerging from trees during surveys.

Mature trees within the survey area were inspected to determine their Potential Bat Roost (PBR) value. All of the trees/tree groups surveyed have a Category 2 PBR rating because they have some suitable features that can provide roosting sites for bats.

4.2 Activity Surveys

Where it was safe to do so, transects were walked along the study area to identify any bat hot spots and corridors. No bats were recorded emerging from any structures during any of the activity surveys.

The Transect surveys involved Active acoustic sampling using handheld bat detectors (Wildlife Acoustics Echometer Touch 2 Bat Detector). Hot spots of bat activity were found across the study area, mostly near the river and near areas

of woodland outside the boundary of proposed works (see Appenidix). Common pipistrelles and soprano pipistrelles were recorded frequently commuting near the treelines close to the river.

There are high levels of sustained disturbances associated with human activity throughout the survey area, such as traffic and artificial lighting. Foraging opportunities within the townland were sparse in sections and of low suitability (low insect abundance, high levels of artificial lighting), which lowers the ecological value of certain sections of the site to Irish bat species.

No. 4 species of bat were recorded foraging in the survey area. These include the following: Soprano pipistrelle, Daubenton's bat, Common pipistrelle and Leisler's bat.

Common pipistrelle and Leisler's bats were the most frequently recorded bat species. The remaining bat species were more associated with dense tree lines and dark areas away from artificial lighting within Town.

In summary, little bat activity was recorded associated with the river running through the town. The majority of bat activity was associated with the dense treelines located within study area, mostly in the eastern side of the survey area, on the south side of the river.

4.2.1 Bat Activity Indices

During transects, the number of times a bat was encountered is described as the number of bat passes. The number of bat passes recorded are used as the standard measure to create a relative index of bat activity. This is either expressed as the number of bat passes per hour or per survey night. A contact ("bat pass"), as recorded in the results from these surveys, describes a bat observed by the surveyor. This contact can range from a commuter passing quickly to a foraging bat circling a feature lasting for several minutes. Bat contacts do not equate to numbers of bats as individual bats of the same species cannot be differentiated. A single bat continuously foraging in proximity to the detector can generate a large number of contacts in one night. In addition, variability occurs in the likelihood of detection between species. The same bat may be recorded in several contacts throughout the night. This survey type cannot estimate abundance of bats, rather activity; the amount of uses bats make of an area/feature. Where multiple visits for a transect are required, the start and end points of transect walks were alternated between visits to intersperse time and location (i.e., to prevent bias due to certain areas always being surveyed close to dusk).

4.3 Local Bat Records

The desk and field-based assessments undertaken of the habitats within the proposed development area revealed High suitability for potential bat roosting features (e.g. bark tear-outs, cavities from storm damage etc.).

The woodland habitats surrounding the survey area provide the greatest foraging and commuting potential for bats. The majority of trees within the survey area were juvenile and semi-mature. The majority of these trees did not support large crevices, apertures or dense ivy growth that could provide suitable roosting habitat for bats. Some trees did however support ivy growth, suggesting moderate suitability to support roosting bats.

The review of existing bat records within the study area (sourced from NBDC) reveals that No. 8 of the No. 9 recorded Irish species have been observed locally. The overall suitability of the area for bat activity was High (31.67). The habitat suitability index for 'All bats' and for each individual species of bat is presented below (See **Table 4.4** below). The index ranges from 0 to 100, with 100 being most suitable for bats.

Table 4.1: Bat Suitability Index for the site and its surrounding area (NBDC, 2023).

Suitability index for different bat species:		
Common Name	**Scientific Name**	**Suitability Score**
Soprano pipistrelle	*Pipistrellus pygmaeus*	38
Brown long-eared bat	*Plecotus auritus*	47
Common pipistrelle	*Pipistrellus pipistrellus*	48
Lesser horseshoe bat	*Rhinolophus hipposideros*	5
Leisler's bat	*Nyctalus leisleri*	38
Whiskered bat	*Myotis mystacinus*	33
Daubenton's bat	*Myotis daubentonii*	29
Nathusius' pipistrelle	*Pipistrellus nathusii*	1
Natterer's bat	*Myotis nattereri*	46
Total Score for All Bat Species		31.67

The area is deemed as favourable for bat activity with local areas of abundance present due to the suitable habitats surrounding and within the survey area. Thus, bats use the site for foraging and/or commuting through the site or along its boundaries, particularly along the hedgerows and treelines.

Table 4.2: Records of all bats available from the NBDC within 2km² grid squares S64X, S64W, S74B and S74C.

Species	Record Count	Date of Last Record	Designation
Brown Long-eared Bat (*Plecotus auritus*)	2	04/06/2012	EU Habitats Directive - Annex IV Protected Species: Wildlife Acts
Daubenton's Bat (*Myotis daubentonii*)	28	22/08/2014	EU Habitats Directive - Annex IV Protected Species: Wildlife Acts
Leisler's bat (*Nyctalus leisleri*)	2	04/06/2012	EU Habitats Directive - Annex IV Protected Species: Wildlife Acts
Pipistrelle (*Pipistrellus pipistrellus sensu lato*)	2	04/06/2012	EU Habitats Directive - Annex IV Protected Species: Wildlife Acts
Soprano Pipistrelle (*Pipistrellus pygmaeus*)	2	04/06/2012	EU Habitats Directive - Annex IV Protected Species: Wildlife Acts

Historic records of bats were recorded within the 10km² grid squares (S64 & S74) in which the study area is located and includes the following species: Brown Long-eared Bat (*Plecotus auritus*), Daubenton's Bat (*Myotis daubentonii*), Lesser Horseshoe Bat (*Rhinolophus hipposideros*), Leisler's bat (*Nyctalus leisleri*), Nathusius's Pipistrelle (*Pipistrellus nathusii*), Natterer's Bat (*Myotis nattereri*), Common Pipistrelle (*Pipistrellus pipistrellus sensu lato*) and Soprano Pipistrelle (*Pipistrellus pygmaeus*) (See **Figures 4.5 – 4.8**).

4.4 Summary of Results

Surveys were undertaken using a range of techniques and covered the peak period of bat activity. Surveys were carried out during suitable weather conditions favourable to bats, on 27th May 2024, 23rd June2024, 18th July 2024 and September 4th 2024. This provides a robust dataset to support a future impact assessment as bat activity was assessed over a

Table 4.3: Bat Surveys Completed (Indicated by ticked box).

Surveys Completed:			
Endoscope Inspection	☑	Daytime Building Inspection	☑
Walking Transect	☑	Daytime Bridge Inspection	☑
Dusk Bat Survey	☑	Trapping / Mist Netting	☐
Dawn Bat Survey	☑	Driving Transect	☐
Static Detector Survey	☐	IR Camcorder filming	☐
Tree PBR Survey	☑	Trapping / Mist Netting	☐
Emergence Survey	☑	Other	☐

The survey area and its environs offer foraging and commuting habitat for bats. A total of No. 4 bat species have been recorded foraging across the survey area on a regular basis. The habitats of highest value to bats within the survey area were considered to be the mature woodlands, the River Barrow and tributaries, hedgerows, treelines, grassland and scrub. The spatial distribution of all species recorded was not uniform: bats were recorded in highest numbers in the vicinity of trees and hedgerows, and lowest in areas of built land with artificial lighting. This is unsurprising, as bats often prefer to feed along linear habitats such as woodland edges or hedgerows. Overall, the survey results demonstrate the value of the study area as a foraging and commuting habitat for bats.

Table 4.4: Bat Survey Results Overview.

Overview of Results:			
Bat Species	**Commuting**	**Foraging**	**Roosts**
Soprano pipistrelle *Pipistrellus pygmaeus*	☑	☑	
Brown long-eared bat *Plecotus auritus*			
Common pipistrelle *Pipistrellus pipistrellus*	☑	☑	
Lesser horseshoe bat *Rhinolophus hipposideros*			
Leisler's bat *Nyctalus leisleri*	☑	☑	
Whiskered bat *Myotis mystacinus*			
Daubenton's bat *Myotis daubentonii*	☑	☑	
Nathusius' pipistrelle *Pipistrellus nathusii*			
Natterer's bat *Myotis nattereri*			

Section 5: IMPACT ASSESSMENT & MITIGATION

5.1 Potential Impacts

Bat species within the area of the proposed development will likely be affected by both the construction phase and subsequent existence of new structures such as embankments and walls which may require the removal of mature trees.

Surveys of bats in the immediate area indicate that a diverse range of bat species use the site and surrounding area. The key impacts on bats as part of the proposed works arise through potential roost loss, loss of feeding areas and disruption of commuting routes.

5.2 Mitigation Measures

As the Graiguenamanagh Flood Relief Scheme project is still in the early stages, the current information on the proposed works is limited and therefore detailed mitigation measures are not provided. The following general measures should be adhered to when selecting the preferred route and for the detailed design and construction of any flood relief scheme:

- Minimise the potential impact of proposed works on mature trees, treelines, and hedgerows.
- Retain trees where possible and protect trees and their roots from proposed works.
- Any trees that required to be felled should be assessed for the Potential Bat Roost (PBR) level prior to felling and alternative roosting sites should be provide (e.g. bat boxes).
- Undertake additional bat survey work on any buildings that may be impacted by proposed works.
- Any works undertaken on bridges/culverts requires bat mitigation measures.
- Restrict the usage of artificial lighting in work zones and ensure that such are turned off during the hours of darkness.
- Any removal of hedgerows and treelines requires landscape replacement (native tree and shrub species).

Standard mitigation measures as would apply to any large-scale development, should be adopted in the construction of the proposed Graiguenamanagh FRS. These include limiting season of disturbance to trees and vegetation to reduce impacts on breeding species, to provide for habitat replacement and to implement measures to avoid and/or control pollution and sedimentation into watercourses during construction and operation phases. Specific measures will be required to protect bats onsite, and these are detailed further below.

5.2.1 Lighting

All European bat species, including Irish bat species, are nocturnal. They usually hide in roosts during the daytime, while fly to feeding areas or drinking sites using commuting routes during the night. Annually bats will hibernate in the winter, swarm in the autumn, and give birth in the summer months.

In all aspects of the bat lifestyle, Artificial Light at Night (ALAN) may significantly change their natural behaviour in relation to roosting, commuting, and feeding. While bats are naturally exposed only to very low lighting levels produced by moonlight, starlight and low intensity twilight, light levels greater than natural light levels can impact on the lifestyle of bats.

Construction Phase Lighting

Where construction lighting is required, light spill should be minimised as much as possible. This can be achieved by the use of directional lighting (i.e. lighting which only shines on the proposed works and not nearby countryside) to prevent overspill. This should be achieved by the design of the luminaire and by using accessories such as hoods, cowls, louvres, and shields to direct the light to the intended area only. Lighting should be minimised in potential foraging and commuting areas, and the times during which the lighting is on should be limited to provide some dark periods. Lights should be positioned to avoid sensitive areas and restricted so that there are dark areas. The timing of lights should be restricted to avoid bat activity (i.e. from dusk until dawn).

Operational Phase Lighting

The following specifications have been recommended for the lighting to be installed:

- 4000k colour temperature
- 0% ULR
- Full cut off visor

5.2.2 Trees to be Retained

Where possible, mature trees and treelines that are located immediately adjacent to planned work areas or are not directly impacted should be avoided and retained intact. Overall impacts on these sites should be reduced through modified design and sensitivity during works. Retained trees should be protected from root damage by machinery by an exclusion zone of at least c. 7 metres or equivalent to canopy height. Such protected trees should be fenced off by adequate temporary fencing prior to other works commencing.

5.2.3 Removal of Trees

Should any mature broadleaved tree(s) be scheduled for removal as part of the proposed development plans, it should be surveyed for bat presence by a suitably experienced specialist immediately prior to felling. If bats are found, an application for a derogation licence should be made to the National Parks and Wildlife Service to allow its legal removal. Such trees should ideally be felled in the period late August to late October, or early November, in order to avoid disturbance of any roosting bats as per National Roads Authority (NRA) guidelines and also to avoid the bird breeding seasons. Tree felling should be completed by mid-November at the latest as bats roosting in trees are vulnerable to disturbance during their hibernation period (November - April). If trees are to be removed outside of these periods extra care should be taken prior to felling to ensure no protected species are present. Trees with ivy-cover, once felled, should be left intact onsite for 24 hours prior to disposal to allow any bats beneath foliage to escape overnight.

5.2.4 Boundary Vegetation

Linear features such as treelines and hedgerows serve as commuting corridors for bats (and other wildlife). The onsite boundary vegetation especially that bordering the Barrow River should be retained and/or replaced once construction ends. Native species should be chosen in all landscaping schemes. Planting schemes should attempt to link in with existing wildlife corridors (hedgerows and treelines) to provide continuity of wildlife corridors.

5.3 Residual Impact

The construction phase of the proposed Graiguenamanagh Flood Relief Scheme may displace certain bat species through disruption of commuting routes however, this is expected to be temporary. If the recommended mitigation measures outlined above to safeguard bats are implemented, preserving the present nature of the site and river

corridor, the residual impact of the development on bats is expected to be negligible and all bat species recorded in the area should persist.

Section 6: SURVEY CONCLUSION

In general (according to Lundy *et al,* 2011), the landscape in which the proposed project is situated is of high suitability for Common Pipistrelle, Soprano Pipistrelle, Leisler's bat and Daubenton's bat.

A total of No. 4 species of bat were recorded commuting and foraging within the survey area. The following bat species were recorded during this bat survey: Common Pipistrelles, Soprano Pipistrelles, Leisler's bats, and Daubenton's bat. This represents No. 4 of the No. 9 resident bat species known to Ireland.

The most abundant species was Common Pipistrelle, followed by Leisler's bat and Soprano Pipistrelle, this is a typical species assemblage for rural sites in Ireland. The remaining No. 1 bat species are less common but are associated with specific habitats. Bat activity was broadly distributed throughout the Site, with no obvious clustering of activity at any specific locations. Activity levels appeared to be slightly higher at some of the sampling points that were near linear habitat features (e.g. a road lined with treelines, or a partial hedgerow).

The ecological value of the Site can be categorised using the valuation system of the CIEEM Guidelines (2018). As the majority of the study area is used on a regular basis by common bat species, it is considered to be of *Local Ecological Value*. Nonetheless, it is noted that all bats and their roosts receive legal protection from destruction or disturbance under the *European Communities (Birds and Natural Habitats) Regulations 2011* (as amended).

The Overriding Purpose of the project is to provide flood defences in Graiguenamanagh Town to the standards of the EU Directive on the Assessment and Management of Flood Risk (Floods Directive 2007/60/EC) transposed into Irish Law as SI 122 of 2010. The proposed flood defences to include an allowance for freeboard (300mm for walls, 500mm for embankments) as per the OPW guidelines and to address Environmental, Social and Health and Safety concerns.

The Graiguenamanagh Flood Relief Scheme was assessed in relation to potential impact on local bat populations. Due to the fact that the majority of bat activity was recorded along linear features such as treelines and hedgerows within the study area, any works which involve loss of treelines and hedgerows will impact on local bat populations due to the removal of commuting routes and foraging habitat.

Therefore, in consideration of the conservation of local bat populations, the application of the proposed mitigation measures outlined above in **Section 5** aims to ensure the implementation of safeguards for bats. By preserving the current nature of the site and river corridor, it is anticipated that the impacts of the development on bats will be negligible, and all bat species recorded in the area should persist.

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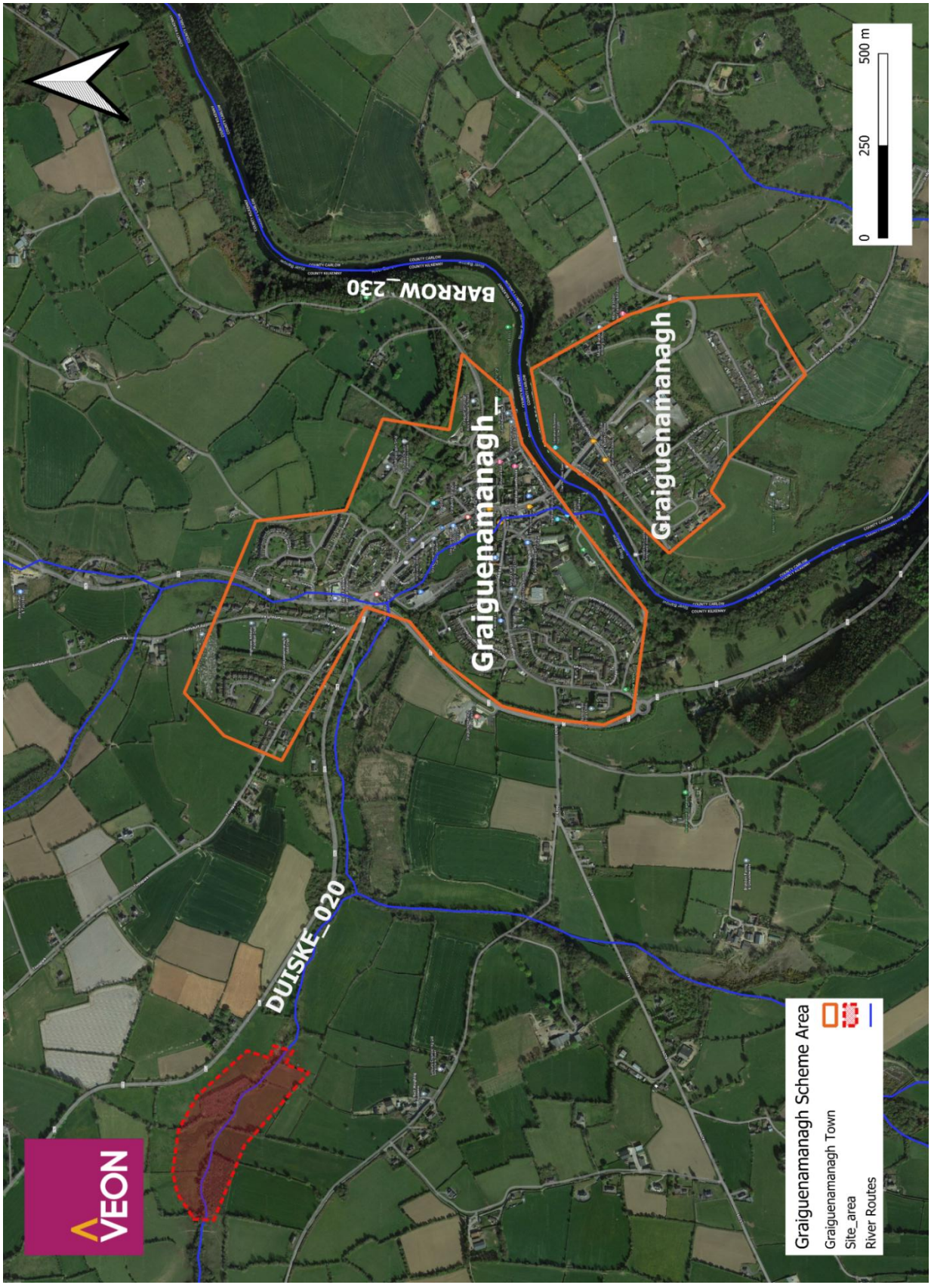
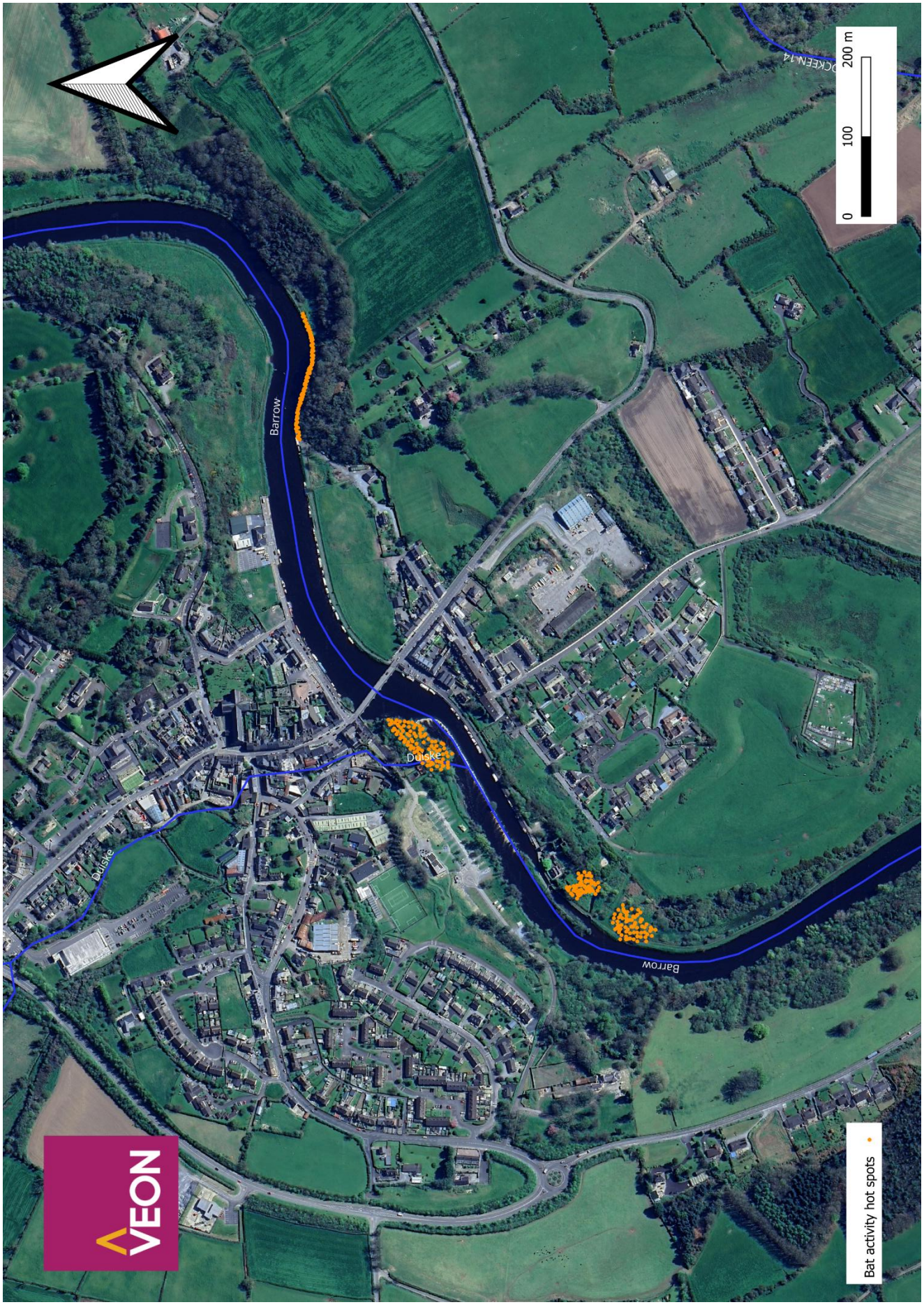
Section 8: APPENDICES

Appendix 1. MAPS & FIGURES



Survey areas in Graiguenamanagh



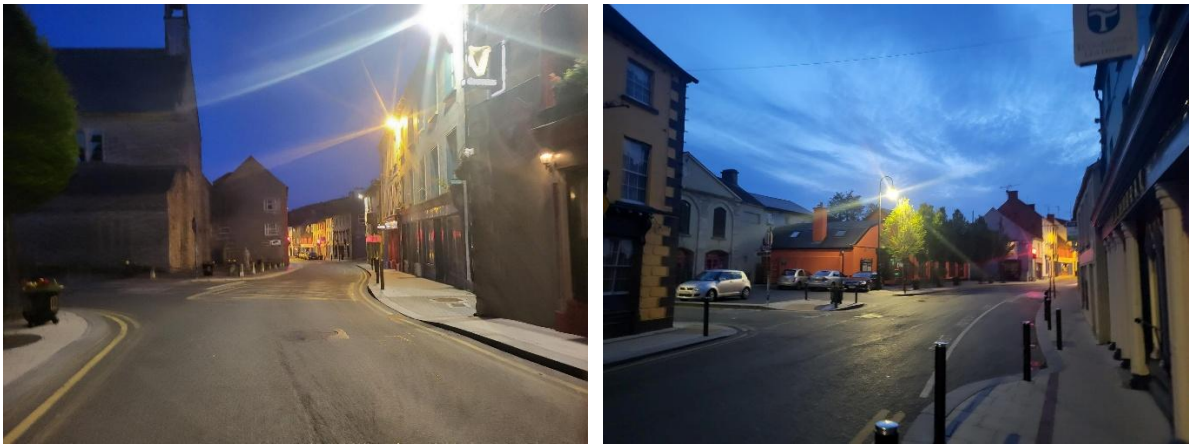
Hotspots of bat activity within and outside the survey areas

Area of bat hotspot activity near the River Barrow

Higher value foraging habitats – grassland and woodland with low levels of artificial lighting.

Main bridge in Graiguenamanagh (no Daubenton's roosts present)

Bat hotspot area – outside of proposed works boundaries



High levels of artificial lighting at night in the town

Appendix 2. BAT SPECIES PROFILES

Ireland has No. 9 known established bat species from two distinct families. Each is briefly described below. For a more comprehensive overview see Roche et al (2014). The conservation status of each species is derived from NPWS (2019).

Vespertilionidae:

Leisler's bat (*Nyctalus leisleri*)

This species is Ireland's largest bat, with a wingspan of up to 320mm; it is also the third most common bat, preferring to roost in buildings, although it is sometimes found in trees and bat boxes. It is the earliest bat to emerge in the evening, flying fast and high with occasional steep dives to ground level, feeding on moths, caddisflies and beetles. The echolocation calls are sometimes audible to the human ear being around 15 kHz at their lowest. The audible chatter from their roost on hot summer days is sometimes an aid to location. The conservation status of this species is Favourable.

Ireland's population is deemed of international importance and the paucity of knowledge of roosting sites, makes this species vulnerable. However, it is widespread across the island. The modelled Core Area for Leisler's bats is a relatively large area that covers much of the island of Ireland (52,820km^2). The Bat Conservation Ireland Irish Landscape Model indicated that the Leisler's bat habitat preference has been difficult to define in Ireland. Habitat modelling for Ireland shows an association with riparian habitats and woodlands (Roche *et al.,* 2014). The landscape model emphasised that this is a species that cannot be defined by habitats preference at a local scale compared to other Irish bat species but that it is a landscape species and has a habitat preference at a scale of 20.5km. In addition, of all Irish bat species, Leisler's bats have the most specific roosting requirements. It tends to select roosting habitat with areas of woodland and freshwater.

The principal concerns for Leisler's bats are poorly known in Ireland but those that are relevant for this survey area are as follows:

- Selection of maternity sites is limited to specific habitats.
- Relative to the population estimates, the number of roost sites is poorly recorded.
- Tree felling, especially during autumn and winter months.
- Increasing urbanisation.

Common pipistrelle (*Pipistrellus pipistrellus*)

The common pipistrelle's echolocation calls peak at 45 kHz. The species forages along linear landscape features such as hedgerows and treelines as well as within woodland. This species is generally considered to be the most common bat species in Ireland. The species is widespread and is found in all provinces. The modelled Core Area for common pipistrelles is a large area that covers much of the island of Ireland (56,485km^2) which covers primarily the east and southeast of the area (Roche *et al.,* 2014). The Bat Conservation Ireland Irish Landscape Model indicates that the Common pipistrelle selects areas with broadleaf woodland, riparian habitats and low-density urbanization (<30%) (Roche *et al.,* 2014). The conservation status of this species is Favourable.

Principal concerns for Common pipistrelles in Ireland that are relevant for this survey area are as follows:

- Lack of knowledge of roosting requirements.
- This species has complex habitat requirements in the immediate vicinity of roosts. Therefore, careful site-specific planning for this species is required in order to ensure all elements are maintained.
- Renovation or demolition of derelict buildings.
- Tree felling .
- Increasing urbanisation (e.g. increase in lighting).

Soprano pipistrelle (*Pipistrellus pygmaeus*)

The soprano pipistrelle's echolocation calls peak at 55 kHz, which distinguishes it readily from the common pipistrelle on detector. The pipistrelles are the smallest and most often seen of our bats, flying at head height and taking small prey such as midges and small moths. Summer roost sites are usually in buildings but tree holes and heavy ivy are also used. Roost numbers can exceed 1,500 animals in mid-summer. The conservation status of this species is Favourable.

This species is generally considered to be the second most common bat species in Ireland. The species is widespread and is found in all provinces, with particular concentration along the western seaboard. The modelled Core Area for soprano pipistrelle is a large area that covers much of the island of Ireland (62,020km^2). The Bat Conservation Ireland Irish Landscape Model indicates that the soprano pipistrelle selects areas with broadleaf woodland, riparian habitats and low density urbanisation (Roche *et al.,* 2014).

Principal concerns for Soprano pipistrelles in Ireland that are relevant for this survey area are as follows:

- Lack of knowledge of roosts.
- Renovation or demolition of structures.
- Tree felling.
- Increasing urbanisation (e.g. increase in lighting).

Nathusius' pipistrelle (*Pipistrellus nathusii*)

Nathusius' pipistrelle is a recent addition to the Irish fauna and has mainly been recorded from the north-east of the island in Counties Antrim and Down (Richardson, 2000) and in Fermanagh, Longford and Cavan. It has also been recorded in Counties Cork and Kilkenny (Kelleher, 2005). However, the known resident population is enhanced in the autumn months by an influx of animals from Scandinavian countries. It is not known whether the Irish population migrates within or from Ireland to another country to overwinter, although there is evidence that Nathusius' pipistrelle bats migrate from Britain to overwinter on continental Europe. The Nathusius' pipistrelle often forages over water or along forest tracks. The conservation status of this species is Favourable.

Natterer's bat (*Myotis nattereri*)

There are three species included in the Myotis species family and their echolocation calls are very similar across these three species. One of the rarer Irish bat species, the Natterer's bat likes woodland, mature hedgerow and pasture habitats. The Natterer's bat has broad wings so it can fly with great manoeuvrability among trees and around hedgerows. It sometimes gleans insects or even spiders from foliage and may eat larger prey at a feeding perch. Its usual roost sites are in tree holes, old stone buildings such as churches and barns, and under bridges. This species has a fringe of stiff bristles along the trailing edge of its tail membrane, which may help to hold or trap its prey.

This species has a slow to medium flight, usually over trees but sometimes over water. It usually follows hedges and treelines to its feeding sites, consuming flies, moths, caddis-flies and spiders. The Natterer's bat is one of our least studied species and further work is required to establish its status in Ireland. The conservation status of this species is Favourable.

The modelled Core Area for Natterer's bats is a relatively large area that covers much of the island of Ireland (52,864km^2). The Bat Conservation Ireland Irish Landscape Model indicates that the Natterer's bat selects areas with broadleaf woodland, riparian habitats and areas with larger scale provision of mixed forest (Roche et al., 2014).

Brown long-eared bat (*Plecotus auritus*)

This species of bat is a 'gleaner', hunting amongst the foliage of trees and shrubs, and hovering briefly to pick a moth or spider off a leaf, which it then takes to a sheltered perch to consume. They often land on the ground to capture their prey. Using its nose to emit its echolocation, the long-eared bat 'whispers' its calls so that the insects, upon which it preys, cannot hear its approach (and hence, it needs oversize ears to hear the returning echoes). As this is a whispering species, it is extremely difficult to monitor in the field as it is seldom heard on a bat detector. Furthermore, keeping within the foliage, as it does, it is easily overlooked. It prefers to roost in old buildings. The conservation status of this species is Favourable.

This species is generally considered to be widespread across the island. The modelled Core Area for Brown long-eared bats is a relatively large area that covers much of the island of Ireland (52,820km^2) with preference suitable areas in the southern half of the island. The Bat Conservation Ireland Irish Landscape Model indicates that the Brown long-eared bat habitat preference is for areas with broadleaf woodland and riparian habitats on a small scale of 0.5km emphasising the importance of local landscape features for this species (Roche *et al.,* 2014).

Principal concerns for brown long-eared bats are poorly known in Ireland, but those that are relevant for this survey area are as follows:

- Selection of maternity sites is limited to specific habitats.
- Lack of knowledge of winter roosts.
- Loss of woodland, scrub and hedgerows.
- Tree surgery and felling.
- Increasing urbanisation.
- Light pollution.

Daubenton's bat (*Myotis daubentonii*)

This bat species prefers feeding close to the surface of smooth water, either over rivers, canals, ponds, lakes or reservoirs but it can also be found foraging in woodlands. Flying at 15 kilometres per hour, it gaffs insects with its over-sized feet as they emerge from the surface of the water - feeding on caddis flies, moths, mosquitoes, midges etc. It is often found roosting beneath bridges or in tunnels and also makes use of hollows in trees. The conservation status of this species is Favourable.

The modelled Core Area for Daubenton's bats is a relatively large area that covers much of the island of Ireland (41,285km^2) reflecting the distribution of sizeable river catchments. The Bat Conservation Ireland Landscape Model indicates that the Daubenton's bat habitat preference is for areas with broadleaf woodland, riparian habitats and low density urbanisation (Roche *et al.,* 2014).

Principal concerns for Daubenton's bats are poorly known in Ireland but those that are relevant for this survey area are as follows:

- Potential roost loss due to bridge works.
- Loss of woodland and forest clearance.
- Loss of woodland, scrub and hedgerows.
- Tree surgery and felling.
- Increasing urbanisation.
- Light pollution.

Whiskered bat (*Myotis mystacinus*)

This species, although widely distributed, has been rarely recorded in Ireland. It is often found in woodland, frequently near water. Flying high, near the canopy, it maintains a steady beat and sometimes glides as it hunts. It also gleans spiders from the foliage of trees. Whiskered bats prefer to roost in buildings, under slates, lead flashing or exposed beneath the ridge beam within attics. However, they also use cracks and holes in trees and sometimes bat boxes. The conservation status of this species is Favourable.

Rhinolophidae:

Lesser horseshoe bat (*Rhinolophus hipposideros*)

This species is the only representative of the Rhinolophidae or horseshoe bat family in Ireland. It differs from our other species in both habits and looks, having a unique nose leaf with which it projects its echolocation calls. It is also quite small and, at rest, wraps its wings around its body. Lesser horseshoe bats feed close to the ground, gleaning their prey from branches and stones. It often carries its prey to a perch to consume, leaving the remains beneath as an indication of its presence.

The echolocation call of this species is of constant frequency and, on a heterodyne bat detector, sounds like a melodious warble. The species is confined to six counties along the Atlantic seaboard: Mayo, Galway, Clare, Limerick, Kilkenny and Cork. The current Irish national population is estimated at 12,500 – 14,000 individuals. This species is listed on Annex II of the EC Habitats Directive and 41 Special Areas of Conservation have been designated in Ireland for its protection, of which 9 have also been selected for the Annex I habitat 'Caves not open to the public'. Where it occurs, it is often found roosting within farm buildings. In Ireland, the overall conservation status of lesser horseshoe bat is assessed as Favourable.

Lesser horseshoe bats forage on flying insects predominantly in deciduous woodland and riparian vegetation normally within a couple of kilometres of their roosts. The bats rely on linear landscape features (e.g. treelines, stonewalls and hedgerows) to navigate and commute from roosts to feeding sites and they are reluctant to fly out in the open.

Lesser horseshoe bats are sensitive to disturbance and normally do not occupy the same buildings as humans. Loss of roosting sites due to deterioration or renovation of old buildings, loss of commuting routes linking roosts to foraging sites and unsympathetic management of foraging sites are the major threats to this species.

Lesser horseshoe bats are very sensitive to light pollution and will avoid brightly lit areas. Artificial light at night at or near roosts may impact bats in a number of ways, for example, delaying emergence time after dusk, causing abandonment of roosts when exits are lit at night and/or reducing reproductive success.

Appendix 10-6 Electrofishing Report 2021

Electrofishing survey of
The Duiske River, Graiguenamanagh,
Co. Kilkenny

Produced by

AQUAFACT International Services Ltd

On behalf of

Byrne Looby

February 2021

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Introduction

This survey was conducted by Ross Macklin on behalf of Aquafact International on the 10th of February 2021 as part of the Graiguenamanagh-Tinnahinch flood relief scheme commissioned by Kilkenny County Council along with Carlow County Council and the Office of Public Works to alleviate the risk of flooding to the communities of Graiguenamanagh-Tinnahinch.

This purpose of this survey is to assess the condition of fish stocks within the Duiske River and the results would help to aid in the design of the flood relief scheme.

AQUAFACT International Services Ltd obtained authorisation under Section 14 of the Fisheries (Consolidation) Act, 1959 as substituted by Section 4 of the Fisheries (Amendment) Act, 1962 to undertake electrical fishing surveys at locations along the Duiske River, Co. Kilkenny, to provide baseline data to inform environmental impact assessment ahead of a planned flood relief scheme for the town of Graiguenamanagh.

Survey Sites

The Duiske River is formed by the confluence of several smaller streams around Graiguenamanagh. It drains approximately 24km^2 and discharges into the River Barrow immediately downstream of Graiguenamanagh Bridge, Co. Kilkenny on the upstream side of a major weir.

Underlying geology consists of mainly slate and schist. Land use of the surrounding area is dominated by pasture with some forestry plantations in the upper part of the catchment. As the river passes through Graiguenamanagh Town, artificial retaining walls alter the course of the river. The mid to lower reaches of the Duiske River forms part of the Barrow SAC (002162).

Three survey sites were chosen as shown below in figure 1. D1 on the Graiguenamanagh Stream (IE_SE_14D040200). D2 and D3 are located on the Duiske River (IE_SE_14D01_0150) within Graiguenamanagh Town.

Previous surveys have identified the majority of sites surveyed on the Duiske as being of Good Ecological Status in regards to Fish under the EU Water Frameworks Directive (Delanty *et al*., 2017).

Previously, species such as Atlantic salmon, brown trout, European eel and lamprey sp. have been encountered within the Duiske River. It has also been identified as a potentially important nursery ground for Atlantic salmon (*Salmo salar*) by Delanty *et al.* (2017) and for Lamprey by King (2006).

According to the EPA's Report on River Water Quality in Co. Kilkenny 2013, the Q values of the Duiske River were Q3-4 and the water chemistry was satisfactory other than slightly

elevated nitrate levels. Pressures on the river were identified as urban dumping of household rubbish within Graiguenamanagh which was observed during their most recent survey in 2011.

Figure 1: Map showing the three electrofishing locations on the Duiske River and the Graiguenamanagh Stream.

Site D1

The Graiguenamanagh Stream at site D1 was a moderate energy lowland depositing channel (FW2). The channel had 1m high banks, was 1m to 1.5m wide and had water depths between 0.15m and 0.3m. The stream had been historically straightened west of the Borris Road (R705) and the stream was culverted underground from the R705 crossing to the Duiske River confluence downstream. The bed was comprised of scattered boulders and cobbles but was dominated by sand and silt with lesser quantities of gravels. The harder substrata were heavily bedded and siltation levels were moderate overall. The macrophyte composition was dominated by *Apium nodiflorum* and *Oenanthe aquatica* that made up 40% by surface area of the streambed combined. *Cladophora glomerata* green filamentous algae covered 10% of the bed. The riparian areas comprised open wet (rushy) semi improved grassland.

Site D1 - Graiguenamanagh Stream	Conductivity (µS/cm)	317	
Date: 10th February 2021	Temperature °C	5.7	
River conditions: Base flow and clear	Elapsed Time	600s	
	Fishing Time	450s	
Elevation: 37m	GPS us end (dd)	52.54755206	-6.958477104
	GPS ds start (dd)	52.54687845	-6.958537284
	Site Dimensions and Area	90m*1.5m	135m^2

Site D2

Site D2 was a lowland depositing watercourse (FW2) that had a 4-5m water width and an average depth of 0.4m. The river deepened locally to 0.6m in pool habitat. The profile comprised 20% pool, 50% riffle and 30% glide and representative of a good quality semi-natural salmonid river. Exposed beds of built-up cobble, gravel and boulder supported frequent emergent *Oenanthe crocata* that further adding to flow diversity. The Duiske River also had more well developed riparian areas than downstream supporting mature alder and willow with dense bramble scrub in the understories. The channel was not heavily impounded by retaining walls as with downstream and had a lower gradient that resulted in a more stable bed greatly benefiting spawning viability. The riverbed supported boulders locally but was dominated by cobbles with well sorted coarse, medium and fine gravels that were unbedded with light siltation. Beds of sand and silt with a high organic fraction were present in the depositing margins adjoining pool habitat. The river supported locally frequent *Ranunculus* sp. (30% cover) which is an extremely important plant for juvenile salmonid populations.

Site D2 - Duiske (Well Lane footbridge)	Conductivity (µS/cm)	236	
Date: 10th February 2021	Temperature °C	6.4	
River conditions: Base flow and clear	Elapsed Time	600s	
	Fishing Time	380s	
Elevation: 16m	GPS us end (dd)	52.54212717	-6.956910104
	GPS ds start (dd)	52.54158303	-6.956362787
	Site Dimensions and Area	70m*4m	280m^2

Site D3

Site D3 was an upland eroding river (FW1) channel in the lower reaches of the Duiske River, *i.e.* a section of steepened gradient. The river had a 3-4m water width and an average depth of 0.3-0.5m with very swift flows. The river depth deepened locally to 0.6m in pool habitat, *i.e*. artificial weir and meander that were the most significant holding habitat areas within the survey reach. The river profile comprised of 10% pool, 60% fast glide and 30% riffle. The river was held between concreted retaining walls, 2.5-3m high in a realigned section of channel located upstream of the road bridge. Overall, the channel was heavily modified at site D1 but retained good semi-natural characteristics in terms of flow diversity. The channel supported localised exposed beds of built-up cobble, gravel and boulder that supported frequent emergent *Oenanthe crocata*. It also supported abundant *Ranunculus* sp. (40% cover) which greatly improved the nursery value of the Duiske River. The instream boulder and concreted weir and walls supported the riverine moss species *Cinclidotus fontinaloides* and *Brachythecium rivulare.* The riparian zone comprised built land (BL3) on both banks.

Site D3 - Duiske, Graignamanagh Town centre	Conductivity (µS/cm)	236	
Date: 10th February 2021	Temperature °C	6.4	
River conditions: Base flow and clear	Elapsed Time	600s	
	Fishing Time	320s	
Elevation: 20m	GPS us end (dd)	52.5401302	-6.955719109
	GPS ds start (dd)	52.53956131	-6.95542303
	Site Dimensions and Area	50m*4m	200m^2

Materials and Methods

Surveying took place on the 10th of February 2021 across three sites, D1 on the Graiguenamanagh Stream, D2 and D3 on the Duiske River.

Electrofishing was carried out using battery powered backpack electrofishing equipment (Smith-Root Lr-24) which was deployed at 240v / 40Hz / 18% duty cycle pulse DC settings across all survey locations.

At each site, electrofishing was carried out over an elapsed time period totalling 10 minutes (600 seconds). Actual fishing time during this period was provided by a 'fishing on' timer mechanism on the LR-24.

For salmonid species and European eel, electro-fishing was carried out in an upstream direction for a 10-minute CPUE, an increasingly common standard approach for wadable streams (Matson *et al.,* 2018).

Electrofishing for lamprey ammocoetes was conducted as per Harvey & Cowx, (2003) by targeting areas of sand/silt, where encountered by using a low frequency (20-30Hz). This was used in combination with the burst of pulses direct current setting to optimize lamprey ammocoete capture without physical damage. This was carried out after completion of the 10-minute CPUE salmonid and eel electrofishing.

Results

Five species were encountered during the survey, namely, brook lamprey (*Lampetra planeri)*, Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta)*, European Eel (*Anguilla anguilla)* and stone loach (*Barbatula barbatula*).

Atlantic Salmon were present at the two sites on the Duiske River but were absent at site D1 on the Graiguenamanagh Stream. Brown Trout were present at all of the survey locations. Brook lamprey were present at two of the three sites being absent at the most downstream site D3. Eels were present at both sites on the Duiske River but were absent at site D1 on the Graiguenamanagh Stream. A single Stone Loach was found on the most downstream survey site D3.

Table 1: Results showing the number and minimum density of each species captured at each of the three sites.

Site Number	0+ brown trout		1++ brown trout		0+ salmon		1++ salmon		European eel		Brook lamprey	
	No.	No./m^2	No.	No./m^2	No.	No./m^2	No.	No./m^2	No.	No./m^2	No.	No./m^2
D1	0		3	0.022							3	0.022
D2	11	0.039	9	0.032	8	0.029	7	0.025	3	0.011	35	0.125
D3	8	0.04	3	0.015	14	0.07	7	0.035	2	0.01		

Length Distribution

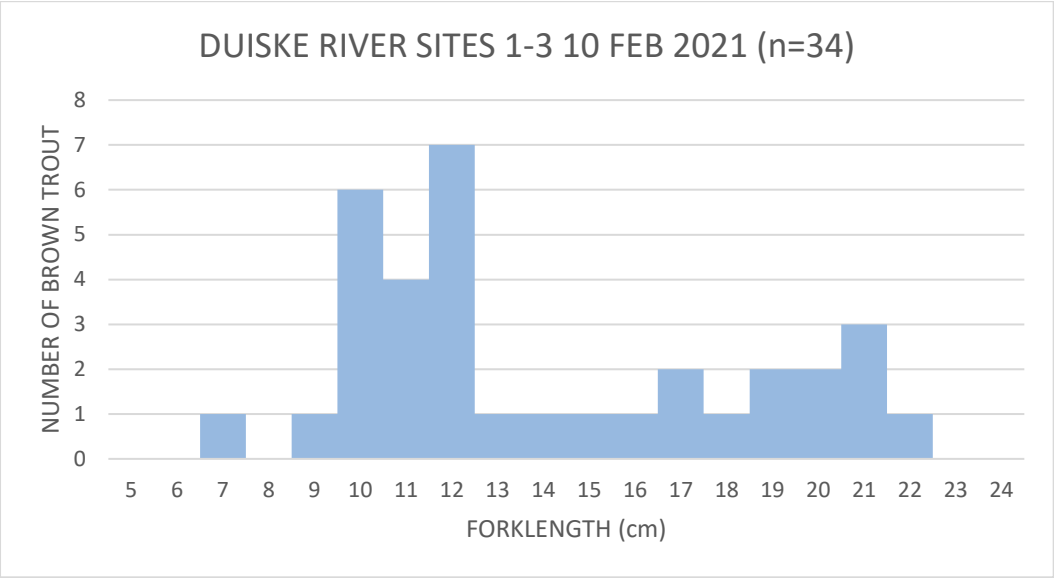

Figure 2: 1 Length frequency distribution of brown trout recorded during the February 2021 three site survey on the Duiske River (fish less than 13cm long are considered 0+).

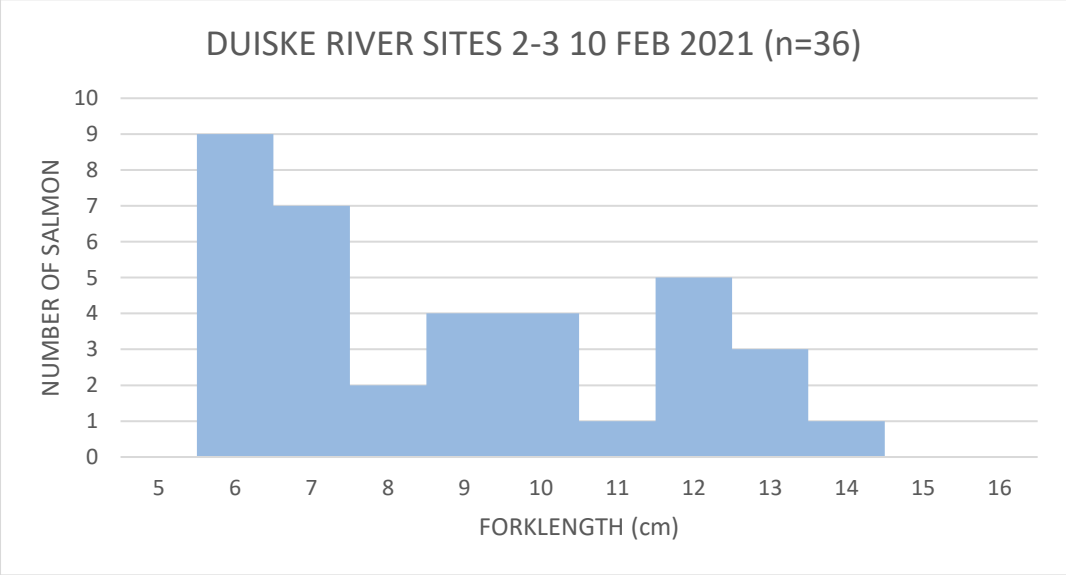

Figure 3: Length frequency distribution of Atlantic salmon recorded during the February 2021 three site survey on the Duiske River (fish less than 10cm long are considered 0+).

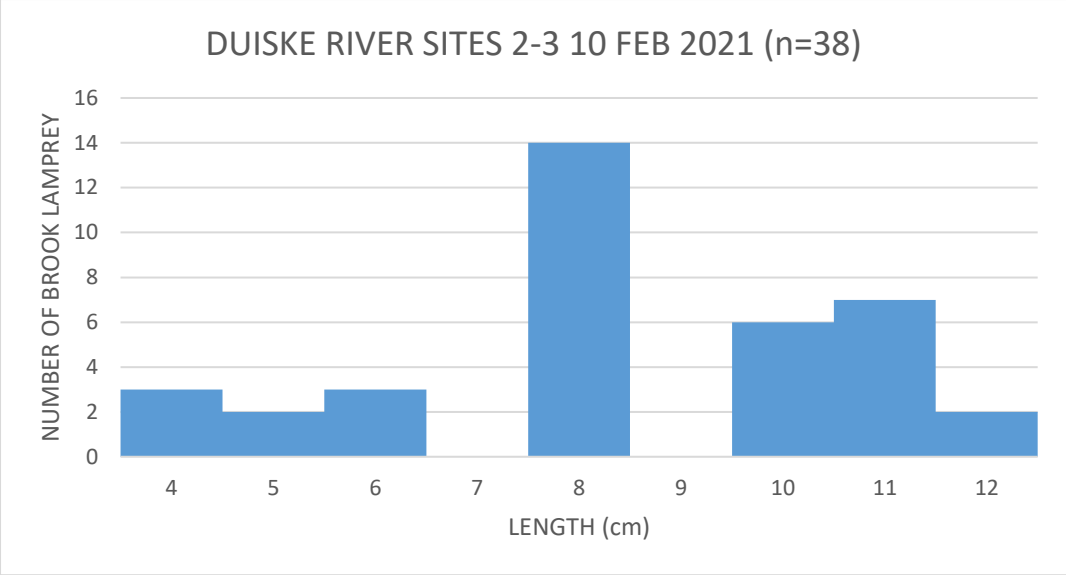

Figure 4: Length distribution of Brook Lamprey across all survey sites.

Brown trout lengths ranged from 7.6-22.4cm, with fish less than 13cm considered to be in the 0+ age group (n=19) and larger fish were considered to be in the 1++ age group (n=15).

Atlantic salmon lengths ranged from 6.3-14.5cm, with fish less than 10cm in length considered to be part of the 0+ age group (n=22) and larger fish were considered to be in the 1++ age group (n=14)

Brook lamprey lengths ranged from 4.6-12.1cm. Brook Lamprey cannot be easily aged from length distributions and therefore no ages were assessed.

Discussion

The Graiguenamanagh Stream, site D1, was a poor to moderate quality spawning channel due to the compacted bed and very limited clean gravels. The nursery value appeared good with riffle and glide sequences and macrophyte cover. However, the fisheries survey results did not reflect this given an absence of juvenile trout. This was considered consequential of the poor spawning habitat rather than the river profile attributes. The channel had very localised pool and deeper glide habitat that supported a small adult trout population. The poor downstream connectivity with the Duiske due to extensive culverting and smaller size of the channel likely accounted for the absence of both European eel and Atlantic salmon that were present downstream (sites D2 & D3). The stream supported moderate quality brook lamprey habitat with localised sand/ silt beds on meanders near glide and pool. The ammocoete densities recorded in these patches of habitat were low indicating that while small local populations were present, the habitat was sub-optimal overall. Never the less, lamprey habitat is often fragmented and isolated in small stream habitats and the presence of any local populations can be considered of high conservation value.

Threats to the site are the historical artificial straightening of the river and a risk of siltation.

In terms of fisheries value, the Duiske River was considered a very good quality salmonid nursery given its larger size and semi-natural profile*, i.e.* mixed glide, riffle and pool sequences. The Atlantic salmon densities also indicate it of very high importance in the Barrow catchment as an Atlantic salmon nursery.

Salmonid spawning habitat at site D2 was considered overall very good given the presence of well sorted coarse, medium and fine gravels amongst cobble. Holding habitat was also good due to the presence of deeper glide and pool. The combination of very good nursery and spawning habitat was reflected in the very good numbers of juvenile salmonids, including mixed cohorts of Atlantic salmon parr. Eel habitat was moderate overall due to downstream impediments to eel passage (*i.e.* weir) with small numbers captured. Lamprey ammocoete habitat was excellent locally with silt and sand beds in pool and glide slack areas supporting healthy populations. The sediment was light and uncompacted with good organic content and indicating very high suitability for ammocoetes. Very good ammocoete habitat was recorded adjoining both bridge abutments at the Well Lane footbridge.

Salmonid spawning habitat at site D3 was considered moderate but improved to good locally given pockets of coarse, medium and fine gravels in pool tailings. Holding habitat was limited overall due to a paucity of deeper pools which was reflected in the lower number of adult salmonids recorded. The combination of good nursery habitat and moderate-good spawning was reflected in the good numbers of juvenile salmonids, including mixed cohorts of Atlantic salmon. Eel habitat was moderate overall due to more limited pools, bedded substrata (due to high flows) and impediments to fish passage (i.e. weir). Lamprey ammocoete habitat was not recorded present due to the high energy of the lower Duiske River and the absence of any significant accumulations of suitable ammocoete burial habitat. Very good lamprey ammocoete habitat is known to be present outside of the survey reach downstream near the Duiske confluence with the River Barrow (pers. obs.).

A small weir 0.5m high located downstream of a small bridge (52.54008488 W, -6.95567596 N) was identified as a potential threat to eel passage in the river.

The results of the February 2021 surveys would be expected to result in fewer fish being captured compared to a similar survey carried out in, say, June – September 2021. By the time February 2020 comes around, there would be fewer and larger 0+ / 1+ salmonids in the stream because juvenile salmonids require larger territories as they grow and consequently occur at a lower density that might have pertained during June – September 2020.

Also, the river flow conditions for sites studied in February 2021 meant that the wetted area equalled the bank to bank stream dimensions whereas for surveys carried out during the summer months the wetted area might be expected to be significantly less than bank to bank stream dimensions resulting is lower wetted area estimates and correspondingly higher minimum density estimates for fish.

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Appendix 10-7 Q-Value Survey Report 2021

Graiguenamanagh
Q-value

Produced by

AQUAFACT International Services Ltd

For

BYRNE LOOBY

February 2021

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Report Approval Sheet

Client	BYRNE LOOBY
Report Title	Graiguenamanagh Q-value
Job Number	JN1595
Report Status	Draft
Issue Date	16th February 2021

Rev	Status	Issue Date	Document File Name	Author (s)	Approved by:
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2	Draft	11.2.2021	JN1595 Graiguenamanagh Q-value	Kevin Mc Caffrey	Brendan O'Connor
3	Draft	16.2.2021	JN1595 Graiguenamanagh Q-value	Kevin Mc Caffrey	Brendan O'Connor

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Appendices

Appendix 1 Species List

1. Introduction

AQUAFACT was contracted by BYRNE LOOBY to carry out a Q-value assessment of the Barrow and Duiske Rivers in Graiguenamanagh Co. Kilkenny as part of an assessment of a proposed flood defence scheme. The sampling was carried out on the 8th of February 2021.

2. Methodology

2.1. Kick sampling

Five kick samples were taken (see Figure 2.1 and Table 2.1). Stream morphology at each station can be seen in Table 2.2. The two-minute kick and one minute stone wash sampling method was employed to collect samples of macroinvertebrates for analysis. This involved placing a standard hand net of pore size 500µm in the river, facing upstream and disturbing the river bed in front of the net mouth. The surveyor, Mr. Kevin McCaffrey, then moved in a diagonal direction upstream to ensure that different micro-habitats were included in the sample. The kick method dislodges macroinvertebrates from the substrates and submerged plant material. This was continued for approximately two minutes and followed by one minute of stone washing. The resulting sample was transferred from the net to a plastic bucket and fixed using a 70% ethanol solution (Toner *et al*., 2005).

The samples were then transported to the AQUAFACT laboratories where the macroinvertebrates were removed and identified using stereoscopic microscopes and the appropriate keys by Mr. McCaffrey who is a qualified freshwater taxonomist. The resulting species list was then used to assign a Biotic Index value (Q-Value) to the sampled streams.

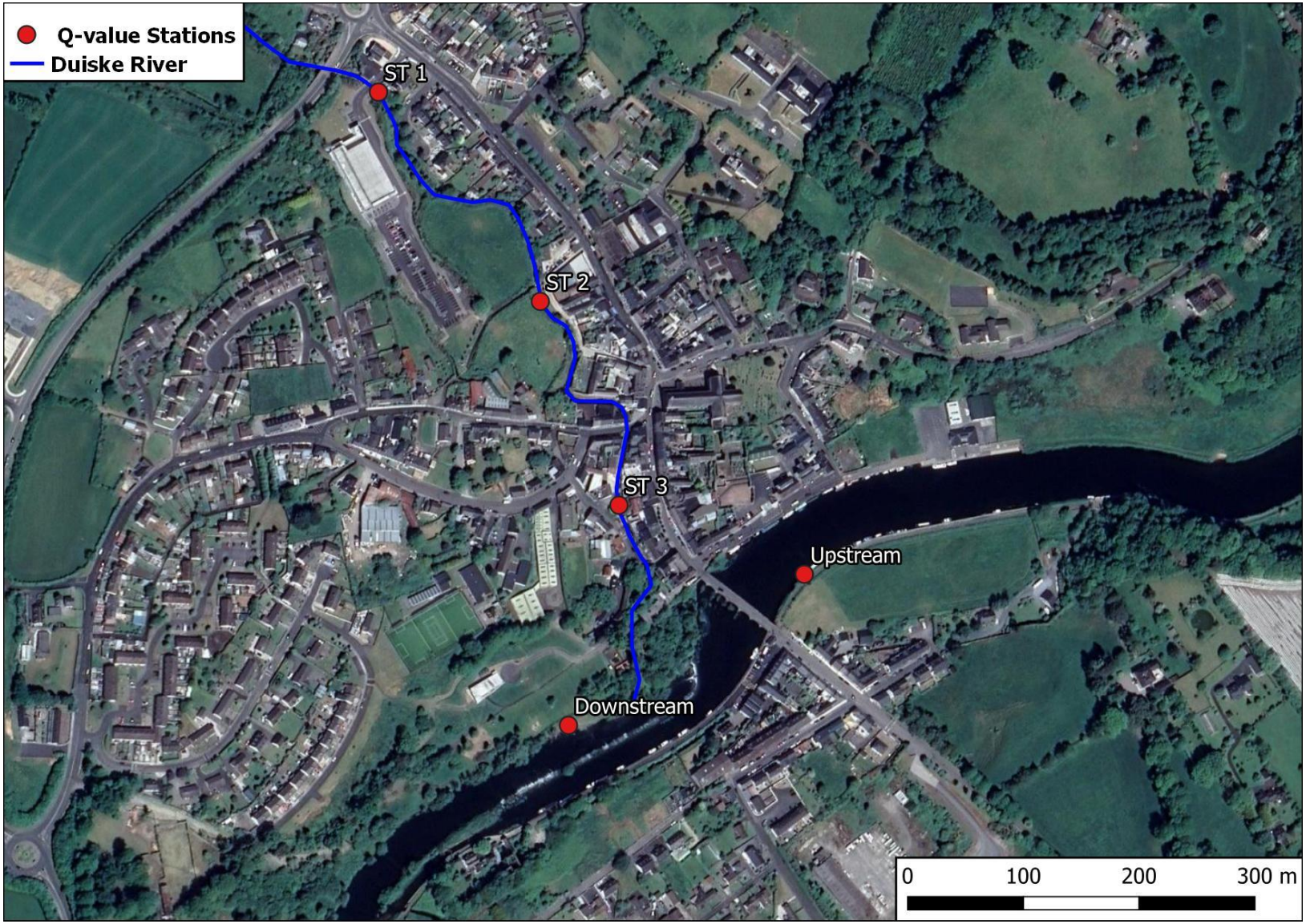

Figure 2.1: Graiguenamanagh Q-value station Locations.

Figure 2.2: Q-value Station 1.

Figure 2.3: Q-value Station 2.

Figure 2.4: Q-value Station 3.

Figure 2.5: Looking towards upstream station above the bridge.

Figure 2.6: Looking across to downstream station at flooded green area.

Table 2.1: Q-value station coordinates for Graiguenamanagh.

Station	Longitude	Latitude
ST 1	-6.95895	52.54344
ST 2	-6.95689	52.54182
ST 3	-6.95589	52.54024
Upstream	-6.95353	52.53971
Downstream	-6.95653	52.53854

Table 2.2: Stream Morphology.

Station	Width (m)	Depth (cm)	Substrate	Flow
ST 1	2.8	49	Cobbles	Flood
ST 2	3.4	44	Cobbles	Flood
ST 3	5.2	36	Cobbles	Flood
Upstream	63	>120	Mud	Flood
Downstream	56	>120	Mud	Flood

2.2. The Biological River Classification System (Q-Scheme)

The Biological River Quality Classification System (Q-Scheme) has been in use in Ireland since 1971. It has undergone a number of modifications since then and has been included in the Local Government (Water Pollution) Act, 1977 (Water Quality Standards for Phosphorus) Regulations, 1998. It is routinely employed by the EPA. For the purpose of this assessment benthic invertebrates have been divided into five indicator groups according to tolerance of pollution, particularly organic pollution.

In order to determine the biological quality of the river, the Q-scheme index is used whereby the analyst assigns a Biotic Index value (Q-Value) based on macroinvertebrate results. The Biotic Index is a quality measurement for freshwater bodies that range from Q1 – Q5 with Q1 being of poorest quality and Q5 being pristine/unpolluted (see Table 2.3).

Table 2.3: Biotic Index scoring system for the Q-Scheme (Toner *et al*., 2005).

Biotic Index	Quality Status	Quality Class
Q5, 4-5, 4	Unpolluted	Class A
Q3-4,	Slightly Polluted	Class B
Q3, 2-3	Moderately Polluted	Class C
Q2, 1-2, 1	Seriously Polluted	Class D

3. Results

All species recorded are included in Appendix 1. Stations 1 to 3 were taken from the Duiske River. Station 1 located to the north of the town recorded a Q-value of 4, which was the highest of any of the stations. Stations 2 and 3 both recorded an intermediate Q3-4. Two stations were sampled in the River Barrow, one upstream of the weir and one downstream. Both locations recorded a Q-value of 3 (Table 3.1). All species recorded where typical of the habitats sampled. Species composition recorded at station 2 and 3 is as expected for a slightly polluted status with only a few sensitive species present and in low numbers.

Table 3.1: Biological sampling results.

Location	Q-value
ST 1	Q4
ST 2	Q3-4
ST 3	Q3-4
Upstream	Q3
Downstream	Q3

4. Discussion

The Duiske River received a quality status of unpolluted as it entered Graiguenamanagh. Stations 2 and 3 located further downstream in the town were classified as slightly polluted. Although Stations 2 and 3 received a lower Q-value than station 1 they both recorded more sensitive species. Station 2 recorded three pollution sensitive species and Station 3 two sensitive species, while Station 1 only recorded one such species. However, Stations 2 and 3 also contained a higher abundance and diversity of pollution tolerant species.

Both of the stations located within the Barrow River were classified as moderately polluted. However, due to the depth of the river and it being in flood, these stations could not be sufficiently sampled for health and safety reasons. The upstream station was sampled from the river bank while the only location that could be sampled downstream was on a flooded grassy bank. As such, many of the habitats within the river could not be sampled and so sensitive species are likely to have been missed.

One minnow was recorded in the upstream sample, while three minnows and two sticklebacks were recorded at the downstream sample.

5. References

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Appendix 1

Species List

Order/Family	Genus/ Species	Common Name	Station 1	Station 2	Station 3	Upstream of bridge	Downstream of bridge
Heptageniidae	*Ecdynurus sp.*			2			
Heptageniidae	*Rhitrogena sp.*		6	7	2		
Ephemerellidae				1	1		
Caenidae	*Caenis sp.*					2	
Nemouridae				2	2		
Leuctridae	*Leuctra sp.*		1		2		
Gammaridae			2	2	6	6	6
Coleptera				2	3		
Hydropsychidae			4	5	16		
Polycentropodidae					3		2
Sericostomatidae			2	12	2		
Baetidae	*Baetis rhodani*	Blue Winged Olive	26	85	49	3	2
chironomidae					1	3	12
Limnephilidae				2	2	3	9
Goeridae					1		
Simuliidae			3	6	2		
Rhyacophilidae				1	1		
Philopotamidae				1			

Order/Family	Genus/ Species	Common Name	Station 1	Station 2	Station 3	Upstream of bridge	Downstream of bridge
Glossosomatidae			3	46	11		
Asellidae	*Assellus aquaticus*	Waterlouse		1	2	2	2
Pediciidae	*Dicranota sp.*		2	2			
Planorbidae	*Ancylus sp.*			1	1		
Lymnaeidae							5
Cyprinidae	*Phoxinus phoxinus*	Minnow				1	3
Gasterosteidae	*Gasterosteus aculeatus*	Three-Spined Stickleback					2
	Total		**48**	**173**	**102**	**20**	**43**
	Species Richness		**9**	**17**	**18**	**7**	**9**

Appendix 10-8 White-Clawed Crayfish Report 2021

Graiguenamanagh-Tinnahinch Flood Relief Scheme white-clawed crayfish (*Austropotamobius pallipes*) survey

Prepared by Triturus Environmental Ltd. for ByrneLooby

June 2021

Please cite as:

Triturus (2021). Graiguenamanagh-Tinnahinch Flood Relief Scheme white-clawed crayfish (*Austropotamobius pallipes*) survey. Report prepared by Triturus Environmental Ltd. for ByrneLooby. June 2021.

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1. Introduction

1.1 Background

Triturus Environmental Ltd. was contracted by ByrneLooby to undertake a baseline white-clawed crayfish (*Austropotamobius pallipes*) survey of the watercourses in the footprint of the proposed Graiguenamanagh-Tinnahinch Flood Relief Scheme (FRS) located near Graiguenamanagh, Co. Kilkenny (**Figure 2.1, Table 2.1**).

The OPW, working in partnership with Kilkenny County Council (KCC), Country Carlow Council (CCC) and other Local Authorities, commissioned and have completed the South Eastern Catchment Flood Risk Assessment and Management (CFRAM) Study. The South Eastern CFRAM study area included Graiguenamanagh-Tinnahinch as an Area for Further Assessment (AFA) and concluded that a flood relief scheme would be viable and effective for the community. The viable scheme (currently under review) is comprised mainly of construction of hard defences and associated works through the urban area of Graiguenamanagh along the banks of both the River Duiske and River Barrow.

A viable scheme option for Graiguenamanagh-Tinnahinch was identified in the CFRAM level of assessment and the preferred measures outlined in the CFRAM comprise:

- Building hard defences, with at risk properties protected by a series of embankments and walls, sheet piled where necessary and set back where possible from, the river channel.
- Hard defences that would protect properties from the 1% AEP fluvial event and with an estimated average height of 1.56 m and total length of 1.31 km.

In light of the above, a white-clawed crayfish (*Austropotamobius pallipes*) survey was undertaken in April 2021 to establish the presence/absence of white-clawed crayfish in the vicinity of the proposed flood relief scheme footprint. This would identify the most important areas in the vicinity of the scheme for the species to inform design considerations to minimise negative effects on local populations. The scheme footprint was located within the River Barrow catchment (Barrow_SC_0130 sub-catchment) and encompassed the River Barrow and two tributaries (Duiske River and Graiguenamanagh River), in addition to a small historical mill race channel linking the Tinnapark Stream and lower Duiske River.

In the vicinity of the proposed FRS, the River Barrow (EPA code: 14B01) and tributary Duiske River (14D04) were located within the River Barrow and River Nore SAC (site code: 002162). Whilst not located within this European site, the Graiguenamanagh Stream (14G42), a tributary of the Duiske River, shared downstream hydrological connectivity with the River Barrow and River Nore SAC.

1.2 Conservation status of white-clawed crayfish in Ireland

The white-clawed crayfish (*Austropotamobius pallipes*) has been listed as endangered since 2010 on the IUCN Red List (Füreder *et al.*, 2010). Given increased pressure on the species' survival, it is listed under Appendix III of the Bern Convention (82/72/EEC) and Annexes II and V of the European Communities (Birds and Natural Habitats) Regulations 2011-2015 (S.I. No. 477/2011).

In Ireland, it is also protected nationally under the Wildlife Act, 1976 and the Wildlife (Amendment) 2000. The European Union (Invasive Alien Species) (Freshwater Crayfish) Regulations 2018 (SI 354/2018) affords further protection to native white-clawed crayfish by prohibiting the introduction and spread of (five no.) invasive 'Union concern' crayfish species listed under EU Regulation 1143/2014.

The current overall conservation status for white-clawed crayfish in Ireland is 'bad', with a deteriorating trend (NPWS, 2019), largely as a result of widespread crayfish plague (*Aphanomyces astaci*) outbreaks in several catchments since 2017.

1.3 Status of white-clawed crayfish in the Barrow catchment (desktop review)

White-clawed crayfish require hard, mineral rich waters flowing over (high calcium) calcareous substrates (Holdich, 2003). Consequentially, crayfish distribution follows many of Ireland's carboniferous limestone belts and occurs throughout the limestone-rich Irish midlands, including in the River Barrow (Lucey & McGarrigle, 1987; Demers *et al.*, 2005). White- clawed crayfish are listed as a qualifying interest for the River Barrow and River Nore SAC identifying the importance of the large river catchment for the species (NPWS, 2011). Populations of crayfish along the main River Barrow channel were, until recently, agreed as being particularly healthy and the species had a widespread distribution in the catchment. Historically, the species was present from the upper reaches and tributaries (Co. Laois) to the lower reaches at the Bahana Weir, St. Mullins. On the main channel of the River Barrow the species tends to favour areas downstream of weirs (pers. obs.) and under bridge aprons where large cobble and boulder is present. White-clawed crayfish also had healthy distributions in the smaller tributaries with improved river profile where well oxygenated water with abundant boulder and cobble substrata exist.

However, large-scale outbreaks of the water oomycete crayfish plague (*Aphanomyces astaci*) resulted in mass mortalities along the River Barrow main channel, from Carlow to Graiguenamanagh, in 2017 (NBDC data). Additional smaller-scale outbreaks were recorded from the upper Barrow catchment, upstream of previous outbreaks, in 2018 and again in 2019 (NPWS, 2019). Crayfish plague is highly infectious (water-borne spores) and usually leads to 100% mortality in a given white-clawed crayfish population within several weeks of infection (Holdich, 2003; Edgerton *et al.*, 2004). These outbreaks have significantly impacted crayfish populations within the River Barrow and the wider catchment (see Discussion for more details).

2. Methodology

2.1 White-clawed crayfish surveys

White-clawed crayfish (*Austropotamobius pallipes*) surveys were undertaken at a total of *n*=14 survey sites under a National Parks and Wildlife (NPWS) open licence (no. C145/2021), as prescribed by Sections 9, 23 and 34 of the Wildlife Act (1976-2018), to capture and release crayfish to their site of capture, under condition No. 6 of the licence.

2.1.1 Crayfish trapping

Twelve 51 x 20cm, 19mm mesh polypropylene Trappy crayfish traps (ballasted with extra rock to prevent excessive movement) were positioned in the vicinity of *n*=5 proposed instream works areas on the Duiske River and River Barrow (**Figure 2.1**). Traps were fished in pairs and were placed in suitable marginal areas overnight and retrieved the following morning. Traps were disinfected with Virkon between sites to minimise transfer of pathogens. All traps were baited with 100g of cat food to attract crayfish to the traps.

2.1.2 Hand-searching, sweep-netting & snorkelling

To expand survey area coverage, hand-searching of instream refugia (including sweep netting) was undertaken at a total of *n*=9 sites on the Duiske River and mill race channel, Graiguenamanagh River and the River Barrow (**Figure 2.1**). Surveys followed the methodology of Reynolds *et al.* (2010) and Peay (2003). A minimum of *n*=25 potential refugia (boulders, macrophyte beds, large woody debris, tree root systems *etc*.) were searched at each site. Additionally, instream snorkelling facilitated hand-searching of deeper areas of river channel (where applicable). An appraisal of white-clawed crayfish habitat at each site and in the wider survey area was also carried out based on physical channel attributes. Furthermore, an appraisal of crayfish distribution and habitat was completed whilst undertaking SCUBA dive surveys for the accompanying freshwater pearl mussel survey (Triturus, 2021) of the River Barrow within the survey area.

2.1.3 Riparian walkover survey (mustelid spraint)

Further to traditional survey methods, it was important to undertake a riparian walkover survey to examine any spraint from mustelids (*i.e*. otters & mink) which may contain crayfish remains. Given that mustelids hunt large areas of river, they can detect cryptic prey present at low densities, which are often not easily attainable via conventional survey methodologies. Whilst not quantitative, riparian walkover/spraint surveys are useful for clarifying the presence of absence of crayfish at a particular site.

Table 2.1 Location of *n*=14 white-clawed crayfish survey sites in the vicinity of Graiguenamanagh, Co. Kilkenny.

Site	Watercourse	Methodology	Location	ITM x	ITM y
D1	Duiske River	Hand-searching/ sweep netting	Tinnapark River confluence	669803	644173
D2	Duiske River	Hand-searching/ sweep netting	R705 road bridge	670580	644089
D3	Duiske River	Hand-searching/ sweep netting	Well Lane footbridge	670754	643912
D4	Duiske River	Hand-searching/ sweep netting	u/s Old Dock Bridge	670840	643629
G1	Graiguenamanagh River	Hand-searching/ sweep netting	u/s R705 culvert	670632	644454
M1	Mill Race channel	Hand-searching/ sweep netting	R705 road bridge	670532	644037
M2	Mill Race channel	Hand-searching/ sweep netting	Well Lane footbridge	670694	643840
B1	River Barrow	Hand-searching/ sweep netting	d/s Graiguenamanagh Weir	670801	643518
B2	River Barrow	Hand-searching/ sweep netting	Lower Tinnahinch Weir	670983	642623
T1	Duiske River	Trapping	Graiguenamanagh/Duiske River confluence	670597	644089
T2	Duiske River	Trapping	d/s Turfmarket Weir	670839	643696
T3	River Barrow	Trapping	Diving board	671125	643765
T4	River Barrow	Trapping	Graiguenamanagh Bridge	670952	643614
T5	River Barrow	Trapping	Graiguenamanagh Weir navigation	670698	643428

2.2 eDNA analysis

To further validate the site surveys and to detect potentially cryptically-low populations of white-clawed crayfish within the study area, *n*=3 water samples from sites on the Duiske River and River Barrow were analysed for *Austropotamobius pallipes* environmental DNA (eDNA) in April 2021. Sampling points were strategically chosen on the Duiske River (upstream of Tinnapark River confluence and downstream of Turfmarket Weir) and River Barrow (Lower Tinnahinch Weir) to maximise habitat coverage and eDNA detection within the wider survey area (**Figure 2.1**).

In accordance with best practice, composite (500ml) water samples were collected from each sampling point, maximising the geographic spread within each site (20 x 25ml samples at each site) and thus increasing the chance of detecting the target species' DNA. Each composite sample was filtered on site using a sterile proprietary eDNA sampling kit. Fixed samples were sent to the laboratory for analysis on the same day as collection. A total of *n*=12 qPCR replicates were analysed for each site. Given the high sensitivity of eDNA analysis, a single positive qPCR replicate is considered as proof of the species' presence (termed qPCR No Threshold, or qPCR NT). Whilst an eDNA approach is not currently quantitative, the detection of the target species' DNA indicates the presence of the species at or upstream of the sampling point. Please refer to **Appendix B** for

full eDNA laboratory analysis methodology.

2.3 Biosecurity

A strict biosecurity protocol following the Check-Clean-Dry approach was employed during the survey. Equipment and PPE used was disinfected with Virkon® between survey sites to prevent the transfer of pathogens and/or invasive species between survey areas. Particular cognisance was given to preventing the introduction or spread of crayfish plague (*Aphanomyces astaci*) given the known presence of the pathogen in the River Barrow in the vicinity of the flood relief scheme. As per best practice, surveys were undertaken at sites in a downstream order (*i.e.* uppermost site surveyed first *etc*.) to prevent the upstream mobilisation of invasive propagules and pathogens. The survey team has aquatic biosecurity training from the University of Leeds.

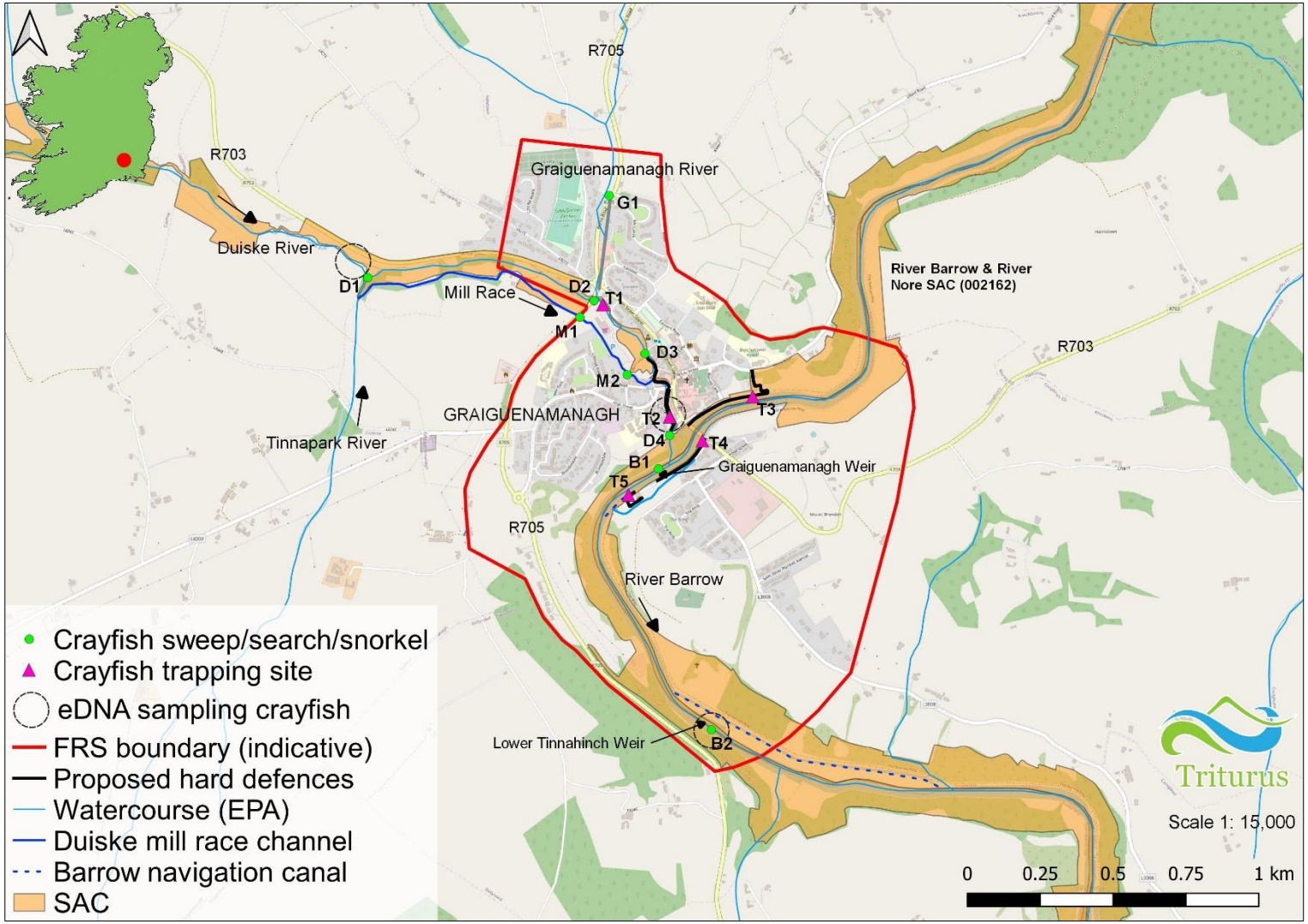

Figure 2.1 Overview of the white-clawed crayfish survey sites in the vicinity of Graiguenamanagh and Tinnahinch, Co. Kilkenny, April 2021.

3. Results

White-clawed crayfish surveys were undertaken on Thursday 29th and Friday 30th April 2021 via trapping (*n*=5 sites), hand-searching/sweep netting (including snorkelling) (*n*=9 sites) and the examination of otter spraints for crayfish remains. No white-clawed crayfish were recorded. Furthermore, eDNA analysis of n=*3* water samples failed to identify any white-clawed crayfish eDNA within the wider survey area.

The results of the surveys are presented below in terms of the number of crayfish recorded and overall crayfish suitability as well as general observations on the ecology of each survey site. The survey sites are summarised per site below and in more detail in **Appendix A**. Scientific names are provided at first mention only.

3.1 Site descriptions & crayfish habitat

3.1.1 Site D1 – Duiske River (Tinnapark River confluence)

Site D1 was located on the Duiske River at the Tinnapark River confluence, upstream of the proposed flood relief scheme boundary. Here, the Duiske River was a largely natural, high-energy upland eroding watercourse (FW1; Fossitt, 2000). The narrow channel averaged 2-2.5m wide and 0.1-0.3m deep in a habitat dominated by fast glide and riffle with only localised pool (0.7m max.). Given high flow rates, the site featured partially bedded (locally heavily bedded) substrata. Despite frequent boulder, these were bedded with silt which precluded crayfish access to potential refugia. Cover of filamentous algae was moderate. The river was bordered by narrow but mature riparian treelines supporting alder (*Alnus glutinosa*), willow (*Salix* sp.) and ash (*Fraxinus excelsior*) with scrubby understories. Shading was moderate and this resulted in low instream growth, with macrophytes limited to marginal hemlock water dropwort (*Oenanthe crocata*). The aquatic moss *Platyhypnidium riparoides* was common on instream boulder with *Hygroamblystegium* sp. occasional. The red alga *Lemanea* sp., characteristic of high-energy watercourses, was also occasional.

No white-clawed crayfish were recorded via sweep-netting or hand-searching of *n*=25 instream refugia (*i.e.* boulder and large woody debris). Although some tree root systems provided some potential habitat, refugia were typically not accessible to crayfish (bedded/compacted) and the banks were not suitable for crayfish burrowing. The high energy nature of the site was sub-optimal for the species. Superior crayfish habitat was present further downstream.

Plate 3.1 Site D1 on the Duiske River at the Tinnapark River confluence.

3.1.2 Site D2 – Duiske River (R705 road bridge)

Site D2 on the Duiske River was located downstream of the R705 road bridge at the confluence with the Graiguenamanagh River (**Figure 2.1**). The river averaged 2.5-3m in width and 0.1-0.3m in depth. The high-energy watercourse (FW1) was dominated by boulder and cobble with patches of gravel/coarse sand. Fast glide dominated with only localised shallow pool present. Given the high flow rates, compaction was relatively high and siltation was low overall. In contrast to upstream areas (highly natural), the river at this site had been historically modified with evident bank modifications (boulder/basket revetments) and ornamental planting. Storm drains were present upstream (at bridge and in Graiguenamanagh River), with high filamentous algae cover (*Vaucheria* sp. & *Cladophora* sp.). indicating enrichment. Flocculent deposits of decaying organic matter and silt (*i.e*. 'floc'[1]) were present locally in more depositional areas. Instream macrophytes were not present given high flows and compacted substrata. *Lemanea* sp. and *Platyhypnidium riparoides* were common on instream boulder with *Hygroamblystegium* sp. occasional.

No white-clawed crayfish were recorded via sweep-netting or hand-searching of *n*=25 instream refugia (*i.e.* boulder and cobble). Given high flow rates, refugia were typically not accessible to crayfish (bedded/compacted) and the banks were not suitable for crayfish burrowing. The high energy nature of the site was sub-optimal for the species. Superior crayfish habitat was present further downstream.

[1] Floc is defined as an aggregation of (mostly dead) organic material, mainly from algae and diatoms, but also with potential origins from decaying macrophytes and associated decomposers (bacteria and fungi). The floc can form a layer at the surface of the substrate, or infiltrate the substrate, generally where there is insufficient flow to keep the material in suspension (Moorkens & Killeen, 2020)

Plate 3.2 The modified Duiske River downstream of the R705 road bridge

3.1.3 Site D3 – Duiske River (Well Lane footbridge)

Site D3 on the Duiske River was located at the Well Lane footbridge (**Figure 2.1**). The river averaged 2.5-3m in width and 0.1-0.3m in depth. The upland eroding watercourse (FW1) was slower-flowing than upstream sites but still characterised by swift, shallow glide with occasional riffles and only localised pool (1m max.). The riverbed featured more in the way of mixed gravels and coarse sand, though the predominant substrata was still cobble with frequent boulder. He substrata were moderately compacted but still accessible to crayfish. Some limited sand/silt accumulations were present in the vicinity of the bridge. Natural scouring has resulted in the western bank being substantially undercut (underneath an adjoining hedgerow/scrub). The site was bordered by scattered treelines of alder and scrub dominated by bramble (*Rubus fruticosus* agg.). Water crowfoot (*Ranunculus* sp.) was frequent downstream of the bridge with hemlock water dropwort (margins only) and *Platyhypnidium riparoides* common. Filamentous algal cover was relatively low but present (*Cladophor*a sp.).

Despite some good suitability, no white-clawed crayfish were recorded via sweep-netting or hand-searching of *n*=25 instream refugia (*i.e.* boulders, cobbles, macrophyte beds and undercut banks). The crayfish habitat was much improved over upstream sites given the presence of instream macrophyte beds and undercut banks (featuring tree root systems). However, though less compacted compared with upstream areas, the boulder and cobble substrata were still partially bedded. Nonetheless, many were accessible to crayfish but none were recorded. Otter spraint recorded underneath the footbridge did not contain any crayfish remains.

Plate 3.3 The Duiske River facing upstream of the Well Lane footbridge.

3.1.4 Site D4 – Duiske River (Old Dock Bridge)

Site D4 was located at Old Dock Bridge on the lower reaches of the Duiske River, approx. 90m upstream of the River Barrow confluence (**Figure 2.1**). The upland eroding watercourse (FW1) had been historically modified and straightened locally, with retaining walls on both banks. Good recovery was evident. The channel was 3-3.5m wide and 0.2-0.5m deep, with fast-flowing glide predominating. Small pools to 1m were associated with upstream meanders. The substrata were dominated by boulder and cobble with small patches of interstitial gravel/coarse sand. Siltation was low given the high flow rates. Enrichment was evident with abundant filamentous algal cover on substrata (*Cladophora* sp. & *Vaucheria* sp.) as well as high amounts of floc. These substrata were bedded/compacted given the high flow rates of the river (as observed upstream). Instream macrophytes were limited to occasional hemlock water dropwort with a relatively high coverage of bryophytes such as *Platyhypnidium riparoides*.

Despite some moderate suitability, no white-clawed crayfish were recorded via sweep-netting or hand-searching of *n*=25 instream refugia (*i.e.* boulders, cobbles). Boulder refugia, whilst frequent, were invariably inaccessible to crayfish given high compaction/bedding of the substrata. Some refugia such as tree roots and flood walls were present but no crayfish were recorded. Otter spraint recorded at the site did not contain any crayfish remains.

Plate 3.4 Site D4 on the lower reaches of the Duiske River (facing downstream towards bridge).

3.1.5 Site G1 - Graiguenamanagh River (upstream R705 culvert)

Site G1 was located on the upper reaches of the Graiguenamanagh River, upstream of an extensive culvert to the Duiske River (**Figure 2.1**). The river represented a small, swift-flowing lowland depositing watercourse (FW2) with a semi-natural profile featuring frequent meanders with riffle, glide and pool sequences. The channel width varied between 1.5-2m with low banks (0.5m bank height). The river was shallow and averaged 0.1-0.2m deep with very occasional pools to 0.3-0.7m max. The bed comprised of mixed large cobble, coarse, medium and fine gravels and sand with frequent silt. The substrata were compacted with moderate siltation that increased in depositing pool areas. Boulder was also present but localised. The exposed hard substrata on the channel margins supported frequent hemlock water dropwort with occasional fool's watercress (*Apium nodiflorum*), lesser water parsnip (*Berula erecta*) and water mint (*Mentha aquatica*). The riparian zone was dominated by open pasture with abundant soft rush (*Juncus effusus*), gorse (*Ulex europaeus*) and scattered alder (*Alnus glutinosa*).

The upper Graiguenamanagh River supported some moderate to good quality crayfish habitat given the presence of large cobble and marginal macrophyte beds. However evident compaction and sedimentation reduced the viability of the habitat for crayfish. None were recorded during the survey. Approximately 50 refugia were searched which included sweeps of macrophytes and large cobble. Further examination with the bathyscope did not reveal any evidence of the species. The notable absence of salmonids (which would typically be expected in such a site) indicated a potential pollution event that may have impacted the small river historically.

Plate 3.5 Representative image of site G1 on the upper Graiguenamanagh River.

3.1.6 Site M1 – Mill Race channel (R705 road bridge)

Located at the R705 road bridge (adjacent to Aldi Graiguenamanagh), the Mill Race channel was a small, 1.5-2m wide, swift-flowing lowland depositing watercourse (FW2). The Mill Race at site M1 was a 1m-wide artificial channel (mature) that averaged 0.1m deep with low (0.5m) bankfull heights. The substrata comprised bedded mixed fine, medium and coarse gravels with small cobble. No large boulders or cobble were present. Siltation was moderate to high locally given the more depositional nature of the habitat. Accumulations of soft sediment were present along the channel margins. Enrichment was also evident with filamentous algae present (10% cover). Instream macrophytes were limited to frequent encroaching hemlock water dropwort with the moss *Chiloscyphus polyanthos* also frequent. The riparian zone was dominated by hedgerows/scrub of hawthorn (*Crataegus monoygna*), bramble and scattered mature trees which provided moderate levels of shading. Amenity grassland (GA2) bordered the channel to the north.

No crayfish were recorded from site M1 via sweep netting or hand-searching. The small, shallow channel provided poor suitability for crayfish given the paucity of suitable refugia and bedded substrata. The banks were also largely unsuitable for burrowing. However, suitability improved slightly further downstream where deeper glide became more prominent.

Plate 3.6 The Duiske Mill Race channel downstream of the R705 road crossing (adjacent to Aldi).

3.1.7 Site M2 – Mill Race channel (Well Lane footbridge)

Located at the Well Lane footbridge crossing, site M2 on the Mill Race channel featured more depositional habitat compared with upstream. Slow-flowing glide of 0.1-0.25m was present with the substrata dominated by silt and localised superficial (silted) gravels. Larger cobble and boulder were rare and bedded in silt where present. In terms of instream macrophytes, water crowfoot was frequent in riffle area downstream of the footbridge, with frequent fool's watercress (*Apium nodiflorum*) and hemlock water dropwort along channel margins. The moss *Chiloscyphus polyanthos* was occasional instream. The riparian zone was dominated by bramble and hawthorn hedgerow on the south with rank grassy areas to the north.

No crayfish were recorded from site M2 via sweep netting or hand-searching. Although the crayfish habitat was improved compared with upstream site M1 (*e.g.* presence of macrophyte beds *etc*.), the shallow channel at site M2 provided poor suitability for crayfish given the paucity of suitable refugia and bedded substrata. The banks were also largely unsuitable for burrowing. The shallow nature of the site and likely low seasonal flows also reduced the overall value for crayfish.

Plate 3.7 The Duiske Mill Race channel upstream of the Well Lane footbridge.

3.1.8 Site B1 - River Barrow (Graiguenamanagh Weir)

Site B1 on the River Barrow was located downstream of Graiguenamanagh Weir (Figure 2.1). The river averaged 20-25m wide with 1-1.5m deep fast glide, grading to deeper, slower-flowing glide (>2.5m) downstream. The bed in the vicinity of the weir was dominated by cobble and coarse gravel with occasional boulder with larger areas of coarse sand with marginal silt downstream of weir pool. Larger substrata, although frequent, were typically compacted and bedded given the high flow rates. Filamentous algal cover was excessively high (>50%), indicating significant enrichment. The weir face featured many crevices and cracks suitable as crayfish refugia and, downstream of the weir pool area, soft steep marginal slopes along the western shore provided some suitability for crayfish burrowing. Growth of instream macrophytes was sparse but arrowhead (*Sagittaria sagittifolia*), clubrush (*Schoenoplectus lacustris*) and very occasional yellow water lily (*Nuphar lutea*) were present. Bryophyte cover was low given abundant filamentous algae and floc.

Despite some high suitability, no crayfish were recorded via hand-searching, sweep-netting or snorkelling at site B1. Approximately 50 refugia were searched which included sweeps of macrophytes, boulder/large cobble, banks suitable for burrowing and the weir structure – areas which historically supported white-clawed crayfish at this site (pers. obs.).

Plate 3.8 Hand-searching and sweep netting for crayfish below Graiguenamanagh Weir.

3.1.9 Site B2 - River Barrow (Lower Tinnahinch Weir)

Site B2 on the River Barrow was located at Lower Tinnahinch Weir (Figure 2.1). Upstream of the weir featured 100% deep (2-3m), slow-flowing glide habitat 30-40m wide with frequent large substrata and instream macrophyte beds. Downstream of the weir was turbulent in nature with abundant large boulders in addition to frequent cobble and coarser gravels in a water death of <1m. The high flow rates here resulted in a moderately compacted bed but low siltation. Filamentous algal cover was high at the time of survey (30% cover). The weir face featured many crevices and cracks suitable as crayfish refugia and, downstream of the weir pool area, soft steep marginal slopes along the northern bank provided some suitability for crayfish burrowing. Large woody debris was also present which provided some high value as crayfish refugia. Growth of instream macrophytes was sparse downstream of the weir but arrowhead, clubrush, hemlock water dropwort and yellow water lily were present. Bryophyte cover was high downstream of the weir on larger instream substrata. The site was bordered by mature treelines and mixed broad-leaved woodland.

Despite some high suitability (and historical presence), no crayfish were recorded via sweep netting, hand-searching or snorkelling at site B2. Furthermore, eDNA sampling did not identify the presence of crayfish at or upstream of this location – see section 3.2 below. Lower Tinnahinch Weir offered abundant suitable refugia for crayfish by way of large boulders, cobble, macrophyte beds, large woody debris and weir sill crevices but the examination of approx. 60 refugia did not reveal any crayfish. Furthermore, otter spraint recorded on the top of the weir structure did not contain any visible crayfish remains.

Plate 3.9 eDNA sampling for white-clawed crayfish and crayfish plague at Lower Tinnahinch Weir, April 2021.

3.1.10 Site T1 – Duiske River (downstream Aldi access bridge)

Trapping site T1 was located on the Duiske River immediately downstream of the Aldi access bridge, approx. 30m downstream from the Graiguenamanagh River confluence (**Figure 2.1**). The swift-flowing river averaged 2.5-3m wide and 0.5-1.5m deep downstream of the access bridge. The substrata were dominated by boulder and cobble with localised patches of mixed gravels and coarse sand. Given high flow rates, the substrata were moderately compacted, with some siltation in pool slacks. Riparian shading (from mature treelines and scrub) was high and instream macrophyte growth was absent. However, aquatic bryophyte coverage was high.

The site was chosen for overnight trapping due to the presence of a 1.5m-deep, tree-lined pool with abundant crayfish refugia by way of tree root systems, undercut banks and large boulders. However, despite high physical suitability, no crayfish were recorded via trapping.

Plate 3.10 Trapping for white-clawed crayfish at site T1 on the Duiske River.

3.1.11 Site T2 – Duiske River (Turfmarket Weir)

Site T2 was located downstream of Turfmarket Weir on the lower reaches of the Duiske River (**Figure 2.1**). The upland eroding watercourse (FW1) had been historically modified and straightened locally, with retaining walls on both banks in addition to a small weir (0.3m fall). The channel was 3m wide and 0.2-0.5m deep, with fast-flowing glide predominating. Small pools to 0.7-1m were associated with the small weir and downstream meanders. The substrata were dominated by boulder and cobble with small patches of interstitial gravel/coarse sand. Siltation was low given the high flow rates. Enrichment was evident with abundant filamentous algal cover on substrata. These were also bedded given high flow rates of the river (as observed upstream).

Despite some good suitability in terms of crayfish refugia (macrophytes, boulders, large cobbles, weir face crevices, retaining wall base crevices *etc*.), no crayfish were recorded via trapping.

Plate 3.11 Trapping the small weir pool at Turfmarket Weir on the lower reaches of the Duiske River.

3.1.12 Site T3 – River Barrow (diving board)

Site T3 was located on the River Barrow upstream of Graiguenamanagh Bridge, adjacent to the diving board at Graiguenamanagh Rowing Club (**Figure 2.1**). The river upstream of Graiguenamanagh Bridge was 40-50m-wide canalised channel (FW2) with depths varying from 1.5-2.5m. The river was bound by a retaining wall along the west (town) bank, with historical modifications present on the east. The river at this location was depositional in nature and featured 100% deep slow-flowing glide. The substrata were dominated by silt with localised areas of sand and bedded cobbles and gravels, particularly associated with the marginal slopes of the channel. Abundant filamentous algae was present on the substrata (very high cover).

Despite some good suitability, no crayfish were recorded via trapping. Furthermore, SCUBA diving undertaken in April 2021 as part of the accompanying freshwater pearl mussel survey for the scheme in this section of river did not identify any white-clawed crayfish. Whilst impacted by both siltation and high filamentous algae/floc cover (**Plate 3.13**), refugia accessible and suitable for crayfish were abundant, such as large boulders, retaining wall crevices and instream debris.

Plate 3.12 Setting baited crayfish traps on the River Barrow at site T3.

Plate 3.13 Potential crayfish refugia adjacent to site T3 (heavily silted with high filamentous algae and floc cover).

3.1.13 Site T4 – River Barrow (Graiguenamanagh Bridge)

Site T4 was located on the River Barrow immediately downstream of Graiguenamanagh Bridge, along the east bank of the river (**Figure 2.1**). The river upstream of the weir, at the bridge, was a 60-70m-wide canalised channel (FW2) with depths varying from 1.5-2m. The river was bound by retaining walls on both banks. Swift-flowing glide predominated with localised pool areas. The substrata alternated between plains of coarse sand and silt with boulder zones in the centre channel. Abundant boulders were present under the bridge arches. Abundant filamentous algae and floc was present on the substrata (very high cover). Macrophyte growth near the trapping site was absent with only localised bryophyte growth (mostly covered by algae).

Despite some good suitability, no crayfish were recorded via trapping. Furthermore, SCUBA diving undertaken in April 2021 as part of the accompanying freshwater pearl mussel survey for the scheme in this section of river did not identify any white-clawed crayfish. Whilst impacted by both siltation and high filamentous algae/floc cover (Plate 3.15), refugia accessible and suitable for crayfish were abundant, such as large boulders, retaining wall crevices and instream debris.

Plate 3.14 Set crayfish traps on the River Barrow at Graiguenamanagh Bridge (east bank).

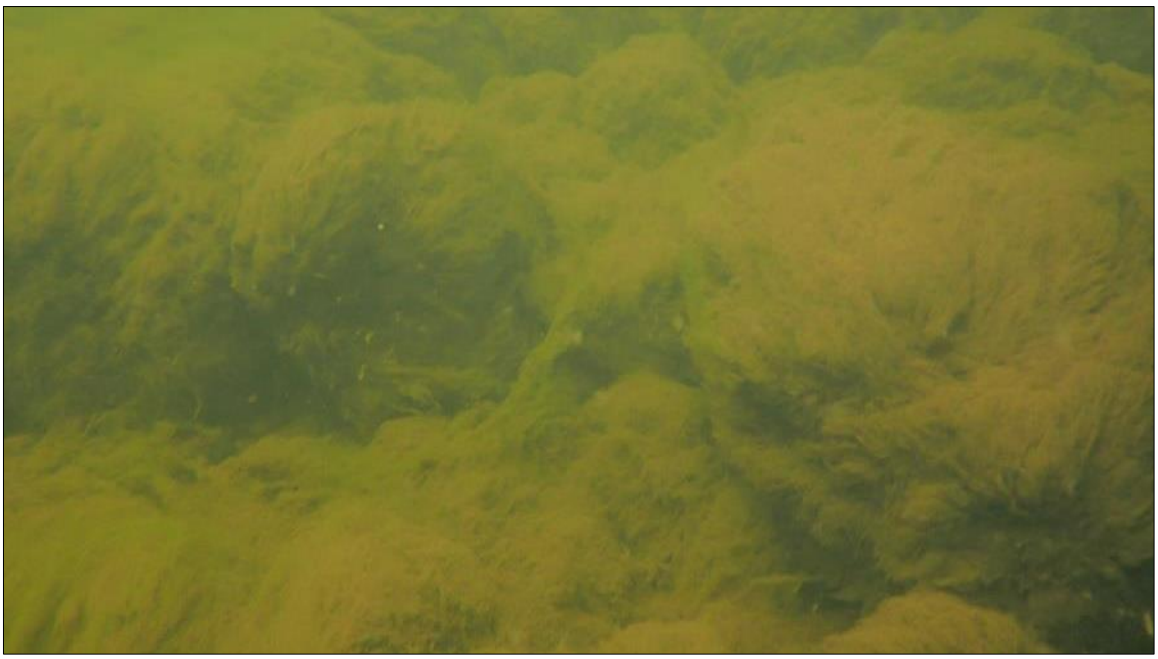

Plate 3.15 Boulder zone in the vicinity of Graiguenamanagh Bridge with very high cover of filamentous algae and floc.

3.1.14 Site T5 – River Barrow (Upper Tinnahinch Lock)

Site T5 was located upstream of the Lock gates at Tinnahinch Lock (Upper) adjacent to Graiguenamanagh Weir on the River Barrow (**Figure 2.1**). The channel was of variable width (5-12m) as it was situated in a macrophyte rich bay upstream of the canal lock gates (**Plate 3.16**). The depth ranged between 1.3m and 2.5m and the water had a very slight flow only. The substrata were dominated by silt although localised boulder and cobble were present. The bed supported submerged arrowhead, yellow water lily, spiked water milfoil and common clubrush. The area had some suitability for crayfish that could utilise the quay walls, adjoining boulder substrata and or macrophyte beds. However, none were recorded during trapping and snorkelling of the area.

Plate 3.16 Trapping area upstream of Tinnahinch Lock (Upper).

3.2 eDNA analysis

Composite water samples collected from the Duiske River upstream of Tinnapark River confluence (C0285), Turfmarket Weir (C0282) and Lower Tinnahinch Weir (C0280) all returned a negative result for white-clawed crayfish eDNA (0 positive of 12 qPCR replicates, respectively) (**Figure 3.1** & **Appendix B**). In conjunction with traditional survey results (provided above), these results were considered as evidence of the species' absence from the watercourses in the vicinity of Graiguenamanagh.

Positive results for crayfish plague eDNA were returned in the River Barrow sample collected at Lower Tinnahinch Weir (C0280) (4 of 12 qPCR replicates) and the lower Duiske River sample (C0282) (12 of 12 QPCR replicates) (**Figure 3.2** & **Appendix B**). The water sample collected from the upper Duiske River, upstream of the Tinnapark River confluence (C0285) tested negative for crayfish plague (0 of 12 qPCR replicates).

Table 3.1 Survey results for the *n*=14 white-clawed crayfish survey sites in the vicinity of Graiguenamanagh and Tinnahinch, Co. Carlow, April 2021.

Site	Watercourse	Methodology	Location	Crayfish recorded
D1	Duiske River	Hand-searching/ sweep netting	Tinnapark River confluence	No
D2	Duiske River	Hand-searching/ sweep netting	R705 road bridge	No
D3	Duiske River	Hand-searching/ sweep netting	Well Lane footbridge	No
D4	Duiske River	Hand-searching/ sweep netting	u/s Old Dock Bridge	No
G1	Graiguenamanagh River	Hand-searching/ sweep netting	u/s R705 culvert	No
M1	Mill Race channel	Hand-searching/ sweep netting	R705 road bridge	No
M2	Mill Race channel	Hand-searching/ sweep netting	Well Lane footbridge	No
B1	River Barrow	Hand-searching/ sweep netting	d/s Graiguenamanagh Weir	No
B2	River Barrow	Hand-searching/ sweep netting	Lower Tinnahinch Weir	No
T1	Duiske River	Trapping	Graiguenamanagh/Duiske River confluence	No
T2	Duiske River	Trapping	d/s Turfmarket Weir	No
T3	River Barrow	Trapping	Diving board	No
T4	River Barrow	Trapping	Graiguenamanagh Bridge	No
T5	River Barrow	Trapping	River Barrow (near Tinnahinch Lock Upper)	No

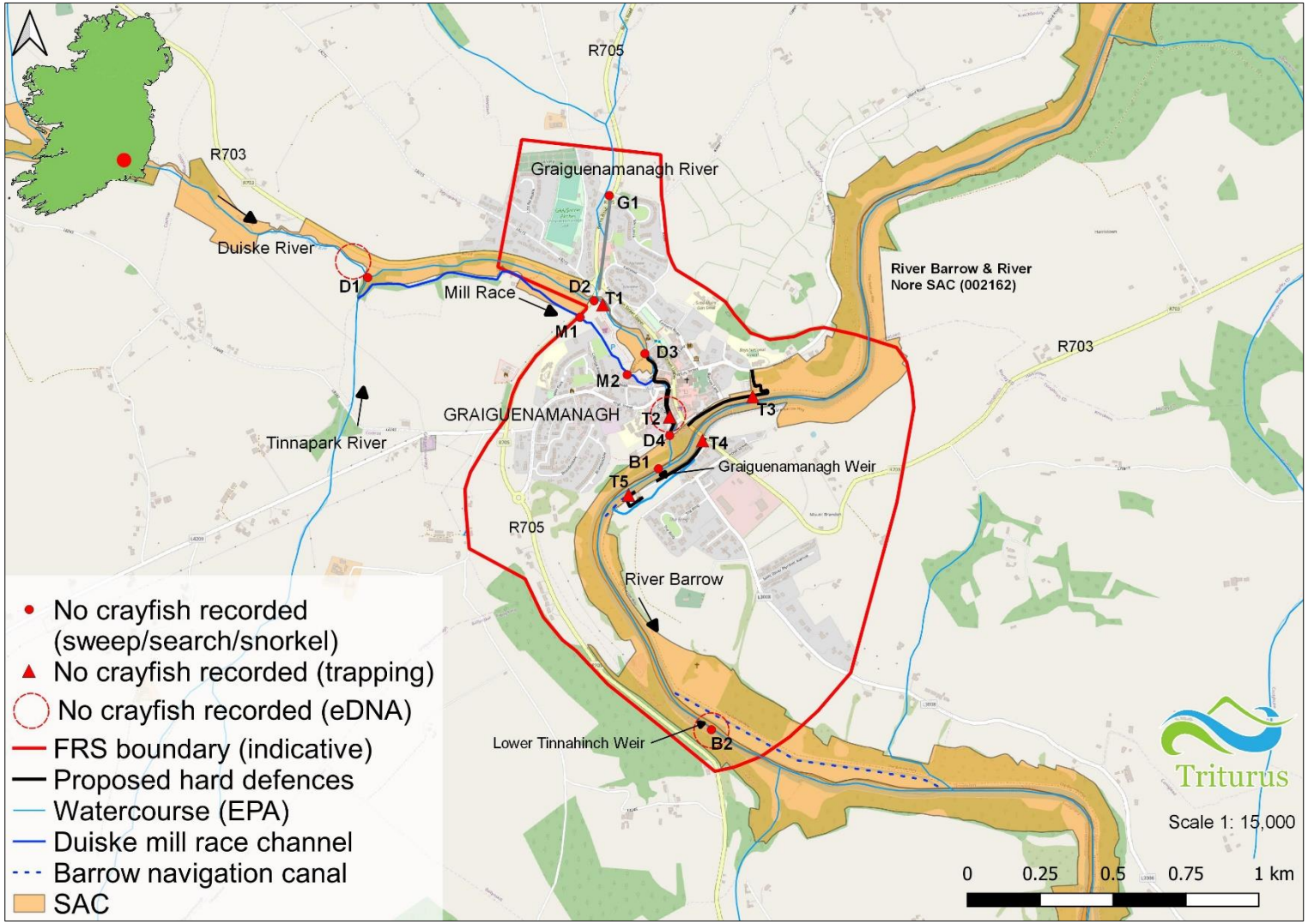

Figure 3.1 Results summary of white-clawed crayfish hand-searching, sweep-netting, snorkelling and trapping surveys, April 2021.

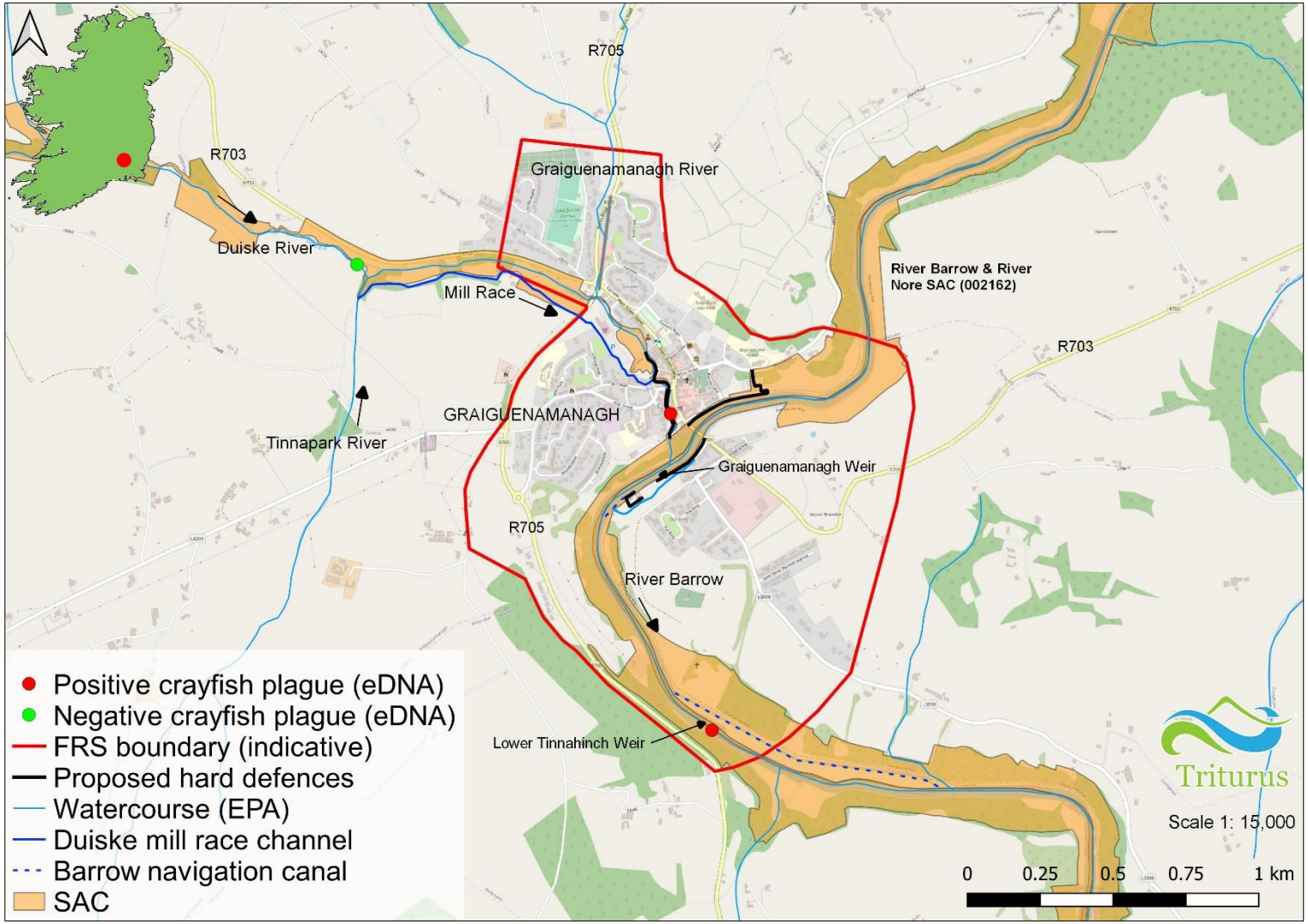

Figure 3.2 Results summary of crayfish plague (*Aphanomyces astaci*) eDNA sampling, April 2021.

4. Discussion

4.1 Absence of white-clawed crayfish

Despite some good suitability and known historical distribution, trapping and traditional surveys (hand-searching, sweep-netting, snorkelling) undertaken at a total of *n*=14 sites on the Duiske River and mill race, Graiguenamanagh River and River Barrow in April 2021 failed to record any white-clawed crayfish. Visual inspection of otter spraints on the Duiske River and River Barrow did not reveal any crayfish remains. SCUBA diving of the main Barrow channel undertaken for the accompanying freshwater pearl mussel survey for the Graiguenamanagh-Tinnahinch FRS (Triturus, 2021) also failed to identify any white-clawed crayfish. These survey findings were further validated by eDNA sampling, which failed to detect any white-clawed crayfish eDNA in the survey area.

Although no historical records were available for the Duiske River, white-clawed crayfish were present until relatively recently in the River Barrow at Graiguenamanagh (2017; Marine Institute data). In line with recent data, our results, regrettably, suggest an extirpation of the species from their known historical range within the River Barrow channel in the vicinity of Graiguenamanagh. Outbreaks of the pathogenic oomycete (water mould) crayfish plague (*Aphanomyces astaci*) were recorded along the River Barrow main channel, from Carlow to Graiguenamanagh, in 2017 (see NBDC data) with characteristic large-scale mortalities recorded from Leighlinbridge downstream to Graiguenamanagh (NPWS, 2017). Additional, smaller-scale outbreaks were recorded from the upper Barrow catchment, upstream of previous outbreaks, in both 2018 and 2019 (NPWS, 2019). Environmental DNA sampling for white-clawed crayfish as part of the National Crayfish Plague Surveillance Program 2018-2019 identified the species presence in the upper River Barrow catchment only (Swords, 2020). Consequently, the conservation status of this Annex II conservation objective species in the River Barrow (part of the River Barrow & River Nore SAC) appears seriously jeopardised.

4.2 Presence of crayfish plague

Whilst our findings regarding the absence of white-clawed crayfish in the vicinity of Graiguenamanagh and Tinnahinch may be expected in light of the above, the presence of crayfish plague eDNA in both the River Barrow (Lower Tinnahinch Weir) and lower Duiske River (Turfmarket Weir) samples was surprising (**Figure 3.2**). Crayfish plague is highly infectious (water-borne spores) and usually leads to 100% mortality in a given white-clawed crayfish population within several weeks of infection (Holdich, 2003; Edgerton *et al.*, 2004). Generally, *Aphanomyces astaci* is considered an obligate crayfish parasite not capable of surviving for a long period outside a crayfish host (Strand *et al.*, 2011; Söderhall & Cerenius, 1999). Exceptions to this theory are typically explained through other mechanisms such as latent infections or reintroductions of the pathogen (Oidtmann, 2012). However, the detection of crayfish plague eDNA in the Duiske River and River Barrow despite the absence of crayfish, suggests the potential for another host species or an artefact of eDNA degradation.

It has long been proposed that the host range of *A. astaci* may include not only crayfish but freshwater decapods in general (*i.e.* higher crustaceans including crabs, crayfish and shrimps) (Unestam & Nylund, 1972; Strand *et al.*, 2011). Indeed, recent experiments demonstrated that freshwater crabs (including the Chinese mitten crab, *Eriocheir sinensis*) can be infected by and spread crayfish plague (Svoboda *et al.*, 2014.). The possibility that some other crustaceans may become accidental hosts of the crayfish plague pathogen, for example when stressed, cannot be rejected (Svoboda *et al.*, 2016). Clearly, more research into other possible host species is required in both an Irish and global context.

Alternatively, though considered unlikely given the strength of our crayfish plague eDNA signatures (**Appendix B**), false positives may have resulted from historic eDNA, which can still be present in sediments after the extinction or emigration of the target species (Turner *et al.*, 2015). However, given downstream transport of eDNA, remnant eDNA detection is more likely to occur in lotic waterbodies rather than riverine systems, particularly one with high flow rates such as the Duiske River (crayfish plague in 12 of 12 qPCR replicates). Both inhibition and different target-eDNA size distributions might also explain differences in detection of white-clawed crayfish (absent) and crayfish plague (present) in our riverine samples. A fundamental distinction between the two species is that *A. astaci* depends, for its proliferation, on the frequent and abundant release of encapsulated spores (~8 µm in diameter). It seems likely that these spores, which are designed for transport along large distances, will show lower sensitivity to degradation than white-clawed crayfish DNA (Troth *et al.*, 2021). Though white-clawed crayfish appear extirpated from the survey area, this characteristic may explain our eDNA results from the Duiske River and River Barrow.

An additional explanation for our results is that white-clawed crayfish currently infected by crayfish plague were present at cryptically-low densities in both the Duiske River and River Barrow, although this defies not only our extensive current survey findings but those of national monitoring programs also.

Given the apparent absence of crayfish hosts, crayfish plague (and its eDNA) may have been recently introduced to the survey area by a multitude of vectors including the surfaces of crustaceans, fish, water birds and mammals such as otter (Svoboda *et al.*, 2016, 2020). Nevertheless, the likelihood of *A. astaci* transmission by such vectors from an area hosting both white-clawed crayfish and crayfish plague (*e.g.* upper Barrow catchment) to the Graiguenamanagh study area seems highly unlikely given the large distances involved (>70km). Given the known distribution of crayfish plague in the main River Barrow channel since 2017, transmission of by mobile species such as otters may explain the presence of *A. astaci* in the lower Duiske River (at Turfmarket Weir).

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6. Appendix A – survey site characteristics

Table A1 Summary characteristics of each white-clawed crayfish survey site in the vicinity of the proposed Graiguenamanagh-Tinnahinch FRS, April 2021.

Site	Watercourse	River profile	Substrata	Crayfish habitat	Macrophytes & bryophytes (DAFOR)	Crayfish recorded	Crayfish plague recorded	Methodology
D1	Duiske River (u/s Tinnapark River confluence)	Upland eroding watercourse (FW1), average 2-2.5m wide and 0.1-0.3m deep, fast glide and riffle with localised pool (0.7m max.), high flow rates	Boulder & cobble dominated with localised beds of mixed gravels; moderate siltation; moderate filamentous algae cover, moderate compaction	Moderate quality Frequent boulder refugia but partially-bedded; tree root systems and undercut banks present	*Oenanthe crocata* (O), *Lemanea* sp. (O), *Platyhypnidium riparoides* (F),	No	**No**	Sweep-netting, hand-searching, eDNA
D2	Duiske River (R705 road bridge)	Upland eroding watercourse (FW1), average 3-4m wide & 0.2-0.5m deep, fast glide dominated, bank modifications near R705 crossing, high flow rates	Boulder & cobble dominated with localised beds of mixed gravels and sand; low siltation, high filamentous algae cover, high compaction	Moderate quality Boulder/cobble refugia compacted and poorly accessible, some refugia in retaining wall bases	*Oenanthe crocata* (O), *Lemanea* sp. (O), *Platyhypnidium riparoides* (F), *Hygroamblystegium* sp. (O)	No	n/a	Sweep-netting, hand-searching
D3	Duiske River (Well Lane footbridge)	Upland eroding watercourse (FW1), average 2.5-2m wide and 0.1-0.3m deep, swift glide with localised pool, retaining wall along east bank	Cobble with frequent boulder & mixed gravels/sand with some deposition areas of silt, low filamentous algae cover, moderate compaction	Good quality Frequent boulder/cobble refugia but partially-bedded; tree root systems, macrophyte beds and undercut banks present, some refugia in retaining wall bases	*Ranunculus* subsp. *Batrachion* agg. (F), *Oenanthe crocata* (O), *Platyhypnidium riparoides* (F), *Hygroamblystegium* sp. (O)	No	n/a	Sweep-netting, hand-searching
D4	Duiske River (Old Dock Bridge)	Upland eroding watercourse (FW1), average 3-3.5 wide and 0.2-0.5m deep, swift glide with localised pool, historically straightened with retaining wall along both banks but good	Boulder and cobble with small patches of interstitial gravel/coarse sand, moderate compaction, abundant filamentous algae and floc	Good quality Frequent boulder refugia but accessibility reduced due to partial-bedding & high filamentous algae; undercut banks present, some refugia in retaining wall bases	*Oenanthe crocata* (O), *Platyhypnidium riparoides* (F)	No	n/a	Sweep-netting, hand-searching

Site	Watercourse	River profile	Substrata	Crayfish habitat	Macrophytes & bryophytes (DAFOR)	Crayfish recorded	Crayfish plague recorded	Methodology
		instream recovery, high flow rates						
G1	Graiguenamanagh River (u/s R705 culvert)	Lowland depositing watercourse (FW2), average 1.5-2m wide and 0.1-0.2m deep, riffle-pool-glide sequences, natural channel u/s culvert, swift-flowing glide	Mixed large cobble, coarse, medium and fine gravels and sand with frequent silt; moderate siltation and high compaction	Moderate quality Boulder & large cobble rare but present; undercut banks, macrophyte beds and tree root systems present	*Oenanthe crocata* (F), *Apium nodiflorum* (O), *Berula erecta* (O), *Mentha aquatica* (O)	No	n/a	Sweep-netting, hand-searching
M1	Mill Race channel (R705 road bridge)	Lowland depositing watercourse (FW2), average 1.5-2m wide and 0.1-0.2m deep, swift flowing riffle and glide with lack of pool	Bedded mixed fine, medium and coarse gravels with small cobble & silt accumulations; no large boulders or cobble present; moderate siltation, high filamentous algae cover	Low-moderate quality Potential refugia rare, banks not suitable for burrowing	*Oenanthe crocata* (O), *Chiloscyphus polyanthos* (O)	No	n/a	Sweep-netting, hand-searching
M2	Mill Race channel (Well Lane footbridge)	Lowland depositing watercourse (FW2), average 1.5-2m wide and 0.1-0.2m deep, slow-flowing glide and riffle	Silt and localised superficial (silted) gravels; larger cobble and boulder were rare and bedded in silt where present	Low-moderate quality Potential refugia rare, banks not suitable for burrowing	*Ranunculus* subsp. *Batrachion* agg. (F), *Apium nodiflorum* (O), *Oenanthe crocata* (O), *Chiloscyphus polyanthos* (O)	No	n/a	Sweep-netting, hand-searching
B1	River Barrow (d/s Graiguenamanagh Weir)	Lowland depositing watercourse (FW2), average 20-25m wide and 1-1.5m deep, fast flowing glide below weir grading to deep pool downstream	Cobble and coarse gravel with occasional boulder with larger areas of coarse sand; moderate compaction; very high filamentous algae cover	Good quality Boulder/cobble refugia frequent but very high cover of filamentous algae; plentiful refugia along weir face	*Sagittaria sagittifolia* (O), *Schoenoplectus lacustris* (O), *Nuphar lutea* (O)	No	n/a	Sweep-netting, hand-searching, snorkelling

Site	Watercourse	River profile	Substrata	Crayfish habitat	Macrophytes & bryophytes (DAFOR)	Crayfish recorded	Crayfish plague recorded	Methodology
B2	River Barrow (Lower Tinnahinch Weir)	Lowland depositing watercourse (FW2), average 30-40m wide and 1-1.5m deep, fast flowing glide below weir grading to deep pool downstream	Abundant large boulders in addition to frequent cobble and coarser gravels; moderate compaction	High quality Abundant boulder refugia, plentiful refugia along weir face	*Sagittaria sagittifolia* (O), *Schoenoplectus lacustris* (O), *Nuphar lutea* (O), *Oenanthe crocata* (O)	No	**Yes; eDNA recorded (4 of 12 qPCR replicates)**	Sweep-netting, hand-searching, snorkelling, eDNA
T1	Duiske River (Aldi access bridge)	Upland eroding watercourse (FW1), 0.5-3m wide and 0.5-1.5m deep, swift glide with deep pool, historical bank modifications	Boulder and cobble with localised patches of mixed gravels and coarse sand	Good quality Abundant boulder refugia, undercut banks, and tree root systems present	*Platyhypnidium riparoides* (F)	No	n/a	Trapping
T2	Duiske River (Turfmarket Weir)	Upland eroding watercourse (FW1), 3m wide and 0.2-0.5m deep, fast-flowing glide with localised pool, retaining walls both banks	Boulder and cobble with small patches of interstitial gravel/coarse sand; abundant filamentous algae	Good quality Frequent boulder/cobble refugia with macrophyte and retaining wall base refugia also present	*Ranunculus* subsp. *Batrachion* agg. (O), *Oenanthe crocata* (O), *Platyhypnidium riparoides* (F)	No	**Yes; eDNA recorded (12 of 12 qPCR replicates)**	Trapping. eDNA
T3	River Barrow (diving board)	Lowland depositing watercourse (FW2), 40-50m wide and 1.5-2.5m deep, 100% slow-flowing glide, retaining wall (quay) along west bank	Silt with localised areas of sand and bedded cobbles and gravels; abundant filamentous algae and floc	Moderate quality Frequent boulder/cobble and macrophyte refugia in addition to retaining wall crevices	*Nuphar lutea (O), Sagittaria sagittifolia* (O)	No	n/a	Trapping
T4	River Barrow (Graiguenamanagh Bridge)	Lowland depositing watercourse (FW2), 60-70m wide and 1.5-2m deep, swift--flowing glide, retaining wall on both banks	Boulder and cobble along south bank with high cover of filamentous algae and floc	Good quality Abundant instream refugia (boulder/cobble, retaining wall crevices, macrophytes *etc*.)	*Sagittaria sagittifolia* (O)	No	n/a	Trapping

Site	Watercourse	River profile	Substrata	Crayfish habitat	Macrophytes & bryophytes (DAFOR)	Crayfish recorded	Crayfish plague recorded	Methodology
T5	River Barrow (u/s Upper Tinnahinch Lock)	Artificial channel (FW3), 5-12m variable width, 1.3-2.5m deep, slow-flowing glide & pool, retaining wall along both banks (*i.e.* lock structure adjacent to weir)	Silt with occasional boulder and cobble; high cover of filamentous algae	Moderate quality Locally frequent instream refugia (boulder/cobble, retaining wall crevices, macrophyte beds)	*Sagittaria sagittifolia* (A), *Myriophyllum spicatum* (F), *Nuphar lutea* (O), *Schoenoplectus lacustris* (O)	No	n/a	Trapping

7. Appendix B – eDNA analysis lab report

Triturus

SureScreen Scientifics

Folio No: E9978b
Report No: 1
Purchase Order: MY01_21
Client: Triturus Environmental Limited
Contact: Ross Macklin

TECHNICAL REPORT

ANALYSIS OF ENVIRONMENTAL DNA SAMPLES FOR THE DETECTION OF CRAYFISH SPECIES AND CRAYFISH PLAGUE

SUMMARY

All organisms continuously release small amounts of environmental DNA (eDNA) into their habitat. By collecting and analysing this eDNA from water samples from lakes, ponds or rivers we can detect the presence or absence of crayfish species including: the white-clawed crayfish (Austropotamobius pallipes), signal crayfish (*Pacifastacus leniusculus*), the marbled crayfish (*Procambarus virginalis*) and the crayfish plague (*Aphanomyces astaci*).

RESULTS

Date sample received at Laboratory: 18/05/2021
Date Reported: 18/06/2021
Matters Affecting Results: None

Lab Sample ID.	Site Name	O/S Reference	Species	Result	SIC	DC	IC	Positive Replicates
C0280	Tinnahinch Weir		*White-Clawed Crayfish*	Negative	Pass	Pass	Pass	0
			Crayfish Plague	Positive	Pass	Pass	Pass	4
C0282	Duiske Lower		*White-Clawed Crayfish*	Negative	Pass	Pass	Pass	0
			Crayfish Plague	Positive	Pass	Pass	Pass	12
C0285	Duiske Upper		*White-Clawed Crayfish*	Negative	Pass	Pass	Pass	0
			Crayfish Plague	Negative	Pass	Pass	Pass	0

If you have any questions regarding results, please contact us: ForensicEcology@surescreen.com

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Reported by: Chris Troth **Approved by:** Jennifer Higginbottom

METHODOLOGY

The analysis is conducted in two phases. The sample first goes through an extraction process where the filter is incubated in order to obtain any DNA within the sample. The extracted sample is then tested via real time PCR (also called q-PCR) for each of the selected target species. This process uses species-specific molecular markers (known as primers) to amplify a select part of the DNA, allowing it to be detected and measured in 'real time' as the analytical process develops. qPCR combines amplification and detection of target DNA into a single step. With qPCR, fluorescent dyes specific to the target sequence are used to label targeted PCR products during thermal cycling. The accumulation of fluorescent signals during this reaction is measured for fast and objective data analysis. The primers used in this process are specific to a part of mitochondrial DNA only found in each individual species. Separate primers are used for each of the species: white-clawed crayfish, signal crayfish and crayfish plague, ensuring no DNA from any other species present in the water is amplified.

Analysis of eDNA requires scrupulous attention to detail to prevent risk of contamination. True positive controls, negative controls and spiked synthetic DNA are included in every analysis and these have to be correct before any result is declared and reported. Stages of the DNA analysis are also conducted in different buildings at our premises for added security. These methods have been extensively tested since 2015 in a number of different environments, habitats, conditions and ecological situations in order to successfully enable the full application of eDNA for the detection of crayfish species and the crayfish plague.

RESULTS INTERPRETATION

SIC: **Sample Integrity Check** [Pass/Fail]
When samples are received in the laboratory, they are inspected for any tube leakage, suitability of sample (not too much mud or weed etc.) and absence of any factors that could potentially lead to inconclusive results.

DC: **Degradation Check** [Pass/Fail]
Analysis of the spiked DNA marker to see if there has been degradation of the kit or sample, between the date it was made to the date of analysis. Degradation of the spiked DNA marker may indicate a risk of false negative results.

IC: **Inhibition Check** [Pass/Fail]
The presence of inhibitors within a sample are assessed using a DNA marker. If inhibition is detected, samples are purified and re-analysed. Inhibitors cannot always be removed, if the inhibition check fails, the sample should be re-collected.

Result: **Presence of eDNA** [Positive/Negative/Inconclusive]
Positive: DNA was identified within the sample, indicative of species presence within the sampling location at the time the sample was taken or within the recent past at the sampling location.
Positive Replicates: Number of positive qPCR replicates out of a series of 12. If one or more of these are found to be positive the pond is declared positive for species presence. It may be assumed that small fractions of positive analyses suggest low level presence, but this cannot currently be used for population studies. In accordance with Natural England protocol, even a score of 1/12 is declared positive. 0/12 indicates negative species presence.
Negative: eDNA was not detected or is below the threshold detection level and the test result should be considered as evidence of species absence, however, does not exclude the potential for species presence below the limit of detection.
Inconclusive: Controls indicate inhibition or degradation of the sample, resulting in the inability to provide conclusive evidence for species presence or absence.

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Appendix 10-9 Freshwater Pearl Mussel Report 2021

Graiguenamanagh-Tinnahinch Flood Relief Scheme freshwater pearl mussel (*Margaritifera margaritifera*) survey

Prepared by Triturus Environmental Ltd. for ByrneLooby

June 2021

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1. Introduction

1.1 Background

Triturus Environmental Ltd. was contracted by ByrneLooby to undertake a baseline freshwater pearl mussel (*Margaritifera margaritifera*) survey of the watercourses in the footprint of the proposed Graiguenamanagh-Tinnahinch Flood Relief Scheme (GTFRS) located near Graiguenamanagh, Co. Carlow (**Figure 2.1, Table 2.1**).

The OPW, working in partnership with Kilkenny County Council (KCC), Country Carlow Council (CCC) and other Local Authorities, commissioned and have completed the South Eastern Catchment Flood Risk Assessment and Management (CFRAM) Study. The South Eastern CFRAM study area included Graiguenamanagh-Tinnahinch as an Area for Further Assessment (AFA) and concluded that a flood relief scheme would be viable and effective for the community. The viable scheme (currently under review) is comprised mainly of construction of hard defences and associated works through the urban area of Graiguenamanagh along the banks of both the River Duiske and River Barrow.

A viable scheme option for Graiguenamanagh-Tinnahinch was identified in the CFRAM level of assessment and the preferred measures outlined in the CFRAM comprise:

- Building hard defences, with at risk properties protected by a series of embankments and walls, sheet piled where necessary and set back where possible from, the river channel.
- Hard defences that would protect properties from the 1% AEP fluvial event and with an estimated average height of 1.56 m and total length of 1.31 km.

In light of the above, a Stage 1 pearl mussel survey was undertaken in April 2021 to establish the presence/absence of freshwater pearl mussel in the vicinity of the proposed flood relief scheme footprint, thus informing impact assessment and mitigation for the works. The scheme footprint was located within the River Barrow catchment (Barrow_SC_0130 sub-catchment) and encompassed the River Barrow and two tributaries (Duiske River and Graiguenamanagh River), in addition to a small historical mill race channel linking the Tinnapark Stream and lower Duiske River. The survey area did not overlap with any *Margaritifera* sensitive areas.

In the vicinity of the proposed GTFRS, the River Barrow (EPA code: 14B01) and tributary Duiske River (14D04) were located within the River Barrow and River Nore SAC (site code: 002162). Whilst not located within this European site, the Graiguenamanagh Stream (14G42), a tributary of the Duiske River, shared downstream hydrological connectivity with the River Barrow and River Nore SAC.

1.2 Conservation status of freshwater pearl mussel in Ireland

The freshwater pearl mussel (*Margaritifera margaritifera*) is listed on the IUCN Invertebrate Red Data List as an 'endangered species' (Moorkens *et al*., 2018) according to the most recent status classification. It is also protected under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). Pearl mussel are protected by law in Ireland under the

Wildlife Acts 1976 to 2018 (S.I. 112, 1990) and the species is listed on Annex II and Annex V of the EU Habitats Directive (92/43/EEC).

Three Article 17 reports have been prepared for pearl mussel (to report on national status as part of the requirements of the Habitats Directive) with the overall conservation status being considered as 'Bad' on all three occasions (NPWS, 2008, 2013, 2019). During 2009, The European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations S.I. No. 296/2009 were created to establish environmental quality objectives for SAC pearl mussel populations, including the preparation of sub-basin management plans. These regulations set out conservation targets for pearl mussel, as shown in **Table 1.1** below.

Table 1.1 Targets for sustainable pearl mussel population structure under the European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009

Criterion	Target to pass	Notes
Numbers of live adults	No recent decline	Based on comparative results from the most recent surveys
Numbers of dead shells	<1% of population and scattered distribution	1% considered to be indicative of natural losses
Mussels shell length ≤65mm	At least 20% of populations ≤65mm in length	Field survey of 0.5 x 0.5 m quadrats must be carried out in suitable habitat areas for juveniles
Mussels shell length ≤30mm	At least 5% of populations ≤30mm in length	Field survey of 0.5 x 0.5m quadrats must be carried out in suitable habitat areas for juveniles

1.3 Status of freshwater pearl mussel in the Barrow catchment (desktop review)

Freshwater pearl mussel are listed as a qualifying interest for the River Barrow and River Nore SAC (NPWS, 2011). However, extant populations are only known from three tributaries. These are the Mountain River[1], Ballymurphy River (Ballyroughan River) (Moorkens, 1992, 2008, 2009a, 2009b; Ross, 2006; DEHLG, 2010a, 2010b, 2010c) (*i.e.* not the main River Barrow channel) and Aughavaud River (DEHLG, 2010c).

The nearest populations to Graiguenamanagh and Tinnahinch are in the Mountain and Ballymurphy Rivers located ≥4km upstream (see **Figure 1.1**). Although a live specimen was recorded in the River Barrow in 1991, c. 5km upstream of Graiguenamanagh near Ballynagrane Lock (Sweeny, 2011), the freshwater pearl mussel would appear to be extinct in the main channel of the River Barrow (Lucey, 1998). Whilst 2008 surveys failed to identify any live mussels in the Aughavaud River (DEHLG, 2010c), which adjoins the River Barrow near St. Mullin's, Co. Carlow (**Figure 1.1**), recent NPWS data (2018) indicates low numbers of pearl mussels within this sub-

[1] Status of freshwater pearl mussel in the Aughnabrisky River (Mountain River tributary) is now uncertain

catchment. There is no means of connectivity with this population and the study area given the river confluence with the River Barrow is located >7km downstream.

The status of the freshwater pearl mussel (*Margaritifera margaritifera*) as a qualifying Annex II species for the River Barrow and River Nore SAC is currently under review (NPWS, 2020). Numerous significant pressures to pearl mussel populations have been identified, including erosion, diffuse nutrient enrichment, diffuse siltation, riparian zone impacts and field drainage, as well as surface water quality impacts (DEHLG, 2010a, 2010b, 2010c). Pearl mussel numbers have declined significantly in the Mountain River and Ballymurphy River sub-catchments, with the remaining low-density populations (<1000 and <300 individuals, respectively) composed entirely of aged adults with no evidence of recruitment for a considerable time (DEHLG, 2010a, 2010b). In both the Mountain River and Ballymurphy River, the greatest risk to pearl mussel persistence is exceptionally high siltation and both populations are in rapid decline (DEHLG, 2010a, 2010b).

There were no contemporary or historical records for freshwater pearl mussel available for the Duiske River, Graiguenamanagh River or River Barrow in the vicinity of Graiguenamanagh or Tinnahinch.

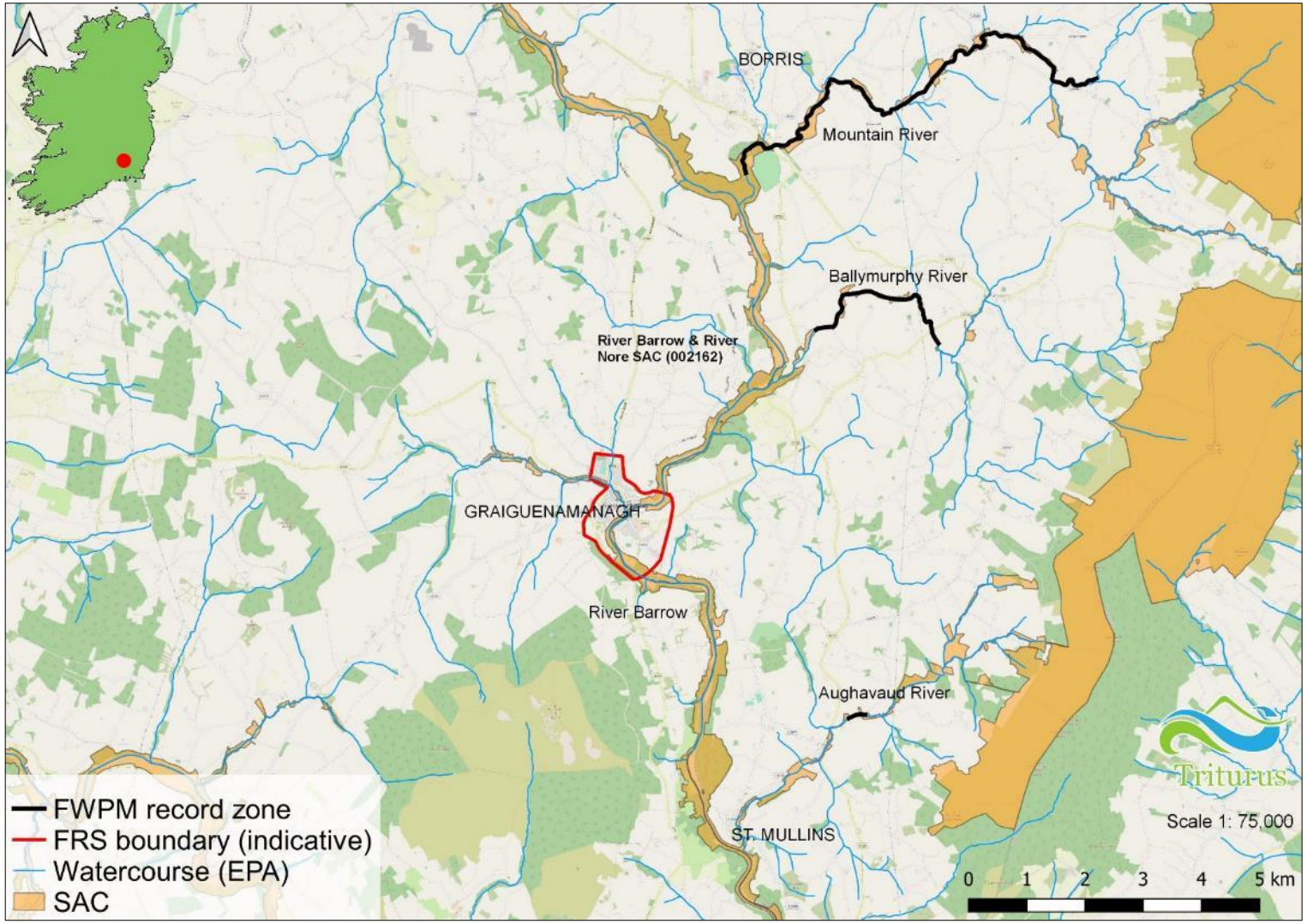

Figure 1.1 Extent of the freshwater pearl mussel records in the River Barrow catchment (adapted from DEHLG 2010a, 2010b and 2010c).

2. Methodology

2.1 Freshwater pearl mussel surveys

The pearl mussel surveys were carried out on Thursday 29th and Friday 30th April 2021 in bright weather, with good underwater visibility and under base flow conditions. This helped to maximise visibility of pearl mussel against dark substrata and also helped increase chances of detection when mussels are filtering in brighter conditions. The visual pearl mussel survey (stage 1 and stage 2) was carried out under Section 23 & 34 of the Wildlife Acts 1976 to 2018 (licence number C136/2021) issued by the National Parks and Wildlife Service (NPWS) on the 12th April 2021. The survey methodology used was in accordance with the Stage 1 and 2 guidelines given by the NPWS in the Irish Wildlife Manual No. 12 (Anon., 2004) (guidelines currently being updated but unpublished at the time of survey). The surveys were also cognisant of the latest European-wide guidance for freshwater pearl mussel survey methodology (*e.g.* CEN, 2017; Boon *et al*., 2019).

Stage 1 presence-absence surveys were undertaken in *n*=5 discreet survey sections (A to E) along a total of c.4km of channel on the Duiske River, Graiguenamanagh River and River Barrow (**Table 2.1, Figure 2.1**). Surveys incorporated a combination of bathyscope surveying, snorkelling and SCUBA diving techniques, dependant on local water depths and flow regimes. To maximise detection rates and efficiency, two operators worked in tandem, with one surveyor in-stream and one bank manager to collate data. As per best practice, surveys within each survey section began downstream and worked upstream at each site to avoid silt and debris blocking the view of pearl mussels and to avoid damage to pearl mussels by trampling (*i.e.* because of better visibility). Notes were also taken on the aquatic habitat conditions and suitability for freshwater pearl mussels at each site, based on the criteria of Moorkens & Killeen (2020), Skinner *et al*. (2003) and Hastie *et al.* (2000).

Table 1 Location of *n*=5 freshwater pearl mussel Stage 1 and 2 survey sections in the vicinity of Graiguenamanagh, Co. Kilkenny.

Section	Watercourse	EPA code	Approx. length (km)	Start point (ITM)	End point (ITM)
A	Duiske River	14D04	0.55	670074, 633212	670596, 644092
B	Duiske River	14D04	0.65	670596, 644092	670840, 643547
C	Graiguenamanagh River	14G42	0.6	670621, 644699	670596, 644092
D	River Barrow	14B01	0.9	671521, 643966	670850, 643537
E	River Barrow	14B01	1.3	670850, 643537	671156, 642529

2.2 eDNA analysis

To further validate the site surveys and to detect potentially cryptically-low populations of freshwater pearl mussel within the study area, water samples from sites on the Duiske River and River Barrow were analysed for *Margaritifera margaritifera* environmental DNA (eDNA) in April 2021. The Turfmarket Weir (Duiske) and Tinnahinch Weir (Barrow) sampling points were strategically chosen to maximise habitat coverage within the study area (**Figure 2.1**).

In accordance with best practice, composite (500ml) water samples were collected from each sampling point, maximising the geographic spread within each site (20 x 25ml samples at each site) and thus increasing the chance of detecting the target species' DNA. Each composite sample was filtered on site using a sterile proprietary eDNA sampling kit. Fixed samples were sent to the laboratory for analysis on the same day as collection. A total of *n*=12 qPCR replicates were analysed for each site. Given the high sensitivity of eDNA analysis, a single positive qPCR replicate is considered as proof of the species' presence (termed qPCR No Threshold, or qPCR NT). Whilst an eDNA approach is not currently quantitative, the detection of the target species' DNA indicates the presence of the species at or upstream of the sampling point. Please refer to **Appendix B** for full eDNA laboratory analysis methodology.

2.3 Biosecurity

A strict biosecurity protocol following the Check-Clean-Dry approach was employed during the survey. Equipment and PPE used was disinfected with Virkon® between survey sites to prevent the transfer of pathogens and/or invasive species between survey areas. Particular cognisance was given to preventing the introduction or spread of crayfish plague (*Aphanomyces astaci*) given the known presence of the pathogen in the River Barrow in the vicinity of the flood relief scheme. As per best practice, surveys were undertaken at sites in a downstream order (*i.e.* uppermost site surveyed first *etc*.) to prevent the upstream mobilisation of invasive propagules and pathogens.

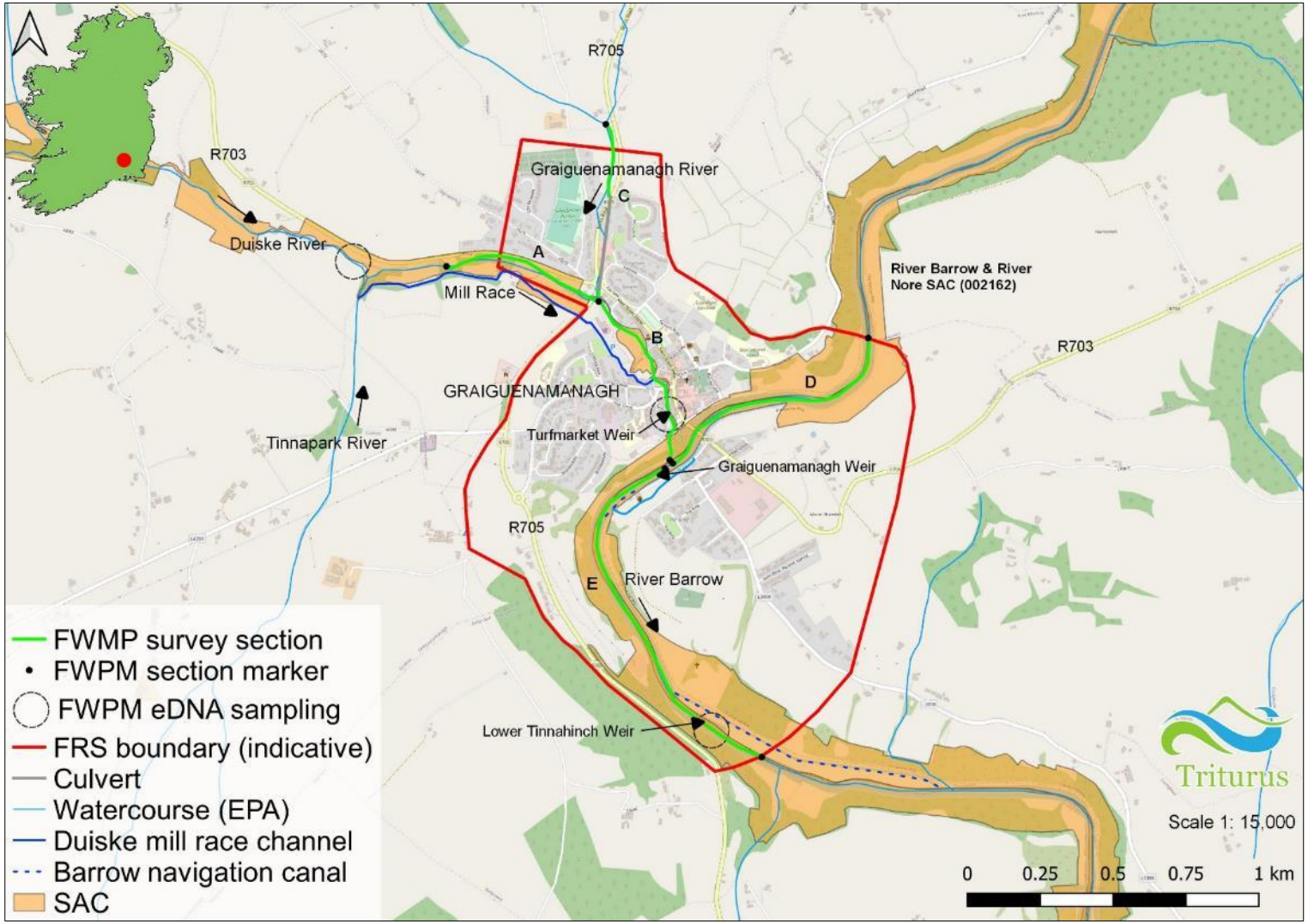

Figure 2.1 Overview of the freshwater pearl mussel survey sections in the vicinity of Graiguenamanagh and Tinnahinch, Co. Kilkenny, April 2021.

3. Results

Freshwater pearl mussel surveys were undertaken on Thursday 29th and Friday 30th April 2021. The results of the surveys are presented below in terms of the number of mussels recorded (live or dead), number of shells and overall pearl mussel suitability as well as general observations on the ecology of each site. The survey sites are summarised per survey section below (A to E) and in more detail in **Appendix A**. Scientific names are provided at first mention only.

3.1 Site descriptions & pearl mussel habitat

3.1.1 Section A – Duiske River (upper)

Section A was located upstream of the Graiguenamanagh River confluence (Aldi access road bridge). Here, the Dusike River was a largely natural, high-energy upland eroding watercourse (FW1; Fossitt, 2000). The river had not been modified, apart from in the vicinity of the R705 road bridge and Aldi bridge where a concrete bridge apron was present (buried under gravels) alongside retaining walls. Several storm drains entered the channel in vicinity of the R705 road bridge (i.e. point sources). The shallow-U shaped channel averaged 3-4m in width and 0.2-0.5m in depth, with locally deeper pool to 0.75m. Riffle and fast glide dominated the survey section but pools were frequent also, with the channel occasionally cascading over larger boulder. The substrata of the high-energy river (prone to spate) were dominated by cobble and boulder with high fractions of mixed gravels and coarse sand in interstitial spaces. Although largely free from siltation (on and within the substrata), the bed was highly compacted due to high flow rates. Some calcification of the substrata was also evident, locally. Flocculent deposits of decaying organic matter and silt (*i.e.* 'floc'[2]) were present locally in more depositional areas (this increased significantly downstream). *Vaucheria* sp. (common) and *Cladophora* sp. algae (less common) were present on instream substrata, indicating enrichment. The river channel meandered through a narrow but mature riparian zone supporting scattered sycamore (*Acer psuedoplatanus*), ash (*Fraxinus excelsior*), alder (*Alnus glutinosa*), hawthorn (*Crataegus monoygna*) and elder (*Sambucus nigra*) with scrubby understories. The channel was bordered by improved agricultural grassland and rough pasture (GA1). Shading was frequently high but not excessive. Macrophytes were rare and limited to occasional hemlock water dropwort (*Oenanthe crocata*) on exposed and marginal gravel deposits. The red algae *Lemanea* sp., characteristic of high-energy watercourses, was common. The aquatic moss *Platyhypnidium riparoides* was common on instream boulder with *Hygroamblystegium* sp. occasional.

No live or dead freshwater pearl mussels were recorded via bathyscope survey or snorkelling in survey section A (**Figure 3.1**). The upper Duiske survey reaches were of high salmonid value in terms of nursery and spawning habitat (both Atlantic salmon and brown trout). However, whilst the substrata were clean, un-silted and stable, these were invariably highly compacted given high flow rates, thus presenting conditions inimical to mussel footing. Significant enrichment was also

[2] floc is defined as an aggregation of (mostly dead) organic material, mainly from algae and diatoms, but also with potential origins from decaying macrophytes and associated decomposers (bacteria and fungi). The floc can form a layer at the surface of the substrate, or infiltrate the substrate, generally where there is insufficient flow to keep the material in suspension (Moorkens & Killeen, 2020)

noted with often high filamentous algal cover instream. As such, there was no suitability for freshwater pearl mussel.

Plate 3.1 The natural Duiske River channel in the uppermost survey reaches of section A.

Plate 3.2 *Vaucheria* sp. algae was common on instream boulders, indicating enrichment.

Plate 3.3 Underwater image showing compacted bed with growth of red algae (*Lemanea* sp.) and filamentous algae (*Cladophora* sp.).

Plate 3.4 Bathyscope survey of the Duiske River upstream of the R705 road bridge.

Plate 3.5 The modified Duiske River downstream of the R705 road bridge.

3.1.2 Section B – Duiske River (lower)

Located downstream of the Graiguenamanagh River confluence (**Figure 2.1**), the lower reaches of the Dusike River in section B were semi-natural (FW1 with some FW2 characteristics in lowermost reaches). However, the high energy (spate-like) river had been historically modified and straightened through Graiguenamanagh town and residential areas with retaining walls often present on both banks (invariably >2-2.5m high). The river channel averaged 3-4m wide with depths of 0.2-0.4m, with occasionally deeper pool to 0.8m. Fast shallow glide and riffle dominated the section with only occasional pool (*e.g.* on meanders). Despite modification, good instream recovery was present although enrichment was evident with abundant filamentous algal cover on substrata (mostly *Cladophora* sp.). Coverage of floc was also high (up to >50%) in areas of lower flow. Substrata cover often exceeded 30-40%. The substrata were dominated by boulder and cobble with patches of gravel/coarse sand. Given the high flow rates, compaction was relatively high and siltation was low overall (as per upstream section A). However, some sediment accumulations (sand/silt) were present in the lowermost reaches near the Barrow confluence and on some meanders. Instream macrophyte cover was greater than upstream section A, with *Ranunculus* sp. vegetation dominating (often >20% cover). The aquatic bryophyte *Platyhypnidium riparioides* was often common on instream boulder and cobble.

No live or dead freshwater pearl mussels were recorded via bathyscope survey or snorkelling in survey section B (**Figure 3.1**). The lower Duiske was of high salmonid value in terms of nursery and spawning habitat (both Atlantic salmon and brown trout). However, whilst the substrata of the lower Duiske channel were clean, un-silted and stable, these were often highly compacted given high flow rates, thus presenting conditions inimical to mussel footing. Significant enrichment was also noted with often high filamentous algal cover instream in addition to locally abundant *Ranunculus* vegetation. As such, there was no suitability for freshwater pearl mussel.

Plate 3.6 The historically modified Duiske River at the Graiguenamanagh River confluence (near Aldi).

Plate 3.7 The Duiske River immediately downstream of the Well Lane footbridge.

Plate 3.8 High cover of filamentous algae and floc in the Duiske River downstream of the Turfmarket Weir, April 2021.

Plate 3.9 The modified Duiske River at Mill Road Bridge (facing downstream).

Plate 3.10 The modified Duiske River at Old Dock Road Bridge (facing upstream).

Plate 3.11 The Duiske River at the Barrow confluence showing clean gravel substrata with marginal soft sediment accumulations.

3.1.3 Section C - Graiguenamanagh River

Survey section C encompassed the Graiguenamanagh River from the West Killeen Stream confluence to the Duiske River confluence (**Figure 2.1**). The river was culverted underground over a steep gradient for much of the survey reach (i.e. 0.35km). The upper reaches, upstream of the R705 road culvert, represented a small, swift-flowing lowland depositing watercourse (FW2) with a semi-natural profile featuring frequent meanders with riffle, glide and pool sequences. The channel width varied between 1.5-2m with low banks (0.5m bank height). The river was shallow and averaged 0.1-0.2m deep with very occasional pools to 0.3-0.7m max. The bed comprised of mixed large cobble, coarse, medium and fine gravels and sand with frequent silt. The substrata were compacted with moderate siltation that increased in depositing pool areas. Boulder was also present but localised. The exposed hard substrata on the channel margins supported frequent hemlock water dropwort with occasional fool's watercress (*Apium nodiflorum*), lesser water parsnip (*Berula erecta*) and water mint (*Mentha aquatica*). The riparian zone was dominated by open pasture with abundant soft rush (*Juncus effusus*), gorse (*Ulex europaeus*) and scattered alder (*Alnus glutinosa*).

The lower reaches of the Graiguenamanagh River represented an upland eroding watercourse (FW1) flowing over a moderate gradient, with frequent cascades over large instream boulder. The river emanated from a large pipe culvert under the Harristown Roundabout (R705) and adjoined the Duiske River approx. 30m downstream. This short section had been historically straightened but not deepened, with retaining walls along both banks (gabion baskets on north, retaining wall on south bank). The channel averaged 1.5m wide with depths highly variable from 0.1-0.5m. Fast glide predominated in between frequent plunge pools (0.6m max). Riffle was present near the Duiske confluence. The substrata were partially bedded given relatively high flow rates, with boulder and cobble dominating. However, medium-fine gravels and sand were frequent interstitially. Flocculent silt deposits were present in pool/margins slacks (rare). Riparian shading was high from retaining walls and scrub vegetation (bramble and ornamental garden plants). No macrophytes were present instream although *Hygroamblystegium* sp. moss was common. *Vaucheria* sp. algae was also common, indicating significant enrichment. The site was of moderate value for salmonids in the lowermost reaches, although the extensive pipe culvert effectively blocked upstream fish passage.

No live or dead freshwater pearl mussels were recorded via bathyscope survey or snorkelling in survey section C (**Figure 3.1**). Neither the upper or lower survey reaches of the Graiguenamanagh River had any suitability for freshwater pearl mussel. Upstream of the R705 culvert, the small size of the channel, bed compaction, enrichment pressures and moderate siltation (derived largely from sheep poaching and adjoining agricultural land use) precluded the presence of pearl mussels. Furthermore, the river did not support a salmonid population upstream of the culvert (2021 Triturus electro-fishing data) and also suffered from low flows, seasonally. The lower survey reaches, downstream of the Harristown Roundabout culvert, were also unsuitable for pearl mussel given evident enrichment, historical modifications, bed compaction and the small nature of the channel.

Plate 3.12 Representative image of the upper survey reaches of the Graiguenamanagh River.

Plate 3.13 Bathyscope survey on the upper reaches of the Graiguenamanagh River.

Plate 3.14 Unsuitable substrata for pearl mussel in the upper survey reaches of the Graiguenamanagh River (silted, partially-bedded gravels and cobble).

Plate 3.15 The Graiguenamanagh River (right) at the Duiske River confluence.

3.1.4 Section D - River Barrow (upstream Graiguenamanagh Weir)

Located upstream of Graiguenamanagh Weir, the River Barrow in survey section D was a large 40-50m wide canalised channel with depths varying from 1.5-2.5m. The river was bound by a retaining wall along the west (town) bank, with historical modifications present on the east. The river at this location was depositional in nature and featured 100% deep slow-flowing glide. The substrata were dominated by silt with localised areas of sand and bedded cobbles and gravels, particularly associated with the marginal slopes of the channel. Downstream of bridge (upstream of the weir), the substrata alternated between plains of coarse sand and silt with boulder zones in the centre channel. Abundant boulders were present under the bridge arches, which often supported freshwater sponges (see **Plate 3.23**). Sand and silt dominated immediately upstream of the weir structure. Abundant filamentous algae was present on the substrata (very high cover). Macrophytes were limited to heterophyllous yellow water lily (*Nuphar lutea*) (submerged more so than emergent) with occasional patches of submerged clubrush (*Schoenoplectus lacustris*) and water mint in marginal areas. Perfoliate pondweed (*Potamogeton perfoliatus*) was occasional with rare spiked water milfoil (*Myriophyllum spicatum*). The channel was lined with reed canary grass (*Phalaris arundinacea*), marsh marigold (*Caltha palustris*), iris (*Iris pseudacorus*), arrowhead (*Sagittaria sagittifolia*), water mint, hemlock water dropwort and scattered invasive Himalayan balsam (*Impatiens glandulifera*).

No live or dead freshwater pearl mussels were recorded via bathyscope or SCUBA diving surveys in survey section D (**Figure 3.1**). The River Barrow upstream of Graiguenamanagh Weir had no suitability for freshwater pearl mussel. However, the deep glide habitat upstream of the bridge did support duck mussel (*Anodonta anatina*), at an average density of 1 per $10m^2$ (**Plate 3.19, 3.20**). The majority of these were located at the base of the quay wall slope (45° angle). This slope had metal debris, cobble and boulder with patches of coarse sand and silt. Duck mussels were present in coarse sand and silt at base of slope, with most mussels recorded covered in silt and evidently choking. A number of dead duck mussels (some recently deceased) were also recorded in a small, heavily-silted off-shoot channel along Old Dock Road (**Plate 3.21**).

Plate 3.16 The River Barrow upstream of Graiguenamanagh Bridge (100% deep depositional glide habitat).

Plate 3.17 SCUBA dive survey of the River Barrow upstream of Graiguenamanagh Bridge, April 2021.

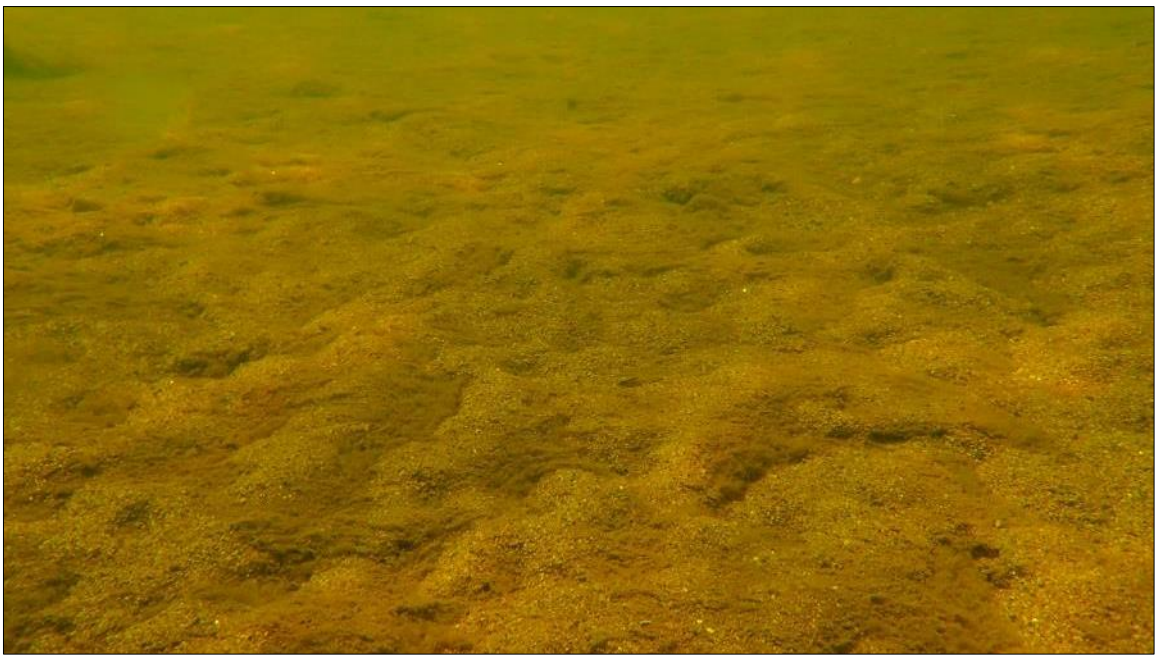

Plate 3.18 Underwater image of the heavily silted substrata present in survey section D (upstream of Graiguenamanagh Bridge).

Plate 3.19 Example of duck mussel (*Anodonta anatina*) recorded in soft sediment upstream of Graiguenamanagh Bridge.

Plate 3.20 Example of duck mussel (*Anodonta anatina*) recorded from survey section D.

Plate 3.21 Dead duck mussel (*Anodonta anatina*) and shells recorded from the small off-shoot channel along Old Dock Road.

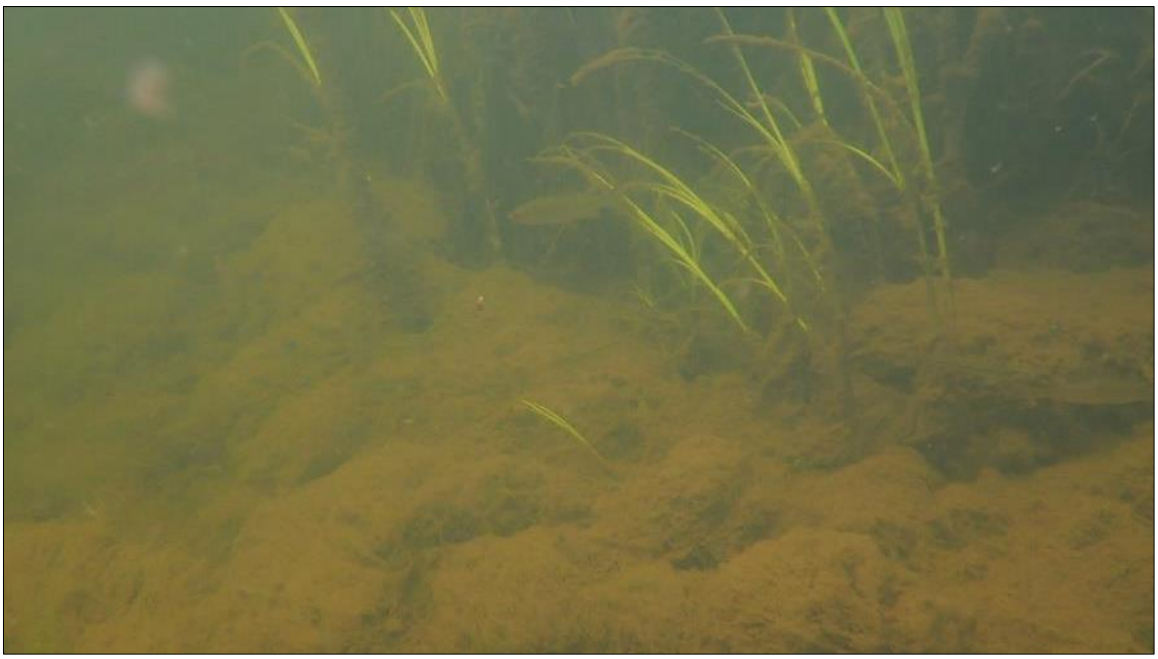

Plate 3.22 Underwater image showing macrophyte growth and heavy coverage of filamentous algae and floc in survey section D (conditions inimical to freshwater pearl mussel).

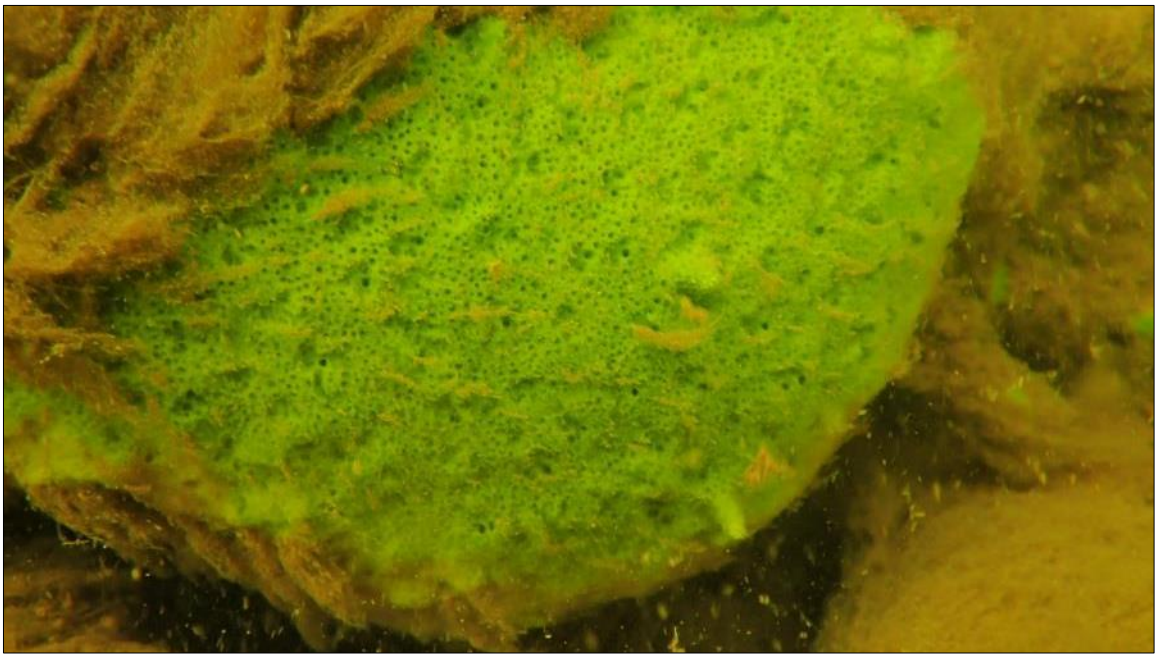

Plate 3.23 Freshwater sponge growing on submerged boulder in the vicinity of Graiguenamanagh Bridge (high coverage of filamentous algae and floc evident).

Plate 3.24 The River Barrow downstream of Graiguenamanagh Bridge and upstream of Graiguenamanagh Weir.

3.1.5 Section E - River Barrow (Graiguenamanagh Weir to Lower Tinnahinch Weir)

Located downstream of Graiguenamanagh Weir, survey section E was dominated by riffle and shallow deep glide grading into deeper glide and pool downstream. The river averaged 1-1.5m deep adjoining the weir but deepened significantly to >3m *c*.100m downstream. From Graiguenamanagh Lock to Tinnahinch Weir, the river was exclusively deep glide and pool. The bed was dominated by cobble and coarse gravel with occasional boulder. Outside of shallower areas associated with the weir, these were heavily silted with relatively high levels of compaction and partial bedding. Excessive filamentous algae was present throughout the survey section, particularly in vicinity of the weir (**Plate 3.26**). Macrophytes were rare but arrowhead, clubrush and localised yellow water lily were present. Scattered, mature treelines of willow (*Salix* spp.), ash and occasional sycamore bordered the river.

No live or dead freshwater pearl mussels were recorded via bathyscope or SCUBA diving surveys in survey section E (**Figure 3.1**). The River Barrow downstream of Graiguenamanagh Weir had no suitability for freshwater pearl mussel given evident enrichment, abundant filamentous algae, high levels of siltation and bedding/compaction of substrata. Very low densities of duck mussel (<1 per $10m^2$) were recorded in the vicinity of the weir, predominantly in localised beds of coarse sand with low densities also recorded in the deeper pool habitat between Graiguenamanagh Weir and Lower Tinnahinch Weir.

Plate 3.25 Graiguenamanagh Weir facing downstream from the weir sill.

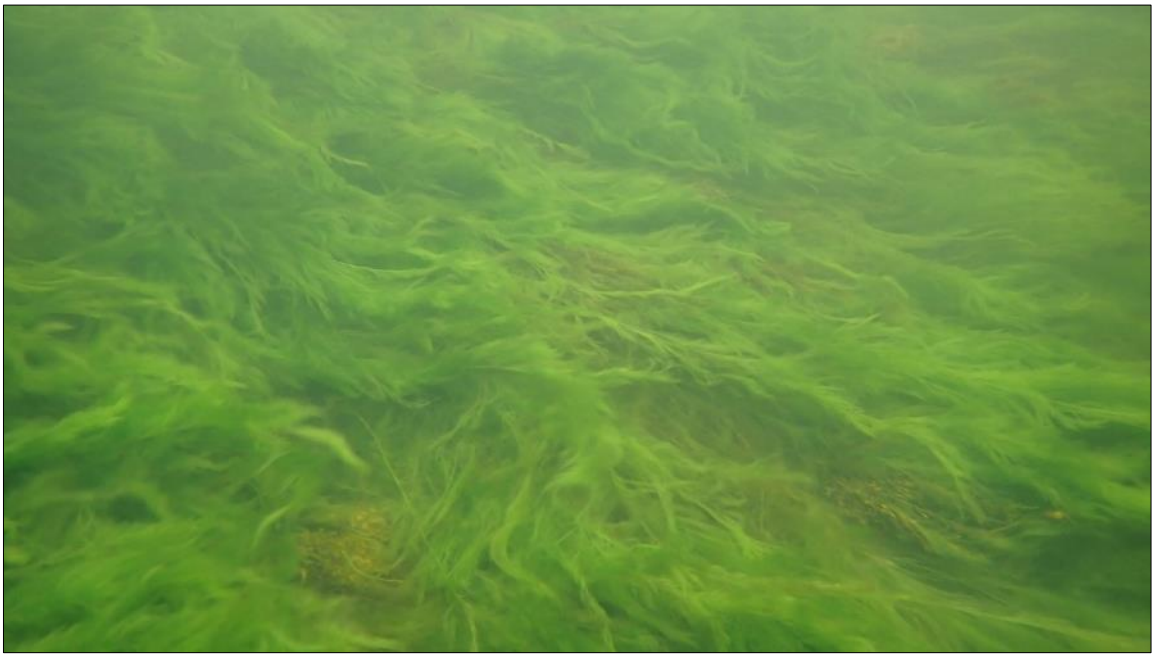

Plate 3.26 Extreme cover of filamentous algae (*Cladophora* sp.) on compacted cobbles immediately downstream of Graiguenamanagh Weir.

Plate 3.27 Downstream of Graiguenamanagh Weir at Duiske River confluence (right foreground).

Plate 3.28 Sampling for *Margaritifera margaritifera* eDNA at Lower Tinnahinch Weir, April 2021.

3.2 eDNA analysis

Composite water samples collected from the Duiske River upstream of Tinnapark River confluence (C0282) and Turfmarket Weir (C0285) returned a negative result for freshwater pearl mussel eDNA (0 positive of 12 qPCR replicates, respectively) (**Appendix B**). These results were considered as evidence of the species' absence from the Duiske River and its tributaries (*i.e.* Graiguenamanagh and Tinnapark Rivers).

However, a positive result for freshwater pearl mussel eDNA was returned in the River Barrow sample collected at Lower Tinnahinch Weir (C0280) (1 of 12 qPCR replicates) (**Figure 3.1** & **Appendix B**). Although eDNA was present at low concentrations, this result indicated the presence of freshwater pearl mussel an undefined distance upstream of Lower Tinnahinch Weir (see Discussion).

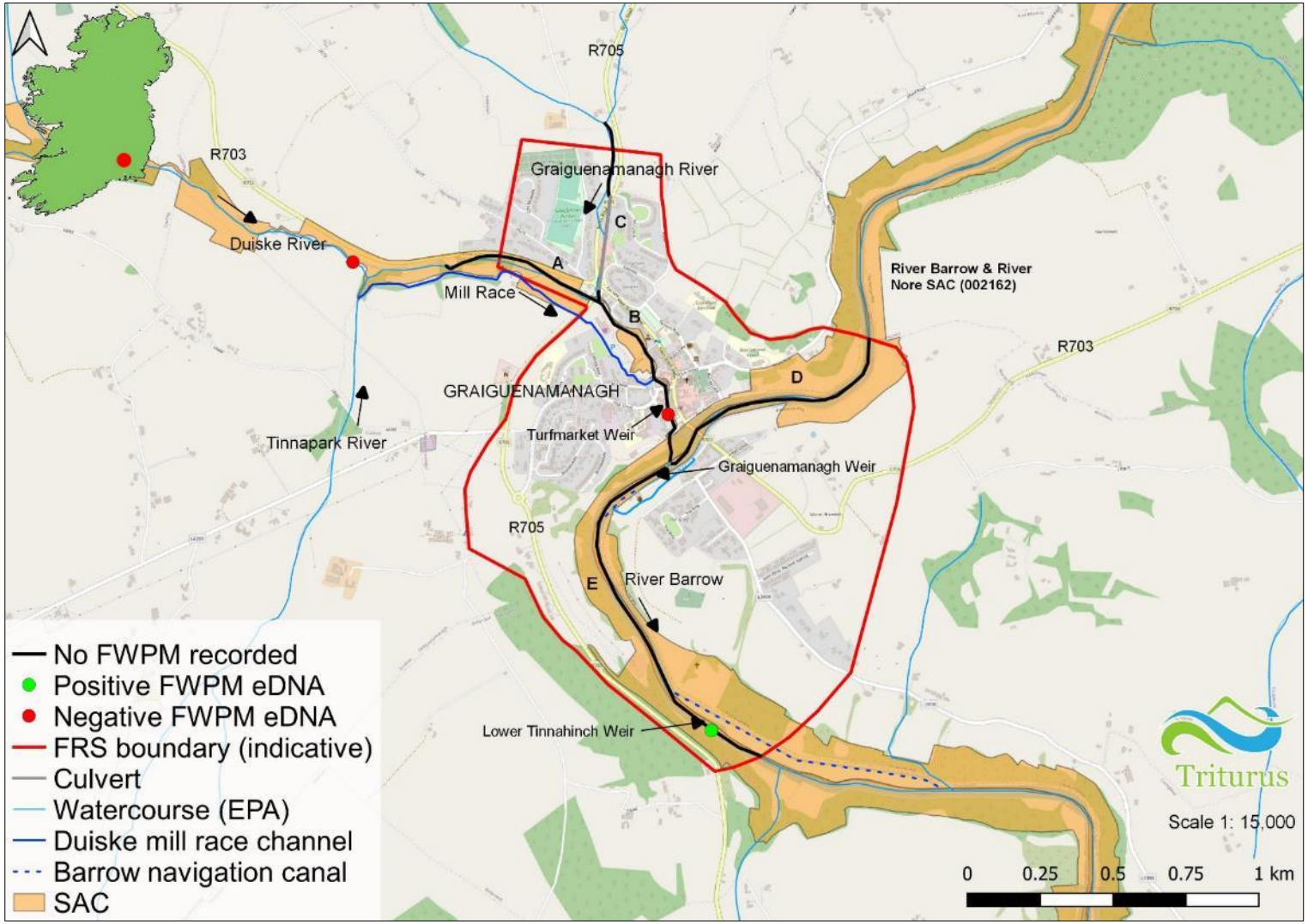

Figure 3.1 Results of freshwater pearl mussel surveys and eDNA analysis, April 2021.

4. Discussion

4.1 Freshwater pearl mussel detection via eDNA

Stage 1 freshwater pearl mussel surveys undertaken in the vicinity of Graiguenamanagh in April 2021 failed to identify freshwater pearl mussels (live or dead) through a combination bathyscope, snorkelling and SCUBA dive surveys. However, *Margaritifera margaritifera* eDNA was detected in the River Barrow water sample, collected at Lower Tinnahinch Weir (1 positive qPCR replicate out of 12; **Appendix B**). Although eDNA via qPCR is not fully quantitative in respect that it can only confirm the presence of a species, the laboratory result supports a low concentration of freshwater pearl mussel DNA within the Barrow channel in the vicinity of Graiguenamanagh. Due to various significant pressures (*e.g.* eutrophication, siltation), the River Barrow retains no suitability for a recruiting freshwater pearl mussel population (see section 4.2) and the species is generally accepted as being extinct within the main Barrow channel (Lucey, 1998; however, see below). Extant populations within the Barrow catchment are confined to the Mountain River, Ballymurphy River (Ballyroughan River) and Aughavaud River sub-catchments (Moorkens, 1992, 2008, 2009a, 2009b; Ross, 2006; DEHLG, 2010a, 2010b, 2010c).

The high sensitivity of eDNA analysis likely enabled a detection of these upstream freshwater pearl mussel populations from the Lower Tinnahinch Weir water sample. Although highly variable, downstream transport of eDNA in riverine environments is known to extend to >100km (Pont *et al*., 2018), with reported detectable distances for freshwater bivalves ranging from as little as 25m to 12km (*e.g*. Preece *et al*., 2020; Lor *et al*., 2020; Stoekle *et al*., 2015; Deiner & Altermatt, 2014). Although studies are lacking, the greatest reported distance at which freshwater pearl mussel eDNA has been detected from a known downstream population is 1.7km (Wacker *et al*., 2019a). In light of this, it is unclear whether our analysis detected pearl mussel eDNA from the upstream Mountain River or Ballymurphy River populations. The Mountain River and Ballymurphy River populations are located c. 7km and 5km upstream of Graiguenamanagh, respectively (see **Figure 1.1**). Alternatively, the detected eDNA may have originated from pearl mussel washed into the main Barrow channel from the Mountain River. Fluvial mussel migration from the Mountain River to the main Barrow channel has been noted previously in the River Barrow catchment (in 1991, Sweeny, 2011). Recent NPWS data (2018) indicate low numbers of pearl mussels within the main Barrow channel downstream of the Mountain River and Little Ballyine River confluences, respectively. These are likely individuals originating in the Mountain River. The closest live pearl mussel record for the River Barrow record is located approx. 6.1km upstream of Graiguenamanagh (Ballyine River confluence). It is possible that our analysis detected eDNA emanating from this location or from an overlooked site of fluvially-migrated mussels from a Barrow tributary.

The use of fresh pearl mussel shells as a source of viable posthumous genetic material has been demonstrated (Geist *et al.,* 2008), although the detectability of such via eDNA sampling is yet to be confirmed for freshwater bivalves. Thus, the exact source of our positive eDNA result remains unclear. Irrespectively, Stage 1 surveys confirmed the absence of freshwater pearl mussels from the Graiguenamanagh survey area (*i.e.* present some undefined upstream only).

4.2 Freshwater pearl mussel habitat

The absence of freshwater pearl mussel from the Graiguenamanagh survey area was unsurprising given habitat characteristics inimical to the species. For example, the River Barrow channel (survey sections D and E) featured high levels of siltation and high coverage of filamentous algae, indicative of significant eutrophication. Siltation of interstitial spaces in the substrata reduces oxygen exchange required by juvenile mussels and is the critical factor determining successful *Margaritifera* recruitment (Hyvärinen *et al*., 2021; Moorkens & Killeen, 2014; Geist & Auerswald, 2007). Siltation (invariably associated with eutrophication) also impacts the filter feeding ability of adult mussels (Goldsmith *et al.,* 2021; Moorkens, 1999) and can lead to mortality via smothering in extreme cases.

Furthermore, the Barrow at Graiguenamanagh Bridge (station RS14B013500) achieved Q3-4 (moderate status) water quality in 2020, a decline from Q4 in 2016 (EPA data). The species typically requires water quality corresponding to high ecological status (*i.e.* ≥Q4-5) (Moorkens, 2000), as set out under the Freshwater Pearl Mussel Regulations S.I. No. 296 (2009). Thus, there is no suitability for *Margaritifera margaritifera* in the River Barrow in the vicinity of Graiguenamanagh.

While the Duiske River had some greater suitability to support freshwater pearl mussel, none were recorded via traditional surreys of eDNA analysis. This high-energy watercourse typically featured a compacted bed dominated by boulder and cobble, with little opportunity for adult mussel footing. Although beds of finer gravels and coarse sand were present locally (in upper survey reaches, upstream of R705), these were typically not accompanied by larger substrata and were not suitable for juvenile mussel burial. Siltation (surface cover & substrata infiltration) and cover of floc increased from low in the upper survey reaches to moderate and locally heavy in the lower reaches of the river. Additionally, there was evident agricultural and urban enrichment resulting in moderate to high filamentous algal cover (often 5-10% cover, increasing moving downstream). Despite the presence of high quality water (Q4-5) in the Duiske upstream of Graiguenamanagh in 2020 (station RS14D040100, EPA data), the issues outlined above would preclude the presence of pearl mussel from the river.

The Graiguenamanagh River (Duiske tributary) provided no suitability for freshwater pearl mussel given high bed compaction, enrichment pressures and moderate siltation (derived largely from sheep poaching and adjoining agricultural land use). Furthermore, the small river did not support a salmonid population upstream of the extensive R705 culvert (2021 Triturus electro-fishing data) and also suffered from low flows, seasonally. The lower survey reaches, downstream of the culvert, were also unsuitable for pearl mussel given evident enrichment, historical modifications and bed compaction.

4.3 Duck mussel (*Anodonta anatina*) in River Barrow channel

Filtering mussels were present in the River Barrow upstream and downstream of Graiguenamanagh Weir and were identified as duck mussel (*Anodonta anatina*). These were present at low densities (≤1 per $10m^2$) but there were many dead shells. Whilst *Anodonta* sp. are

somewhat tolerant of organic enrichment (Lucey, 1995), it was considered that the observed eutrophication of the River Barrow (high filamentous algal cover) in addition to siltation was negatively impacting the habitat. Duck mussel are classed as a 'vulnerable' species in Ireland (Byrne *et al*., 2009). In light of this and the restricted distribution within the Barrow catchment (refer to NBDC data), the Graiguenamanagh populations can, therefore, be considered of high conservation value. In contrast to freshwater pearl mussel which require salmonids as obligate intermediate hosts to complete their life cycle (Taeubert & Geist, 2017; Wacker *et al*., 2019b), *Anodonta* sp. glochidia may develop in a wide range of fish species, including brown trout as well as cyprinids (Huber & Geist, 2020; Dias *et al*., 2020; Chowdhury *et al*., 2018). Duck mussels demonstrate a relatively high plasticity and tolerance to different abiotic conditions and can thus be found from fast-flowing streams to lentic habitats (Zieritz & Aldridge, 2011). Whilst sympatry with *Margaritifera* has been noted (Lopes-Lima *et al*., 2016), life history and water quality tolerance discrepancies mean that freshwater pearl mussel and duck mussel are not typically found in coexistence.

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6. Appendix A – survey site characteristics

Table A1 Summary characteristics of each freshwater pearl mussel survey section in the vicinity of the proposed Graiguenamanagh-Tinnahinch FRS, April 2021

Section	Watercourse	River profile	Bordering land uses & riparian habitat	Substrata	Riverbed condition & siltation	Macrophytes & bryophytes (DAFOR)	FWPM recorded	Threats & pressures
A	Duiske River (upper)	Upland eroding watercourse (FW1), average 3-4m wide & 0.2-0.5m deep, fast glide dominated, largely natural channel with some modifications near R705 crossing, high flow rates, narrow but mature riparian zone with moderate to high shading, low macrophyte cover, moderate bryophyte cover	Improved agricultural grassland (GA1), treelines (WL2), scrub (WS1), mixed broad-leaved woodland (WD1)	Boulder & cobble dominated with localised beds of mixed gravels and sand	Low siltation and high compaction overall; low floc cover; filamentous algal cover often 5-10%; storm drains present near R705	*Oenanthe crocata* (O), *Lemanea* sp. (O), *Platyhypnidium riparoides* (F), *Hygroamblystegium* sp. (O)	No	Eutrophication, siltation
B	Duiske River (lower)	Upland eroding watercourse (FW1), average 3-4m wide & 0.2-0.4m deep, fast glide dominated, historically modified & locally straightened with frequent retaining walls, poorly intact riparian zones (urbanisation), moderate macrophyte cover (enrichment), moderate bryophyte cover	Buildings and artificial surfaces (BL3), amenity grassland (GA2), treelines (WL2), scattered trees and parkland (WD5)	Boulder & cobble dominated with localised beds of mixed gravels and sand	Low siltation and high compaction overall; high floc cover; abundant filamentous algal cover; storm drains present throughout	*Ranunculus* subsp. *Batrachion* agg. (F), *Oenanthe crocata* (R), *Platyhypnidium riparoides* (F), *Hygroamblystegium* sp. (R)	No	Eutrophication, siltation, water quality, channel modifications, hydromorphological impacts
C	Graiguenamanagh River	Upland eroding watercourse (FW1), average 1-1,5m wide & 0.1-0.3m deep, fast glide dominated, natural	Improved agricultural grassland (GA1), wet grassland (GS4), treelines	Small cobble & mixed gravels upstream of culvert with	Moderate siltation & compaction overall	*Oenanthe crocata* (O), *Apium nodiflorum* (O), *Berula erecta* (R), *Mentha aquatica* (R),	No	Eutrophication, siltation, water quality, channel modifications and hydromorphological

Section	Watercourse	River profile	Bordering land uses & riparian habitat	Substrata	Riverbed condition & siltation	Macrophytes & bryophytes (DAFOR)	FWPM recorded	Threats & pressures
		channel upstream of R705 culvert but heavily modified downstream (retaining walls, culvert), well-developed riparian zone only in upper reaches, moderate macrophyte cover (enrichment)	(WL2), scrub (WS1), buildings and artificial surfaces (BL3)	boulder & cobble downstream	(increasing downstream)	*Hygroamblystegium* sp. (R)		impacts (downstream of culvert)
D	River Barrow (upstream Graiguenamanagh Weir)	Lowland depositing watercourse (FW2), average 40-50m wide & 1.5-2.5m deep, 100% slow-flowing glide, historically modified (retaining walls/quays), poorly intact riparian zone (urbanisation), low to macrophyte cover (usually margins only)	Buildings and artificial surfaces (BL3), dry meadows and grassy verges (GS2), treelines (WL2), improved agricultural grassland (GA1)	Silt with localised areas of sand and bedded cobbles & gravels, occasional boulder	Heavy siltation, abundant filamentous algae and floc	*Nuphar lutea* (O), *Schoenoplectus lacustris* (O), *Potamogeton perfoliatus* (R), *Myriophyllum spicatum* (R), *Sagittaria sagittifolia* (O)	No	Eutrophication, siltation, water quality, channel modifications
E	River Barrow (downstream Graiguenamanagh Weir)	Lowland depositing watercourse (FW2), average 20-35 wide & 1-3m deep, dominated by slow flowing glide & pool (faster near weir), historically modified near town (weir), well-developed riparian zone downstream of town, low macrophyte cover (usually margins only)	Buildings and artificial surfaces (BL3), amenity grassland (GA2), treelines (WL2), scattered trees and parkland (WD5)	Silt with localised areas of cobble & occasional boulder (cobble & gravels dominated near weir)	Heavy siltation, abundant filamentous algae and floc	*Nuphar lutea* (O), *Schoenoplectus lacustris* (O), *Potamogeton perfoliatus* (R), *Sagittaria sagittifolia* (O), *Mentha aquatica* (O)	Yes; eDNA recorded at Lower Tinnahinch Weir (see section 4.1)	Eutrophication, siltation, water quality, channel modifications

7. Appendix B – eDNA analysis lab report

SureScreen Scientifics

Folio No: E9978
Report No: 1
Purchase Order: -
Client: Triturus Environmental Ltd
Contact: Ross Macklin

TECHNICAL REPORT

ANALYSIS OF ENVIRONMENTAL DNA IN WATER FOR AQUATIC SPECIES DETECTION

SUMMARY

When aquatic organisms inhabit a waterbody such as a pond, lake or river they continuously release small amounts of their DNA into the environment. By collecting and analysing water samples, we can detect these small traces of environmental DNA (eDNA) to confirm the presence or absence of the target species within the waterbody.

RESULTS

Date sample received in laboratory: 05/05/2021
Date results reported: 18/05/2021
Matters affecting result: None

TARGET SPECIES: Freshwater pearl mussel *(Margaritifera margaritifera)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
C0280	Tinnahinch Weir	-	Pass	Pass	Pass	Positive	1/12
C0282	Duiske Upper	-	Pass	Pass	Pass	Negative	0/12
C0285	Duiske Lower	-	Pass	Pass	Pass	Negative	0/12

If you have any questions regarding results, please contact us: ForensicEcology@surescreen.com

Reported by: **Dr Chris Troth (BSc)** Approved by: **Dr Chris Troth (BSc)**

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Company Registration No. 08950940

METHODOLOGY

The samples detailed above have been analysed for the presence of target species eDNA following scientifically published eDNA assays and protocols which have been thoroughly tested, developed and verified for use by SureScreen Scientifics.

The analysis is conducted in two phases. The sample first goes through an extraction process where each of the 6 sub-sample tubes are first centrifuged and pooled together into a single sample which then undergoes DNA extraction. The extracted sample is then tested via real time PCR (also called q-PCR) for each of the selected target species. This process uses species-specific molecular markers (known as primers) to amplify a select part of the DNA, allowing it to be detected and measured in 'real time' as the analytical process develops. qPCR combines amplification and detection of target DNA into a single step. With qPCR, fluorescent dyes specific to the target sequence are used to label targeted PCR products during thermal cycling. The accumulation of fluorescent signals during this reaction is measured for fast and objective data analysis. The primers used in this process are specific to a part of mitochondrial DNA only found in each individual species. Separate primers are used for each of the species, ensuring no DNA from any other species present in the water is amplified.

If target species DNA is present, the DNA is amplified up to a detectable level, resulting in positive species detection. If target species DNA is not present then amplification does not occur, and a negative result is recorded.

Analysis of eDNA requires scrupulous attention to detail to prevent risk of contamination. True positive controls, negative controls and spiked synthetic DNA are included in every analysis and these have to be correct before any result is declared and reported. Stages of the DNA analysis are also conducted in different buildings at our premises for added security.

SureScreen Scientifics Ltd is ISO9001 accredited and participate in Natural England's proficiency testing scheme for GCN eDNA testing. We also carry out regular inter-laboratory checks on accuracy of results as part of our quality control procedures.

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SureScreen Scientifics

INTERPRETATION OF RESULTS

SIC: **Sample Integrity Check** [Pass/Fail]
When samples are received in the laboratory, they are inspected for any tube leakage, suitability of sample (not too much mud or weed etc.) and absence of any factors that could potentially lead to inconclusive results.

DC: **Degradation Check** [Pass/Fail]
Analysis of the spiked DNA marker to see if there has been degradation of the kit or sample, between the date it was made to the date of analysis. Degradation of the spiked DNA marker may indicate a risk of false negative results.

IC: **Inhibition Check** [Pass/Fail]
The presence of inhibitors within a sample are assessed using a DNA marker. If inhibition is detected, samples are purified and re-analysed. Inhibitors cannot always be removed, if the inhibition check fails, the sample should be re-collected.

Result: **Presence of eDNA** [Positive/Negative/Inconclusive]

Positive: DNA was identified within the sample, indicative of species presence within the sampling location at the time the sample was taken or within the recent past at the sampling location.

Positive Replicates: Number of positive qPCR replicates out of a series of 12. If one or more of these are found to be positive the pond is declared positive for species presence. It may be assumed that small fractions of positive analyses suggest low level presence, but this cannot currently be used for population studies. Even a score as low as 1/12 is declared positive. 0/12 indicates negative species presence.

Negative: eDNA was not detected or is below the threshold detection level and the test result should be considered as evidence of species absence, however, does not exclude the potential for species presence below the limit of detection.

Inconclusive: Controls indicate inhibition or degradation of the sample, resulting in the inability to provide conclusive evidence for species presence or absence.

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Appendix 10-10 Aquatic Ecology Survey Report 2023

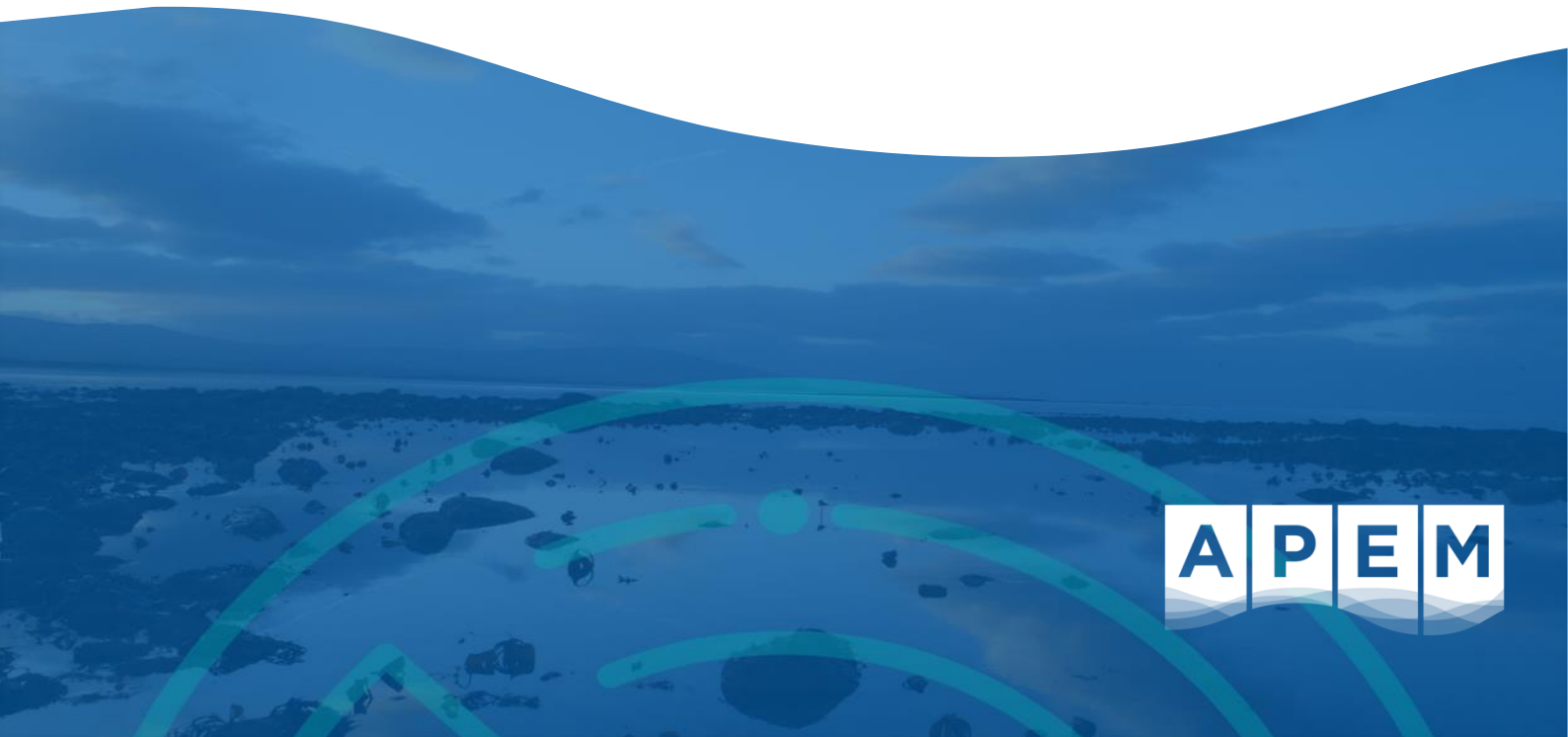
ByrneLooby

Griaguenamanagh-Tinnahinch Flood Relief Scheme

Aquatic Ecology Surveys Report

P00012428

October 2023



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Reference no:	P00012428
Date of issue:	25 October 2023

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Document Control

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1. Introduction

1.1. Background

APEM Ireland was commissioned by ByrneLooby to carry out aquatic surveys and prepare an aquatic ecology baseline report in support of the planning application for the flood storage area proposed on the Duiske River as part of the Graiguenamanagh and Tinnahinch Flood Relief Scheme. This follows a desk study baseline report carried out by APEM Ireland early in 2023 (APEM 2023).

1.2. Site Description

The proposed development site ("the Site") is located at Graiguenamanagh, Co. Kilkenny and is centred at Irish Transverse Mercator (ITM) 669328 644387 (Figure 1). The Site covers a ca. 750 m stretch of the lower reaches of the Duiske River that lies within the River Barrow and River Nore SAC. The Site is located in an agricultural setting, surrounded by grazing farmland.

The Duiske River is formed by the confluence of several smaller streams around Graiguenamanagh. It drains approximately 24 km^2 and discharges into the River Barrow immediately downstream of Graiguenamanagh Bridge, Co. Kilkenny on the upstream side of a major weir. It is classified by the EPA as suffering agricultural and urban run-off pressures, as well as from hydromorphological issues. Despite this, the EPA's own Q value sampling, conducted upstream in 2020, gave this river a High Ecological Quality status under the Water Framework Directive (WFD).

1.3. Brief Description of the Proposed Development

The following project description was provided by ByrneLooby for the proposed raised defences and Duiske River storage area.

The Proposed Scheme consists of a series of raised defences (flood walls and embankments) along the River Duiske and River Barrow. It further includes upstream storage of flood waters (upstream on the River Duiske) to facilitate a reduced extent of flood walls downstream in the built-up area of Graiguenamanagh, particularly in the complex areas of Turf Market where there are significant buildability and archaeological constraints. The flood storage area is to be located within agricultural lands of the Barrow Valley, approximately 1.5km upstream of the River Barrow and River Duiske confluence. Flood waters will be held back by headwall and flow control structure, which will enable a controlled release of waters through the River Duiske during a flood event.'

1.4. retaining embankmentPurpose of this Report

The purpose of this report is to describe the results of a series of baseline, aquatic ecology surveys conducted at the proposed works sites, which will inform the planning application.

1.5. Aquatic Ecology Survey Site Selection

A desk study was conducted to inform as to the kind of surveys that were necessary and as to the locations of such surveys. It was determined that to be able to effectively assess water quality under baseline conditions at the Site, three sites needed to be sampled for macroinvertebrates and water chemical analysis. Two locations were also selected for survey for white-clawed crayfish. Fish habitat surveys were undertaken across the Site (Figure 2 – Figure 6)

1.6. Evidence of Technical Competence and Experience

Summaries of the qualifications and experience of the personnel involved in the work, and their role in delivering it, are outlined below. Gráinne Keogh and Adon McFarlane carried out the field surveys. Gráinne Keogh and Adon McFarlane prepared this report and it was technically reviewed by Michael Dobson and Eliot Taylor.

Gráinne Keogh is a Senior Ecologist at APEM Ireland and holds an MSc in Marine Biology and a BSc in Ecology and Environmental Biology. Gráinne has carried out field and lab work across marine, terrestrial, and freshwater environments; these include habitat surveys and mapping, species identification, freshwater pearl mussel surveys, electrofishing surveys and chemical and biological water quality analysis including SSRS and Q Value assessments. She has previously worked on the Climate Change Mitigation Research Project in Inland Fisheries Ireland and she has also spent time at sea on research vessels conducting fisheries surveys with the Marine Institute. Grainne has a robust understanding of the impact assessment processes, and Irish and EU wildlife legislation and has written a number of Appropriate Assessments, Natura Impact Statements and Ecological Impact Assessments to support planning applications.

Dr Adon McFarlane is a freshwater biologist, specialising in protected species. He is an experienced field scientist, with extensive skills in the fields of freshwater habitat assessment; freshwater pearl mussel survey; white-clawed crayfish survey, macroinvertebrate survey, fish habitat assessment and electrofishing survey. He has built up skills in the collection of data both in the field and laboratory, analysis of data using statistical software programs such as R, BORIS, RAVEN and Minitab, creation of distribution maps using GIS. Adon has very strong technical skills in both freshwater and marine laboratory and fieldwork instrumentation and equipment usage. Adon has worked on a number of ecological reports, including Appropriate Assessments, Ecological Impact Assessments (EcIA), Preliminary Ecological Appraisal Reports (PEAR) and Invasive Species Reports.

Dr Michael Dobson FLS MCIEEM is a freshwater biologist with over 35 years' experience. He spent 20 years as a research scientist, specialising in ecology and management of rivers and freshwater wetlands throughout Europe and East Africa, along with developing biotic indices for river quality assessment in Central America. He was Director of the Freshwater Biological Association for six years before joining APEM in 2013, working initially in the limnology and water quality team before setting up its dedicated invasive species team in 2019 and moving to APEM Ireland in 2022. Mike has written many peer- reviewed papers in ecology and biogeography, along with two undergraduate textbooks for Oxford University Press (both in their second editions) and seven identification guides to freshwater invertebrates of Britain and Ireland. He has extensive experience of survey design, data analysis and reporting, including publication and verbal reporting for non-technical audiences. He has written and reviewed Habitats Directive assessments in both Ireland and the UK.

Dr Eliot Taylor CSci CEnv CWEM is a highly experienced freshwater environmental, ecological and technical specialist with +30 years' experience, including of numerous short and long-term assignments in over 15 western, eastern and southern African countries. He has extensive experience of work in integrated water resources management; catchment management; climate change adaptation; ecological and environmental impact assessment; environmental flow assessment; freshwater invasive species control; use of freshwater macroinvertebrate communities to determine water quality and sedimentation issues, as well as their conservation value. Eliot has undertaken assessment and understanding of wetlands and other freshwater aquatic ecosystems and freshwater and planning and management of wetland protected sites (Ramsar, SAC, SPA, National Parks etc). He is experienced in the provision of technical advice to clients, development and implementation of plans and reports, managing and facilitating workshops, as well as community and broader stakeholder consultation and participation. He has advised on the development / implementation of

water related policy, plans and assessments in liaison with development partners, private sector clients and a range of governments. Since September 2020, Eliot has been APEM Ireland's Divisional Director, based in Cork.

2. Field survey locations

2.1. Water quality and macroinvertebrate surveys

All survey sites are located on the Duiske River, three locations were chosen for surveys. Firstly, upstream of the proposed retaining embankment and within the area potentially to be flooded, secondly, around the location of the embankment construction itself, and thirdly, downstream of the proposed retaining embankment (Table 2-1, Figure 2). The exact retaining embankment location is not yet confirmed (Jackelyn Wren, *pers. comm.*) so the survey location was chosen to be representative of the area within which it will be placed.

Table 2-1 Location of water quality and macroinvertebrate survey sites

Site number	Description	Location
1	Downstream of works area; c. 155 m downstream of probable retaining embankment location	ITM 669480 , 644329
2	Within area of works	ITM 669319 , 644396
3	Upstream of works area; c. 475 m upstream of probable retaining embankment location	ITM 668895 , 644567

2.2. Fish habitat surveys

Fish habitat surveys were carried out along the entire river stretch within the Site (Figure 3 – Figure 6). This stretch ran from ca. 677 m upstream of the area of proposed works, through the area of proposed works (ca. 42 m) to a point ca. 327 m downstream of the area of proposed works. In covering this area, all channels within the proposed area of flooding, within the proposed area of works and the area that will be immediately downstream of the works, were all surveyed.

2.3. White-clawed crayfish surveys

Two survey locations were chosen to determine the presence/absence of white-clawed crayfish (WCC - *Austropotamobius pallipes*) on the Duiske River; these were one upstream of the location of works, and one at the location of the works.

3. Water Samples

3.1. Methods

Water quality assessment took place at three sites on 10th August 2023 (Plate 1-Plate 3). Field measurements were taken *in situ*, using a multimeter probe, and water samples were additionally collected for laboratory analysis. Each sample was collected in a pre-sterilised sampling bottle, pre-rinsed with river water. Water samples were taken from just below the surface, ensuring that the riverbed was not disturbed. Once sample bottles were filled, they were transported to an INAS accredited laboratory for analysis within the recommended holding time for the selected water quality parameters.

3.2. Results

The physiochemical data collected *in situ* in August 2023 is shown in Table 3-1. Readings were similar across all three sites and showed a general absence of negative water quality impacts, with high oxygen saturation and moderate conductivity levels.

Table 3-1. Summary of physicochemical readings recorded in situ in August 2023

Parameter	Unit of Measurement	Site 1 – Downstream of works area	Site 2 – within area of works	Site 3 – upstream of works area
Time of reading	HH:MM	07:50	08:45	09:50
Temperature	°C	14.8	14.7	14.7
Dissolved Oxygen	% Saturation	95.3	94.3	96
Dissolved Oxygen	mg/l	9.66	9.54	9.54
pH	-	7.57	7.56	7.55
Conductivity	µS/cm	182.6	180.8	168.40

Laboratory results for water quality parameters are shown in Table 3-2. BOD and ammonia, both indicators of organic pollution, were low across all sites. Suspended solids were also comparably low at all sites.

Nutrient concentrations were also low and, apart from a slight increase in orthophosphate at Site 2, similar across all sites. Other parameters also showed similarity across all sites.

3.1. Conclusions

The results show no adverse water quality impacts and little difference between the samples taken upstream, within, and downstream of the Site.

3.2. Limitations

A key limitation is the number of water quality readings available. Water quality can be variable, and will change under different flow and runoff conditions, so a single sample or set of readings can only give a snapshot indication of conditions at the point in time at which they are taken.

Table 3-2. Summary of laboratory water quality parameters from samples collected in August 2023

Parameter	Unit of Measurement	Site 1 - Downstream of works area	Site 2 - within area of works	Site 3 - upstream of works area
Biochemical Oxygen Demand (BOD)	mg/l	<1	<1	<1
Chemical Oxygen Demand (COD)	mg/l	<10	<10	<10
Suspended Solids	mg/l	2	<2	<2
Total Nitrogen as N	mg/l	2.44	2.39	2.37
TON as N	mg/l	2.64	2.64	2.63
Nitrate as NO_3	mg/l	12.4	11.7	11.7
Nitrite as NO_2	mg/l	<0.017	<0017	<0.017
Ammonia as N	mg/l	0.029	0.025	0.027
Total Phosphorus as P	mg/l	<0.05	<0.05	<0.05
Orthophosphate as PO_4-P	mg/l	0.012	0.043	0.020
TPH (>C5 - C44) by GC-FID	ug/l	<20	28*	35*
Alkalinity, total by titration	mg/l $CaCO_3$	52	48	48
Iron, total	ug/l	115	103	106
Iron, dissolved	ug/l	22	23	20
Copper, dissolved	ug/l	<1	<1	<1
Arsenic, dissolved	ug/l	1	1	1
Zinc, dissolved	ug/l	8	5	7
Dissolved Organic Carbon (DOC)	mg/l	2.75	2.32	1.93

*Unknown pattern: indicates the presence of naturally forming hydrocarbons in the sample that cannot be attributed with a known 'fingerprint' such as diesel or kerosene.

4. Macroinvertebrate Survey

4.1. Methods

Kick-sampling was carried out at the three sites on 9th August 2023 (Plate 1-Plate 3) according to the standard methodology used by the EPA (Toner *et al.,* 2005). A two-minute macroinvertebrate kick sample was conducted at each site using a standard, 1 mm mesh size, long-handled net, principally from the faster flowing riffle habitats, but glides, margins and pools were included according to their proportional presence. A further one-minute hand search was carried out to locate macroinvertebrates that attached themselves to solid structures, such as the underside of the cobbles. Each sample was preserved on site with >90% Isopropanol solution and returned to the laboratory for further analysis. Specimens were identified, under a binocular microscope, to family level in the laboratory using the standard range of identification keys published by the Freshwater Biological Association, AIDGAP and others, and their relative abundance was recorded.

An EPA Q-value classification was assigned to each site. The Q-values were assigned based on the presence and relative abundance of sensitive groups and the consideration of additional qualifying criteria, as described by Toner *et al.* (2005) and outlined in more detail in Appendix C.

4.2. Results

Results from the macroinvertebrate survey are provided in Table 4-1 and a full taxa list is provided in Appendix C. Each of the sites would be classed as Q3 based on the data gathered, equivalent to Moderate WFD status. Each site was dominated by Group C (tolerant) taxa, with a small number of Group B (less sensitive) taxa. All sites had a similar invertebrate composition, although overall abundance and taxon richness was lower in Site 2 than the other sites. Two Group A (sensitive) taxa were recorded, but only as single individuals and thus, as per the methodology, not included in the Q-value calculation.

Table 4-1. Summary of Q values assigned, and total number of taxa observed at each site in August 2023

Parameter		Site 1 - Downstream of works area	Site 2 – within area of works	Site 3 - upstream of works area
Q Value Classification		Q3	Q3	Q3
Number of Taxa	Group A (sensitive)	-	*	*
	Group B (less sensitive)	3	1	3
	Group C (tolerant)	11	9	10
	Group D (very tolerant)	-	-	-
	Group E (most tolerant)	-	-	-
	Total+	19	13	21

*Present, but only as single individuals, so not included in the classification

+Other taxa were present and counted in the total number of taxa but either had only one individual and were, therefore, discounted from Q value classification, or were not a taxon considered in the classification system

4.3. Conclusions

The Q-value assessment for the Duiske River, based on the data collected in August 2023, suggests Moderate WFD status, in contrast to the most recent EPA assessment in which High WFD status was assigned, but it was consistent across the three sites.

4.4. Limitations

The dataset is from a single sampling event and while it will integrate environmental conditions over the several months coved by the life cycles of the taxa recorded, it cannot give an indication of interannual variation. Where possible, therefore, it is always advisable to take repeat samples in different seasons in multiple years.

5. Fish and Habitat Surveys

5.1. Methods

5.1.1. Fish species present

Presence of fish species within the area to be affected was determined from pre-existing data and designations. Habitat walkover surveys were conducted in order to identify suitable habitat for the key fish species and their associated important life stages . Electrofishing was not conducted, as it has several disadvantages, including the fact that it is a one-off survey, and consequently species or individuals may be missed due to seasonal and shorter-term temporal changes in distribution. Existing datasets, which have the advantage of being collected at multiple times, show what has previously been recorded at the sites and habitat walkover surveys then identify suitable habitat for the key species and life stages of importance.

Baseline fisheries data was obtained from previous electrofishing surveys conducted upstream and downstream of the proposed works area on the Duiske River. These surveys were conducted by Inland Fisheries Ireland (IFI) for the Water Framework Directive fish ecological status 2008-2021 project. The newly published dataset river layer shows river fish status and fish distribution from surveys carried out from 2008 to 2021, as well as the species recorded and the dates the surveys were conducted[2]. Aquafact Ltd also conducted electrofishing surveys on the Duiske River in 2021 ca. 1.4 km downstream of the proposed works area.

IFI were contacted regarding the need for electrofishing in the area and have stated that we can assume all fish QIs of the River Barrow and River Nore SAC are present within the works area. This confirmed our original decision and recommendation to the client, not to undertake electrofishing and so minimise disturbance to any SAC QI populations.

5.1.2. Fish habitat survey

Walkover habitat surveys were conducted on 09 August 2023. Weather conditions were dry with 6/8 okta cloud cover, Beaufort 0 wind[3], air temperature 19°C. The river flow at this time was considered low and, therefore, allowed for good visibility during habitat surveys. Each survey mapped habitats suitable for salmonids and lamprey. An outline of the requirements for each survey is detailed in Appendix D.

The methodology applied to the habitat survey follows that of Hendry & Cragg-Hine (1997). This field mapping technique involves hand drawing features, onto a high-resolution map (OS 1 km tiles), at a scale of 1:10,000 using a field tablet. The riverbank was walked, noting habitat features in the river channel and drawing these directly onto the map, with the boundaries of the different habitat classifications being drawn to represent their actual position within the river, and with annotations as required. Prominent features, such as log jams, macrophyte beds, weirs and bridges, were noted and their locations confirmed using handheld GPS unit. This approach allows exact representation of areas of individual habitat types encountered and, in doing so, a mosaic of the different habitat types can be drawn along the whole section of the river. Definitions of habitat types included in the survey are

[2] Water Framework Directive Fish Ecological Status 2008-2021 | Water Framework Directive Fish Ecological Status 2008-2021 | Inland Fisheries Ireland Data Hub (arcgis.com)

[3] https://www.met.ie/forecasts/marine-inland-lakes/beaufort-scale

outlined in Appendix D. The drawings of the habitat types along the section of the river were subsequently digitised using QField and QGIS.

5.1. Results and Discussion

5.1.1. Fish species present

Electrofishing surveys were conducted ca. 550m upstream of the proposed work site on 20 July 2015 and 09 July 2020 and ca. 1.5 km downstream of the proposed work site on 09 July 2020 by IFI, and ca. 1.4 km downstream of the proposed work site by Aquafact Ltd on 10 February 2021. These surveys identified the presence of salmon (*Salmo salar*), brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*) and lamprey spp. The Duiske River has also been identified as a potentially important nursery ground for Atlantic salmon by Delanty *et al.* (2017) and for lamprey (King, 2006).

Although no observations of Twaite Shad *Alosa fallax* [1103] have been recorded within the Duiske River, as the proposed site is within the River Barrow and River Nore SAC (002162) it needs to also be assumed that this QI fish species is present and should be considered for mitigation.

Table 2-1 below identifies the fish species actually recorded both above and below the proposed works area during electrofishing surveys.

Table 2-1. Fish species recorded by IFI and Aquafact on River Duiske with potential to reside within works area

Fish Species	2015 IFI Survey (Upstream of proposed works)	2020 IFI Survey (Upstream of proposed works)	2020 IFI Survey (Downstream of proposed works)	2021 Aquafact Survey (Downstream of proposed works)
Salmon, *Salmo salar*	X	X	X	X
Brown Trout, *Salmo trutta*	X	X	X	X
European eel, *Anguilla anguilla*		X	X	X
Lamprey species	X			X

5.1.2. Fish Habitat Surveys

The fish habitat survey covered a length of ca. 1,045 m of the Duiske River. Digitised maps of the walkover habitat survey are presented in (Figure 3 – Figure 6). Using these maps, the habitat was assessed for suitability based on the species listed as qualifying interests in the SAC, and on those species recorded previously at the site.

The section surveyed was characterised mainly as riffle, mixed juvenile, pool and glide habitats. The substrate was composed mainly of gravels, cobbles and boulders, with areas of fine silts and sand (Plate 7-Plate 11). The average width of the section surveyed was 5 m ranging between ca. 3 – 7m with fast to moderate flow. Instream macrophytes included *Apium nodiflorum*, *Mentha aquatica* and *Nasturtium officinale*. Areas suitable for lamprey ammocoetes were observed throughout the survey stretch, characterised by areas of stable fine sediment or sand which is greater than 15 cm deep with a low water velocity and the presence of organic detritus (Plate 4 -Plate 6). Undercut banks and tunnelled vegetation causing shading from deciduous tree canopy are present along the watercourse.

Himalayan Balsam, *Impatiens glandulifera,* is present on both banks along the entire stretch of the surveyed river, with dense areas being observed (Figure 7), including at the area of proposed works (Plate 19-Plate 20). Areas of suboptimal silted spawning habitat for salmonids were observed downstream, as well as at areas of the channel impacted by poaching from livestock (Plate 15-Plate 16, Plate 23).

5.2. Conclusions

Overall, the Duiske River provides a good mix of aquatic habitats, favoured by a range of fish and invertebrate species. Salmonid and mixed juvenile habitat was prevalent with adult salmonid passageway (fast moving glides and runs) and resting and holding areas (glides, and pools) being found along the reach. Abundant salmonid parr were observed throughout the survey area with large aggregations being observed in pool habitats.

It can, therefore, be safely assumed that all the species recorded in recent surveys are present throughout and that, likewise, those species listed as QIs in the SAC designation, namely the three species of lamprey, can be assumed to be present at the site on the basis of the survey.

5.3. Limitations

The use of historical fish survey data and the SAC designation, combined with the detailed walkover and fish habitat survey, reduces the limitations in determining species present.

6. White-clawed crayfish Survey

6.1. Methods

Prior to conducting field surveys for white-clawed crayfish (WCC - *Austropotamobius pallipes*), a check for previous records in the catchment was carried out.

Licences for WCC surveys were secured from National Parks and Wildlife Service (NPWS) prior to commencement of the survey (Licence No. C225/2023).

Two surveys were conducted on 09 August 2023 to determine the presence/absence of WCC on the Duiske River upstream of, and at, the area of works and according to the standard methodology used by Peay (2003) and Gammell *et al.* (2021). The river sections surveyed are shown in Figure 2. On arrival, channel conditions were assessed, and a 100 m stretch of suitable river was chosen for survey within the 500m survey stretch. Hand-searching of 50 potential refuges within 5 patches was carried out at each chosen 100 m stretch. Potential refuges were defined as any suitable substrata (e.g., boulder, cobble, woody debris) that would be resistant to high flows and capable of providing cover for WCC. Refuges were searched facing upstream to minimise the disturbance of softer substrata. Where possible, refuges were replaced after searching. Habitat features for each patch were also recorded.

In addition to hand-searching, a string of four trappy funnel baited crayfish traps (Plate 17 - Plate 18) were laid out on 09 August 2023 and left overnight, these within an area of suitable habitat that included abundant refuges and vegetation. Traps were spaced approximately 4 m apart and laid parallel to the riverbank in approximately 0.5 m of water. Each end of the rope was secured to the bank in order to prevent the baited traps from being moved. Each trap was baited with approximately 40 g of raw fish (mackerel). Traps were left overnight and checked early the following morning on 10 August 2023.

6.2. Results

WCC have been recorded throughout the Barrow catchment (Department of Culture, Heritage and the Gaeltacht, 2019). Crayfish plague, caused by the water mould *Aphanomyces astaci,* is present in the river (Update on Crayfish Plague in Ireland | Fish Health Unit).

No crayfish were found during surveys and the traps laid overnight were empty when retrieved. However extensive areas of suitable habitat were found throughout the site in the form of large cobble and boulders, undercut banks and woody debris within the glide/run sections, as well as along river margins with overhanging vegetation (Plate 12 - Plate 14). It is possible, therefore, that crayfish plague is now found within the Duiske River, accounting for the absence of the species in the reaches surveyed.

6.3. Conclusions

The absence of any records of WCC, or of other evidence, such as partial remains from predation, and despite an intensive search in a reach with suitable habitat, suggests the absence of this species from the Site. This may be due to upstream movement in recent years of crayfish plague, previously confirmed within the River Barrow.

6.4. Limitations

A survey of this type, based on a single site visit and short river reach, always has the risk of missing presence of the species elsewhere in the area to be affected. However the complete absence of

records, including from the baited traps, which will attract this mobile species, would suggest either genuine absence or the presence of very low numbers existing in small, localised populations. Notwithstanding the probable absence of WCC, its listing as an QI feature for the SAC means that consideration of this species is required irrespective, particularly with regard to habitat restoration following the works.

7. General conclusion

The baseline aquatic ecology surveys conducted revealed similar conditions along the reach surveyed. Water quality readings suggested an absence of pollution at the time of the survey, and the presence of large numbers of salmonids observed during fish habitat surveys would support this. The apparent low quality shown by the macroinvertebrate samples (Q-value 3, equivalent to Moderate WFD status) is, therefore, interesting in this regard.

Fish habitat surveys identified that the channel of the Duiske River surveyed provides a good mix of aquatic habitats, favoured by a range of fish and invertebrate species. Salmonid and mixed juvenile habitat was prevalent with adult salmonid passageway and resting and holding areas being found along the reach. There are therefore species present, or that can be assumed to be present at, upstream and downstream of the proposed works that need to be considered in the design of any mitigation; these include lamprey and salmon.

While WCC is apparently now absent, there is good habitat, and the river is a site for potential reintroduction in due course. No evidence of WCC was found at the proposed site during hand search and trapping surveys. However, the sensitivity and conservation importance of this species, its listing as a QI feature for the SAC, and its presence within the system prior to the outbreak of crayfish plague, means that consideration of this species is required irrespective of whether it is recorded. A preliminary recommendation therefore is to consider habitat restoration for WCC following the works as extensive areas of suitable habitat were found throughout the site.

Himalayan Balsam is present on both sides of the river within the riparian zone along the entire stretch of the surveyed area, with dense areas being observed, including within the area of proposed works. It is recommended that this invasive species is removed by an approved contractor following best practice prior to works and prior to the formation of seed pods which may cause the species to spread further within the site.

Possible mitigation to prevent a reduction in water quality and damage to the river channel habitats following the works may include improved fencing along the riverbank and riparian zone, along with provision of drinking troughs, in order to prevent the poaching from livestock which was evident at a number of locations along the channel surveyed.

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Appendix A: Figures

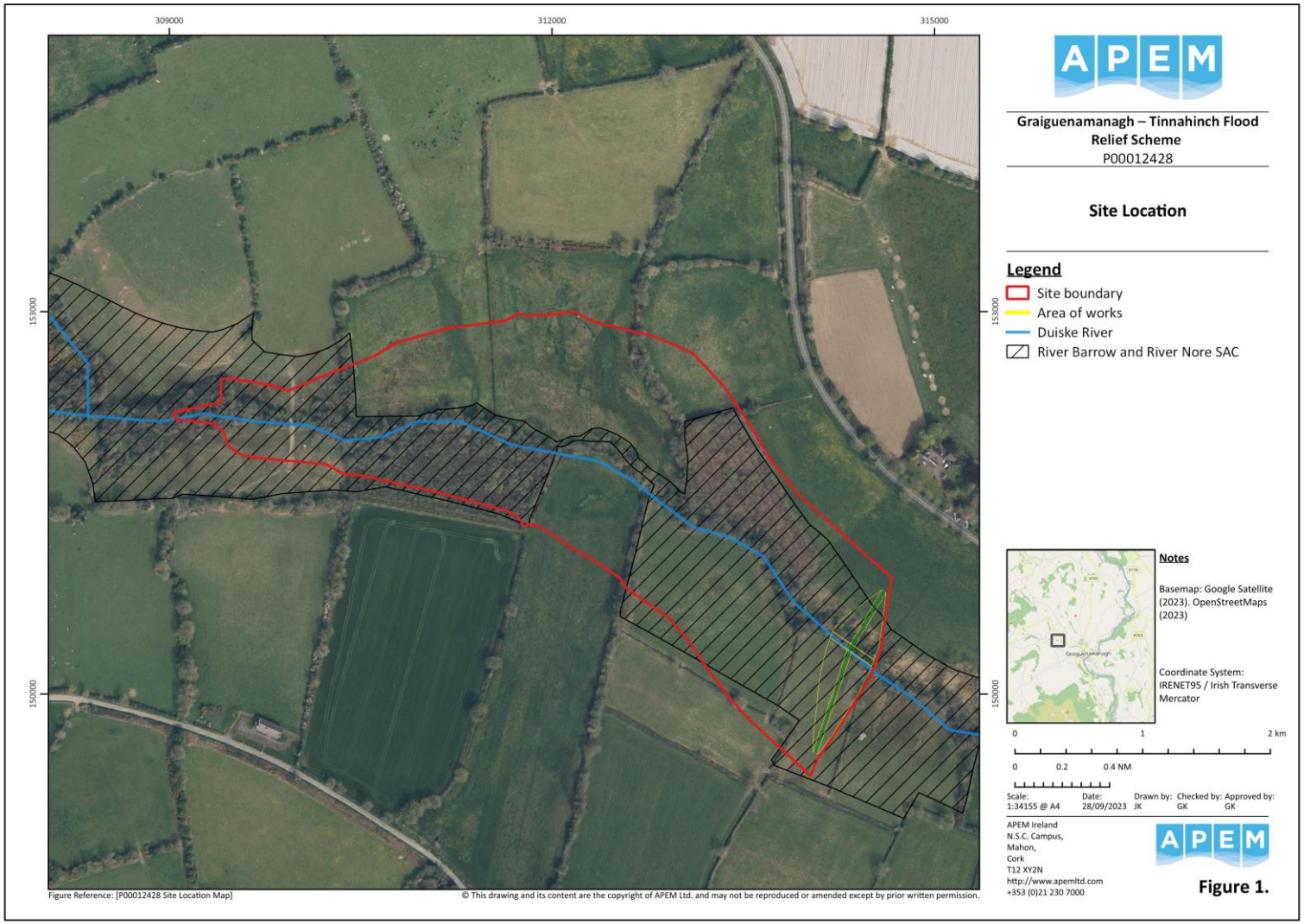

Figure 1 Site location at Graiguenamanagh

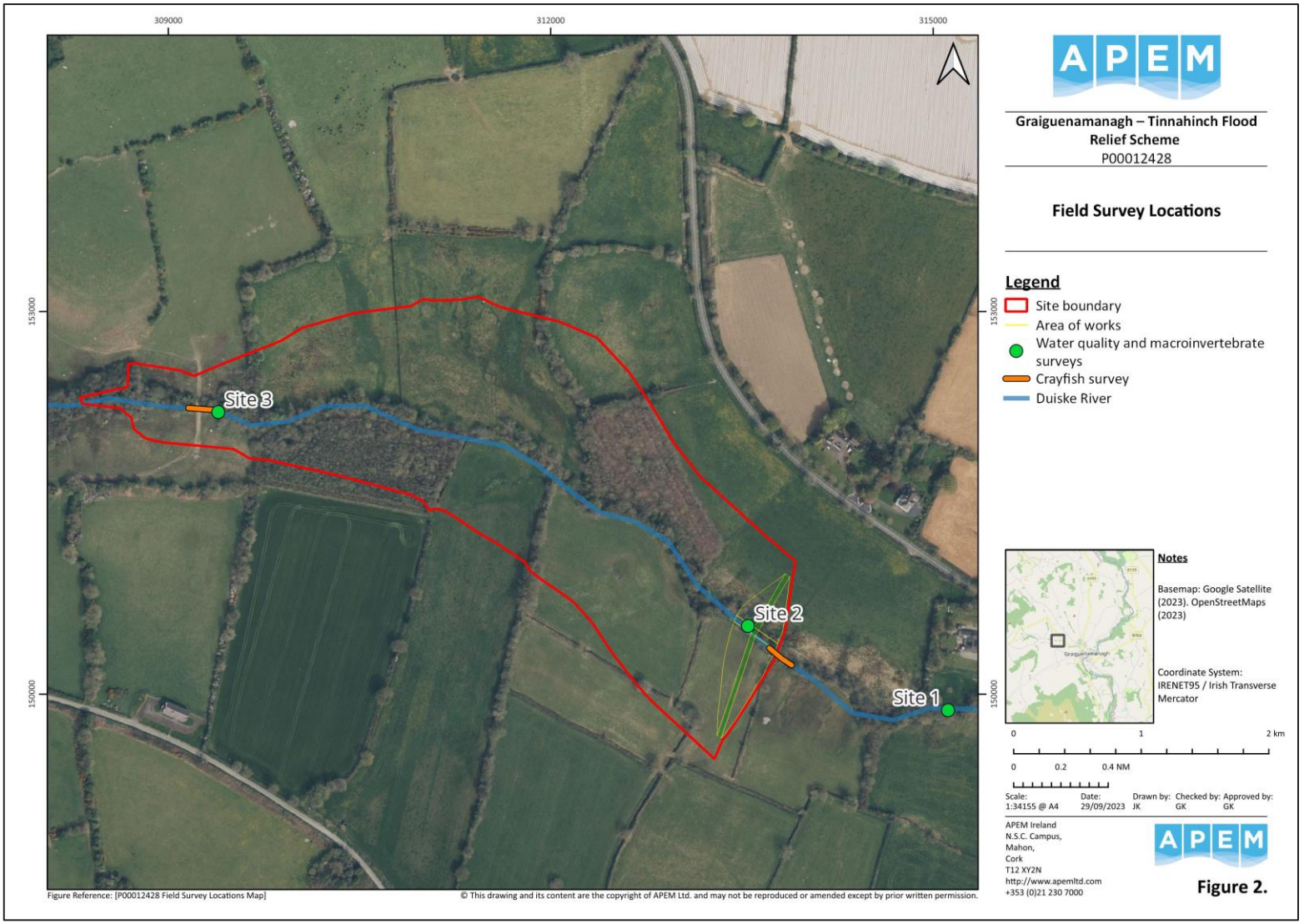

Figure 2 Survey locations at Graiguenamanagh

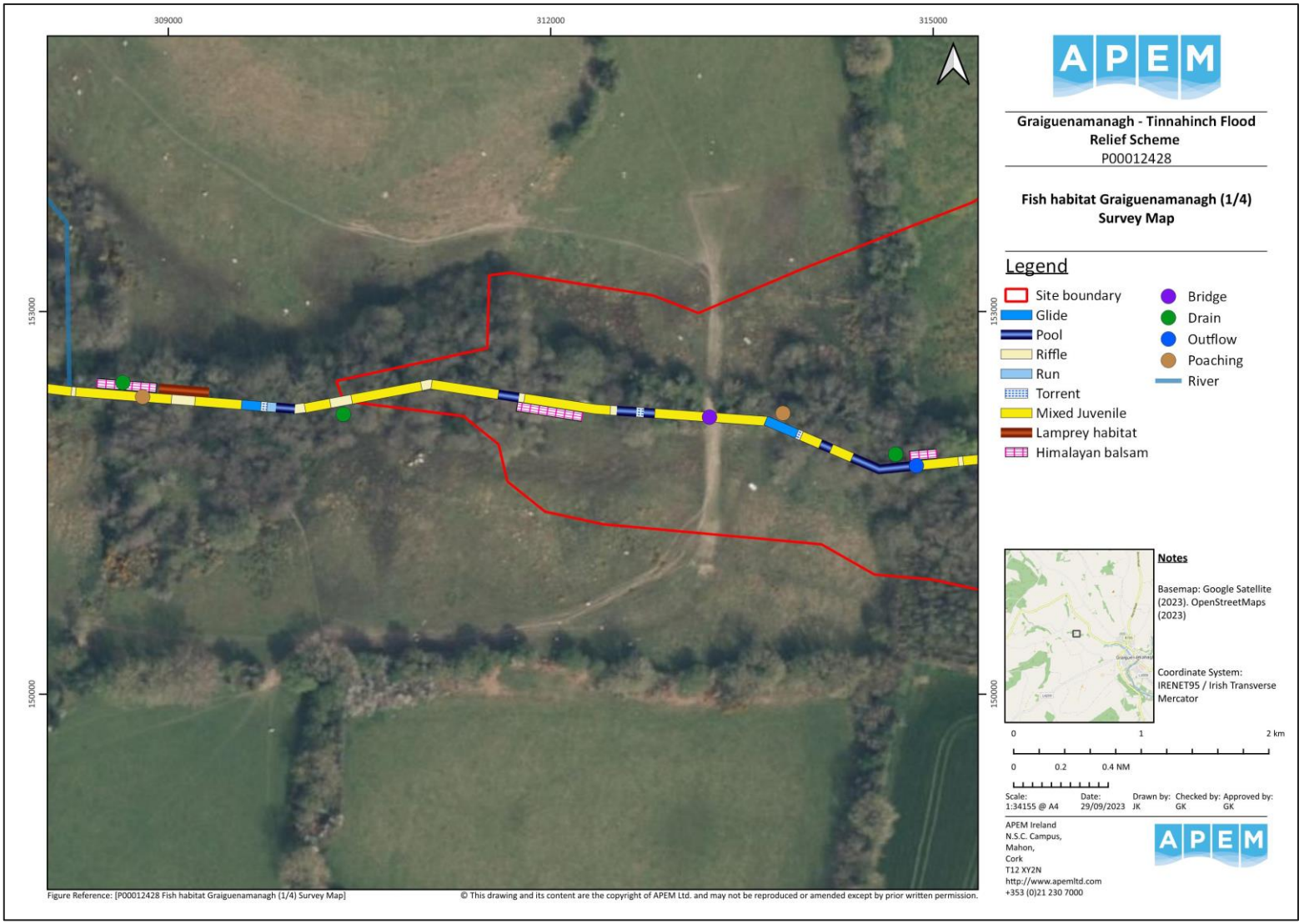

Figure 3 Fish habitats present at Graiguenamanagh 1/4

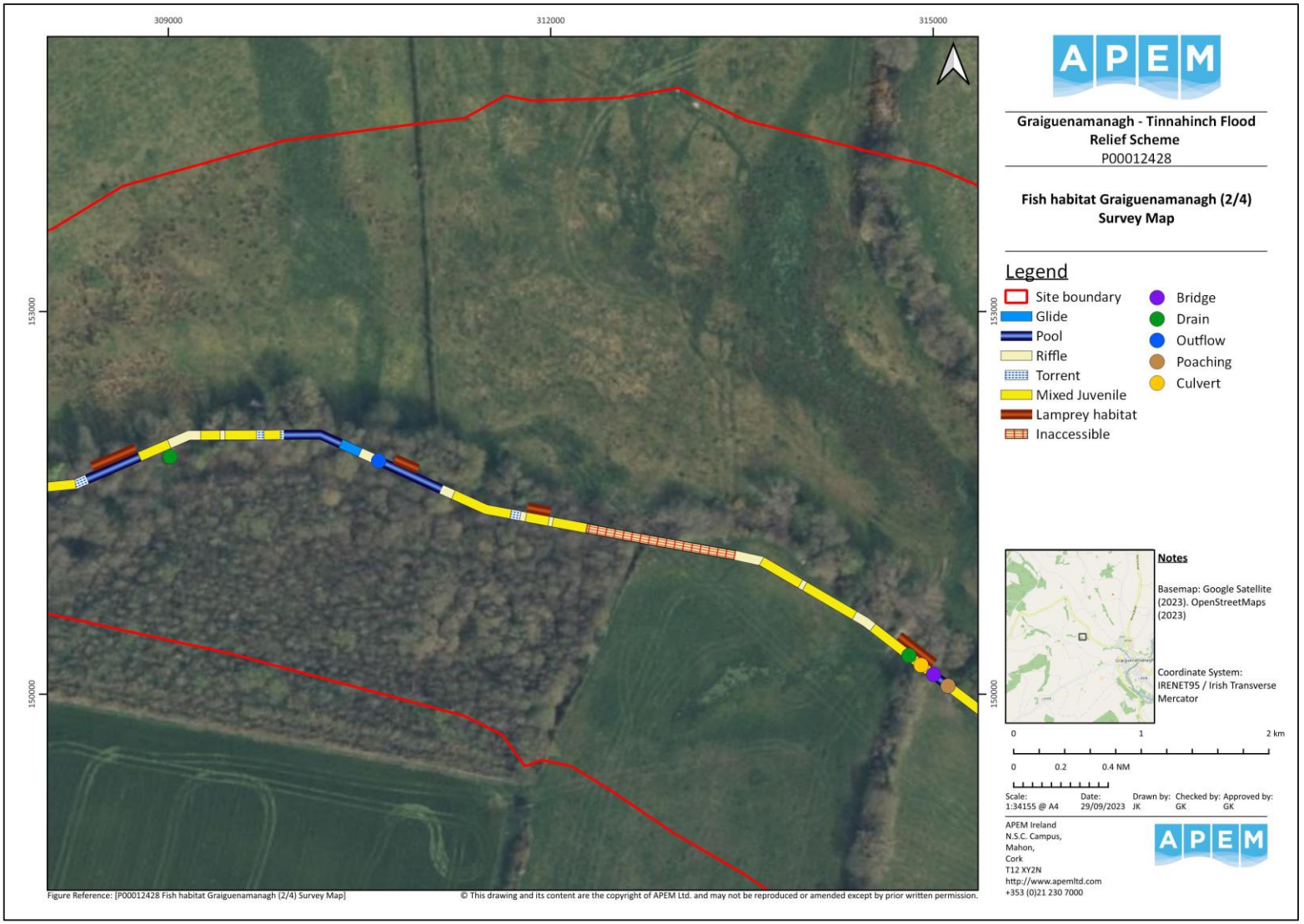

Figure 4 Fish habitats present at Graiguenamanagh 2/4

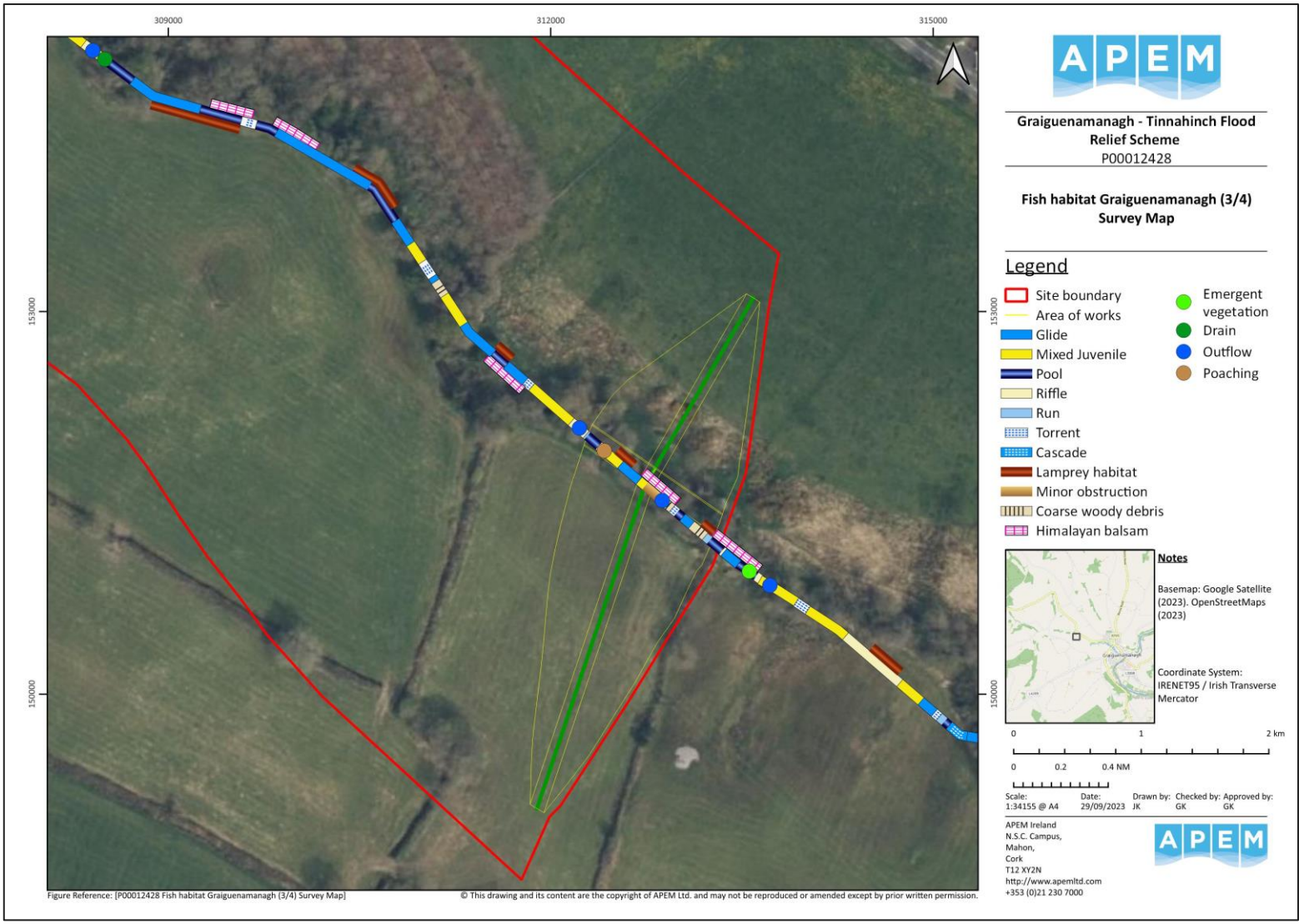

Figure 5 Fish habitats present at Graiguenamanagh 3/4

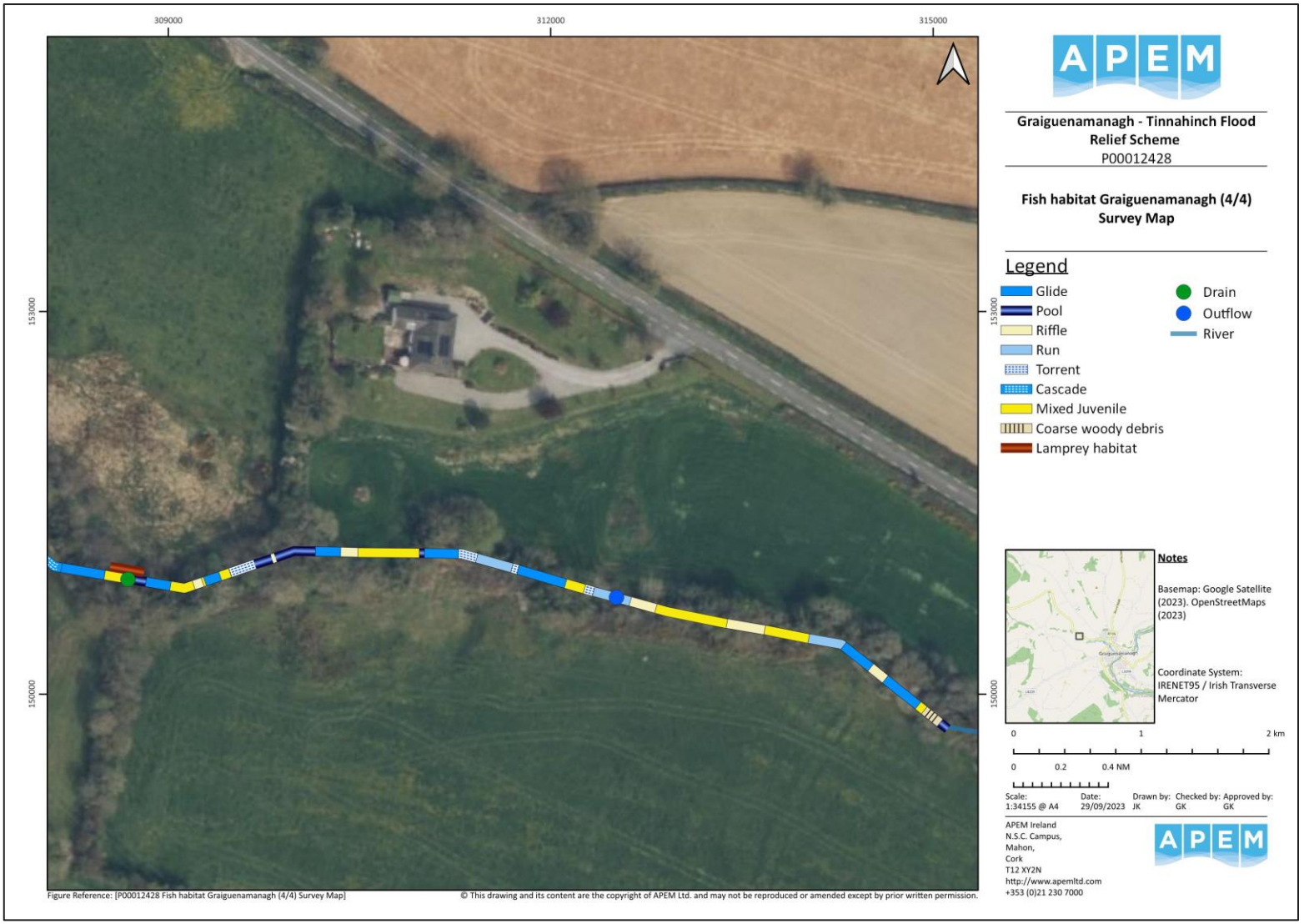

Figure 6 Fish habitats present at Graiguenamanagh 4/4

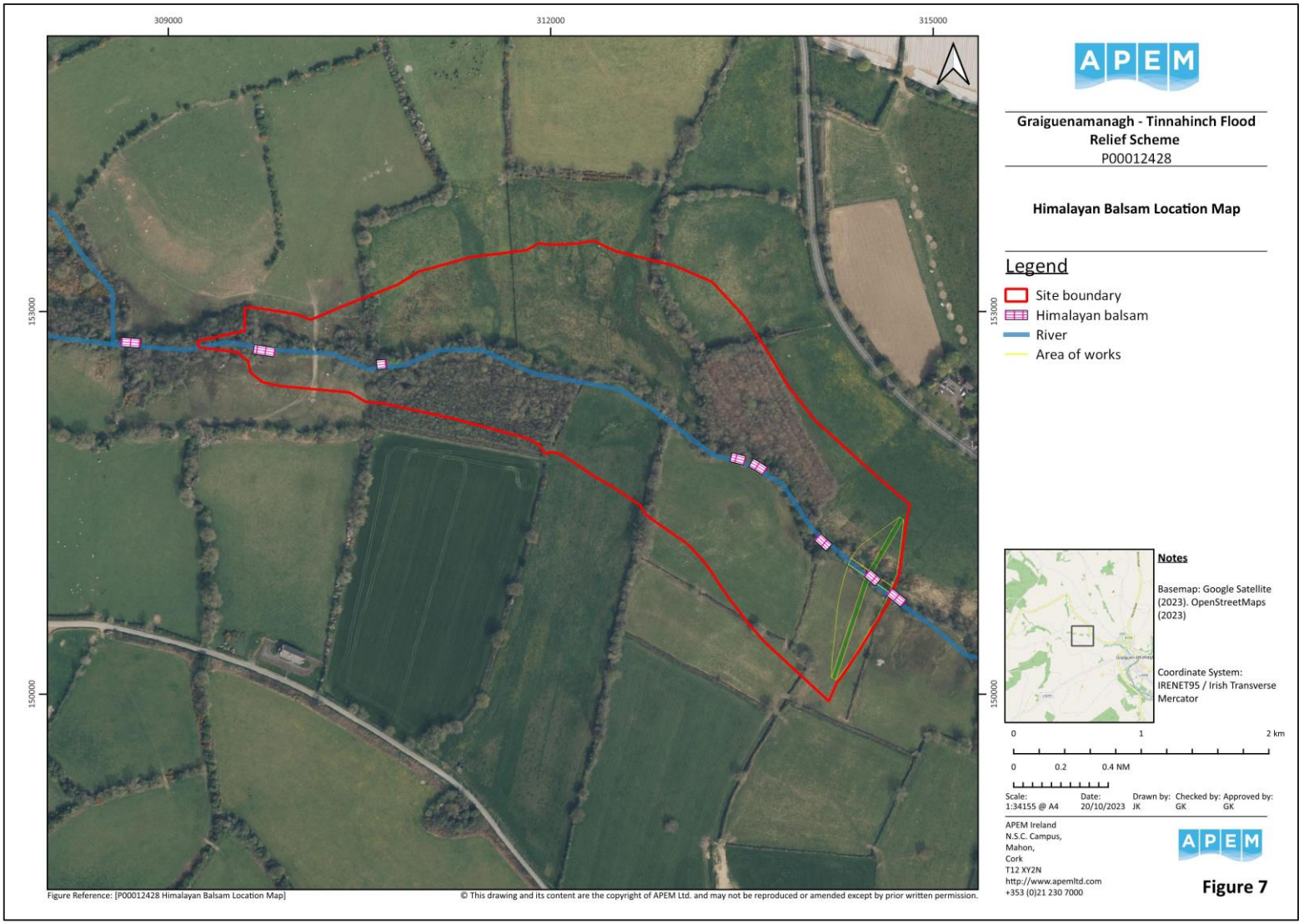

Figure 7 Dense stands of Himalayan Balsam present within and nearby the Site at Graiguenamanagh

Appendix B: Plates

Plate 1 Kick sample and water quality Site 1

Plate 2 Kick sample and water quality Site 2

Plate 3 Kick sample and water quality Site 3

Plate 4 Suitable lamprey habitat - 1

Plate 5 Suitable lamprey habitat - 2

Plate 6 Suitable lamprey habitat - 3

Plate 7 Suitable mixed juvenile salmonid habitat - 1

Plate 8 Suitable mixed juvenile salmonid habitat - 2

Plate 9 Suitable mixed juvenile salmonid habitat - 3

Plate 10 Suitable mixed juvenile salmonid habitat -4

Plate 11 Suitable mixed juvenile salmonid habitat - 5

Plate 12 Suitable mixed juvenile salmonid habitat with abundant crayfish refuges present

Plate 13 Suitable crayfish habitat - 1

Plate 14 Suitable crayfish habitat - 2

Plate 15 Potential spawning habitat - 1

Plate 16 Potential spawning habitat - 2

Plate 17 Crayfish traps in situ - 1

Plate 18 Crayfish traps in situ - 2

Plate 19 Himalayan balsam along the riverbank - 1

Plate 20 Himalayan balsam along the riverbank - 2

Plate 21 Land drain outflow - 1

Plate 22 Land drain outflow -2

Plate 23 Livestock access point with poaching

Appendix C: Description of Q Value Assessment and Taxa List

1 Q-Value Assessment

The EPA Q-value classification is assigned based on the assessment of a macroinvertebrate sample, which involves recording the taxa present at a suitable and attainable taxonomic resolution (under field conditions) and their categorical relative abundance determined using approximate counts (as described in Feeley *et al*., 2020). From this, the number of taxa present and categorical relative abundance of sensitive (Group A), less sensitive (Group B), tolerant (Group C), very tolerant (Group D) and most tolerant (Group E) taxa to organic pollution is examined. Additional Qualifying Criteria are also considered, consisting of recording the abundance of *Cladophora* spp, macrophytes, and slime growths / sewage fungus, as well as dissolved oxygen percent saturation and the level of substratum siltation. Then, based on the combination of number and relative abundance of the sensitive or tolerant groups present, a Q-value is assigned. Details on the assignment of the scores can be found in Toner *et al*., (2005).

In Ireland, macroinvertebrates are the main Biological Quality Element (BQE) determining the ecological status in rivers (required by the Water Framework Directive; WFD), based on the Q-value. The WFD requires BQE scores to be expressed as an Ecological Quality Ratio (EQR) to standardize and provide a common scale of ecological quality across participatory Member States using differing national methods. Intercalibration of the Q-value with the EQR and the corresponding ecological status are described in Table 0-1.

Table 0-1. EPA water quality status summary

Comparing the Q-value, ecological quality ratio (EQR), corresponding Water Framework Directive (WFD) status and pollution gradient resulting from anthropogenic pressures (Feeley et al., 2020).

Q value Score	EQR	Pollution Gradient	WFD Ecological Status
Q5	1.0	Unpolluted	High
Q4-5	0.9	Unpolluted	High
Q4	0.8	Unpolluted	Good
Q3-4	0.7	Slightly Polluted	Moderate
Q3	0.6	Moderately Polluted	Poor
Q2-3	0.5	Moderately Polluted	Poor
Q2	0.4	Seriously Polluted	Bad
Q1-2	0.3	Seriously Polluted	Bad
Q1	0.2	Seriously Polluted	Bad

2 Macroinvertebrate taxa and abundance recorded

Table 0-2. List of taxa and abundance recorded at each site during August sampling

Taxa	Group	Site 1	Site 2	Site 3
Ecdyonurus sp.	A		1	1
Rhithrogena sp.	A			1
Leuctra sp.	B	19		16
Agapetus sp.	B		2	
Glossosoma sp.	B			1
Goeridae	B			
Sericostomatidae	B	7		5
Limnephilidae	B	5	1	2
Baetis rhodanii	C		6	13
Serratella ignita	C	17	13	16
Hydropsyche sp.	C	10		6
Chimarra marginata	C	1		
Wormaldia sp.	C	6		
Philopotamus montanus	C	31		
Rhyacophila sp.	C	4	2	1
Elmidae	C	74	61	117
Chironomidae	C	19	4	55
Simuliidae	C	17	20	32
Pediciidae	C	8	19	14
Gammarus sp.	C	6	4	19
Ancylus fluviatilis	C			1
Lymnaeidae	C	1		
Ceratopogonidae		1	1	
Dixa sp.				1
Naididae		2		3
Lumbriculidae		3		2
Lumbricidae		1	9	2
Total number of individuals		232	143	308
Total number of taxa		19	13	20
Total number of Q value taxa		15	11	16

Appendix D: Fish habitat surveys

1. Salmonid habitat assessment

The principal instream physical habitat variables that determine suitability for juvenile salmonids are water depth, water velocity, streambed substratum and cover (Heggenes 1990). The habitat types and their descriptions are outlined in Table 0-1 and were recorded, where present, during the survey.

Table 0-1. Habitat classification system for salmonids

Habitat type	Description
Spawning Gravel	Ideally stable but not compacted, with a mean grain size 25 mm or less for trout, but up to 80 mm for salmon. 'Fines' (< 2 mm grain size) to be less than 20% by weight.
Fry (0+) habitat	Shallow, < 20 cm deep, fast flowing (> 30 cm/s), with surface turbulence and a gravel and cobble substrate
Parr (>1+) habitat	20 - 30 cm deep, fast flowing (>30 cm/s), surface turbulent, with gravel / cobble / boulder substrate.
Riffles	Shallow (< 30 cm deep), fast-flowing (> 50 cm/s), surface turbulent, gravel / cobble / boulder substrate.
Glides	= or > 30 cm deep, moderate velocity in range 10-30 cm/sec, surface smooth and unbroken, relatively even substrate of cobbles with finer material
Pools	= or > 40 cm deep, slow flowing (< 10 cm/s), surface unbroken, substrate with a high proportion of sand and silt.
Run	= or > 40 cm deep, moderate flow (>10 – 100 cm/s), broken surface. Often the interface between pool, glide and other habitats
Mixed Juvenile	10 - 30 cm deep, fast flowing (>30 cm/s), surface turbulent, with gravel /cobble / boulder substrate.

In addition to the habitats listed in Table 0-1, other features within the study site are noted including:

- The existence of physical barriers to fish migration which are graded 1-3 (G1 being impassable at Q90 flow conditions and G3 passable under Q90 flow conditions).
- Areas of excessive erosion which could cause siltation of spawning habitat- e.g., areas where cattle enter the river.
- Anthropogenic alterations to the channel which could affect fish migration.
- Areas which could cause difficulties for migrating or spawning individuals during periods of low water levels (e.g., shallow areas near weirs, spawning gravels etc.).
- Locations where branches cross the entire channel giving rise to tunnel vegetation.

2. Lamprey habitat assessment

The guidance published in JNCC (2015) was applied to lamprey habitat assessments. Our approach followed Natura 2000 guidance for the monitoring of river, brook and sea lamprey (*Lampetra fluviatilis, Lampetra planeri* and *Petromyzon marinus*; Harvey and Cowx 2003) and included assessment of habitats using visual mapping of substrates suitable for adult and Juvenile lamprey (Maitland 2003). The habitats suitable for lamprey spawning and larval lamprey (ammocoetes) are outlined in Table 0-2 and were recorded, where present, during the survey.

Table 0-2. Definitions of ecologically functional habitat types for lamprey
(based on Maitland 2003; Harvey & Cowx 2003)

Species / Life stage	Habitat Description
Lampetra spp. spawning	Areas of small stones and gravel in shallow flowing water
Petromyzon marinus spawning	Flowing water amid larger gravel/cobble
Lampetra spp. ammocoetes	Stable fine sediment or sand > 15 cm deep, low water velocity and the presence of organic detritus
Petromyson marinus ammocoetes	Non-marginal (open channel) sites of >1.5 m depth featuring fine sand and silt accumulations; lower velocity areas of pools and glide habitat

Appendix 10-11 Tree Survey Report 2024

ARBORICULTURAL REPORT

Location: -
Lands at Graiguenamanagh, Co. Kilkenny
& Tinnahinch, Co. Carlow

Prepared for: -
ByrneLooby Ltd.

Prepared by: -
Ethan Gannon 'Dip Arb L4 (ABC), ISA Cert Arb, Cert Hort L6 (QQI), TechArborA'

09th May 2025

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1.0 Introduction

1.1 In support of the environmental assessments being undertaken by ByrneLooby for the proposed Graiguenamanagh/Tinnahinch Flood Relief Scheme; Veon Ltd has been instructed to provide the following information in accordance with BS 5837:2012 Trees in Relation to Design, Demolition and Construction – Recommendations.

1. Tree Survey
2. Arboricultural Impact Assessment
3. Arboricultural Method Statement
4. Tree Constraints and Removal/Retention Plan

1.2 The OPW, working in partnership with Local Authorities, have concluded that a flood relief scheme would be viable and effective for the Graiguenamanagh/Tinnahinch communities. The flood defence measures proposed are currently being reviewed through project-level assessment and optioneering.

2.0 Limitations of Survey

2.1 The tree survey was conducted from ground level only, without the use of decay detection equipment. All findings, observations and recommendations are based on the knowledge and experience of the surveyor. Information contained in this report covers only those items that were examined and reflects the condition of those items at the time of the inspection. Trees are dynamic living organisms, whose health and condition can be subject to rapid change, depending on multiple external and internal factors. The conclusions and recommendations contained in this report relate to the trees at the time of inspection and its validity will diminish over time. Trees should be routinely assessed, particularly after storms.

3.0 Site Inspection & Methodology

3.1 The areas were assessed between the 23rd and 25th of May 2023, the 19th of December 2023 and the 15th November 2024. Trees were visually assessed from ground level and the findings from this assessment are in the Tree Survey in Appendix 1, along with the supporting tree survey form key and images of the surveyed trees. The Arboricultural data presented in the Tree Survey has been recorded in line with BS 5837:2012. The tree survey was conducted by collecting and assessing the following information on all significant trees located on site and proximal to the site.

- Tree number
- Tree species both common and scientific
- Dimensions (height, trunk diameter, crown spread, crown clearance, Root Protection Area)
- Age class
- Physiological condition

- Structural condition
- Preliminary recommendations
- Estimated remaining contribution within their present environment
- Retention category grade
- Ecological significance

3.1 Aluminium tags have been stapled to the trees at a height of 1.5m for identification purposes. Trees that were inaccessible for tagging, and Tree Groups or Tree Lines growing as one coherent unit have been numbered numerically i.e. Tree No. 1, Tree Group No. 1, Tree Line No. 1, respectively.

3.2 The Tree Constraints and Removal/Retention Plan has been created using ArcGIS mapping, with the maps provided in Appendix 3. These maps illustrate the five surveyed areas, with detailed descriptions available in Section 4, "Summary of Findings". The maps show tree positions, tag numbers, trees for removal (in red), trees for retention (in green) and Root Protection Areas (RPA). The Root Protection Area (RPA) constraint for each tree has been shown as a 'Light Blue Circle' and all proposed development should be positioned outside of the RPA of retained trees. The RPA is the minimum area around individual trees to be protected from disturbance during construction works; RPA is usually expressed as a radius in meters measured from the centre of the tree's stem.

3.3 The tree retention category has been assessed and categorised according to their quality and value within the existing context (BS 5837:2012 sec 4.5), and not in conjunction with any proposed development plans. In making this assessment, particular consideration was given to:
-Arboricultural Value – including health, structural form, life expectancy, species and its physical contribution to or effects on other features located on site.
-**Landscape Value** – an assessment of a tree's locality, including its contributions to other features as well as to the overall site.
-**Cultural Value** – additional contributions made such as conservation, historical, commemorative value.

3.4 The trees have been divided into one of the following categories, in accordance with the BS 5837:2012 cascade chart illustrated in Table 4 (Appendix 1). The classification process begins by determining whether the tree falls within the (U) category (unretainable), if not, then the process will continue by assuming that all trees are considered according to the criteria for inclusion in the high category (A). Trees that do not meet these strict criteria will then be considered for inclusion in the moderate category (B), and failing this, they will be allocated a low category (C).

3.5 The Arboricultural Impact Assessment in Section 5 describes how construction activities can impact trees, and it details the specific impacts the proposed works will have on the existing tree population.

3.6 The Arboricultural Method Statement (AMS) in Section 6 outlines appropriate control measures to protect trees and hedgerows during construction. This includes site investigation, preparation, clearance, demolition and post-development. Construction will proceed according to the AMS to safeguard retained trees, tree groups and hedgerows on and adjacent to the site.

4.0 Summary of Findings

4.1 The survey was divided into five areas.

4.2 Area 1 is where the upstream storage area is proposed, north-west of the towns (see Figure 1). It is the largest of the areas and it consists of agricultural grass fields that slope down to form a valley with the River Duiske which meanders through its centre. Mature hedgerows comprised of species such as hawthorn *(Crataegus monogyna),* blackthorn *(Prunus spinosa),* elder *(Sambucus nigra),* goat willow *(Salix caprea),* holly *(Ilex aquifolium)* and spindle *(Euonymus europaeus)* make up the boundaries between these fields, and mature trees including ash *(Fraxinus excelsior),* oak *(Quercus robur),* horse chestnut *(Aesculus hippocastanum),* sycamore *(Acer pseudoplatanus)* and alder *(Alnus glutinosa)* make up the upper canopies of these hedgerows. All the ash trees display symptoms of ash dieback – causal agent *Hymenoscyphus fraxineus*. The oak trees in this area hold the highest merit, the majority of which have been given Category A grades. There are also two semi-mature forestry plantations in this area comprised of ash *(Fraxinus excelsior),* oak *(Quercus robur),* beech *(Fagus sylvatica)* and alder *(Alnus glutinosa).*

Figure 1: Area 1 outlined in orange.

4.3 Area 2 is a grass field bounded by walls and fences, with a single mature hawthorn *(Crataegus monogyna)* and sycamore *(Acer pseudoplatanus)* towards the back (north) of the field (see Figure 2).

4.4 Area 3 is the trees along the planned defences at the beginning of the River Duiske, east of the Hub (see Figure 2). There are two mature oak trees *(Quercus robur*), a group of mature Lawson cypress' *(Chamaecyparis lawsoniana),* and a mature large leaved lime *(Tilia platyphyllos)* all close the bridge. There is also group of early mature trees between the river and the recreation area, species present include alder *(Alnus glutinosa)*, beech *(Fagus sylvatica)*, white willow *(Salix alba)*, wild cherry *(Prunus avium)* and hazel *(Corylus avellana).*

4.5 Area 4 is the trees adjacent to the planned embankment and raised ground behind Tinnahinch Quay (see Figure 2). This area is mainly a private garden, with four, self-set trees - a semi mature and early mature ash *(Fraxinus excelsior),* a semi mature sycamore *(Acer pseudoplatanus)* and a mature goat willow *(Salix caprea).* There is also a mixed species, mature woodland on the higher ground to the west of this area, separated by a retaining wall, the trees that make up the outer canopy formation of this woodland, and overhang Area 4, include ash *(Fraxinus excelsior),* western red cedar *(Thuja pilcata)* and larch *(Larix decidua).*

4.6 Area 5 is the trees along the planned raised defence wall adjacent to Tinnahinch Castle and the quay (see Figure 2). Significant trees in this area include a mature horse chestnut *(Aesculus hippocastanum*) and a mature sycamore *(Acer pseudoplatanus),* both located on the adjoining property side of the wall that runs parallel to the public walkway and river. Outside of this, in the overgrown scrub area to the south of the river, there is a mature white willow *(Salix alba)* and a group of semi mature alder *(Alnus glutinosa)* and white willows *(Salix alba)*. To the east of this area, but still along the quay, there is a group of three, mature, moderate quality, Category B, Lawson cypress *(Chamaecyparis lawsoniana)* trees and a mature, moderate quality, Category B, birch *(Betula pendula)* growing in a small grass area adjoining residences.

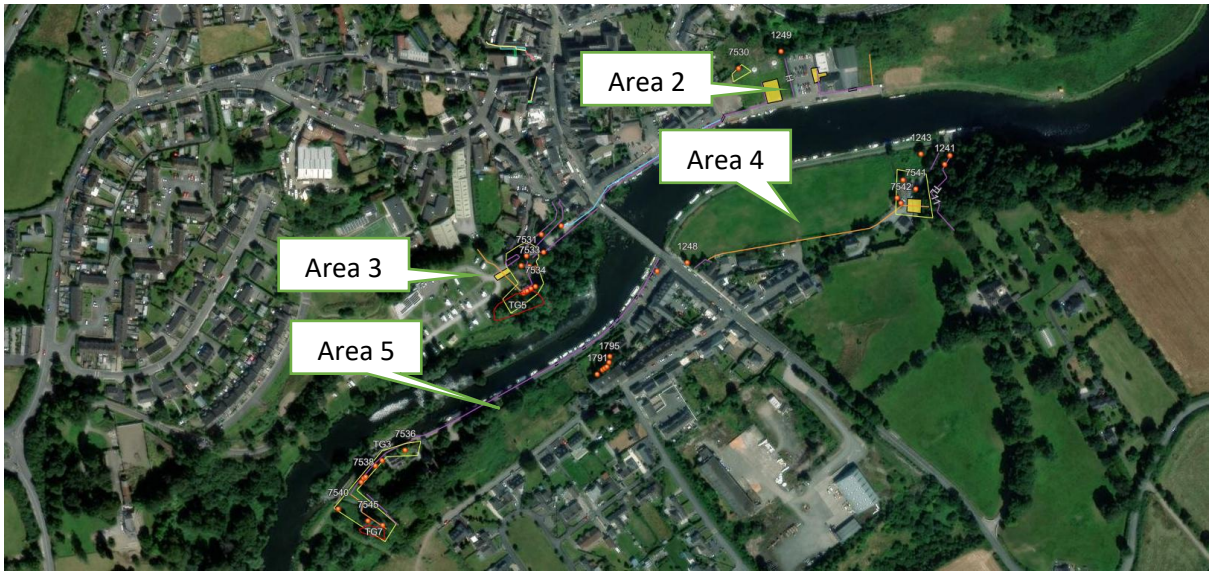


Figure 2: Overview of Town Areas Nos. 2-5 in their environs.

4.7 In total, 64 Trees were individually tagged, and 6 Trees, 8 Tree Groups, 15 Hedges, 2 Woodland Blocks and 13 Tree Lines were numbered numerically.

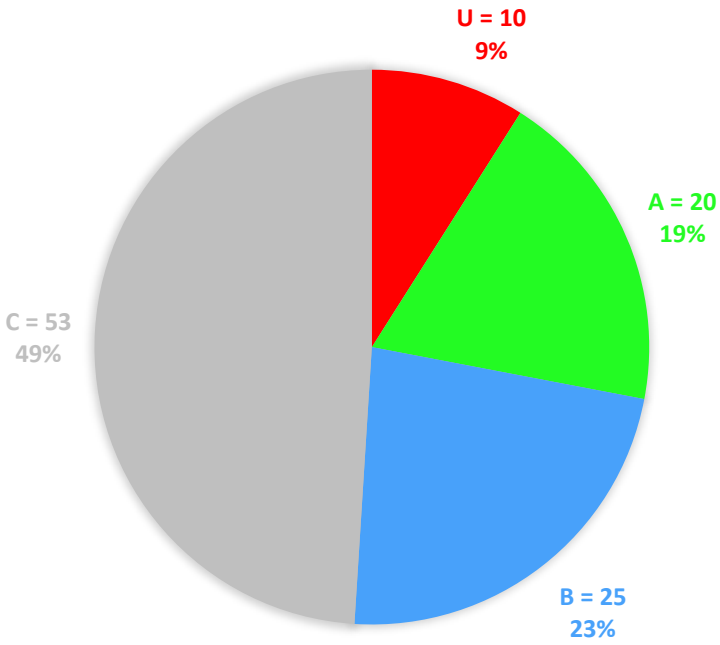


Figure 3: Category grade distribution of the surveyed trees (see Table 4 in Appendix 1 for category grade definitions). Note that tree groups, tree lines, woodland blocks and hedges have been assigned a single value in this figure - see Table 1 below for detailed breakdown of the category grade distribution.

Table 1: Category grade table of surveyed trees.

Category Grade	No. of Trees
Category U 8 Trees 2 Tree Lines	**Tree Nos.** 7519, 1253, 7526, T7, T4, 1241, 1242, 7537 **Tree Line Nos.** 11, 12
Category A 19 Trees 1 Tree Line	**Tree Nos.** 7503, 7504, 7505, 7506, 7508, 7509, 7510, 7515, 1251, 1252, 7524, 7527, T3, 7528, 7529, 7520, T2, 7531, 1243 **Tree Line No.** 6
Category B 21 Trees 1 Tree Line 3 Tree Groups	**Tree Nos.** 7507, 7512, 7513, 7518, 7523, 7521, T1, 1249, 7530, 7532, 7534, 7535, T5, 7543, 7536, 7538, 1791, 1792, 1793, 1794, 1796 **Tree Line No.** 9 **Tree Group Nos.** 1, 2, 5
Category C 22 Trees 15 Hedges 2 Woodland Blocks 9 Tree Lines 4 Tree Groups	**Tree Nos.** 7501, 7502, 7511, 7514, 7516, T6, 7525, 7522, 7533, 1244, 1245, 1246, 1247, 7541, 7542, 7544, 1248, 7539, 7540, 7545, 7546, 1795 **Hedge Nos.** 1A, 1B, 1C, 1D, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 **Woodland Block Nos.** 1, 2 **Tree Line Nos.** 1, 2, 3, 4, 5, 7, 8, 10, 13 **Tree Group Nos.** 3, 4, 6, 7517
Total = 70 Trees, 8 Tree Groups, 15 Hedges, 2 Woodland Blocks, 13 Tree Lines	

5.0 Arboricultural Impact Assessment

5.1 This proposed development will require the removal of the trees in Table 2. Note that Category U are poor-quality and therefore deemed unsuitable for retention.

Table 2: Tree removal table and their category grade.

Category Grade	No. of Trees
Category U 4 Trees 1 Tree Line	**Tree Nos.** 1253, 7519, 1797, T4 **Tree Line No.** 12
Category A 3 Trees	**Tree Nos.** 1251, 1252, 7531
Category B 7 Trees 1 Tree Group	**Tree Nos.** 7518, 7532, 7534, 7535, T5, 7543, 1796 **Tree Group No.** 2
Category C 9 Trees 1 Tree Group 4 Hedges 2 Tree Lines	**Tree Nos.** 7516, 7533, 1244, 1245, 1246, 1247, 1248, 7542, T6 **Tree Group No.** 7517 **Hedge Nos.** 1C, 1D, 11, 12 **Tree Line Nos.** 4, 5
Total = 23 Trees, 2 Tree Groups, 4 Hedges, 3 Tree Lines	

5.2 All the trees for retention will be proximal to the proposed construction works. It is therefore essential that tree protective fencing measures, as outlined in section 6.5 and Appendix 3, are adhered to protect trees from mechanical damage and impacts on the rhizosphere.

5.3 Services installation should utilise existing infrastructure and service routes to mitigate soil and root damage. All services must be routed outside retained trees Root Protection Area (RPA). No excavations or trenches are to be dug within a RPA as this can have massive impacts on tree health and stability. See section 6.11 and 6.12 for guidance on protecting trees from excavation and service installation.

5.4 New hard surfaces, such as paths, within a RPA must be avoided. Where this is not possible, No-Dig using cellular confinement systems will be used to raise ground levels and mitigate impacts on the rhizosphere. See section 6.10 for more details on working in a Construction Exclusion Zone (CEZ)

5.5 The overall impact the proposed development will have on the arboricultural assets is considered to be moderate to high. Tree loss compensation will therefore need to be negotiated between the developer and the local authorities involved in this flood relief scheme, to ensure compliance with their relative regulations.

6.0 Arboricultural Method Statement

6.1 This Arboricultural Method Statement provides information on how the trees will be protected throughout the construction phases. A copy of the Arboricultural Method Statement and Tree Constraints, Removal/Retention Plans will be retained in the site offices for reference. The protection of trees is divided into three stages:
Pre-Construction stage, Construction Works Stage, Post-Construction Stage.

6.2 Pre-Construction Works

6.2.1 The project arboriculturist will work with the design team to show how and where trees can be less impacted and how trees can have less impact on the proposal.

6.2.2 The design team will adjust the layout where practicable to reduce these impacts.

6.2.3 Any issues in relation to the trees on site will be discussed with the project arboriculturist and local authority prior to works being carried out.

6.3 Site Meetings

6.3.1 Prior to construction work, meetings will be necessary between the project arboriculturist, the development team and local authority, so that tree protection and trees for removal and retention can be agreed upon.

6.4 Tree Works

6.4.1 All tree works will be carried out prior to construction activity on site. The tree surgery contractor will be insured, qualified and have a method statement detailing how they will undertake the works required. The tree works will be in accordance with BS:3998 2010.

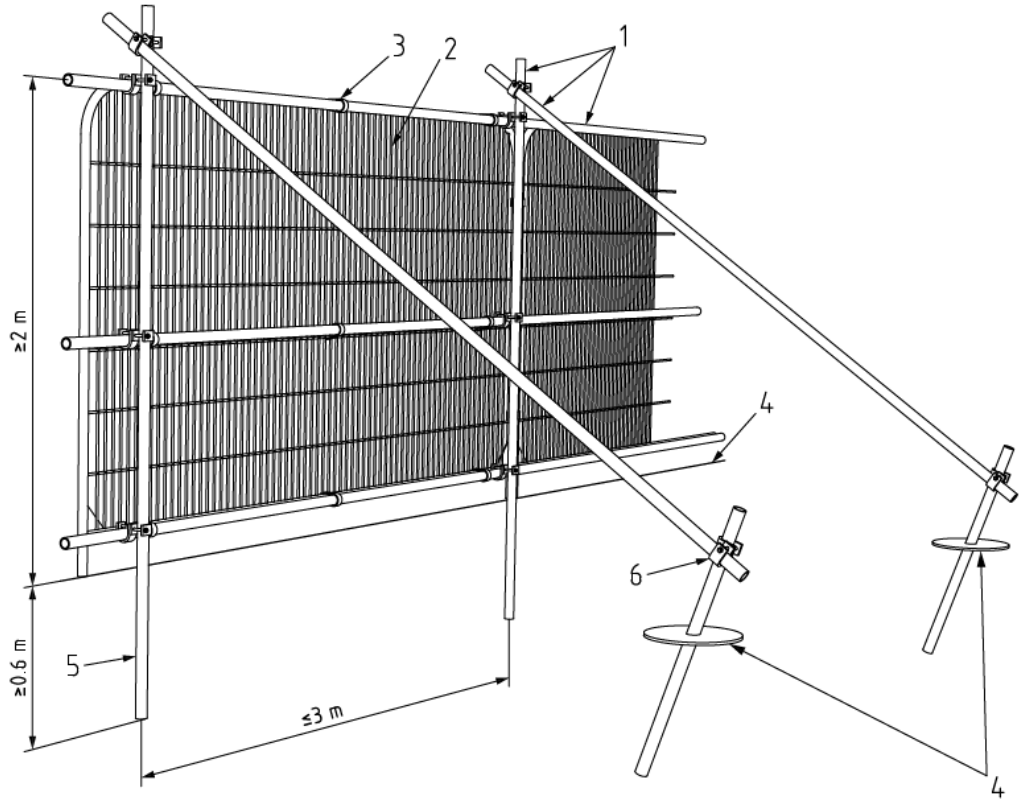
6.4.2 The removal of a tree will not cause damage to another tree or its surroundings. When stumps are to be removed or grinded using heavy machinery, any neighbouring tree's Root Protection Area (RPA) will be protected using ground guards or sheets of heavy-duty plywood butted together over a layer of compressible woodchip.

6.5 Tree Protective Fencing

6.5.1 When tree works are completed, the line of protective fencing will be erected outside of the Root Protection Area (RPA) – shown as a light blue on the Tree Constraints Plans and attached shapefiles. The area between the protective fencing and trees is the

Construction Exclusion Zone (CEZ), this zone is necessary to protect the tree, its RPA and areas for supplementary planting.

6.5.2 The fencing will be 2.3m high, with vertical and horizontal scaffold bars well braced together to resist impact. The verticals will be spaced out at a maximum interval of 3m and driven securely into the ground. Onto this, Heras fence panels will be securely fixed with scaffold clamps. In some instances, site hoarding can serve as tree protective fencing, but only upon approval by the project arboriculturist.



Key

1 Standard scaffold poles
2 Heavy gauge 2 m tall galvanized tube and welded mesh infill panels
3 Panels secured to uprights and cross-members with wire ties
4 Ground level
5 Uprights driven into the ground until secure (minimum depth 0.6 m)
6 Standard scaffold clamps

Figure 4: Tree Protective Fencing example using uprights driven into the ground.

6.5.3 All weather 'Keep Out' signs will be secured to the fences.

Figure 5: 'Keep Out' sign examples for tree protective fencing.

6.5.4 In some cases, stabiliser struts mounted on a block tray will be more practicable.

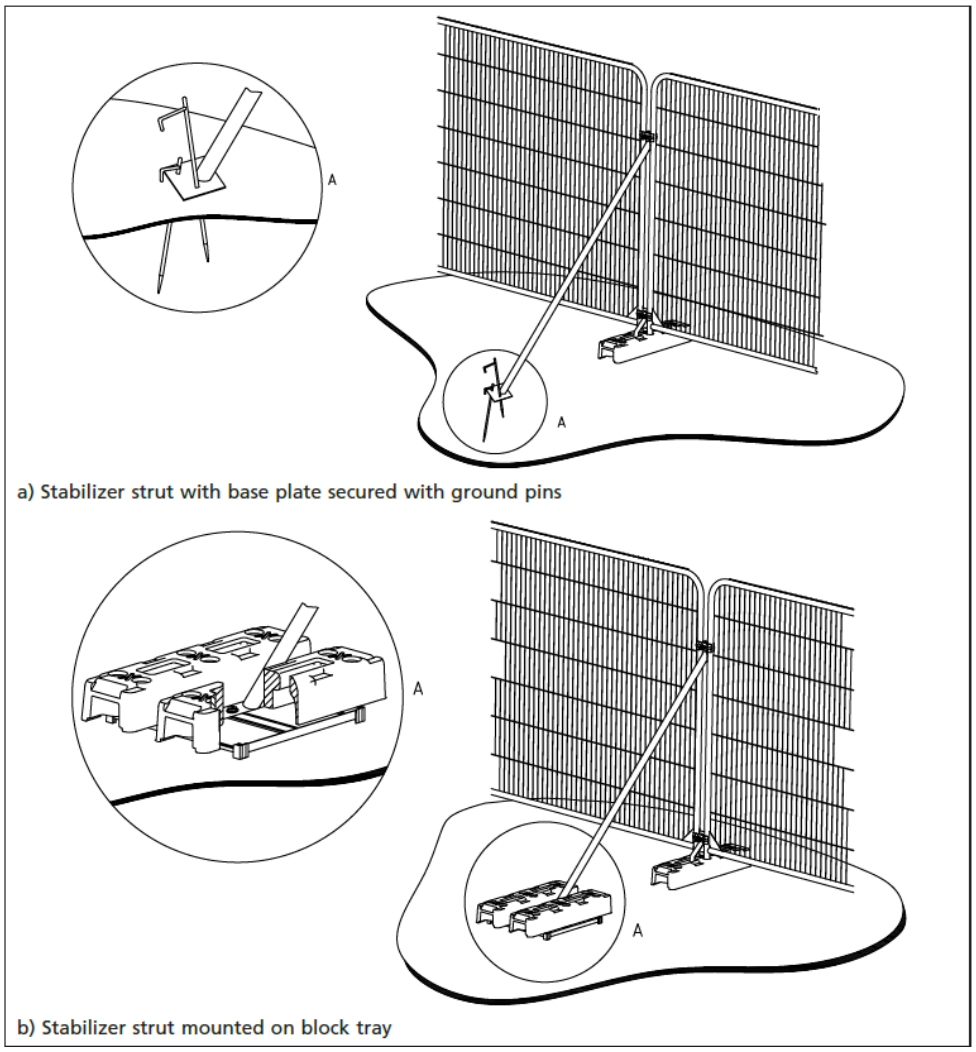


Figure 6: Tree Protective Fencing example using above ground stabilising units

6.5.5 Where space is limited for the installation of tree protective fencing, tree protective boxes (using timber frames and plywood) and ground protection will be used (see section 6.7 for ground protection details and 6.10 for working within a Construction Exclusion Zone).

6.6 Site access, storage of material, work yards and staff car parking

6.6.1 These areas will be a minimum of 10 metres away from trees and away from slopes.

6.6.2 Storage area will be clearly sign posted so that all personnel know where to store materials.

6.6.3 Materials will be stored in containers and/or on pallets with plastic coverings to prevent soil from getting compacted and/or contaminated.

6.7 Ground Protection

6.7.1 Where traffic is expected within in a Construction Exclusion Zone (CEZ), and it has been approved by the project arboriculturist, ground protection will be used to dissipate the vertical load and prevent soil contamination. The ground protection will be a three-dimensional cellular confinement system, such as 'Cell Web' (see step by step instructions for 'Cell Web' installation below).

Step 1

- Loose organic matter and woody vegetation will be removed carefully using hand tools.
- Undulating surfaces will be made using stone with no fines and it will not be compacted.

Step 2

- The non-woven, geotextile, fleece, separation filtration layer will be placed over the prepared ground surface, with dry joints overlapping by 300mm.

Step 3

- Constraints, such as treated timber or railway sleepers, will be placed along the edges to contain the fill material.

Step 4

- The cellular confinement system (Cell Web 150-200mm) will be placed over the geotextile layer and the cell walls will be pinned and anchored open for infilling.

Step 5

- The infill material, 20-40mm clean sharp stone, will be filled into the open cells of the Cell Web in a 'roll-out' fashion so that the machinery is driving on the filled Cell Web. The infill material will be compacted to the desired density.

Step 6

- The Cell Web will be slightly surcharged with 25mm of 40-20mm clean angular stone.

6.8 Construction Works Stage

6.8.1 Once works have commenced on site, the project arboriculturist will be informed of any planned works within the Construction Exclusion Zone, so that a suitable protection plan can be put in place.

6.8.2 The project arboriculturist will monitor the trees for any decline during the construction phase and make recommendations towards their health and safety as they arise.

6.9 Tree Protective Fencing

6.9.1 Throughout the construction phase, the tree protective fencing will remain in place, upright and rigid. It will be the main contractor's responsibility to check the fencing daily and have any faults immediately fixed.

6.9.2 Under no circumstances will the Construction Exclusion Zone (behind the Tree Protection Fencing) be used for the storage of equipment or materials.

6.10 Working within the Construction Exclusion Zone (CEZ)

6.10.1 The project arboriculturist will be consulted when works are to occur within the CEZ so that mitigation measures can be put in place e.g., ground guards or sheets of heavy-duty plywood butted together over a layer of compressible woodchip, or the use of three-dimensional cellular confinement systems (see section 6.7 for applying 3D cellular confinement systems).

6.10.2 Where tree protective fencing is to be temporarily taken down for works within the CEZ, it will be stored in a secure location outside of the CEZ, before being reinstated after the works.

6.10.3 Ground protection for temporary works within the CEZ will be applied from outside the CEZ working in the way ('roll-out' method) on a singular route, and from inside the CEZ working away from the tree when being removed, this will reduce the potential for soil compaction.

6.10.4 Temporary portable barriers will be positioned at the edge of the temporary ground protection area to prevent personnel from entering onto the unprotected soil.

6.10.5 All works will be carried out manually; no heavy machinery will be used within the CEZ.

6.10.6 Removal of structures and materials within a CEZ will be done manually using appropriate hand tools, such as a mattock, pneumatic breaker, shovel, wheelbarrow etc., if roots are encountered, the guidance in section 6.12.4 & 6.12.5 will be followed.

6.10.7 Where permanent surfaces are to be installed within a CEZ, No-Dig methods will be implemented, and finished surfaces will be porous to allow gas and water movement (see Figure 7).

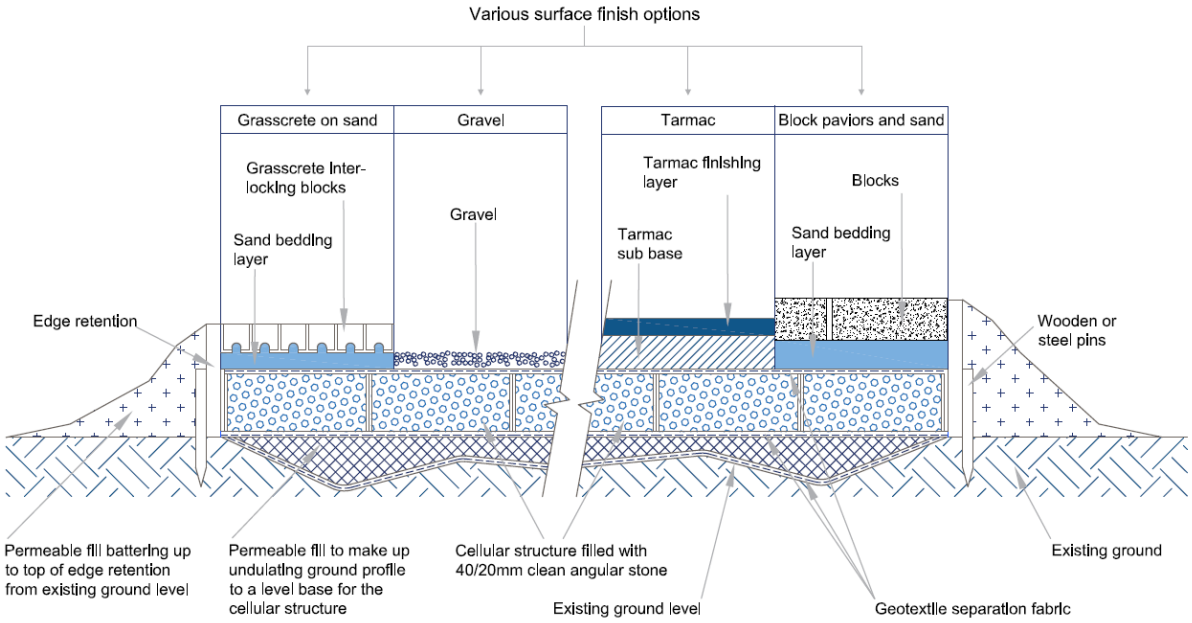


Figure 7: No-Dig, cellular confinement surface with examples of finishing options

6.11 Excavations

6.11.1 Excavations within a Root Protection Area (RPA) will be avoided where possible. Where this is not possible, it will be viewed on site by the development team, local authority and the project arboriculturist, so that any potential impacts can be assessed and mitigated.

6.11.2 Excavations for strip foundations in an RPA will be avoided, unless this is necessary to prevent flooding. Instead, specially engineered foundations such as piles or pads with above-ground beams will be used, localising excavation to just the pile or pad holes, allowing for water and gas exchange and avoiding roots first identified by site investigation.

6.11.3 Trial holes, using compressed air soil displacement (Air-Spade), or hand tools, will be made to a minimum depth of 600mm prior to installation, so that large roots (over 25mm diameter) are avoided.

6.11.4 Roots <25mm in diameter may be pruned back using sharp cutting tools, such as a secateurs or hand pruning saw, leaving as clean a wound as possible. Roots occurring in clumps or of 25mm diameter and over will only be severed following consultation with the project arboriculturist, as such roots might be essential to the tree's health and stability.

6.11.5 If roots are to be left exposed overnight or for longer, they will be covered with soil removed from the pit or with hessian sack (jute) to reduce frost damage or drying out; hessian sack will be kept moist in prolonged dry periods, and dry in freezing temperatures. Hessian sack will be removed before the area is backfilled.

6.11.6 Ground protection will be used when installing piles or pads within a RPA. e.g., ground guards or sheets of heavy-duty plywood butted together over a layer of compressible woodchip, or the use of three-dimensional cellular confinement systems (see section 6.7 for applying 3D cellular confinement systems). Gaps in the ground protection will be left for where the pile or pad is to be installed.

6.11.7 Where piling is to be installed near to trees, the smallest practicable pile diameter will be used, as this reduces the possibility of striking major tree roots and reduces the size of the rig required to sink the piles, which reduces the potential of soil compaction.

6.11.8 If the rig is expected to interfere with the tree's crown, then working space will be provided by facilitation pruning or temporarily tying back tree branches. Pruning or tying will be undertaken in accordance with a specification prepared by the project arboriculturist.

6.11.9 A sleeved bored pile or screw pile will be used to protect the soil and adjacent roots from the potentially toxic effects of uncured concrete.

6.12 Services

6.12.1 Services will be routed outside of the Root Protection Area (RPA) to avoid soil and root damage.

6.12.2 If routing underground services through the RPA is unavoidable, trenchless insertion methods will be implemented, with entry and retrieval pits outside of RPA (see trenchless examples in Table 3).

Table 3: Trenchless solutions for differing utility apparatus installation requirements

Method	Accuracy	Bore dia. [A)]	Max. sub. [B)] length	Applications	Not suitable for
	mm	mm	m		
Microtunnelling	<20	100 to 300	40	Gravity-fall pipes, deep apparatus, watercourse/ roadway undercrossings	Low-cost projects due to relative expense
Surface-launched directional drilling	≈100	25 to 1 200	150	Pressure pipes, cables including fibre optic	Gravity-fall pipes, e.g. drains and sewers [C)]
Pipe ramming	≈150	150 to 2 000	70	Any large-bore pipes and ducts	Rocky and other heavily obstructed soils
Impact moling [D)]	≈50 [E)]	30 to 180 [F)]	40	Gas, water and cable connections, e.g. from street to property	Any application that requires accuracy over distances in excess of 5 m

6.12.3 To avoid damage to roots when using trenchless insertion methods, the depth of the pit will be 750mm. Methods involving external lubrication of the equipment with materials other than water or vegetable oil (e.g. mineral oil, bentonite, etc.) will not be used when working within the RPA.

6.12.4 If the service route must pass through the RPA, it will be routed under the centre of the tree, where there are less roots.

6.12.5 If roots can be retained and protected, excavation using hand-held tools and pneumatic breakers may be acceptable for shallow service runs – feeding the services between and under roots and moving intact roots away from the working area where they are pliable. Root exposure and severance will follow the guidance in section 6.12.4 & 6.12.5.

6.12.6 Under no circumstances will heavy machinery be used to excavate open trenches within a RPA.

6.12.7 See National Joint Utilities Group (NJUG) Guidelines for the planning, installation and maintenance of utility apparatus in proximity to trees. Volume 4, Issue 2 London NJUG 2007 for more guidance.

6.13 Use of Cranes

6.13.1 If the use of cranes is expected to interfere with trees, then working space will be provided by facilitation pruning or temporarily tying back tree branches. Pruning or tying will be undertaken in accordance with a specification prepared by the project arboriculturist.

6.13.2 The smallest crane practicable will be used to prevent potential damage to trees and soil compaction. If there is a large crane on site, then it may be more prudent to move materials around trees from a far, as this will prevent soil compaction around trees.

6.13.3 To prevent damage to trees, a banksman will be used to direct the loads being lifted and there will be radio communication between the designated groundsmen and the crane operator.

6.14 Finished Ground Levels & Landscaping

6.14.1 The existing ground levels of the Root Protection Area (RPA) will be maintained and incorporated into the finished development. If the new ground level outside of the RPA is higher, then a retaining structure will be used to prevent water pooling around the tree.

6.14.2 No heavy machinery will be used within the RPA. Landscaping will be done manually and works within a RPA will follow the guidance in section 6.10.

6.14.3 Herbicide around retained trees will be avoided where possible, where this is not possible (such as when eradicating invasive species), direct, systemic applications will be applied to the target plant so that spray off is prevented; residual herbicides will not be used.

6.15 The following is a list of additional activities that are not allowed within a Construction Exclusion Zone or within the vicinity of the trees being retained:

6.15.1 Stockpiling of soil or rubble.

6.15.2 Washing of machinery.

6.15.3 Attaching notice boards, cables, or other services to any part of the tree.

6.15.4 Using neighbouring trees as anchor points.

6.15.5 Fires or burning of any kind.

6.15.6 Any action likely to cause waterlogging.

6.16 Post Construction Works

6.16.1 This development will not be considered complete until all retained trees have been re-examined by the project arboriculturist and he is satisfied that they can be safely integrated into the finished development.

Appendix 1
Tree Survey and Key

BS 5837 – Survey Form Key

Tag No: Tag stapled to tree for reference
Species: Both scientific and common name are provided
Stem diam: Stem diameter - diameter of the main stem in millimetres measured at 1.5m. This measurement forms the basis of the
Root Protection Area (RPA) calculation – that being the equivalent to a circle with a radius of 12 x the stem diameter
Crown spread: The radial spread of the crown from the centre of the tree, indicated at four cardinal points, **N**orth, **S**outh, **E**ast and **W**est.
C.Ht: The height of the first significant branch, measured in metres
C. Circa
A: Average
T: Tree, **TL:** Tree Line, **TB**: Tree Belt, **TG**: Tree Group, **H**: Hedge, **SB**: Shrub Border
LE: Life Expectancy of the tree in years
Age classes:
Young: In the first fifth of its life expectancy
Semi-Mature: In the second fifth of its life expectancy
Early-Mature: In the third fifth of its life expectancy
Mature: In the penultimate fifth of its life expectancy, reached maximum height
Over-Mature: In the final fifth of its life expectancy, in natural decline
Dead wood diameter sizes:
Small: <50mm
Medium: Between 50 – 100mm
Large: >100mm
Phys Cond: Physiological condition, an assessment of the tree's overall health –
Good: Good vitality e.g., healthy foliage or buds, crown density is consistent with that of the species
Fair: Low vitality e.g., sparseness of foliage or buds
Poor: Poor vitality e.g., dieback of foliage or shoot development, disease affecting growth.
Dead: The tree is dead
Struc Cond: Structural condition, noting any structural defects –
Good: No major structural defects observed (possibly some minor defects)
Fair: Minor defects present, such as bark wounds and isolated decay pockets, structure affected due to overcrowding and is dependent on group structure
Poor: Major structural defects present such as extensive dead wood, decay cavities affecting stability, splitting or cracking at unions
Preliminary Recommendations: Any initial work requirements in terms of sound arboricultural practice, irrespective of proposed works
Cat.: Category grade in terms of quality and value (Table 4)

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
WB1	**ash, alder, goat willow, birch, sycamore, hazel**	Semi-Mature	14	140	2	2	2	2	1	7	Fair	Fair	Dominant species is ash and oak with abundant alder present. Ash trees in decline from ash dieback with a lot already dead. Understory of hazel and goat willow. Forest is un-thinned.	It requires no works at present.	Distinct ecosystem	20+	C2	The northern periphery trees could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood extent is reached.	Retain
TG1	**alder** *Alnus glutinosa*	Mature	17	300	4	4	2	2	2	8	Good	Good	A group of trees with a combined canopy formation. Cattle are grazing in this area.	Cordon off area from cattle to prevent soil being poached.	It forms part of the ecological corridor in this area.	20+	B2	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood extent is reached.	Retain
TL1	**ash, sycamore**	Mature	15	280	3	3	3	3	2	8	Poor	Fair	Line of mainly ash with some sycamore trees growing on the northern side of the river. The ash trees are in decline from ash dieback. They have combined	They require no works at present	They form part of the ecological corridor in this area.	10+	C3	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood extent is reached.	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													group canopy formation.						
H2	**goat willow, hawthorn, gorse, spindle, dog-rose**	Mature	4	280	NA	NA	3	3	0	3	Fair	Fair	It extends north to south and makes up the boundary between two fields. It receives no maintenance. Reinforced by fence.	It requires no works at present.	Ecological corridor.	NA	C2	No impacts expected.	Retain
TL2	**ash** *Fraxinus excelsior*	Mature	16	330	3	3	4	4	2	3	Poor	Poor	A line of ash trees making up the upper canopy of H2. They are all in decline from ash dieback.	They require no works at present. Retain for ecological value.	Bat roost potential as the trees die from ash dieback and cavities develop.	10+	C3	No impacts expected.	Retain
7501	**ash** *Fraxinus excelsior*	Mature	16	810	5	5	5	5	3	9.7	Poor	Fair	Large tree growing out of the hedgerow bank. Minor symptoms of ash die back. Ivy is in mid crown	It requires no works at present. Retain for ecological value.	Bat roost potential as the tree dies from ash dieback and cavities develop. Ivy could form nesting potential and is a food source for birds.	10+	C3	No impacts expected.	Retain
7502	**ash** *Fraxinus excelsior*	Mature	17	400	5	4	5	5	3	4.8	Poor	Poor	Growing out of H2. It is in decline from ash die back.	It requires no works at present. Retain for ecological value.	Bat roost potential as the tree dies from ash	<10	C3	No impacts expected.	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													Bark included junction at 2m.		dieback and cavities develop.				
7503	**oak** *Quercus robur*	Early Mature	15	640	2	5	6	3	2	7.7	Good	Fair	It is growing out of H2. It was originally twin stemmed from near base, but one limb has failed, leaving a large wound that is susceptible to decay. Ivy is in mid crown.	It requires no works at present.	Decay cavity has bat roost potential. Ivy could form nesting potential and is a food source for birds.	40+	A2	No impacts expected.	Retain
7504	**oak** *Quercus robur*	Early Mature	13	410	4	4	6	4	3	4.9	Good	Fair	It is growing out of H2. Bark wounds at 0.5 m on eastern side. Ivy is in mid crown.	It requires no works at present.	Bat roost potential at bark wound. Ivy could form nesting potential and is a food source for birds.	40+	A2	No impacts expected.	Retain
H1A	**goat willow, hawthorn, ash, sycamore, gorse, holly, dog-rose**	Mature	5	280	4	4	NA	NA	0	3	Fair	Fair	It extends east to west and makes up the boundary between a number of fields. Double sided hedge, growing on either side of the river, this section is on northern side. It	It requires no works at present.	Ecological corridor.	NA	C2	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													receives no maintenance. Ash trees in decline from ash dieback.					extent is reached	
H1B	**goat willow, alder, hawthorn, ash, sycamore, gorse, holly, dog-rose**	Mature	5	280	4	4	NA	NA	3	3	Fair	Fair	It extends east to west and makes up the boundary between a number of fields. Double sided hedge, growing on either side of the river, this section is on southern side. It receives no maintenance. Ash trees in decline from ash dieback	It requires no works at present.	Ecological corridor.	NA	C2	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood extent is reached	Retain
H3	**hawthorn** *Crataegus monogyna*	Semi-Mature	2	180	1	NA	NA	1	0	3	Good	Fair	A relatively newly planted hedge extending east to west, making up the boundary between two fields.	It would benefit from trimming to improve hedge structure	Ecological corridor.	NA	C2	No impacts expected.	Retain
7505	**oak** *Quercus robur*	Early Mature	14	600	5	6	5	6	3	7.2	Fair	Fair	It is growing out of H1. Minor decay cavity at base on western side. Bark included junction at 1 m on northern side. Broken branch at	It requires no works at present.	Bat roost potential at broken branch.	40+	A2	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													2 m on western side.					extent is reached.	
7506	**oak** *Quercus robur*	Mature	18	940	#	7	10	12	3	11	Fair	Fair	It is growing out of H1. Broad spreading crown. Birds nest at 16 m on northern side. Limb failure at 12 m on northern side. Crown appears to be retrenching.	It requires no works at present.	Birds nest in crown. Bat roost potential at broken limb.	40+	A2	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood extent is reached.	Retain
7507	**horse chestnut** *Aesculus hippocastanum*	Early Mature	12	600	4	4	4	3	2	7.2	Good	Good	It is growing out of H1A. It is multiple stemmed from base and shares a canopy with some of the taller trees in H1.	It requires no works at present.	Food source for wildlife	20+	B1	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood extent is reached.	Retain
H4	**goat willow, hawthorn, blackthorn, sycamore, gorse, holly, dog-rose, yew, honeysuckle, oak, ash**	Mature	7	300	NA	NA	4	4	0	3	Fair	Fair	It extends north to south, and it makes up the boundary between two fields. There is a c.2m open wet drainage ditch on its eastern side. It receives no maintenance.	It requires no works at present.	Ecological corridor.	NA	C2	No impacts expected.	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
7508	**oak** *Quercus robur*	Mature	12	620	2	6	9	3	3	7.4	Fair	Fair	It makes up the outer canopy formation of WB2 and has an asymmetrical crown orientated to the west because of this.	It requires no works at present.	Food source for wildlife	40+	A2	No impacts expected.	Retain
7509	**oak** *Quercus robur*	Mature	16	630	4	7	6	5	3	7.6	Fair	Good	It makes up the outer canopy formation of WB2. Broken branch at 1 m on western side.	It requires no works at present.	Bat roost potential in broken branch at 1m.	40+	A2	No impacts expected.	Retain
7510	**oak** *Quercus robur*	Mature	16	660	7	7	7	5	3	7.9	Fair	Good	It makes up the outer canopy formation of WB2. Dead branches at 3 m on southern inside. 30% die back of foliage in its crown.	It requires no works at present.	Bat roost potential in dead branch at 3m.	40+	A2	No impacts expected.	Retain
7511	**ash** *Fraxinus excelsior*	Early Mature	13	290	3	3	3	3	5	3.5	Poor	Poor	It is growing out of H4 and is in advanced decline from ash dieback	It requires no works at present. Retain for ecological value.	Bat roost potential as the tree dies from ash dieback and cavities develop.	<10	C3	No impacts expected.	Retain
TL3	**ash** *Fraxinus excelsior*	Mature	16	400	5	5	4	4	2	2	Poor	Poor	Line of ash trees growing out of H4. They are all in decline from ash dieback, with	It requires no works at present. Retain for ecological value.	Bat roost potential as the trees die from ash dieback and	10+	C3	No impacts expected.	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													evidence of branch and limb failure already.		cavities develop.				
7512	**sycamore** *Acer pseudoplatanus*	Mature	14	500	5	4	5	5	3	6	Good	Good	It is growing out of H4, and it is twin stemmed from base with ivy extending into its mid crown.	It requires no works at present.	Ivy has value as a food source and nesting potential as it develops	20+	B1	No impacts expected.	Retain
7513	**oak** *Quercus robur*	Mature	13	620	5	4	4	6	3	7.4	Fair	Fair	It is growing out of H4, dieback is developing in the western side of its crown.	It requires no works at present.	Bat roost potential if dead wood continues to develop	20+	B1	No impacts expected.	Retain
7514	**ash** *Fraxinus excelsior*	Early Mature	13	200	2	3	4	1	3	2.4	Poor	Poor	It is growing out of H4, and is in decline from ash dieback	It requires no works at present. Retain for ecological value.	Bat roost potential as the tree dies from ash dieback and cavities develop.	<10	C3	No impacts expected.	Retain
7515	**oak** *Quercus robur*	Semi-Mature	8	300	4	4	4	4	3	3.6	Good	Good	It is growing out of H4, and it is has the potential to form part of the long-term tree cover in this area.	It requires no works at present.	Food source	40+	A1	No impacts expected.	Retain
H5	**goat willow, hawthorn, gorse, dog-rose**	Mature	7	280	4	4	NA	NA	0	3	Fair	Fair	It extends east to west and makes up the boundary between the woodland and two and two adjoining fields. There is a	It requires no works at present.	Ecological corridor.	NA	C2	No impacts expected.	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													c.0.5m open drainage ditch on its northern side						
WB2	**oak, beech, ash, willow, holly**	Semi-Mature	18	180	3	3	3	3	1	8	Fair	Fair	30-year-old thinned forest. Mostly oak and beech with ash and holly regrowth understory. Wet soil conditions with some windblow already. Mound drains full of water already.	If area is going to be used as flood relief. No more thinning should occur.	Distinct ecosystem	40+	C2	The southern periphery trees could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood extent is reached	Retain
7516	**alder** *Alnus glutinosa*	Semi-Mature	9	390	4	3	3	4	1	0	Good	Good	Twin stemmed from near base	It requires no works at present.	Food source for wildlife	20+	C1	It will need to be removed to facilitate the water flow control structure.	Remove
TL5	**alder, ash**	Mature	11	200	4	4	4	4	2	0	Fair	Fair	Trees growing along riverbank with combined canopy formation. Ash trees in decline from ash dieback, some are dead already.	They require no works at present.	It forms part of the ecological corridor.	10+	C3	They will need to be removed to facilitate the flow control structure.	Remove
TG 7517	**alder** *Alnus glutinosa*	Early Mature	13	300	4	4	4	4	2	0	Good	Fair	A group of alder stems growing on	They require no works at present.	They form part of the	20+	C2	It will need to be removed to	Remove

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													the southern side of the river with a combined group canopy formation		ecological corridor along this hedgerow			facilitate the flow control structure.	
7518	**oak** *Quercus robur*	Semi-Mature	9	180	3	3	3	3	1	0	Good	Good	Located on the southern side of riverbank.	It requires no works at present.	Food source for wildlife.	40+	B1	It will need to be removed to facilitate the water flow control structure.	Remove
7519	**ash** *Fraxinus excelsior*	Early Mature	13	300	3	3	3	3	3	0	Poor	Poor	It advanced decline from ash dieback	It will need to be removed if this area comes into active use.	Bat roost potential as the tree dies from ash dieback and cavities develop.	<10	U	It will need to be removed to facilitate the water flow control structure.	Remove
TL4	**alder** *Alnus glutinosa*	Early-Mature	13	300	3	3	3	3	2	0	Fair	Fair	A line of alders growing on the northern side of the river. They have a combined group canopy formation.	They require no works at present.	It forms part of the ecological corridor.	20+	C2	It will need to be removed to facilitate the flow control structure.	Remove
H1C	**goat willow, hawthorn, holly, dog-rose**	Mature	5	280	4	4	NA	NA	0	0	Fair	Fair	It extends east to west and makes up the boundary between a number of fields. Double sided hedge, growing on either side of the river. It	It requires no works at present.	Ecological corridor.	NA	C2	It will need to be removed to facilitate the flow control structure.	Remove

Tree Survey																			
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													receives no maintenance.						
H1D	**goat willow, hawthorn, holly, dog-rose**	Mature	5	280	4	4	NA	NA	0	0	Fair	Fair	It extends east to west and makes up the boundary between a number of fields. Double sided hedge, growing on either side of the river. It receives no maintenance.	It requires no works at present.	Ecological corridor.	20+	C2	It will need to be removed to facilitate the flow control structure.	Remove
TL12	**ash** *Fraxinus excelsior*	Early-Mature	11	380	2	3	3	2	2	0	Poor	Fair	Line of trees in decline from ash dieback	Remove but leave 3m stumps for ecological value	Food source for wildlife	<10	U	It will need to be removed to facilitate the proposed works.	Remove
TL13	**alder** *Alnus glutinosa*	Early-Mature	15	430	4	4	4	4	2	0	Good	Good	Ivy on main stems. They form the upper canopy of the hedgerow	Ivy will require severing when it suppresses its crown	Food source for wildlife	20+	C2	May suffer root damage during construction	Retain
T6	**alder** *Alnus glutinosa*	Early Mature	14	420	2	4	4	3	2	0	Good	Good	Ivy in upper crown	Ivy will require severing when it suppresses its crown	Food source for wildlife	20+	C2	It will need to be removed to facilitate the proposed works.	Remove
H11	**dog-rose, hawthorn, bramble, blackthorn, gorse, holly**	Semi-Mature	3	100			1	1		0	Good	Fair	It extends north to south and makes up the boundary between two fields.	It requires no works at present.	Ecological corridor.	_	C2	It will need to be removed to facilitate the water storage structure	Remove

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
1251	**oak** *Quercus robur*	Early Mature	12	450	5	5	5	5	2	0	Good	Good	Growing out of H11. Symmetrical crown. Ivy in mid crown.	Ivy will require severing when it suppresses its crown	Food source for wildlife	40+	A1	It will need to be removed to facilitate the proposed works.	Remove
1252	**oak** *Quercus robur*	Early Mature	12	460	5	5	5	5	2	0	Good	Good	Growing out of H11. Symmetrical crown. Ivy in mid crown.	Ivy will require severing when it suppresses its crown	Food source for wildlife	40+	A1	It will need to be removed to facilitate the proposed works.	Remove
1253	**ash** *Fraxinus excelsior*	Early Mature	10	380	3	2	3	3	2	0	Poor	Poor	It is in advanced decline from ash dieback	Remove	Food source for wildlife	<10	U	It will need to be removed to facilitate the proposed works.	Remove
7523	**horse chestnut** *Aesculus hippocastanum*	Early Mature	13	400	5	5	5	5	1	4.8	Good	Fair	Located on the riverbank. Bark included junction from 1 m.	It requires no works at present.	Ivy has ecological value as a food source and nesting potential	40+	B1	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood extent is reached.	Retain
7524	**oak** *Quercus robur*	Mature	14	500	4	4	4	3	1	6	Fair	Fair	It is growing up and out of the riverbank on the southern side.	It requires no works at present.	Lichen growth is present, and it has value as a food source	40+	A2	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
																		extent is reached.	
7525	**alder** *Alnus glutinosa*	Mature	16	350	3	3	3	3	3	4.2	Fair	Good	20% die back of foliage in crown, potentially Phytophthora disease. Ivy in upper crown.	It requires no works at present.	Ivy has value as a food source and for nesting	10+	C1	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood extent is reached.	Retain
7526	**ash** *Fraxinus excelsior*	Mature	14	380	3	3	3	3	2	4.6	Poor	Poor	It is in advance decline from ash dieback	It will need to be removed if this area comes into active use.	Bat roost potential as dead wood develops due to ash dieback.	<10	U	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood extent is reached.	Retain
7527	**oak** *Quercus robur*	Mature	14	800	5	6	5	6	3	9.6	Good	Fair	It is growing out of the hedgerow on the southern side of the river. There is some naturally suppressed dead wood in its crown.	It requires no works at present.	Bat roost potential at broken branch.	40+	A2	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood extent is reached.	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
T3	**oak** *Quercus robur*	Mature	14	500	4	4	5	3	1	0	Fair	Fair	It is located on the southern side of the riverbank. There is a broken branch at 1 m on the southern side.	It requires no works at present.	Bat roost potential at broken branch.	40+	A2	No impacts expected.	Retain
7528	**oak** *Quercus robur*	Mature	15	500	4	4	3	5	1	0	Good	Fair	Oak within hedgerow along southern side of riverbank. It has a combined group canopy formation with the neighbouring tree line.	It requires no works at present.	Ivy has value as a food source and for bird nesting.	40+	A2	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood extent is reached.	Retain
7529	**oak** *Quercus robur*	Mature	18	610	6	5	4	5	4	0	Good	Good	Oak tree within hedgerow along southern side of riverbank. It has a combined group canopy formation with the neighbouring tree line. Ivy is in upper crown. Invasive Himalayan balsam around base and on opposite side of river	Remove invasive Himalayan balsam from this area.	Ivy has value as a food source and for nesting potential	40+	A2	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood extent is reached.	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
H6	**ash, dog-rose, hawthorn, bramble, blackthorn**	Semi-Mature	1	100	NA	NA	1	1	0	3	Good	Fair	It extends north to south and makes up the boundary between two fields. I suspect it was once a larger hedge that has been heavily cut back. It's growing out of raised bank	It requires no works at present.	Ecological corridor.	NA	C2	No impacts expected.	Retain
7520	**oak** *Quercus robur*	Semi-Mature	9	360	4	4	4	5	2	4.3	Good	Good	Growing out of the hedgerow. Potential to form part of the long-term tree cover in this area.	It requires no works at present.	Food source for wildlife	40+	A1	No impacts expected.	Retain
H7	**honeysuckle, goat willow, gorse, hawthorn, dog-rose, elder**	Semi-Mature	1	280	1	1	NA	NA	0	3	Good	Good	It extends east to west and makes up the boundary between two fields. It is a well-structured hedge that receives regular trimming. There is a 0.5 metre drainage ditch on its northern side. It's growing out of a raised bank.	It requires no works at present.	Ecological corridor.	NA	C2	No impacts expected.	Retain
7521	**goat willow** *Salix caprea*	Mature	9	580	5	5	5	5	1	7	Good	Fair	Twin stemmed from base. Bark included junction in one stem. Ivy is	It requires no works at present.	Ivy has value as a food source and for bird	20+	B1	No impacts expected.	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													extending into mid crown. Some broken branches in lower crown on southern side.		nesting. There will be bat roosting potential if the dead wood develops on the southern side of lower crown.				
7522	**ash** *Fraxinus excelsior*	Semi-Mature	8	200	3	3	3	3	2	2.4	Poor	Fair	It is growing out of the hedgerow. It has symptoms of ash die back.	It requires no works at present. Retain for ecological value.	Ivy has value as a food source and for bird nesting. Bat roost potential as the tree dies from ash dieback and cavities develop	<10	C3	No impacts expected.	Retain
H8	**goat willow, gorse, hawthorn, holly, elder, rowan, honeysuckle**	Mature	6	300	NA	NA	4	4	0	3	Fair	Fair	It extends north to south and makes up the boundary between two fields. It is growing out of a raised bank. C.1m deep, open, wet drainage ditch on its western side	It requires no works at present.	Ecological corridor.	NA	C2	No impacts expected.	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
TL6	**oak** *Quercus robur*	Mature	20	700	9	9	9	9	2	10	Good	Fair	Line of mature oaks with a combined group canopy formation. Some naturally suppressed dead wood in their lower crowns and Ivy is extending into their mid crowns.	It requires no works at present.	It forms part of the ecological corridor.	40+	A2	No impacts expected.	Retain
T1	**oak** *Quercus robur*	Mature	15	600	4	6	4	5	3	7.2	Poor	Poor	Large dead wood developing in its crown. Growing out of the hedgerow.	It requires no works at present.	Bat roost potential as dead wood continues to develop.	40+	B2	No impacts expected.	Retain
TL7	**alder, ash**	Early-Mature	14	350	4	4	3	3	2	7	Fair	Fair	Line of alder and ash trees making up the upper canopy of H1B. Ash trees are in decline from ash die back.	It requires no works at present.	It forms part of the ecological corridor.	10+	C2	It could suffer root asphyxiation if the 1% Annual Exceedance Probability baseline flood extent is reached	Retain
H9	**goat willow, hazel, rowan, hawthorn, holly, dog-rose, oak,**	Mature	5	280	NA	NA	3	3	0	3	Fair	Fair	It extends north to south and makes up the boundary between two fields. It's growing	It requires no works at present.	Ecological corridor.	NA	C2	No impacts expected.	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
	elder, blackthorn												out of a raised hedgerow bank.						
T2	**oak** *Quercus robur*	Mature	15	650	6	6	7	6	2	7.8	Good	Good	Prominent tree. Ivy in upper crown.	It requires no works at present.	Ivy could form nesting potential and is a food source for birds.	40+	A2	No impacts expected.	Retain
1797	**ash** *Fraxinus excelsior*	Early Mature	12	680	6	4	5	5	2	0	Fair	Fair	Growing from the hedgerow. Minor symptoms of ash dieback. Overhangs the public road to the north.	Cut into the hedge and maintain as hedge bulking	Food source for wildlife.	<10	U	It requires removal to facilitate access gate and road	Remove
H12	**elder, dog-rose, bramble, hawthorn**	Mature	2		2	1					Fair	Fair	It extends east to west and forms the boundary between the public road (R703) to the north and the adjoining field to the south. Located next to T7. It is a small section of a long hedgerow	It requires no works at present.	Ecological corridor	10+	C2	This small section needs to be removed to facilitate access gate and road to the uphill water control structure	Remove
1249	**sycamore** *Acer pseudoplatanus*	Mature	17	900	6	4	7	4	2	11	Good	Good	Group of stems that may have suffered root damage during the installation of	Ivy will require severing when it suppresses its crown	Ivy in crown	40+	B2	No impacts expected.	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													the footpath. Ivy is in mid crown.						
H10	***Cornus alba***	Early-Mature	2	180			1	1			Good	Good	Ornamental hedge extending north to south – makes up the boundary between the field and the car park	Continue to maintain through regular trimming	Ecological corridor	10+	C2	None expected	Retain
7530	**hawthorn** *Crataegus monogyna*	Mature	7	600	4	4	4	5	1	7.2	Fair	Fair	Located at the back of the field. Broad spreading crown.	It requires no works at present.	Ivy has value as a food source and for nesting potential	20+	B1	No impacts expected.	Retain
7531	**oak** *Quercus robur*	Mature	16	800	6	4	2	9	5	0	Fair	Fair	Large oak located next to the bridge. Limbs removed in past, leaving wounds that are susceptible to decay.	It requires no works at present.	Bat roost potential at pruning wounds	40+	A2	It will need to be removed to facilitate hard defences.	Remove
TG2	**Lawson cypress** *Chamaecyparis lawsoniana*	Mature	18	350	2	2	2	2	1	4	Fair	Fair	Group of 18 trees with combined canopy formation. Internal road on southern side. Ivy in mid crown.	They require no works at present.	It forms part of the ecological corridor.	20+	B2	It will need to be removed to facilitate the development.	Remove
7532	**oak** *Quercus robur*	Mature	17	1040	2	2	2	2	3	0	Fair	Fair	Its crown has been heavily reduced (topped) in the past, resulting in new small crown of re-	It requires no works at present.	Bat roost potential at pruning wounds	40+	B2	It will need to be removed to facilitate flood defences.	Remove

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													growth. Leaning 15 degrees from road towards river.						
7533	**alder** *Alnus glutinosa*	Semi-Mature	6	200	2	2	2	2	1	0	Good	Good	Small alder tree right on river bank. Twin stemmed.	It requires no works at present.	Food source for wildlife.	20+	C1	It will need to be removed to facilitate hard defences.	Remove
7534	**white willow** *Salix alba*	Mature	20	650	5	5	5	5	2	0	Fair	Fair	It is growing out of the riverbank, and there is ivy in its mid crown. Broken branch at 8 m on its western side.	It requires no works at present.	Bat roost potential at broken branch.	20+	B2	It will need to be removed to facilitate hard defences.	Remove
7535	**large leaved lime** *Tilia platyphyllos*	Mature	20	1000	6	6	6	7	0	0	Fair	Fair	Prominent tree. Hard surfacing is close to its base. Overhead utility wire passes through its mid crown. Ivy is in mid crown. Some tip die back evident.	Review annually for tip dieback development.	Ivy has value as a food source and for nesting potential	20+	B2	It will need to be removed to facilitate hard defences.	Remove
T4	**sycamore** *Acer pseudoplatanus*	Mature	15	300	3	3	3	3	3	3.6	Dead	Poor	Standing dead on river bank	Reduce to a height of 8 m and retain for ecological value	Bat roost potential as cavities develop.	<10	U	It will need to be removed to facilitate the proposed works.	Remove
T5	**sycamore** *Acer pseudoplatanus*	Mature	19	840	6	5	5	5	2	0	Good	Good	It is located on the riverbank and growing through the wall, causing	It requires no works at present.	Light ivy cover on main stem	40+	B2	It will need to be removed to facilitate the	Remove

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													structural damage to it					proposed works.	
TG5	**alder, beech, willow, wild cherry, hazel**	Early Mature	16	360	4	4	3	3	2	5	Good	Fair	Group of c.25 trees with a combined canopy formation. Growing in the open the grass area along the river.	It requires no works at present.	Ivy present will provide nesting potential and food source for wildlife, as will tree leaves.	20+	B2	Potential root damage, dependent on root distribution, in north-eastern corner where hard defences are proposed.	Retain
1244	**rowan** *Sorbus aucuparia*	Semi-Mature	11	200	1	1	1	1	2	0	Good	Fair	It is being suppressed by the neighbouring trees that also afford it shelter		Food source for wildlife	10+	C2	It will need to be removed to facilitate the proposed works.	Remove
1245	**beech** *Fagus sylvatica*	Semi-Mature	14	200	5	1	3	3	2	0	Good	Fair	Spindly tree with asymmetrical crown orientated to the north due to group growing environment that also affords it shelter		Food source for wildlife	10+	C2	It will need to be removed to facilitate the proposed works.	Remove
1246	**alder** *Alnus glutinosa*	Semi-Mature	13	200	2	1	1	1	2	0	Good	Fair	Spindly tree due to group growing environment that also affords it shelter		Food source for wildlife	10+	C2	It will need to be removed to facilitate the proposed works.	Remove
1247	**beech** *Fagus sylvatica*	Semi-Mature	14	240	5	1	3	3	3	0	Good	Fair	Spindly tree with asymmetrical crown orientated to the north due to group growing		Food source for wildlife	10+	C2	It will need to be removed to facilitate the proposed works.	Remove

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													environment that also affords it shelter						
7541	**ash** *Fraxinus excelsior*	Early Mature	13	250	2	3	3	3	5	4	Poor	Poor	In decline from ash dieback. Stonework previously done right to trunk. Small dead wood in upper crown.	It requires no works at present. Retain for ecological value.	Bat roost potential as the tree dies from ash dieback and cavities develop.	<10	C3	No impacts expected.	Retain
7542	**ash** *Fraxinus excelsior*	Early Mature	15	400	3	5	4	3	1	0	Fair	Fair	Ash tree with very little symptoms of ash dieback. Stonework previously done right to trunk on southern side.	It requires no works at present.	Bat roost potential as the tree dies from ash dieback and cavities develop.	10+	C1	It will need to be removed to facilitate the soft defences.	Remove
7543	**sycamore** *Acer pseudoplatanus*	Semi-Mature	11	250	4	5	5	5	1	0	Good	Fair	Located in field in open grass area. Twin stemmed from base	It requires no works at present.	Food source for wildlife.	40+	B1	It will need to be removed to facilitate the soft defences.	Remove
7544	**goat willow** *Salix caprea*	Mature	8	300	4	5	5	5	1	3.6	Good	Fair	Broad spreading crown with low crown formation down to ground	It requires no works at present.	Food source for wildlife.	20+	C1	It may suffer some soil compaction due to the proposed works proximal to it.	Retain
TL8	**ash, thuja, larch**	Mature	18	400	5	5	5	5	3	5	Fair	Fair	They make up the outer canopy formation of the woodland and are growing on raised ground separated	They require no works at present.	Distinct ecosystem.	10+	C2	No impacts expected.	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													by a 1m stone retaining wall. Ash tree showing symptoms of ash dieback.						
1241	**ash** *Fraxinus excelsior*	Early Mature	16	700	5	4	2	5	4	8.4	Poor	Fair	It is in decline from ash dieback and it overhangs the garden building. Cavity at 2m on western side	Tree owner should consider removing or reducing size to reduce risk	Food source for wildlife	<10	U	No impacts expected.	Retain
1242	**ash** *Fraxinus excelsior*	Early Mature	14	700	4	2	2	4	3	8.4	Poor	Fair	It is in decline from ash dieback and it overhangs the garden building.	Tree owner should consider removing or reducing size to reduce risk	Food source for wildlife	<10	U	No impacts expected.	Retain
1243	**oak** *Quercus robur*	Early Mature	10	580	5	5	5	5	1	7	Good	Good	Prominent tree. Its crown overhangs the public path to the north and it has been cut back in the past to provide clearance over it	Continue to maintain clearance with path through regular pruning	Lichens	40+	A2	No impacts expected.	Retain
TL11	**ash** *Fraxinus excelsior*	Early-Mature	14	390	4	4	4	4	2	5	Poor	Fair	Line of trees in decline from ash dieback	Tree owner should consider removing or reducing size to reduce risk	Food source for wildlife	<10	U	No impacts expected.	Retain
1248	**ash** *Fraxinus excelsior*	Mature	10	900	3	3	3	3	0	0	Fair	Fair	Twin stemmed. It was topped in the past at 7 m with multiple stemmed, regrowth	Review annually for symptoms of ash dieback	Food source for wildlife	10+	C2	It will need to be removed to facilitate the proposed works.	Remove

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													occurring to produce a new, compact crown						
TG7	**cherry plum, whitebeam, Lawson cypress cv, privet**	Mature	8	400	4	3	3	3			Good	Good	It is a combination of hedge plants with a taller cherry plum that was allowed to grow tall above the height of the hedge and a white beam at the eastern end. They collectively form the boundary between the field and the adjoining property.	It requires no works at present.	Birds may nest in hedge plants	10+	C2	They may suffer some minor soil and root damage due to the proposed works in this area	Retain
7536	**horse chestnut** *Aesculus hippocastanum*	Mature	18	1040	7	6	6	7	2	12	Fair	Fair	Located on the adjoining property side of the boundary wall. Bleeding canker evident on trunk. Prominent tree	Review annually for bleeding canker development.	Food source for wildlife.	20+	B3	It may suffer root damage from hard defences installation	Retain
TG3	**yew, holly**	Semi-Mature	7	200	2	2	2	2	2	0	Good	Good	Ornamental trees growing on the adjoining property side of the boundary wall	It requires no works at present.	Bird nest potential in dense foliage.	20+	C1	It will need to be removed to facilitate hard defences.	Retain
7537	**sycamore** *Acer pseudoplatanus*	Mature	16	1200	4	5	3	5	3	0	Good	Poor	Growing on the adjoining property side of the boundary wall. It	The tree owner should consider reducing it to an 8m	Bat roost potential at pruning wound.	<10	No imp acts exp	Retain	The tree owner should consider

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													has been heavily reduced (topped) in the past due to brittle cinder fungus at base on southern side.	stump/snag for ecological value			ecte d.		reducing it to an 8m stump/snag for ecological value
7538	**sycamore** *Acer pseudoplatanus*	Mature	22	1200	6	8	4	8	3	0	Good	Fair	Large tree growing on the adjoining property side of the boundary wall. Broad, spreading crown	It requires no works at present.	Food source for wildlife.	20+	B2	No impacts expected.	Retain
7539	**horse chestnut** *Aesculus hippocastanum*	Mature	7	1200	4	2	5	2	3	0	Poor	Poor	It has been reduced to an 8m stump in the past	It requires no works at present.	Bat roost potential at pruning wound.	<10	C3	No impacts expected.	Retain
TG4	**Lawson cypress** *Chamaecyparis lawsoniana*	Semi-Mature	8	200	2	2	2	2	2	0	Good	Good	3 Lawson cypress trees growing on the adjoining property side of the boundary wall	It requires no works at present.	Bird nest potential in dense foliage.	20+	C1	No impacts expected.	Retain
7540	**hawthorn** *Crataegus monogyna*	Semi-Mature	4	200	2	2	2	2	0	2.4	Good	Good	Small hawthorn on edge of path.	It requires no works at present.	Food source for wildlife. Ivy has value as a food source and bird nesting.	40+	C1	No impacts expected.	Retain
7545	**white willow** *Salix alba*	Mature	16	600	6	8	5	6	1	0	Good	Fair	It is multiple stemmed from base with a broad spreading crown. Growing on the	It requires no works at present.	Food source for wildlife.	10+	C2	No impacts expected.	Retain

Tree Survey																			
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													western side of the river in the scrub area.						
7546	**alder** *Alnus glutinosa*	Early Mature	11	240	3	3	3	3	2	0	Good	Good	It forms part of a larger group in the scrub area to the west of the river	It requires no works at present.	Food source for wildlife.	20+	C1	No impacts expected.	Retain
TL9	**ash, copper beech, horse chestnut, sycamore**	Mature	20	500	5	5	5	5	1	10	Good	Good	Line of mature trees growing on the eastern side of the stream. They have a combined group canopy formation and a scrub area is developing between the tree line and the river. One of the ash trees is in advanced decline from ash dieback	They require no works at present.	Ecological corridor.	20+	B2	No impacts expected.	Retain
TL10	**Leyland cypress 'Castlewellan'** × *Cuprocyparis leylandii* 'Castlewellan'	Early-Mature	8	300	NA	4	4	NA	0	6	Fair	Fair	It extends east to west and its height has been reduced one its southern side.	It requires no works at present.	Ecological corridor.	20+	C2	No impacts expected.	Retain
TG6	**alder, white willow**	Semi-Mature	10	120	2	2	2	2	2	6	Good	Fair	A group of mainly alders with some white willow also present, growing up with a combined canopy	It requires no works at present.	Food source for wildlife.	20+	C2	No impacts expected.	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
													formation located in the scrub area to the west of the river.						
1791	**Lawson cypress** *Chamaecyparis lawsoniana* cv.	Early Mature	14	650	3	2	4	3	0	8	Good	Good	It is four stemmed from base due to natural layering and it forms part of a group with the neighbouring trees	No works presently	Low ecological value as coniferous	20+	B2	It may suffer minor root damage from hard defences installation	Retain
1792	**Lawson cypress** *Chamaecyparis lawsoniana* cv.	Early Mature	14	680	4	2	2	3	0	8	Good	Good	It is four stemmed from base due to natural layering and it forms part of a group with the neighbouring trees. Bark included junction at 2 m but it is less of a risk due to this area being of low use and it is sheltered by the neighbouring trees	No works presently	Low ecological value as coniferous	20+	B2	It may suffer minor root damage from hard defences installation	Retain
1793	***laburnum anagyroides***	Mature	10	480	4	2	2	1	0	7	Good	Fair	It is growing up through the two neighbouring Lawson cypress trees and it is sheltered by them	No works presently	Food source for wildlife	20+	B2	It may suffer minor root damage from hard defences installation	Retain
1794	**Lawson cypress**	Early Mature	14	680	3	2	4	1	0	8	Good	Good	It forms part of a group with the	No works presently	Low ecological	20+	B2	It may suffer minor root	Retain

Tree Survey																		
Tree No.	**Species**	**Age Class**	**Ht. m**	**Stem Diam mm**	**N m**	**S m**	**E m**	**W m**	**C. Ht m**	**RPA m**	**Phys Cond**	**Struc Cond**	**Comments**	**Management Recommendations**	**Ecological Value**	**LE years**	**Cat.**	**Impacts**	**Remove – Retain**
	Chamaecyparis lawsoniana cv.												neighbouring trees and it is sheltered by them		value as coniferous			damage from hard defences installation	
1795	**goat willow** *Salix caprea*	Mature	10	490	7	4	5	4	0	6	Good	Good	A group of stems growing centrally in this group of trees	No works presently	Food source for wildlife	10+	C2	It may suffer minor root damage from hard defences installation	Retain
1796	**birch** *Betula pendula*	Mature	16	820	7	7	5	5	2	0	Good	Good	Prominent tree with ivy in mid crown. Its crown overhangs the adjoining property. Witches broom infection observed. Branch failure at 7 m western side.	No works presently	Food source for wildlife	20+	B2	It will need to be removed to facilitate the proposed flood wall	Remove
1797	**Lawson cypress** *Chamaecyparis lawsoniana* cv.	Early Mature	14	650	3	2	4	3	0	8	Good	Good	It is four stemmed from base due to natural layering and it forms part of a group with the neighbouring trees	No works presently	Low ecological value as coniferous	20+	B2	It may suffer minor root damage from hard defences installation	Retain

Appendix 2
Tree Survey Images

Area 1

Image 1: Typical topography of Area 1 with the sloping fields divided by hedgerows and tree lines

Image 2: Tree Line No. 7 – mature oak trees growing out of Hedge No. 9

Image 3: Woodland Block No. 2 – semi mature trees that are poorly tapered due to competition for light

Image 4: Tree Line No. 2, growing out of Hedge No. 2 , with symptoms of ash dieback – as do most ash trees in this area

Image 5: Hedge No. 1B with Tree Line No. 5 in the upper canopy

Area 2

Image 6: Area 2 is mainly an open field with a single hawthorn – Tag No. 7530 – at the back

Image 7: Tag No. 7530

Area 3

Image 8: Tag No. 7535, a mature large-leaved lime

Image 9: Tag No. 7531, mature oak next to the bridge

Image 10: Tree Group No. 5 along the river, made up of alder, beech, willow, cherry and hazel

Image 11: Tree Group No. 2, Lawson cypress' next to the bridge

Image 12: Tag No. 7532, mature oak next to the bridge

Area 4

Image 13: Woodland just outside of Area 4

Image 14: Tag No. 7541 in decline from ash dieback

Area 5

Image 15: Tag No. 7537, mature sycamore with *Kretzschmaria deusta* fungus at base – see management recommendations in Tree Survey in Appendix 1.

Image 16: Tag No.7538, mature sycamore

Image 17: Tree Line No. 10, parallel to the side channel

Image 18: Tag Nos. 1791-1796 from right to left. Three mature Lawson cypress', a laburnum, a goat willow and a birch.

Appendix 3
Tree Protection and Removal Plans

Figure 8: Area 1 - Tree removal/retention and Root Protection Area constraints

Figure 9: Western section of Area 1

Figure 10: Northern section of Area 1

Figure 11: Southern section of Area 1

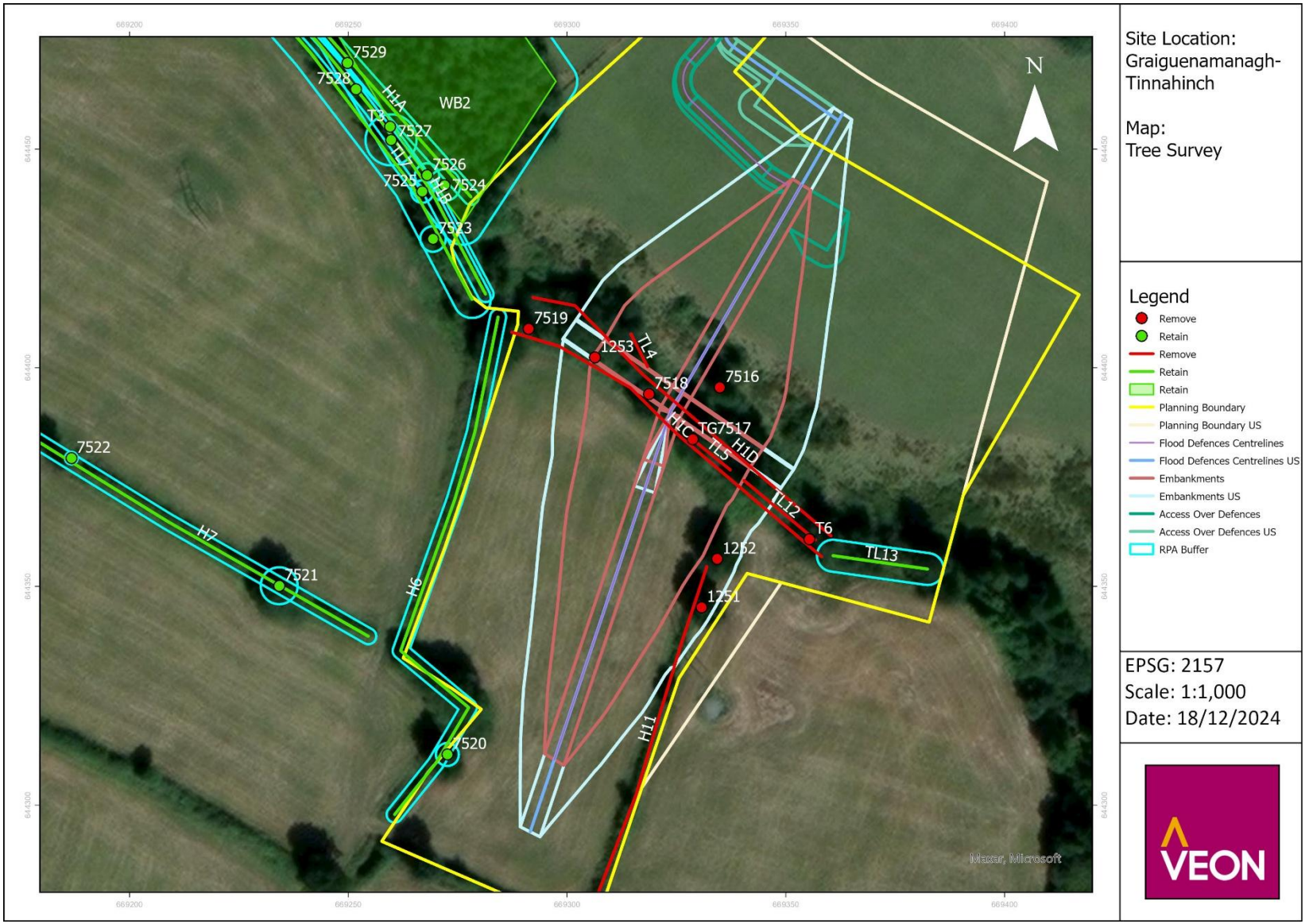


Figure 12: Eastern section of Area 1

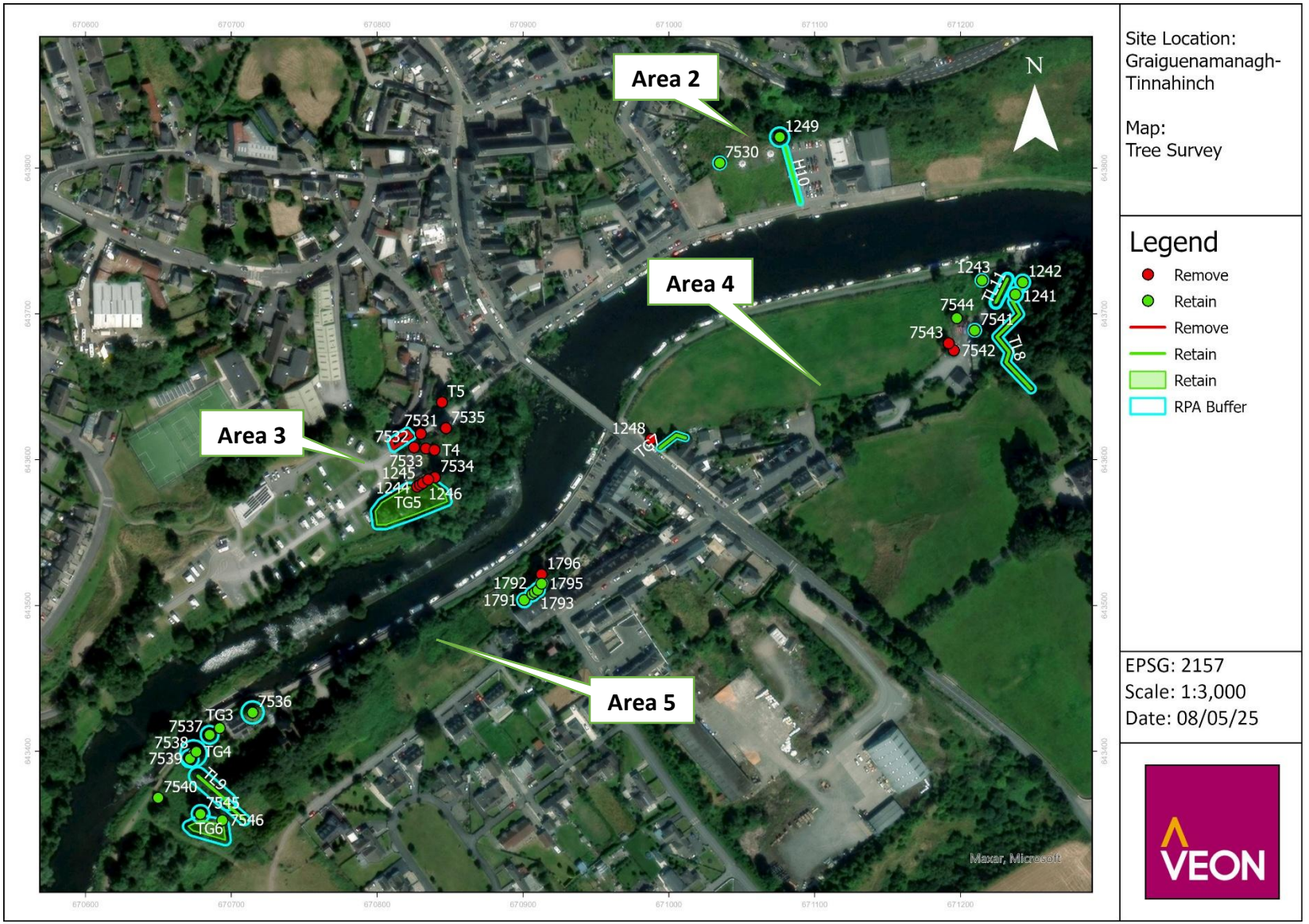


Figure 13: Area 2, 3, 4, 5 - Tree removal/retention and Root Protection Area constraints

Figure 14: Close up of Area 2

Figure 15: Close up of Area 3 – Note that the outline of TG5 is crown spread, not stems, so these trees can be retained

Figure 16: Close up of Area 4

Figure 17: Eastern section of Area 4 & western section of Area 5

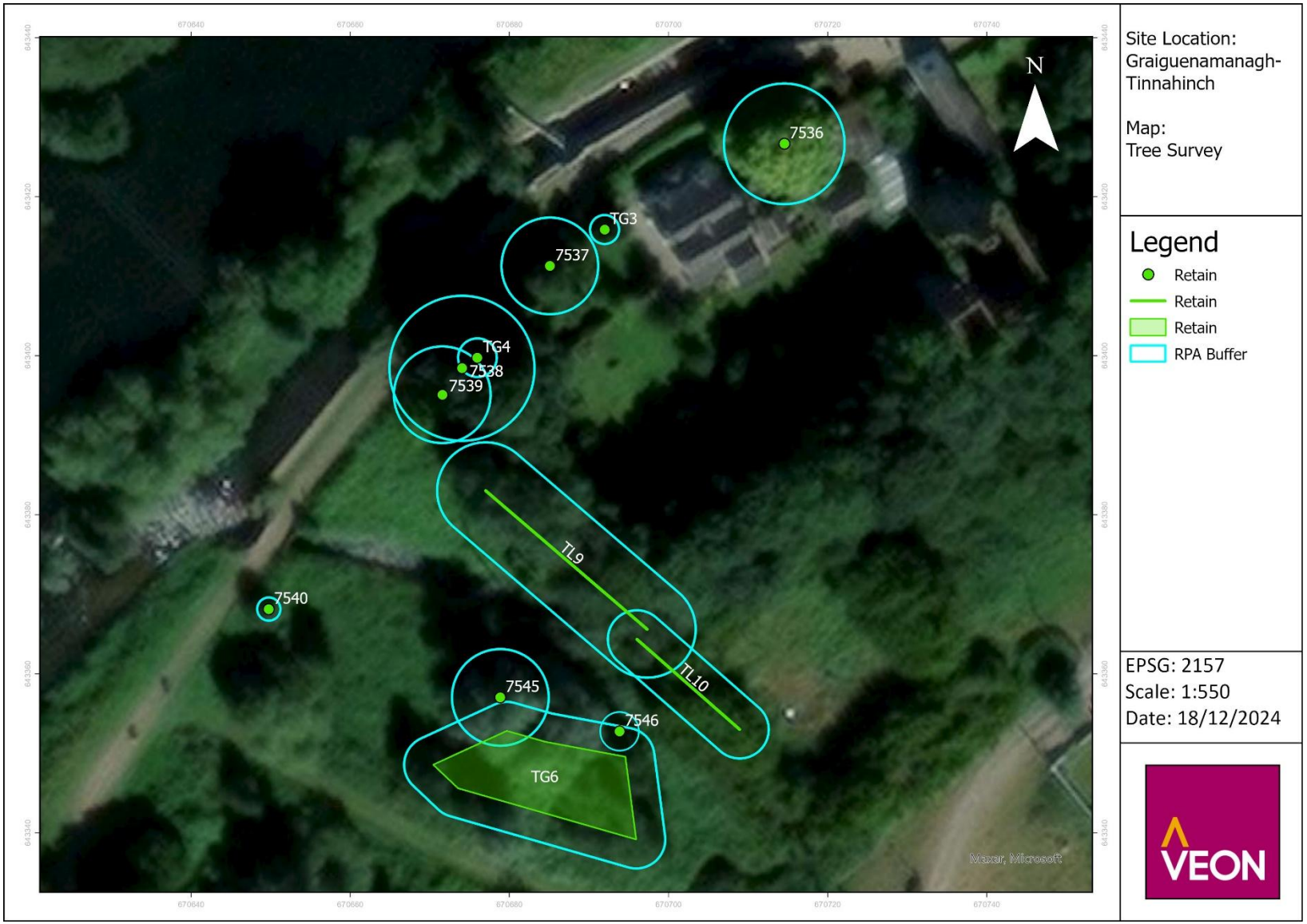


Figure 18: Close up of Area 5

Appendix 10-12 Ecology Surveys 2020-2024 (including results of specialist bird and mammal surveys 2024)

Graiguenamanagh-Tinnahinch Flood Relief Scheme

Ecology Surveys 2020-2024

Report No. W3451-AYE-ENV-R015

26th May 2025

Revision 00

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Disclaimer: Please note that this report is based on specific information, instructions, and information from our Client and should not be relied upon by third parties.					

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1 Introduction

1.1 Project Background

Kilkenny County Council (KCC) and Carlow County Council (CCC) have engaged the services of Ayesa (formerly Byrnelooby) for the Planning/Development Consent of a proposed Flood Relief Scheme (FRS) for the Graiguenamanagh-Tinnahinch Flood Relief Scheme (GTFRS) (the "Scheme'').

1.2 Ecology Survey Background

At the conception of the Project in 2020, a series of ecological surveys were conducted to inform the environmental constraints study and optioneering assessment of the Scheme going forward. The surveys conducted are detailed in Table 1-1.

When these initial surveys were completed, they considered the habitat and species that may be impacted by the options identified in the Catchment Flood Risk Assessment and Management (CFRAM) level assessment, which included defences within the environs of the town of Graiguenamanagh-Tinnahinch only. However, since then, the Scheme has been undergoing extensive optioneering and engineering design as well as stakeholder engagement and as such, new design developments have been incorporated. The most notable change was the inclusion of an upstream storage facility along the River Duiske which, through optioneering and stakeholder engagement, was found to have a significant benefit to the Scheme. Since the area proposed for the upstream storage (US) was not initially included in the original ecology surveys, a dedicated set of surveys has been undertaken in 2023 and 2024 to identify important habitats and species in the area proposed for development. These surveys are additionally detailed in Table 1-1.

Alongside, Ayesa reviewed the lifespan of the original ecological surveys conducted in 2020/2021 and, in accordance with available and applicable advice, made recommendations of additional surveys to provide up-to-date baseline information for input into the EIAR. The Advice Note from the Chartered Institute of Ecology and Environmental Management (CIEEM) 'on the Lifespan of Ecological Reports & Surveys' (April 2019) was referenced in making these recommendations. The Report detailing the reasoning behind these recommendations is included in Appendix A and the dates of these surveys are outlined in Table 1-1.

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Table 1-1: Ecological Surveys Conducted for the GTFRS 2020 - 2024

Survey Type	**Original Surveys 2020-2021** (completed in the towns of GT only)	**Upstream Storage Area Surveys 2023-2024** (completed at the US area only)	**Top Up Ecology Surveys 2023-2024** (completed in the towns of GT only, to 'top up' the original surveys)
Bat Survey	14-16/09/2020	02/08/2023, 15/08/2023, 16/08/2023 01/09/2023, 05/09/2023, 07/09/2023, 12/09/2023 & 22/09/2023	27/05/2024, 23/06/2024, 18/07/2024, 04/09/2024
Wintering Bird Survey	16-18/02/2021	Visit 1:19-20/12/2023 Visit 2:16-17/01/2024 Visit 3: 22-23/02/2024	Visit 1:19-20/12/2023 Visit 2:16-17/01/2024 Visit 3: 22-23/02/2024
Breeding Bird Survey	02/04/2021	Visit 1: 09-11/09/2023 Visit 2: 28-29/03/2024 Visit 3:26-27/06/2024	Visit 1: 09-11/09/2023 Visit 2: 28-29/03/2024 Visit 3:26-27/06/2024
Mammal Survey (including otter, badger, pine martin, red squirrel).	16-18/02/2021	09-11/09/23	28/29 March 2024
Herpetofauna Survey	16-18/02/2021	28/29 March 2024	*Not required (no suitable habitat identified)*
Flora Survey	16-18/02/2021	Not required (observations made in January 2023 for H&S)	26-27/06/2024
Water Quality & Q-values/ invertebrates Survey	08/02/2021	09 & 10/08/2023	26-27/06/2024
Fish Habitat Survey	10/02/2021	09/08/2023	*Not required (original data suitable)*
Electrofishing Survey	10/02/2021	*Not required (original data suitable)*	*Not required (original data suitable)*
White-Clawed Crayfish	29/04/2021	10/08/2023	*Not required (original data suitable)*
Freshwater Pearl Mussel	30/04/2021	*Not required (original data suitable)*	*Not required (original data suitable)*
Arboricultural Survey	First visit - 23/05/2023 – 25/05/2023 Second visit – 19/12/2023 & 15/11/ 2024		*Not required (survey is not out of date)*

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1.3 Purpose of Report

This report details the findings of all ecology surveying completed for the GTFRS between 2020 and 2024, as summarized in Table 1-1.

1.4 Proposed project

The Proposed Scheme consists of a series of raised defences (flood walls and embankments) along the River Duiske and River Barrow. It further includes upstream storage of flood waters (upstream on the River Duiske) to facilitate a reduced extent of flood walls downstream in the built-up area of Graiguenamanagh. The Proposed Scheme will be designed to provide protection to the communities of Graiguenamanagh-Tinnahinch from the 1 in 100-year flood event (1% AEP).

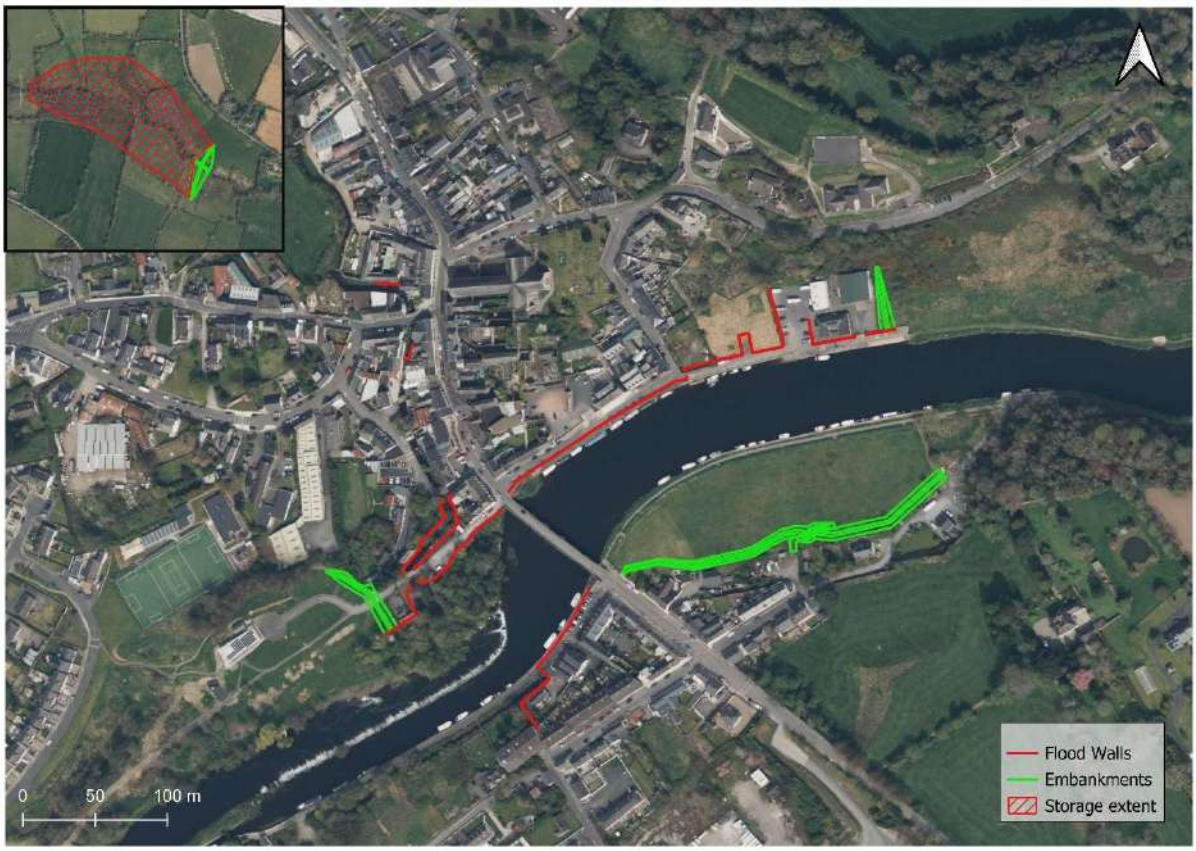

Figure 1-1: Scheme Design

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1.5 Qualifications

Table 1-2 provides a summary of the staff involved in the surveying and reporting.

Table 1-2: Ecology Team Qualifications

Title	Name	Role	Qualifications	Years' experience
Director, Environment	Barry Sheridan	Report reviewer	MA Env Sci, HDip Bus/I.T., HDip Env. Eng, HDip Acoustics	20+
Environmental Consultant	Andrea Brogan	Report reviewer	B.A (Hons)	5
Senior Ecologist	Jeff Hean	Survey, Report Preparation	Ph. D in Zoology IES Member	8
Ecologist	Joe Butler	Survey, Report Preparation	BSc (Zoology) MSc (Wildlife Conservation & Management) QCIEEM	5
Graduate Ecologist	Meadhbh Stack	Survey, Report Preparation	BSc (Ecology and Environmental Biology) QCIEEM	1

Some surveys have been conducted by external ecologists, namely AQUAFACT/APEM, Triturus and Veon. The roles and qualifications of the survey teams involved are included in their individual reports.

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2 Bat Surveys

2.1 Original CFRAM Survey (2020)

Ayesa's internal ecologist team completed this survey in September 2020. The original survey was undertaken with the CFRAM Study Area extent in mind, within the towns of Graiguenamanagh and Tinnahinch. The results of the survey are outlined in the Bat Survey Report included in Appendix B.

2.2 Upstream Storage Area (2023/2024)

This survey was completed externally by Veon in August and September 2023. The results of the survey are included in Veon's survey report, included in Appendix C.

2.3 Top up Survey (2023/2024)

This survey was completed externally by Veon in June 2024. The intention was to 'top up' the original surveys completed in 2020, as outlined above. The results of the survey are included in Veon's survey report, included in Appendix D.

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3 Breeding Bird Surveys

3.1 Overview

3.1.1 Original CFRAM Survey (2021)

Ayesa's internal ecologist team completed a single breeding bird observation survey in April 2021. The original survey was undertaken with the CFRAM Study Area extent in mind, within the towns of Graiguenamanagh and Tinnahinch.

The results of the survey are outlined in Section 3.3 and Appendix E of this Report.

3.1.2 Upstream Storage Area (2023/2024)

A series of breeding bird surveys were conducted at the upstream storage area by Ayesa's internal ecology team. These were conducted across three visits within the breeding bird survey season, the first in September 2023, the second in March 2024 and the third in June 2024.

The results of these surveys are outlined in Section 3.3 and Appendix E of this Report.

3.1.3 Top up Survey (2023/2024)

A series of breeding bird surveys were conducted by Ayesa's internal ecology team to 'top up' the original CFRAM level surveys outlined above. As with the above, these were conducted across three visits within the breeding bird survey season, the first in September 2023, the second in March 2024 and the third in June 2024.

The results of these surveys are outlined in Section 3.3 and Appendix E of this Report.

3.2 Survey Methodology

3.2.1 Guidelines

The breeding bird survey methodology was designed and undertaken in accordance with guidance described in:

- Countryside Bird Survey: Status and Trends of Common and Widespread Breeding Birds 1998-2016 (Lewis et al., 2019b).
- Breeding Bird Survey: Methodology and Survey Design (BTO, 2023). [Online] Available at: https://www.bto.org/our-science/projects/breeding-bird-survey/research-conservation/methodology-and-survey-design
- I-WeBS Counter Manual: Guidelines for Irish Wetland Bird Survey Counters
- Bird Census Techniques (Bibby, *et al*., 2000)

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- 'Field Guide to the Birds of Britain and Europe' by John Gooders (Larousse) - identification
- I-WeBS best practice guidelines of standard techniques for traditional ground surveying are the recommended methods by Bird Watch Ireland.

3.2.2 Ethics Statement

Precautionary measures were taken to ensure minimal/no disturbances were imposed on the feeding/breeding/nesting of breeding birds present. Care was taken at all times to avoid flushing any species within the sampling sites, with previously researched vantage point locations with recommended distances and wintering waterbird species-specific responses to human disturbances.

3.2.3 Survey Method and Locations

3.2.3.1 Original CFRAM Survey (2021)

The survey involved line transects along the routes shown in Figure 3-1. It was carried out early in the morning, approximately 30 minutes after sunrise. Where possible, surveying was avoided during heavy rain, strong winds or poor visibility (e.g. fog). Each transect line was walked by the ecologist, and all avian species observed (visually or aurally) were recorded. Binoculars were used to scan the surrounding landscape during the transect. Direct sightings were recorded in line with the guidance contained in the Countryside Bird Survey (CBS) Manual (Birdwatch Ireland, 2012), which recommends sightings to be grouped into the following distance bands (perpendicular to and either side of the transect line):

- Within 25m
- Between 25m and 100m
- Greater than 100m
- Birds in flight at any distance

Some crossover is possible during these surveys, and this was noted if it occurred. The ecologist used professional judgement as to whether to include a record that may have been recorded in a separate transect. Features of the landscape that were deemed significant for birds (e.g. potential breeding habitats, Kingfisher perches, existing nests etc.) were recorded.

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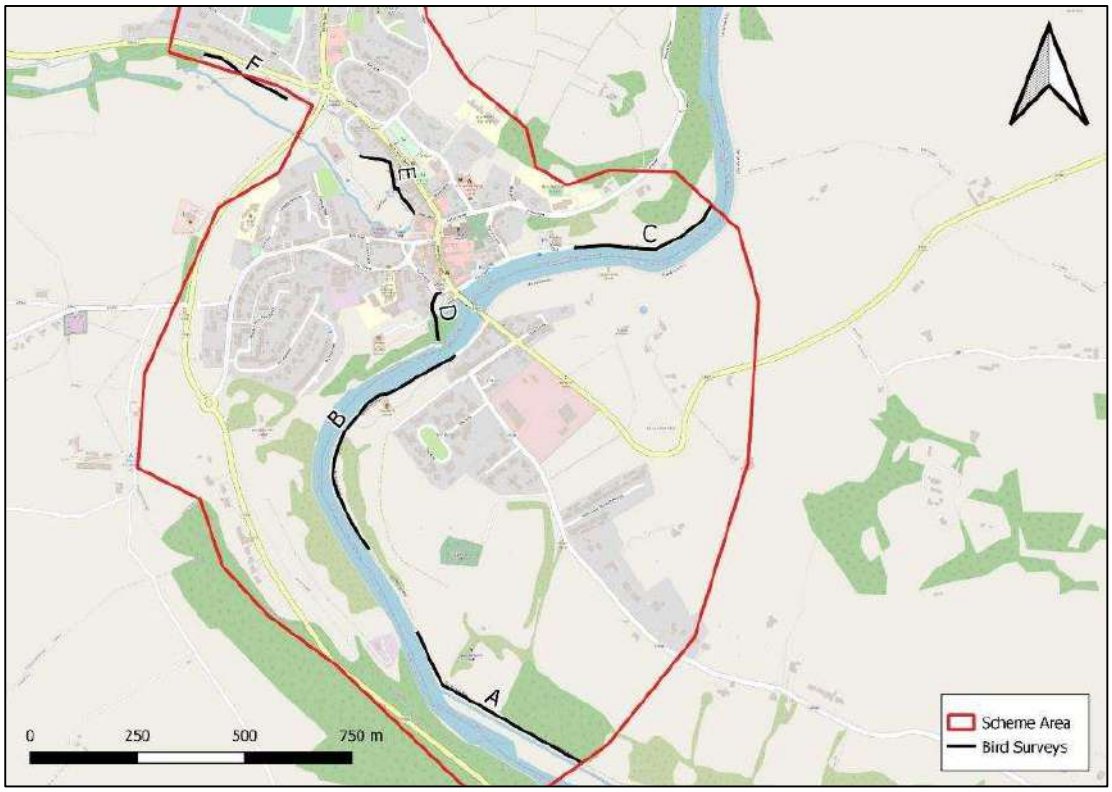

Figure 3-1. Bird Transect Routes

3.2.3.2 Upstream Storage Area & Top Up Surveys, Summer 2023

The Ayesa ecologists identified thirteen stationary vantage points located adjacent to and within the site from which to carry out the point counts/surveys, whilst continuing to record birds between the vantage points. The thirteen stations provided optimal visibility of the Site and surrounding landscape. The River Duiske was given two predefined stationary vantage points to provide maximum visibility upstream of the project site.

Two surveys of the site were carried out between the hours of 6:00 and 9:00 (beginning roughly one hour after dawn) on 10/09/23 and 11/09/23. Visits are timed so that the first is in the early part of the breeding season (April to mid-May) and the second at least four weeks later (mid-May to the end of June). Counts should begin in the early morning, so that they coincide with maximum bird activity, but avoid concentrated song activity at dawn (BTO, 2023).

Weather conditions within the project site were recorded at the time of survey. Activities that occur at the site that are or have the potential to cause disturbance to waterbirds were also recorded, regardless of whether they cause a noticeable disturbance to birds at the time of observation, or not.

The ecologists stayed at each stationary location for 20 minutes continuously scanning the surrounding areas using a pair of binoculars (Celestron 71008 SkyMaster 25 x 70 Binoculars), and all bird species observed were recorded. Information regarding the species of bird, number of birds (of the same species) and the birds' behaviour were similarly noted. The Countryside Bird Survey (CBS) Manual (Birdwatch Ireland, 2012) recommends

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sightings to be grouped into distance bands (perpendicular to and either side of the transect line), however this was deemed unnecessary on this occasion as no distance sampling analysis will be undertaken. The primary purpose of this survey is to identify which species utilize the site and the surrounding areas, not to provide accurate counts for population trends as in the CBS.

Aural recordings were also obtained using the app BirdNET (Kahl et al., 2021). BirdNET's in-app machine learning was used to determine species, according to Kahl et al. (2021) BirdNET has a mean average precision of 0.791 for single-species recordings. Despite the high level of confidence, the ecologist compared aural records obtained in the field to existing records to add a higher level of certainty to species identification.

August is considered to be the end of the breeding season for most bird species in Ireland. Consequently, subsequent breeding bird surveys are planned between March and May 2024. Precautionary measures were taken to ensure minimal/no disturbances were imposed on the feeding/breeding/nesting of breeding birds present. Care was taken at all times to avoid flushing any species within the sampling sites, with previously researched vantage point locations with recommended distances and wintering waterbird species-specific responses to human disturbances.

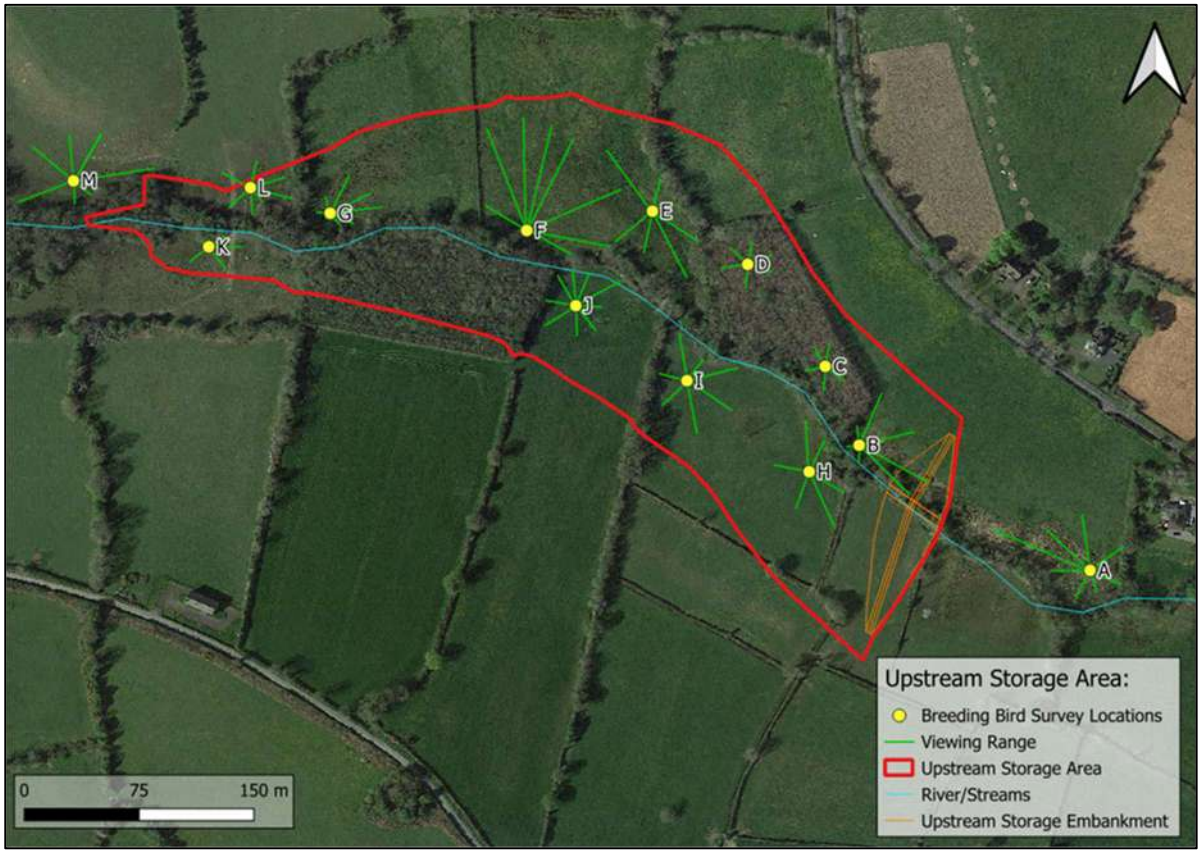

Figure 3-2: Breeding Bird Survey Count Locations and Viewing Ranges (Upstream Storage Area)

3.2.3.3 Upstream Storage Area & Top Up Surveys, Spring/Summer 2024

The ecologists modified the survey methodology carried out in Summer 2024. Instead, the ecologists identified eight stationary vantage points located adjacent to and within the site from

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which to carry out the point counts/surveys, whilst continuing to record birds between the vantage points. Five points were located within Graiguenanamagh-Tinnahinch Townlands (Figure 3-2) and the remaining three points were located at the Upstream Storage site (Figure 3-3).

Three surveys of the site were carried out, beginning at approx. 9 am on 28-29/03/2024, 22-23/05/2024, and 26-27/06/2024. Counts should begin in the early morning, so that they coincide with maximum bird activity, but avoid concentrated song activity at dawn (BTO, 2023).

The survey methodology was in line with that utilised in the Breeding Bird surveys 2023.

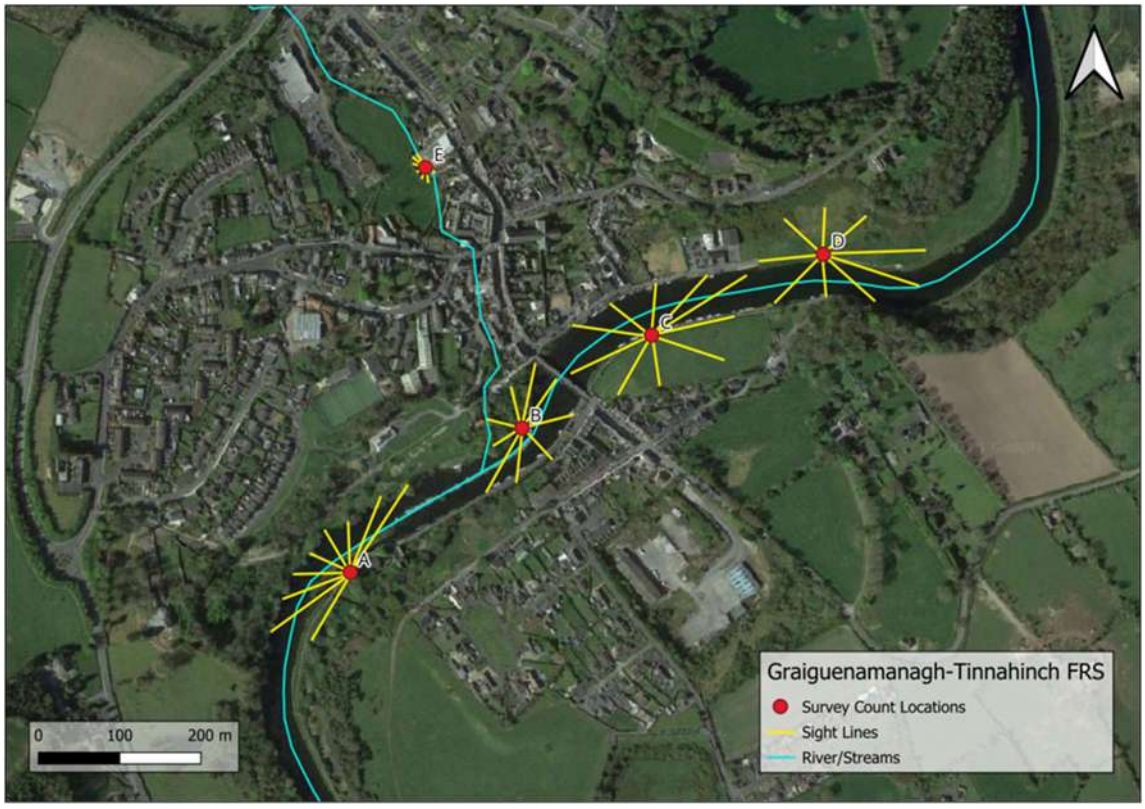

Figure 3-2: Breeding Bird Survey Count Locations and Site Lines – Graiguenamanagh and Tinnahinch Townlands

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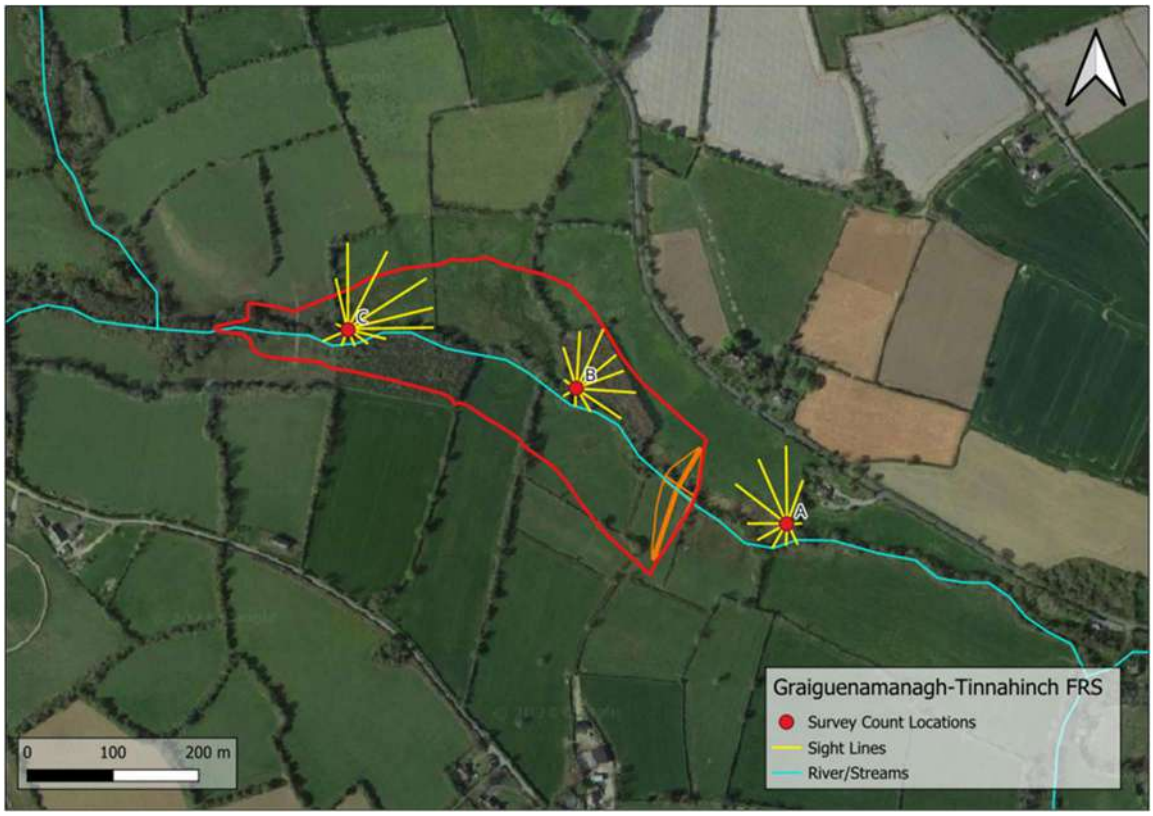

Figure 3-3: Breeding Bird Survey Count Locations and Site Lines – Upstream Storage Area

3.2.4 Results Interpretation

The species observed onsite were cross-referenced with the current list of Birds of Conservation Concern in Ireland (BoCCI), as well as the species listed in the Annexes of the EU Birds Directive (2009/147/EC) (EC, 2009). Based on their observed behaviour and their location in relation to the proposed project footprint, a determination was made as to the nature of their relationship with the site – whether they utilise the site for nesting and/or foraging purposes.

It is noted that all species of wild birds are protected under Section 22 of the Wildlife Act (No. 39 of 1976) and its amendments. In the context of the proposed works, this prohibits the destruction or disturbance of nests and/or eggs of wild birds (in the absence of a derogation licence).

3.2.4.1 Birds of Conservation Concern Ireland (BoCCI)

Based on qualitative data on species populations and distributions, BoCCI comprises lists of priority birds so that resources can be effectively allocated for their conservation. The system follows a traffic light system (i.e. red, amber, and green), with red being the highest conservation priority. Some of the criteria, which may trigger a species to be Red or Amber-listed, reflect global or European status regardless of how the species is faring in Ireland. It is important to have this wider context in status assessments to ensure protection of populations which are declining elsewhere in their range.

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3.3 Survey Results

3.3.1.1 Original CFRAM Survey (2021)

The birds recorded during the original Breeding Bird Survey in 2020 are shown in Appendix E of this report. Twenty-five (25) species were recorded, and of these, six (6) are protected under the Wildlife Acts, three (3) are listed on BOCCI's Amber list, and three (3) are listed in Annex II and III of the EU Birds Directive.

Sites deemed suitable for perching Kingfishers were recorded, and are also outlined in Appendix E. In total, 18 Kingfisher perches were recorded across both the breeding and wintering bird surveys conducted in 2021.

3.3.1.2 Upstream Storage Area & Top Up Surveys (2023-2024)

The birds recorded during the Breeding Bird Survey undertaken by the Ayesa ecologists on 9-11/08/2023, 28-29/03/2024, 22-23/05/2024, and 26-27/06/2024 are shown in Appendix E of this report. These results are listed in tables that refer to each stationary point that bird records were taken from in both the Upstream Storage Area and within the Graiguenamanagh-Tinnahinch towns.

Table 3.1 lists out the bird species that were recorded during this breeding survey that carry special protection (Birds of Conservation Concern in Ireland or birds listed in the Annexes of the EU Birds Directive (2009/147/EC) (EC, 2009)).

Photographs of bird species recorded during the survey are shown in Appendix F of this report. These pictures were taken using mobile phone devices; therefore, it was difficult to obtain high quality images of certain species of birds. Several recorded bird species were not captured on camera during the survey (Appendix F). This includes the Kingfisher which moves up and downstream at a fast pace and is difficult to photograph without the use of a high-quality camera.

Table 3-1: Recorded birds listed for special protection – Ayesa, 2023/2024.

Birds of Conservation Concern in Ireland (BoCCI)	**EU Birds Directive – Annexed Species**
Amber Listed:	Annex I:
House Sparrow (*Passer domesticus*)	
Starling (*Sturnus vulgaris*)	Annex II:
Wood Pigeon (*Columba palumbus*)	House Sparrow (*Passer domesticus*)
	Mallard (*Anas platyrhynchos*)
	Wood Pigeon (*Columba palumbus*)
	Annex III:
	House Sparrow (*Passer domesticus*)
	Mallard (*Anas platyrhynchos*)
Red Listed:	Wood Pigeon (*Columba palumbus*)

The habitats located within and surrounding the scheme area includes scrub, treelines, hedgerows, and woodland. These habitats are considered suitable nesting habitat for various passerine species. This includes the bird species that were recorded during the Birdwatch

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Ireland, and Ayesa surveys. This is significant in the context of all nests and eggs being protected under Section 22 of the Wildlife Acts.

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4 Wintering Bird Surveys

4.1 Overview

4.1.1 Original CFRAM Survey (2021)

Ayesa's internal ecologist team completed a single wintering bird observation survey in February 2021. The original survey was undertaken with the CFRAM Study Area extent in mind, within the towns of Graiguenamanagh and Tinnahinch.

The results of the survey are outlined in Section 4.3 and Appendix G of this Report.

4.1.2 Upstream Storage Area (2023/2024)

A series of wintering bird surveys were conducted at the upstream storage area by Ayesa's internal ecology team. These were conducted across three visits within the wintering bird survey season, the first in December 2023, the second in January 2024 and the third in February 2024. The survey methodology was in line with that utilised in the Breeding Bird surveys 2023 and 2024.

The results of these surveys are outlined in Section 4.3 and Appendix G of this Report.

4.1.3 Top up Survey (2023/2024)

A series of wintering bird surveys were conducted by Ayesa's internal ecology team to 'top up' the original CFRAM level surveys outlined above. As with the above, these were conducted across three visits within the wintering bird survey season, the first in December 2023, the second in January 2024 and the third in February 2024.

The survey methodology was in line with that utilised in the Breeding Bird surveys 2023 and 2024.

The results of these surveys are outlined in Section 4.3 and Appendix G of this Report.

4.2 Survey Methodology

4.2.1 Guidelines

The wintering bird survey methodology was designed and undertaken in accordance with guidance described in:

- Low tide waterbird surveys: survey methods and guidance notes (Lewis and Tierney, 2014); and
- I-WeBS Counter Manual: Guidelines for Irish Wetland Bird Survey Counters
- Bird Census Techniques (Bibby, *et al*., 2000)

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- 'Field Guide to the Birds of Britain and Europe' by John Gooders (Larousse) – identification
- I-WeBS best practice guidelines of standard techniques for traditional ground surveying are the recommended methods by Bird Watch Ireland.

4.2.2 Ethics Statement

Precautionary measures were taken to ensure minimal/no disturbances were imposed on the feeding/roosting of wintering birds present. Care was taken at all times to avoid flushing any species within the sampling sites, with previously researched vantage point locations with recommended distances and wintering waterbird species-specific responses to human disturbances.

4.2.3 Survey Method and Locations

4.2.3.1 Original CFRAM Survey (2021)

The same methodology was employed as with the breeding bird survey. See Section 3.2.3.1 for details.

4.2.3.2 Upstream Storage Area

The ecologists identified eight stationary vantage points located adjacent to and within the site from which to carry out the point counts/surveys, whilst continuing to record birds between the vantage points. Five points were located within Graiguenanamagh and Tinnahinch Townlands (Figure 4-1) and the remaining three points were located at the Upstream Storage site (Figure 4-2).

Three surveys of the site were carried out, beginning at approx. 9 am on 19-20/12/23, 16-17/01/24, and 22-23/02/24. Counts should begin in the early morning, so that they coincide with maximum bird activity, but avoid concentrated song activity at dawn (BTO, 2023).

Weather conditions within the project site were recorded at the time of survey. Activities that occur at the site that are or have the potential to cause disturbance to waterbirds were also recorded, regardless of whether they cause a noticeable disturbance to birds at the time of observation, or not.

The ecologists stayed at each stationary location for 30 minutes continuously scanning the surrounding areas using a pair of binoculars (Celestron 71008 SkyMaster 25 x 70 Binoculars), and all bird species observed were recorded. Information regarding the species of bird, number of birds (of the same species) and the birds' behaviour were similarly noted. The Countryside Bird Survey (CBS) Manual (Birdwatch Ireland, 2012) recommends sightings to be grouped into distance bands (perpendicular to and either side of the transect line), however this was deemed unnecessary on this occasion as no distance sampling analysis will be undertaken. The primary purpose of this survey is to identify which species utilize the site and the surrounding areas, not to provide accurate counts for population trends as in the CBS.

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Aural recordings were also obtained using the app BirdNET (Kahl et al., 2021). BirdNET's in-app machine learning was used to determine species, according to Kahl et al. (2021) BirdNET has a mean average precision of 0.791 for single-species recordings. Despite the high level of confidence, the ecologist compared aural records obtained in the field to existing records to add a higher level of certainty to species identification.

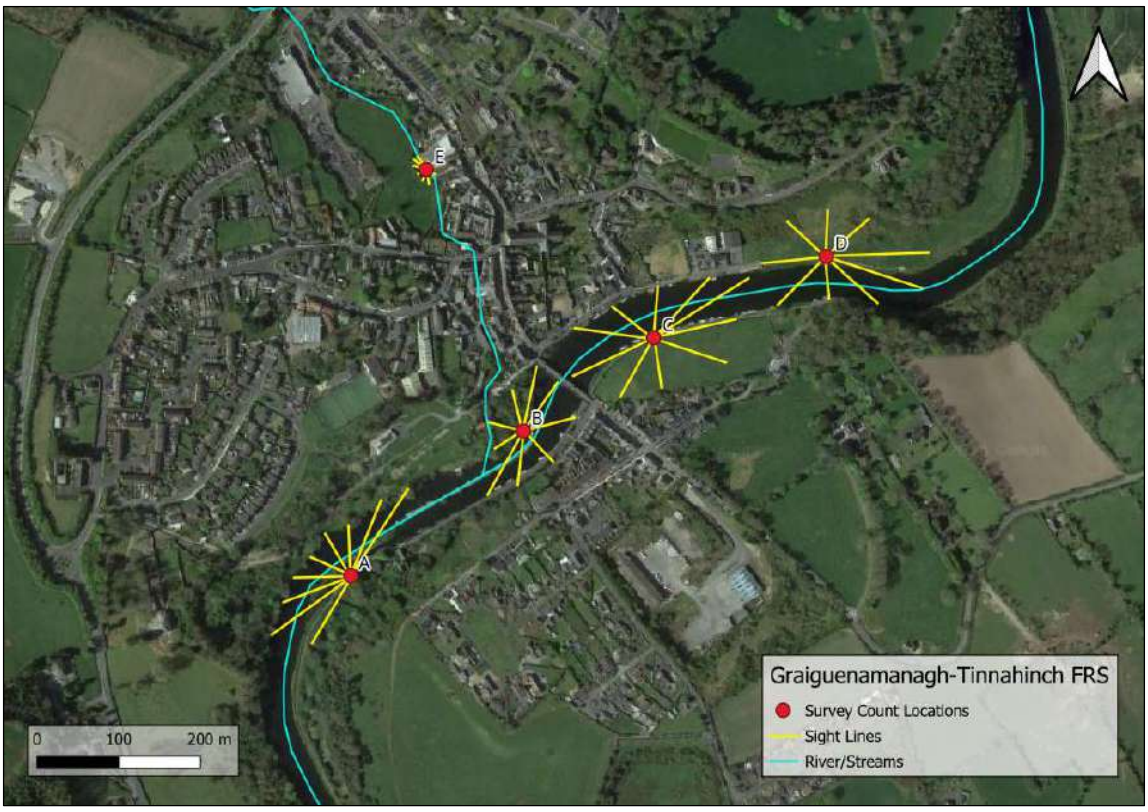

Figure 4-1: Wintering Bird Survey Count Locations and Site Lines – Graiguenamanagh-Tinnahinch Townlands

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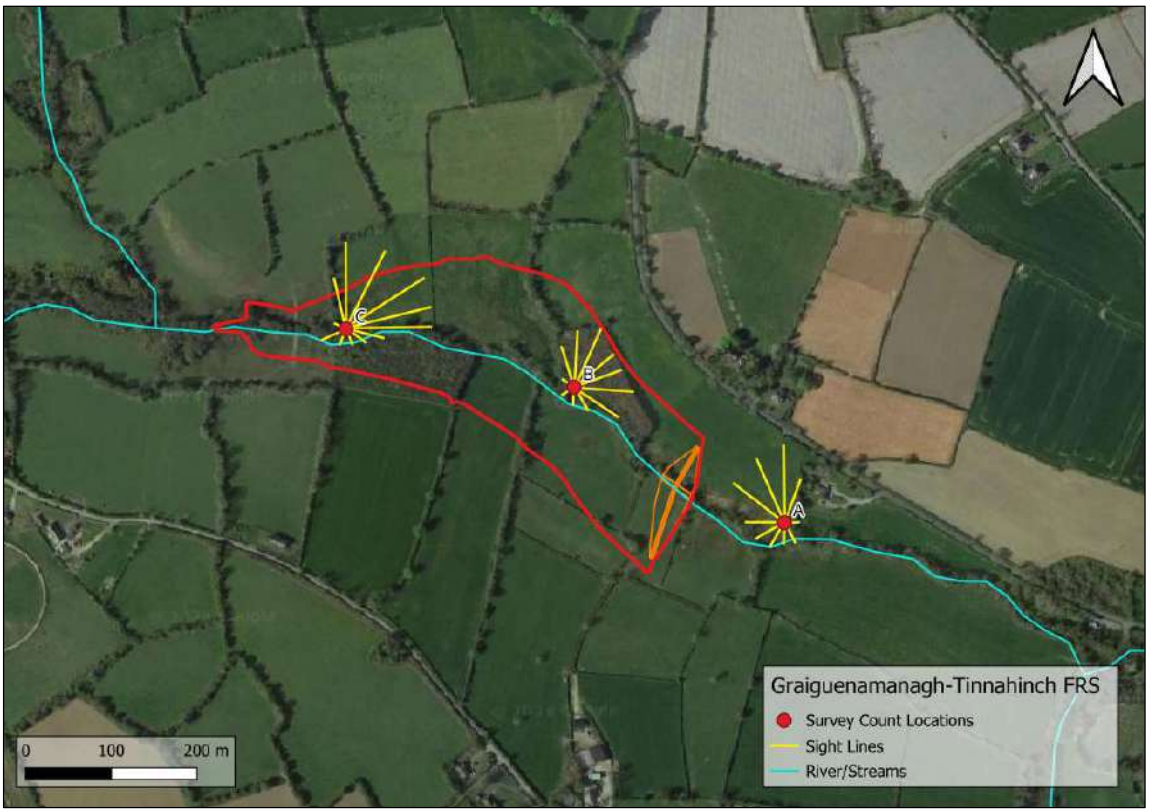

Figure 4-2: Wintering Bird Survey Count Locations and Site Lines – Upstream Storage Area

4.2.4 Results Interpretation

The species observed onsite were cross-referenced with the current list of Birds of Conservation Concern in Ireland (BoCCI), as well as the species listed in the Annexes of the EU Birds Directive (2009/147/EC) (EC, 2009). Based on their observed behaviour and their location in relation to the proposed project footprint, a determination was made as to the nature of their relationship with the site – whether they utilise the site for nesting and/or foraging purposes.

It is noted that all species of wild birds are protected under Section 22 of the Wildlife Act (No. 39 of 1976) and its amendments. In the context of the proposed works, this prohibits the destruction or disturbance of nests and/or eggs of wild birds (in the absence of a derogation licence).

4.2.4.1 Birds of Conservation Concern Ireland (BoCCI)

Based on qualitative data on species populations and distributions, BoCCI comprises lists of priority birds so that resources can be effectively allocated for their conservation. The system follows a traffic light system (i.e. red, amber, and green), with red being the highest conservation priority. Some of the criteria, which may trigger a species to be Red or Amber-listed, reflect global or European status regardless of how the species is faring in Ireland. It is important to have this wider context in status assessments to ensure protection of populations which are declining elsewhere in their range.

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4.3 Survey Results

4.3.1.1 Original CFRAM Survey (2021)

The birds recorded during the original Wintering Bird Survey in 2021 are shown in Appendix G of this report. Twenty-one (21) species were recorded, and of these, five (5) are protected under the Wildlife Acts, three (3) are listed on BOCCI's Amber list, and two (2) are listed in Annex II and III of the EU Birds Directive.

Sites deemed suitable for perching Kingfishers were recorded, and are outlined in Appendix E. In total, 18 Kingfisher perches were recorded across both the breeding and wintering bird surveys conducted in 2021.

4.3.1.2 Upstream Storage Area & Top Up Surveys (2023-2024)

The birds recorded during the Wintering Bird Survey undertaken by the Ayesa ecologists on 19-20/12/2023, 16-17/01/2024 and 22-23/02/2024 are shown in Appendix G of this report. These results are listed in tables that refer to each stationary point that bird records were taken from in both the Upstream Storage Area and within the Graiguenamanagh-Tinnahinch towns.

Table 4.1 lists out the bird species that were recorded during this wintering bird survey that carry special protection (Birds of Conservation Concern in Ireland or birds listed in the Annexes of the EU Birds Directive (2009/147/EC) (EC, 2009)).

Photographs of bird species recorded during the survey are shown in Appendix H of this report. These pictures were taken using mobile phone devices; therefore, it was difficult to obtain high quality images of certain species of birds. Several recorded bird species were not captured on camera during the survey (Appendix H). This includes the Kingfisher which moves up and downstream at a fast pace and is difficult to photograph without the use of a high-quality camera.

Table 4.1: Recorded birds listed for special protection – Ayesa, 2023/2024.

Birds of Conservation Concern in Ireland (BoCCI)	**EU Birds Directive – Annexed Species**
Amber Listed:	Annex I:
Common Kingfisher (*Alcedo atthis*)	Common Kingfisher (*Alcedo atthis*)
Common Starling (*Sturnus vulgaris*)	
Great Black-Backed Gull (*Larus marinus*)	
Great Cormorant (*Phalacrocorax carbo*)	Annex II:
Wood Pigeon (Columba palumbus)	Wood Pigeon (*Columba palumbus*)
	Annex III:
	Mallard (*Anas platyrhynchos*)
	Wood Pigeon (*Columba palumbus*)

Overwintering birds also use the project footprint and its surroundings for feeding and shelter.

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5 Mammal Surveys

5.1 Overview

5.1.1 Original CFRAM Survey (2021)

Ayesa's internal ecologist team completed a single mammal observation survey in February 2021. The original survey was undertaken with the CFRAM Study Area extent in mind, within the towns of Graiguenamanagh and Tinnahinch. The results of the survey are outlined in Section 5.3 of this Report.

5.1.2 Upstream Storage Area (2023/2024)

A mammal survey was undertaken by Ayesa's internal ecology team in August 2023 and March 2024. The results of this surveys are outlined in Section 5.3 of this Report.

5.1.3 Top up Survey (2023/2024)

A mammal survey was undertaken by Ayesa's internal ecology team in March 2024. The intention was to 'top up' the original CFRAM level surveys outlined above. The results of this survey are outlined in Section 5.3 of this Report.

5.2 Survey Methodology

5.2.1 Guidelines

The mammal surveys were undertaken in accordance with the following guidelines:

- Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes (NRA, 2008)
- Guidelines for the Treatment of Badgers prior to the Construction of National Road Schemes (NRA, 2006)
- A Guide to Identifying Evidence of Pine Martens in Wales (Vincent Wildlife Trust, 2017)
- Practical Techniques for Surveying and Monitoring Squirrels (Gurnell et al., 2009, for the Forestry Commission)

5.2.2 Survey Method and Locations

5.2.2.1 Top Up Survey Methodology (2023/2024)

A mammal survey was carried out in March 2024 by Ayesa's internal ecology team. The intention was to 'top up' the original CFRAM level surveys outlined previously. Mammals

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were surveyed through the detection of field signs and direct observations. Target notes were also taken, providing supplementary information on ecological features which were significant to specific construction proposals, or features that were too small to map.

Mammals evidence was looked for in the below original scheme area shown in Figure 5.1.

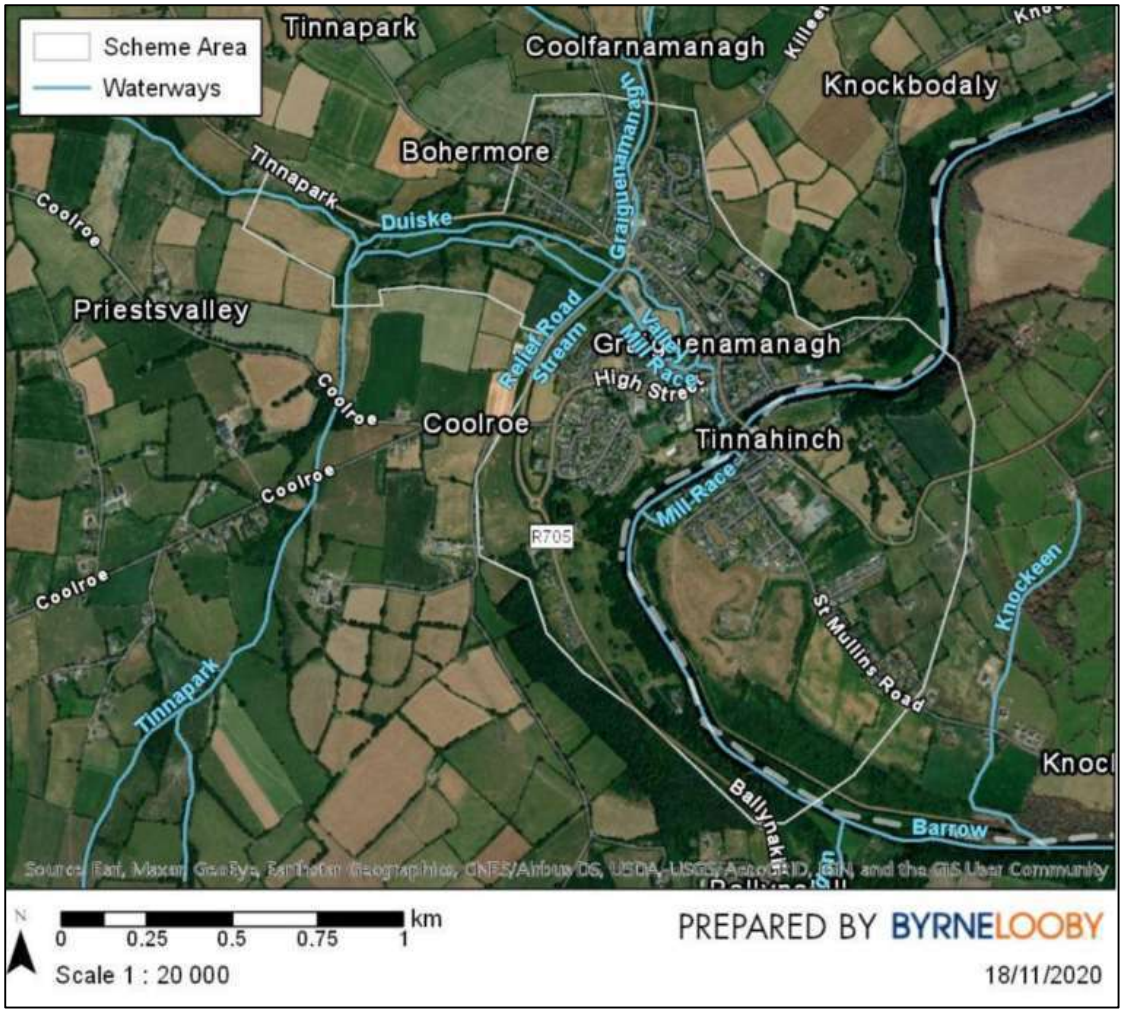

Figure 5-1. Original CFRAM Schem Area surveyed for the presence of mammals in 2021 and March 2024

5.2.2.2 Upstream Storage Area Survey Methodology 2023/2024

Site visits were carried out by Ayesa ecologists on 9th - 11th of August 2023 and 27th - 29th March 2024 to conduct specialist mammal surveys. Mammals were surveyed through the detection of field signs, mammal footprint tunnels, and by direct observations. The mammal footprint tunnels were subsequently collected on the 11th August 2023 and 29th March, and data stored for analysis. These field surveys were carried out using the methodology outlined below.

Target notes were also taken, providing supplementary information on ecological features which were significant to specific construction proposals, or features that were too small to map.

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Figure 5-2 below, provides an overview of the area extent that was surveyed for tracks and signs of mammals.

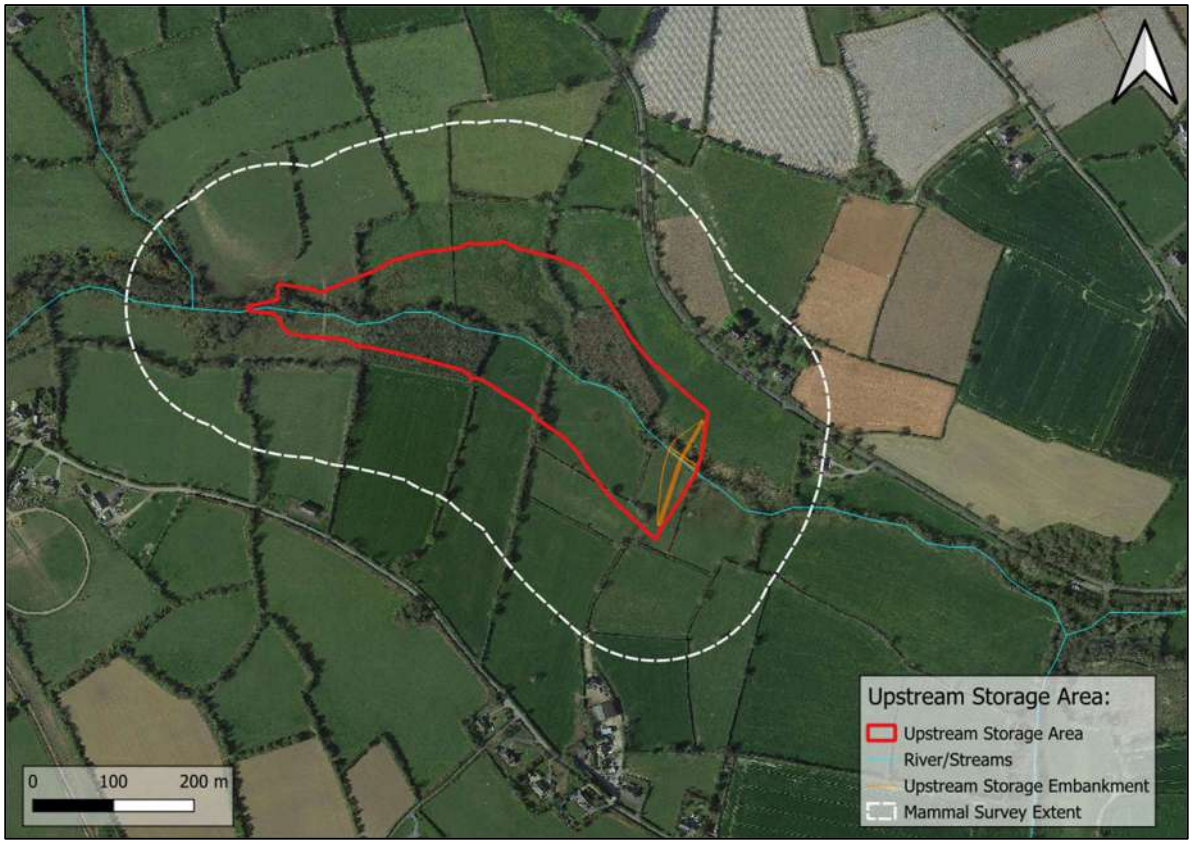

Figure 5-2: Mammal Survey Extent – Upstream Storage Area

5.2.2.3 Walkover Surveys

The ecologist noted features of interest during the field survey. In practice, the approach to this type of survey is one whereby certain features of interest are searched for and recorded as part of the mammal survey. Any features of interest were photographed, and their GPS location were recorded. Features of interest for this project were non-volant mammals, particularly otters, deer, badgers, pine martens, red squirrels, hedgehogs, Irish stoat, Irish mountain hare and pygmy shrews.

The ecologist searched and took note of the following evidence (if observed):

- Direct sightings of mammals (live or dead)
- Burrows, setts, dens, dreys, day nests, holts, and otter couches
- Prints, hair traces
- Prey/food remains
- Faeces

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- Scratching posts at the base of tree trunks
- Snuffle holes (small scrapes where badgers have searched for insects, earthworms, and plant tubers)
- Trails, paths, runs.

For badgers, pine marten, Irish stoat, red squirrel, hedgehog, and Irish hare the search area comprised all land within the Site boundary and surrounding agricultural grasslands and along both sides of the River Duiske, 600m stretch along the banks, where possible.

For otter, the search comprised all land within the Site boundary, surrounding agricultural grasslands and along both sides of the River Duiske, 600m stretch along the banks, where possible. The following guidance documents were consulted when carrying out these surveys:

- Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes (NRA, 2008)
- Guidelines for the Treatment of Badgers prior to the Construction of National Road Schemes (NRA, 2006)
- A Guide to Identifying Evidence of Pine Martens in Wales (Vincent Wildlife Trust, 2017)
- Practical Techniques for Surveying and Monitoring Squirrels (Gurnell et al., 2009, for the Forestry Commission)
- Guidelines for Ecological Impact Assessment in the UK and Ireland; Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2018)
- Lundy, M.G., Aughney, T., Montgomery, W.I., & Roche, N., (2011) Landscape conservation for Irish bats & species-specific roosting characteristics. Bat Conservation Ireland.

5.2.2.4 Mammal Footprint Tunnel Survey

The mammal footprint tunnel provides a non-invasive and effective presence/absence survey method for small mammals, particularly hedgehogs and other elusive/nocturnal mammals. For this survey, the tunnels were specifically used were to determine Otter presence. The ecologists used corrugated plastic/Corri board sheets to construct the tunnels into a triangular shape. Separately, Corri board was cut into thin trays to fit the middle section of the tunnel i.e., the bait tray (Figure 5-3). A shallow plastic bowl was secured to the centre of the bait tray and two pieces of ink pads (wash cloth cut in half) were attached either side of the bowl doused in a mix of black acrylic paint and washing up liquid (long lasting ink).

Additionally, strips of masking tape were also used to serve as ink pads by pouring the ink on top of the tape placed on either side of the bowl. Two labelled A4 sheets were secured onto the bait tray at either end to be used as the tracking paper (Figure 5-4). Dog food pouches in jelly/gravy was used as bait for the mammal tunnels. Once the bait trays were set up, they were slid back into the triangular tunnel and pegged into position using camping

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pegs in suitable sheltered locations, namely along hedgerows and riverbanks. The tunnels were left in place for one week.

Note: The mammal walks into the tunnel over the tracking sheets and then the inkpads to the shallow bowl of dog food. When the mammal exits the tunnel their pawprint now covered in ink marks the tracking paper upon exiting the tunnels, leaving the ecologists with decipherable and distinctive prints for identification.

The labelled tracking papers were then removed from the baiting trays and photographed. The ecologists used a ruler to measure the dimensions of the various footprints and used online resources to narrow down and identify which animals the tracks belong to.

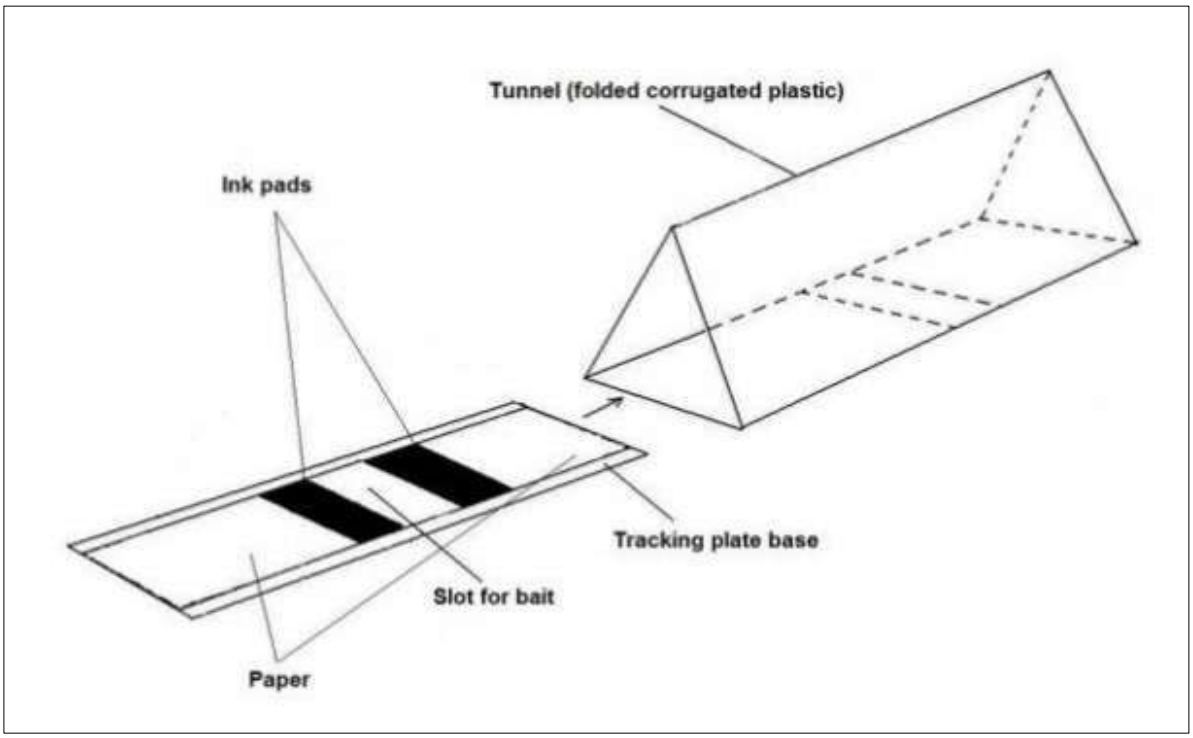

Figure 5-3: Design of the tracking tunnels and sliding baiting tray with ink pads and tracking paper used to capture the footprints of small mammals.

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Figure 5-4: Mammal Footprint Tunnels - setup and results three days later.

Figure 5-5 overleaf shows the locations of the mammal footprint tunnels. Several tunnels were installed on the righthand side of the riverbank over a stretch of over 600 metres, this accounts for areas of the river located upstream and downstream within the proposed scheme area. These tunnels' locations can give a good representation of otter activity in the area by recording areas close to the River Duiske, which the otter depends upon for feeding and travel. Other mammals such as mink (which are semi-aquatic) may also use this stretch of the river for feeding.

The tunnels were installed during daylight hours on 9th of August 2023 and were collected on the morning of 11th August 2023. Therefore, the prints recorded from the tunnels are representing two full nights of mammal activity (most mammal activity (foraging etc.) occurs during the night).

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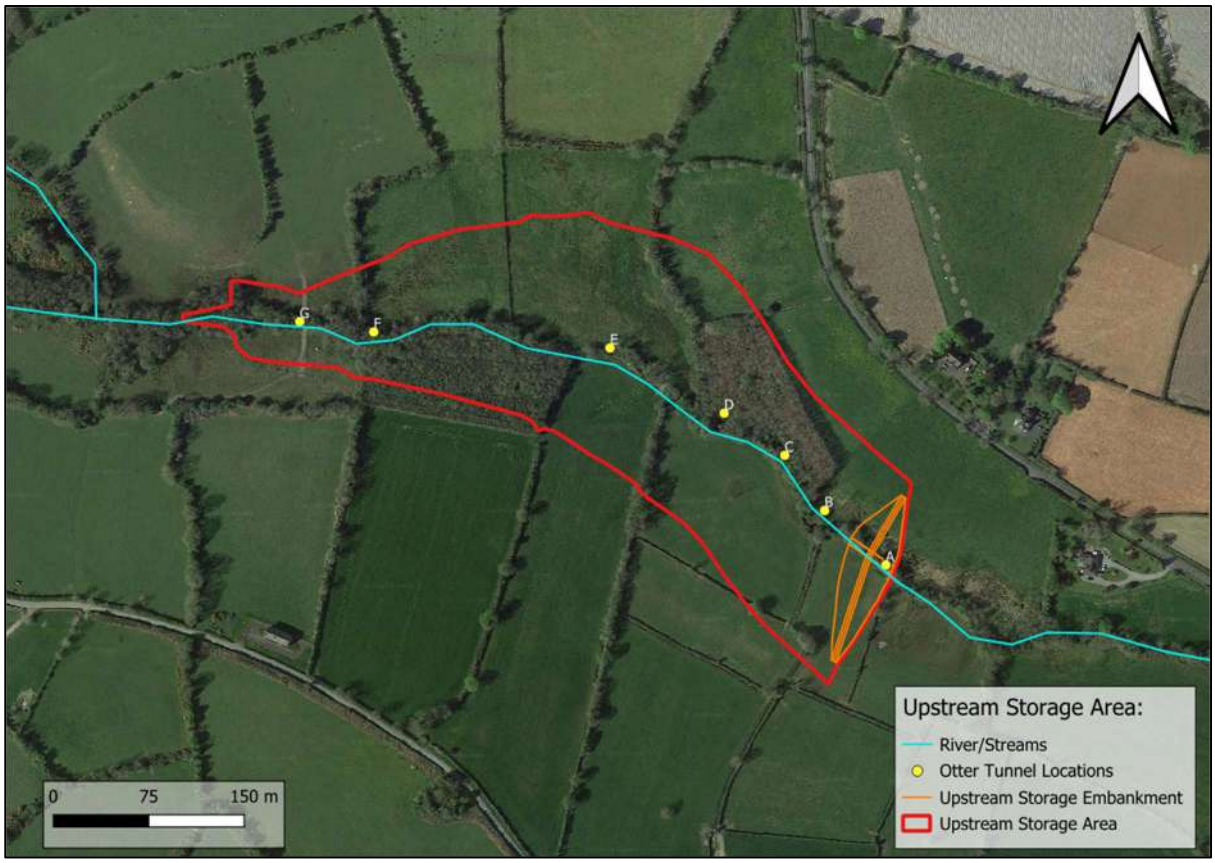

Figure 5-5: Location of Mammal Footprint Tunnels.

The following guidance documents were used when identifying footprints recorded in the tunnels:

- How to Read Prints from Tracking Tunnels – MothNet (2018)
- Pest Detective (Culprits). Available online at: https://www.pestdetective.org.nz/culprits/
- Identify-tracks (The Wildlife Trust, 2023). Available online at: https://www.wildlifetrusts.org/how-identify/identify-tracks

5.2.2.5 Survey/Data Limitations/Constraints

The following limitations are recognised:

- Nocturnal and/or rare and cryptic mammals such as otter, badger, Irish stoat (though not strictly nocturnal, much of their hunting occurs at night), hedgehog, and pine marten (largely nocturnal) cannot be enumerated by direct observations. True representation of species presence/absence and abundance cannot be achieved as a result of this limitation.
- Ecological survey timing and seasonal constraints providing limited or preliminary data –many protected faunal species are also seasonally constrained with survey timing; potential limitations included periods of hibernation, seasons of low activity (certain

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species only emerging in certain seasons), and outside the breeding season (high activity).

- Areas that were inaccessible during the mammal surveys; e.g., certain portions of the the banks along the River Duiske. Therefore, species may have been present on-site but were missed as the Site walkover was difficult to access for assessment/evaluation.

- As mammals are highly mobile species, covering large ranges for hunting/foraging, evidence/live sightings of the species such as the deer, badger, pine marten, otter, etc. may have been missed.

- Data limitations of the biological records may not be relied upon as a present-day/updated representation of presence/absence and/or distribution of species. The records can provide indications of the likely presence/absence of species within the Site and the surrounds. However, it should be noted the absence of records for protected species does not equate to evidence of their absence from the area. In addition, variability can occur in the accuracy of online records, and their point counts/observations are often georeferenced to the nearest 1km grid square.

Despite the above-mentioned limitations, a robust understanding of the site's ecology from the mammal survey was obtained.

5.3 Survey Results

5.3.1.1 Original CFRAM Survey (2021)

Evidence of otter was observed during the 2021 survey, presented in the table and figure below. Photographic evidence is included in Appendix I.

Table 5-1. Field Survey - Evidence of Otters

ID	Coordinates (ITM)	Notes
1	670659, 643367	Potential holts on the River Barrow. Located where mill race goes under the R705 near Aldi. This area is extremely dry due to the shelter of the overpass – there is very little vegetation, and the soil is very loose. There are a number of scars in the embankment where it seems otters have attempted to burrow, but the soil was too unstable to sustain a solid tunnel and kept collapsing. For this reason, the BL ecologists note that it is unclear if any of these were ever viable holts (see Figure 6.5).
2	670526, 644040	Potential couch on Duiske River – adjacent to where the mill race joins the canal by Tinnahinch Castle (see Figure 6.4).
3	670624, 643195	Potential spraint on the River Barrow. It had a grainy texture common with otter spraints, but had a pale colour that suggested that it may simply be dog faeces. Located on a clump of grass on the riverbank (see Figure 6.6).

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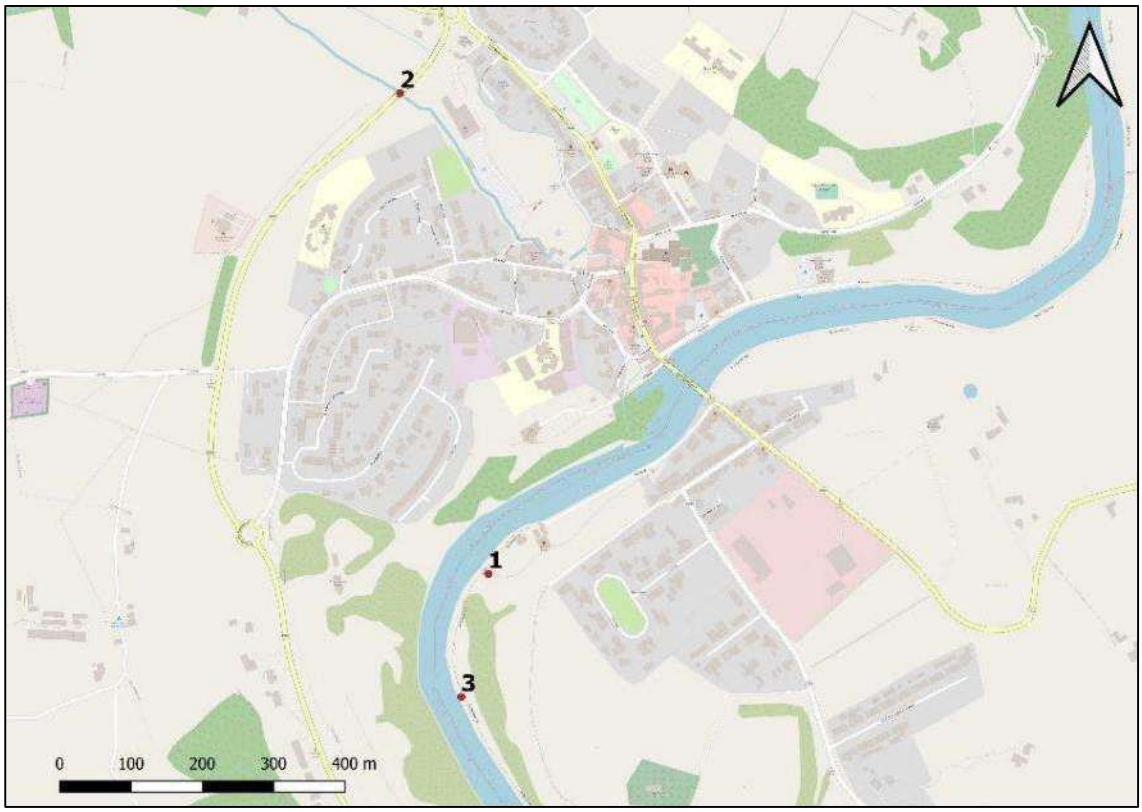

Figure 5-6. Locations of Otter Evidence

Faeces of the Eurasian rabbit (*Oryctolagus cuniculus*) were observed in the field adjoining the Killeen Stream at the northern end of the scheme area.
No evidence of red squirrel (*Sciurus vulgaris*), pine marten (*martes martes*) or badger (*meles meles*) activity was observed during the field surveys.

5.3.2 Upstream Storage Area (2023)

Evidence of non-volant mammals was observed in several locations throughout the site. Images of mammal evidence is shown in Appendix I. Primarily, there was evidence to suggest the presence of badger, as observed through the presence of scat and footprints (see Appendix I). There was no evidence of otter, fox, mink, pine martin or other small carnivorous mammals observed throughout the proposed development site, however. The above-mentioned evidence of mammal activity is mapped in Figure 5.7 below.

5.3.3 Top Up Survey (2024)

Evidence of non-volant mammals was observed in several locations throughout the site. Images of mammal evidence is shown in Appendix I. Primarily, there was evidence to suggest the presence of badger, as observed through the presence of footprints (see Appendix I). Fish remains were seen on the bank of the River Barrow close to the town centre. This may be as result of an otter or mink foraging in the area. There was no evidence of fox, pine martin or other small carnivorous mammals observed throughout the proposed development site, however. The above-mentioned evidence of mammal activity is mapped in Figure 5.7 below.

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Figure 5-7. Mammal evidence within the upstream storage area and the original Graiguenamanagh/Tinnahinnch CFRAM scheme area 2023/2024

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6 Herpetofauna Surveys

6.1 Overview

6.1.1 Original CFRAM Survey (2021)

Ayesa's internal ecologist team completed a single herpetofauna observation survey in February 2021. The original survey was undertaken with the CFRAM Study Area extent in mind, within the towns of Graiguenamanagh and Tinnahinch. The results of the survey are outlined in Section 6.3 of this Report.

6.1.2 Upstream Storage Area (2023/2024)

A herpetofauna survey was undertaken by Ayesa's internal ecology team in March 2024. The results of this surveys are outlined in Section 6.3 of this Report.

6.1.3 Top up Survey (2023/2024)

A survey was not recommended within the towns of Graiguenamanagh and Tinnahinch, as no suitable habitat was noted. This recommendation is detailed further in the report contained under Appendix A.

However, given historical observations made in 2021, the Environmental Impact Assessment Report (EIAR) will assume presence of spring-spawning herpetofauna within the project area, and will include appropriate pre-construction mitigation as a matter of course.

6.2 Survey Methodology

This survey relied on the field on the identification of amphibian populations at their breeding sites. Reliably detecting amphibian populations in terrestrial habitats away from their breeding sites or at other times of year requires a substantial amount of survey effort (and is simply not possible during the hibernation period) and therefore should be avoided wherever possible. Key cards were used onsite to help identify any amphibians and/or their associated spawn during the survey.

6.3 Survey Results

6.3.1.1 Original CFRAM Survey (2021)

Evidence of common frog was observed upstream of Graiguenamanagh Bridge, as presented in the table and figures below.

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Table 6-1: Field Records - Common Frog

ID	Coordinates (ITM)	Notes
1	671192, 643714	Frogspawn. Located in small area of reed swamp (see section 4.1.4). See photograph – Figure 6.11
2	671349, 643713	Frogspawn. Located on leaf litter, creeping buttercup and cleavers – not in standing water (see Figure 6.12)

Figure 6-1: Locations of common frog spawn sightings

Figure 6-2: Frogspawn (ID-1) – 16.02.21

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Figure 6-3: Frogspawn (ID-2) – 16.02.21

6.3.2 Upstream Storage Area (2024)

No evidence of amphibians and/or their associated spawn was found in the upstream storage area during the 2024 survey. There was also a lack of potential spawning habitat observed within this area.

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7 Flora Surveys

7.1 Overview

7.1.1 Original CFRAM Survey (2021)

Ayesa's internal ecologist team completed a single flora observation survey in February 2021. The original survey was undertaken with the CFRAM Study Area extent in mind, within the towns of Graiguenamanagh and Tinnahinch. The results of the survey are outlined in Section 7.3 of this Report.

7.1.2 Upstream Storage Area (2023/2024)

A dedicated survey for flora was not considered a requirement for the upstream storage area, however observations were made as part of a Habitats and Species Walkover in January 2023. The results of the survey are outlined in Section 7.3 of this Report.

7.1.3 Top up Survey (2023/2024)

A flora survey was undertaken by Ayesa's internal ecology team in June 2024. The intention was to 'top up' the original CFRAM level surveys outlined above. The results of this survey are outlined in Section 7.3 of this Report.

7.2 Survey Methodology

A complete inventory was made of all flora species observed within the survey areas. Each species was cross-referenced with the Third Schedule of the Birds and Natural Habitats Regulations (invasive species), the Flora (Protection) Order, 2022, and Ireland Red List No. 10: Vascular Plants (Wyse Jackson et al., 2015).

7.3 Survey Results

7.3.1 Original CFRAM Survey (2021)

No flora species of conservation interest were observed. This includes all species listed in Schedules A and B of the Flora (Protection) Order 2015 (S.I. No. 356/2015).

Plant species observed in the survey area are outlined in the table below.

Table 7-1: Plant Species Present in Survey Area

Common Name	Scientific Name
TREES	
Sycamore	*Acer pseudoplatanus*
Horse chestnut	*Aesculus hippocastanum*
Alder	*Alnus glutinosa*

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Common Name	Scientific Name
Silver birch	*Betula pendula*
Downy birch	*Betula pubescens*
Birch species	*Betula sp.*
Cypress species	*Chamaecyparis sp.*
Hawthorn	*Crataegus monogyna*
Beech	*Fagus sylvatica*
Ash	*Fraxinus excelsior*
Blackthorn	*Prunus spinosa*
Sessile oak	*Quercus petraea*
Pedunculate oak	*Quercus robur*
Oak species	*Quercus sp.*
Willow species	*Salix sp.*
Grey willow	*Salix cinerea*
Crack willow	*Salix fragilis*
Yew	*Taxus baccata*
Irish Yew	*Taxus baccata* 'fastigiata'
SHRUBS	
Butterfly bush	*Buddleja davidii*
Holly	*Ilex aquifolium*
Cherry Laurel	*Prunus laurocerasus*
Bramble	*Rubus fruticosus agg.*
Gorse	*Ulex europaeus*
Rose species	*Rosa* spp.
Box	*Buxus sempervirens*
CLIMBERS	
Hedge Bindweed	*Calystegia sepium*
Old man's beard	*Clematis vitalba*
Ivy	*Hedera helix*
Honeysuckle	*Lonicera periclymenum*
GRASSES	
Common bent	*Agrostis capillaris*
Cock's-foot	*Dactylis glomerata*
Yorkshire fog	*Holcus lanatus*
Perennial rye grass	*Lolium perenne*
Common reed	*Phragmites australis*
Annual meadow grass	*Poa annua*
RUSHES	
Soft rush	*Juncus effusus*
AQUATIC PLANTS	
Crowfoot species	*Ranunculus* sp.
HERBS	
Ground elder	*Aegopodium podagraria*
Wild cabbage	*Brassica oleracea*
Wild turnip	*Brassica rapa*
Ivy-leaved toadflax	*Cymbalaria muralis*
Wild angelica	*Angelica sylvestris*
Cow parsley	*Anthriscus sylvestris*
Lords-and-ladies	*Arum maculatum*
Daisy	*Bellis perennis*
Wavy bitter-cress	*Cardamine flexuosa*

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Common Name	Scientific Name
Hairy bitter-cress	*Cardamine hirsuta*
Common mouse-ear	*Cerastium fontanum*
Rosebay willowherb	*Chamerion angustifolium*
Opposite-leaved golden-	*Chrysosplenium oppositifolium*
Creeping thistle	*Cirsium arvense*
Marsh thistle	*Cirsium paluste*
Foxglove	*Digitalis purpurea*
Great willowherb	*Epilobium hirsutum*
Broad-leaved willowherb	*Epilobium montanum*
Square-stalked willowherb	*Epilobium tetragonum*
Japanese knotweed	*Fallopia japonica*
Meadowsweet	*Filipendula ulmaria*
Cleavers	*Galium aparine*
Dove's foot crane's bill	*Geranium molle*
Herb-robert	*Geranium robertianum*
Wood avens	*Geum urbanum*
Giant rhubarb	*Gunnera tinctoria*
Hogweed	*Heracleum sphondylium*
Bluebell	*Hyacinthoides non-scripta*
Hamalyan balsam	*Impatiens glandulifera*
Yellow iris	*Iris pseudacorus*
Red dead-nettle	*Lamium purpureum*
Great woodrush	*Luzula sylvatica*
Water forget-me-not	*Myosotis scorpioides*
Forget-me-not species	*Myosotis* spp.
Hemlock water-dropwort	*Oenanthe crocata*
Ribwort plantain	*Plantago lanceolata*
Silverweed	*Potentilla anserina*
Creeping cinquefoil	*Potentilla reptans*
Primrose	*Primula vulgaris*
Selfheal	*Prunella vulgaris*
Winter heliotrope	*Petasites pyrenaicus*
Meadow buttercup	*Ranunculus acris*
Lesser celandine	*Ranunculus ficaria*
Creeping buttercup	*Ranunculus repens*
Common sorrel	*Rumex acetosa*
Curled dock	*Rumex crispus*
Broad-leaved dock	*Rumex obtusifolius*
Water figwort	*Scrophularia auricularia*
Common ragwort	*Senecio jacobaea*
Groundsel	*Senecio vulgaris*
Smooth sow-thistle	*Sonchus oleraceus*
Russian comfrey	*Symphytum x uplandicum*
Dandelion	*Taraxacum officinalis agg.*
White clover	*Trifolium repens*
Navelwort	*Umbilicus rupestris*
Common nettle	*Urtica dioica*
Brooklime	*Veronica beccabunga*
Germander speedwell	*Veronica chamaedrys*
Wood speedwell	*Veronica montana*
Common vetch	*Vicia sativa*

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Common Name	Scientific Name
Bush vetch	*Vicia sepium*
Dog violet	*Viola riviniana*
FERNS & ALLIES	
Scaly male fern	*Dryopteris affinis*
Southern polypody	*Polypodium cambricum*
Polypody	*Polypodium vulgare*
Bracken	*Pteridium aquilinum*
Water horsetail	*Equisetum fluviatile*
MOSSES *	
Brachythecium species	
Grimmia pulvinata	
Tortula muralis	

* This represents those species positively identified by surveyors and is not intended to provide a complete list.

Invasive species, including Himalayan Balsam, Japanese Knotweed and Giant Rhubarb were observed.

7.3.2 Top Up Survey (2024)

No flora species of conservation interest were observed. This includes all species listed in Schedules A and B of the Flora (Protection) Order 2015 (S.I. No. 356/2015).

Plant species observed in the survey area are outlined in the table below.

Table 7-2. Plant Species Present in Survey Area

Common Name	Scientific Name
Trees	
Sycamore	*Acer pseudoplatanus*
Horse chestnut	*Aesculus hippocastanum*
Alder	*Alnus glutinosa*
Silver birch	*Betula pendula*
Downy birch	*Betula pubescens*
Lime	*Tilia cordata*
Cypress species	*Chamaecyparis sp.*
Hawthorn	*Crataegus monogyna*
Beech	*Fagus sylvatica*
Ash	*Fraxinus excelsior*
Blackthorn	*Prunus spinosa*
Sessile oak	*Quercus petraea*

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Pedunculate oak	*Quercus robur*
Rowan	*Sorbus aucuparia*
Grey willow	*Salix cinerea*
Crack willow	*Salix fragilis*
Bay Willow	*Salix pentandra*
Hazel	*Corylus avellana*
Eastern Hornbeam	*Ostrya virginiana*
Italian Alder	*Alnus cordata*
Scots Pine	*Pinus sylvestris*
Shrubs	
Butterfly bush	*Buddleja davidii*
Holly	*Ilex aquifolium*
Cherry Laurel	*Prunus laurocerasus*
Bramble	*Rubus fruticosus agg.*
Gorse	*Ulex europaeus*
Rose species	*Rosa* spp.
Box	*Buxus sempervirens*
Climbers	
Hedge Bindweed	*Calystegia sepium*
Old man's beard	*Clematis vitalba*
Ivy	*Hedera helix*
Honeysuckle	*Lonicera periclymenum*
Virginia Creeper	Parthenocissus quinquefolia
Grasses	
Common bent	*Agrostis capillaris*
Cock's-foot	*Dactylis glomerata*
Yorkshire fog	*Holcus lanatus*
Perennial rye grass	*Lolium perenne*
Common reed	*Phragmites australis*
Annual meadow grass	*Poa annua*
Rushes	
Soft rush	*Juncus effusus*
Great Wood	
Herbs	
Ground elder	*Aegopodium podagraria*
Wild cabbage	*Brassica oleracea*
Wild turnip	*Brassica rapa*

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Navelwort	*Umbilicus rupestris*
Ivy-leaved toadflax	*Cymbalaria muralis*
Wild angelica	*Angelica sylvestris*
Cow parsley	*Anthriscus sylvestris*
Lords-and-ladies	*Arum maculatum*
Daisy	*Bellis perennis*
Wavy bitter-cress	*Cardamine flexuosa*
Hairy bitter-cress	*Cardamine hirsuta*
Common mouse-ear	*Cerastium fontanum*
Rosebay willowherb	*Chamerion angustifolium*
Opposite-leaved golden-saxifrage	*Chrysosplenium oppositifolium*
Creeping thistle	*Cirsium arvense*
Marsh thistle	*Cirsium paluste*
Foxglove	*Digitalis purpurea*
Great willowherb	*Epilobium hirsutum*
Broad-leaved willowherb	*Epilobium montanum*
Square-stalked willowherb	*Epilobium tetragonum*
Japanese knotweed	*Fallopia japonica*
Meadowsweet	*Filipendula ulmaria*
Cleavers	*Galium aparine*
Herb-robert	*Geranium robertianum*
Wood avens	*Geum urbanum*
Hogweed	*Heracleum sphondylium*
Bluebell	*Hyacinthoides non-scripta*
Yellow iris	*Iris pseudacorus*
Water forget-me-not	*Myosotis scorpioides*
Hemlock water-dropwort	*Oenanthe crocata*
Ribwort plantain	*Plantago lanceolata*
Silverweed	*Potentilla anserina*
Creeping cinquefoil	*Potentilla reptans*
Primrose	*Primula vulgaris*
Selfheal	*Prunella vulgaris*
Winter heliotrope	*Petasites pyrenaicus*
Meadow buttercup	*Ranunculus acris*
Lesser celandine	*Ranunculus ficaria*
Creeping buttercup	*Ranunculus repens*
Common sorrel	*Rumex acetosa*

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Curled dock	*Rumex crispus*
Broad-leaved dock	*Rumex obtusifolius*
Water figwort	*Scrophularia auricularia*
Common ragwort	*Senecio jacobaea*
Groundsel	*Senecio vulgaris*
Smooth sow-thistle	*Sonchus oleraceus*
Russian comfrey	*Symphytum x uplandicum*
Dandelion	*Taraxacum officinalis agg.*
White clover	*Trifolium repens*
Navelwort	*Umbilicus rupestris*
Common nettle	*Urtica dioica*
Brooklime	*Veronica beccabunga*
Germander speedwell	*Veronica chamaedrys*
Wood speedwell	*Veronica montana*
Common vetch	*Vicia sativa*
Bush vetch	*Vicia sepium*
Dog violet	*Viola riviniana*
Common Reed	*Phragmites australis*
Meadow sweet	*Filipendula ulmaria*
Ragwort	*Jacobaea vulgaris*
Himalayan Balsam	*Impatiens glandulifera*
Winter Heliotrope	*Petasites pyrenaicus*
Field Mustard	*Brassica rapa*
Bearberry cotoneaster	*Cotoneaster dammeri*
Large leaf spindle	*Euonymus europaeus*
Water horsetail	*Equisetum fluviatile*
Scarlet pimpernel	*Anagallis arvensis*
Rugosa rose	*Rosa rugosa*
Common forget - me - not	*Myosotis scorpioides*
Mallow Common	*Malva sylvestris*
Field horsetail	*Equisetum arvense*
Snowberry	*Symphoricarpos albus*
Fushia	*Fuchsia magellanica*
Honeysuckle	*Lonicera periclymenum*
Pineapple weed	*Matricaria discoidea*
Aquatic Plants	
Water Crowfoot	*Ranunculus aquatilis*
Ferns	

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Maidenhair spleenwort	*Asplenium trichomanes*
Scaly male fern	*Dryopteris affinis*
Southern polypody	*Polypodium cambricum*
Polypody	*Polypodium vulgare*
Bracken	*Pteridium aquilinum*
Hart's-tongue fern	*Asplenium scolopendrium*
Mosses	
	Brachythecium species
	Grimmia pulvinata
	Tortula muralis

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8 Water Quality / Q-Value Surveys

8.1 Overview

8.1.1 Original CFRAM Survey (2021)

This survey was completed externally by AQUAFACT in February 2021. The results of the survey are outlined in AQUAFACT's survey report, included in Appendix J.

8.1.2 Upstream Storage Area (2023)

This survey was completed externally by APEM in August 2023. The results of the survey are outlined in APEM's survey report, included in Appendix K.

8.1.3 Top Up Survey (2024)

A Q-value survey was undertaken by Ayesa's internal ecology team in June 2024. The intention was to 'top up' the original CFRAM level surveys outlined above. The results of this survey are outlined in Section 8.3 of this Report.

8.2 Survey Methodology

Five kick samples were taken, see Figure 8.1 and Table 8.1. Stream morphology at each station can be seen in Table 8.2. The two-minute kick and one minute stone wash sampling method was employed to collect samples of macroinvertebrates for analysis. This involved placing a standard hand net of pore size 500µm in the river, facing upstream and disturbing the riverbed in front of the net mouth. The ecologist then moved in a diagonal direction upstream to ensure that different micro-habitats were included in the sample. The kick method dislodges macroinvertebrates from the substrates and submerged plant material. This was continued for approximately two minutes and followed by one minute of stone washing.

The resulting sample was transferred from the net to a plastic bucket, then placed into a white sorting tray allowing for the bankside assessment to take place. The freshwater invertebrates were then assigned to the suitable indicator group. The derived species list was then used to assign a Biotic Index value (Q-Value) to the sampled streams.

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Due to the depth of the River Barrow in the “Upstream” location that Aquafact performed a kick sample in 2021, it was not possible to use this station for the top-up survey. This section of river was also in flood and could not be sampled for health and safety reasons.

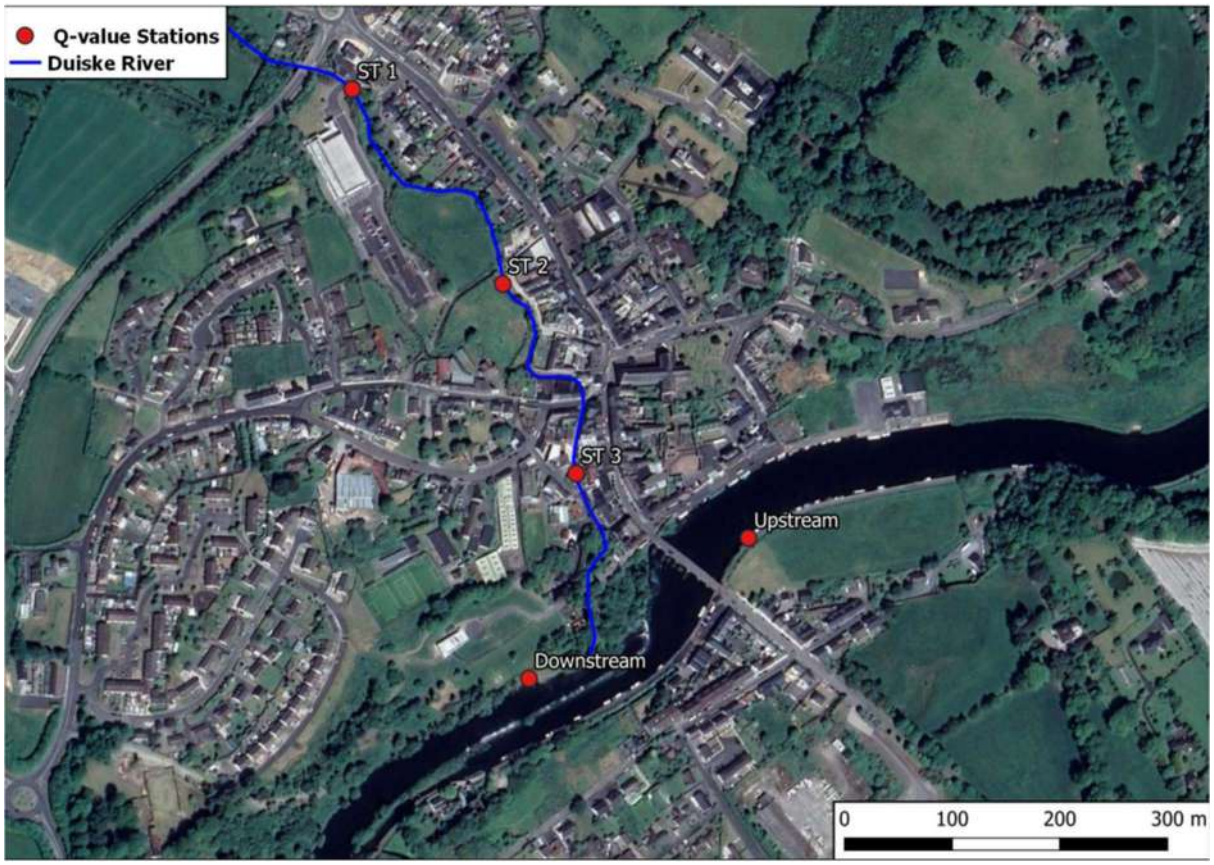

Figure 8.1. Graiguenamanagh Q-value station locations.

Table 8-1. Q-value station coordinates for Graiguenamanagh.

Station	GPS Coordinate
ST1	52.543472, -6.958914
ST2	52.541958, -6.956879
ST3	52.540334, -6.955860
Downstream	52.538656, -6.955710

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Table 8-2. Stream Morphology

Station	Width (m)	Depth (cm)	Substrate	Flow
ST1	2.8	49	Cobbles	Flood
ST2	3.4	44	Cobbles	Flood
ST3	5.2	36	Cobbles	Flood
Downstream	56	>120	Mud	Flood

8.3 Survey Results

8.3.1 Original CFRAM Survey (2021)

Included in Appendix J.

8.3.2 Upstream Storage Area (2023)

Included in Appendix K.

8.3.3 Top Up Survey (2024)

Photographs and examples species recorded at each station are included in Appendix L. Stations 1 to 3 were taken from the Duiske River. Station 1 located to the north of Graiguenamanagh town recorded a Q-value of 3, which was the lowest of any of the stations. Stations 2 and 3 both recorded an intermediate Q3-4. One station was sampled in the River Barrow, station 4 located downstream of the weir. Station 4 recorded an intermediate Q-value of 4-5 (Table 8.2). All species recorded where typical of the habitats sampled. Species composition recorded at station 2 and 3 is as expected for a slightly polluted status with only a few sensitive species present and in low numbers.

Table 8.2. Biological sampling results.

Station	Q-Value
ST 1	Q3
ST 2	Q3-4
ST 3	Q3-4
Downstream	Q4-5

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9 Fisheries Surveys

9.1.1 Original CFRAM Survey (2021)

An electrofishing survey was completed externally by AQUAFACT in February 2021. The results of the survey are outlined in APEM's survey report, included in Appendix M.

9.1.2 Upstream Storage Area (2023)

A fish habitat survey was completed externally by APEM in August 2023. The results of the survey are included in APEM's survey report, included in Appendix K.

Given the availability of electrofishing data both collected as part of the Scheme, and available from Inland Fisheries Ireland (IFI), the conduct of electrofishing surveys was not considered a requirement. This decision was accepted by IFI, as outlined in the report in Appendix K.

9.1.3 Top Up Survey

No notable qualitative changes to any habitats in the study area have been noted and, from secondary review, no significant pollution events occurred in either river since 2021. For this reason, and the availability of recent electrofishing data, additional fish habitat and electrofishing surveys were not considered a requirement. This recommendation is detailed further in the report contained under Appendix A.

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10 White-Clawed Crayfish Surveys

10.1.1 Original CFRAM Survey (2021)

A white-clawed crayfish survey (including trapping, hand-searching, sweep-netting, snorkeling and eDNA analysis) was completed externally by Triturus Environmental Ltd. in April 2021. The results of the survey are outlined in Triturus Environmental Ltd.'s survey report, included in Appendix N.

10.1.2 Upstream Storage Area (2023)

A white-clawed crayfish survey (including trapping and hand-searching) was completed externally by APEM in August 2023. The results of the survey are included in APEM's survey report, included in Appendix K.

10.1.3 Top Up Survey

In the original survey completed in 2021, no white-clawed crayfish were recorded via hand-searching/sweep netting and eDNA samples returned a negative result for white-clawed crayfish and crayfish plague eDNA. Therefore, additional surveys were not considered a requirement. This recommendation is detailed further in the report contained under Appendix A.

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11 Freshwater Peal Mussel Surveys

11.1 Original CFRAM Survey (2021)

A freshwater pearl mussel survey (including bathyscope surveying, snorkeling and SCUBA diving techniques and eDNA analysis) was completed externally by Triturus Environmental Ltd. in April 2021. The results of the survey are outlined in Triturus Environmental Ltd.'s survey report, included in Appendix O.

11.2 Upstream Storage Area

During the original survey completed in 2021, no live or dead freshwater pearl mussels were recorded via bathyscope survey or snorkelling and eDNA samples returned a negative result for freshwater pearl mussel eDNA. Therefore, dedicated surveys for the upstream storage area were not considered a requirement. This recommendation is detailed further in the report contained under Appendix A.

11.3 Top Up Survey

As above.

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12 Arboreal Surveys

An arboreal survey was completed at both the upstream storage area and within the towns of Graiguenamanagh and Tinnahinch in May 2023 and November/December 2023/2024 by Veon. The methodology and results of the survey are included in Veon's survey report, included in Appendix P.

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13 Conclusion

This ecological survey report for Graiguenamanagh FRS has provided up to date ecological information of the site regarding bats, birds, mammals, herpetofauna, flora, and aquatic surveys that have been undertaken as part of the scheme. This has ensured that the environmental assessment has been carried out with reliable up-to-date baseline information, and that any concerns from stakeholders (namely NPWS) are considered as part of the EIAR.

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Appendix A: Report on the Requirement for Ecology ‘Top Up’ Surveys (BL/AQUAFACT, 2023)

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Graiguenamanagh-Tinnahinch Flood Relief Scheme

Report on the Requirement for Ecology 'Top Up' Surveys

Kilkenny County Council

Report No. W3451-ENV-R013
18 October 2023
Revision 00

CARLOW COUNTY COUNCIL

Kilkenny County Council
Comhairle Chontae Chill Chainnigh

OPW

Tionscadal Éireann
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Disclaimer: Please note that this report is based on specific information, instructions, and information from our Client and should not be relied upon by third parties.					

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1. Introduction & Context

1.1. Project History

Kilkenny County Council (KCC), through partnership with the Office of Public Works (OPW) and Carlow County Council (CCC), is progressing the Graiguenamanagh-Tinnahinch Flood Relief Scheme (GTFRS) (hereafter referred to as the 'Proposed Scheme'). KCC progressed the scheme to address the high levels of flood risks in Graiguenamanagh and Tinnahinch, under the EC Directive on the Assessment and Management of Flood Risks 2007 and the EU Floods Directive, as implemented in Ireland by SI 122 of 2010 EC Regulations 2010 and SI 495/2015.

KCC has commissioned ByrneLooby (BL) to develop and implement the GTFRS. AQUAFACT is on board as the lead ecologist on the Project and previously carried out a set of ecological surveys for the Proposed Scheme in 2020 and 2021 along and within the River Barrow and River Duiske within the Scheme Area (see Figure 1 and AQUAFACT reports 2020/2021).

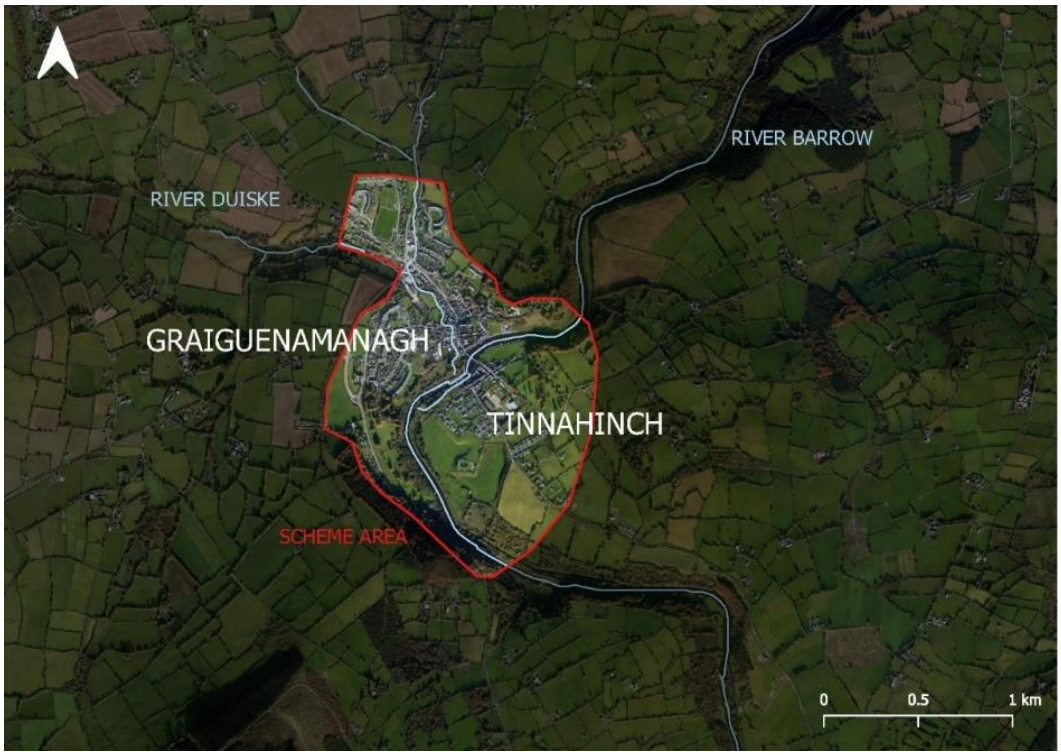

Figure 1. Scheme Area

1.2. Objectives of this Report

From the conduct of the original set of surveys in 2020/2021, the Proposed Scheme has been undergoing extensive optioneering and engineering design as well as stakeholder engagement and as such, has delayed the delivery of the Planning Application and therefore Environmental Impact Assessment Report (EIAR). As a result, ByrneLooby is currently reviewing the lifespan of a series of ecological surveys conducted for the Proposed Scheme in 2020/2021 in order to determine whether, in accordance with available and applicable advice, additional surveys are required to provide up-to-date baseline information for input into the EIAR. Given the lack of national guidance and/or legislation on the matter, the Advice Note from the Chartered Institute of Ecology and Environmental Management (CIEEM) 'on the Lifespan of Ecological Reports & Surveys' (April 2019) has been referenced. Here, for surveys that are 18 months to 3 years old (as is the case for the majority of surveys for the Proposed Scheme, see Table 1 below), the following is advised:

'A professional ecologist will need to undertake a site visit and may also need to update desk study information (effectively updating the Preliminary Ecological Appraisal) and then review the validity of the report, based on the factors listed below. Some or all of the other ecological surveys may need to be updated. The professional ecologist will need to issue a clear statement, with appropriate justification, on:

- *The validity of the report;*
- *Which, if any, of the surveys need to be updated; and*
- *The appropriate scope, timing and methods for the update survey(s).*

The likelihood of surveys needing to be updated increases with time and is greater for mobile species or in circumstances where the habitat or its management has changed significantly since the surveys were undertaken. Factors to be considered include (but are not limited to):

- *Whether the site supports, or may support, a mobile species which could have moved on to site, or changed its distribution within a site (see scenario 1&2 examples);*
- *Whether there have been significant changes to the habitats present (and/or the ecological conditions/functions/ecosystem functioning upon which they are dependent) since the surveys were undertaken, including through changes to site management (see scenario 3 example);*

- *Whether the local distribution of a species in the wider area around a site has changed (or knowledge of it increased), increasing the likelihood of its presence.'*

AQUAFACT has therefore been commissioned to provide the above services, including a re-survey in same section of the river by means of a walk over (to determine if there were any substantial visual changes in ecological conditions), to review historical surveys undertaken and their respective reports and to make recommendations as to whether or not these require re-survey, given the passage of time since they were carried out. The surveys undertaken previously are outlined in the table below.

Survey Type	Survey Date	Age (CIEEM, 2019)
Bat Survey	14-16/09/2020	>3 years
Wintering Bird Survey	16-18/02/2021	18 months – 3 years
Breeding Bird Survey	02/04/2021	18 months – 3 years
Mammal Survey (including otter, badger, pine martin, red squirrel).	16-18/02/2021	18 months – 3 years
Herpetofauna Survey	16-18/02/2021	18 months – 3 years
Flora Survey	16-18/02/2021	18 months – 3 years
Q values/invertebrates Survey	08/02/2021	18 months – 3 years
Electrofishing Survey	10/02/2021	18 months – 3 years
White-Clawed Crayfish (eDNA sampling and testing)	29/04/2021	18 months – 3 years
Freshwater Pearl Mussel (eDNA sampling and testing)	30/04/2021	18 months – 3 years
Trees	June 2023	<12 months

Table 1. Survey History for the Proposed Scheme

When these initial surveys were completed in 2020/2021, the options identified in the CFRAM level assessment included defences within the environs of the town of Graiguenamanagh-Tinnahinch and therefore, all surveys were undertaken within the study area identified in Figure 1 only. Through project level optioneering and engineering and stakeholder engagement, the inclusion of an upstream storage facility was identified as a benefit to the scheme. The area that this is proposed to encompass is currently (summer 2023) undergoing ecology surveying for mammals, breeding birds, bats, herpetofauna, Q-value and invertebrates, water quality and fisheries habitat. Therefore, the recommendations made in this report are only in relation to those historical surveys undertaken within the town.

With regard to alien species, AQUAFACT was instructed not to comment on these as there is regular on-going treatment with concurrent reporting, in accordance with a specific Invasive Alien Species Management Plan.

This report documents the main findings of the abovementioned walkover, and comments upon the requirement to re-survey specific specialised ecology. The walkover and provision of recommendations in this report have been carried out by Dr. Brendan O'Connor who has 38 years' experience as an ecologist.

1.3. Brief Scheme Description

A scheme option was identified at the CFRAM level of assessment. Following this, a project-level options assessment has been conducted to reassess and consider all possible measure to reduce flood risk, not just those in the CFRAM assessment. Development was based on more detailed information than was available for the CFRAM, including detailed hydrological assessment, hydraulic modelling studies and environmental studies.

Five (nos. 5) options were identified and assessed through Multi-Criteria Assessment (MCA) and engineering optioneering and were presented for public and stakeholder engagement in August 2022. Combining objective analysis and professional judgement, with reference to the information gathered through the environmental assessment and public consultation, the preferred option was determined.

The Proposed Scheme consists of a series of raised defences (stone/glass barriers and embankments) along the River Duiske and the River Barrow. It further includes upstream storage of flood waters (upstream on the River Duiske) to facilitate a reduced extent of flood walls downstream in the built-up area of Graiguenamanagh.

2. Site Walkover (2023)

As mentioned, an updated walkover survey was conducted by Brendan O'Connor on August 9th, 2023. Weather on the day was mostly cloudy also but with some sunny spells. There was no rain. The walkover survey involved examining and recording the habitats and flora and fauna that are present along the riverbank and photographing representative elements of these. All floral identifications were made in the field and binoculars were used to identify birds.

2.1. General Observations

The August 2023 walkover survey in Graiguenamanagh did not document any noticeable differences between what habitats and their conspicuous species were recorded along the riverbanks of the Barrow and the Duiske in the 2021 site survey. Much of the riverbanks are either within or close to the built environment of the town or are management grassland walkways and quay walls.

3. Review & Recommendations

3.1. Bats

3.1.1. Previous Survey (2020)

ByrneLooby carried out a two-day bat survey in September 2020, commencing with an initial walkover survey of the site during daylight hours to gain an overview of the site with regard to its potential use by bats. Potential roost sites were revisited at dawn and dusk on the following two nights/mornings to establish whether they were being used as roosts by bats. Bat activity was monitored using a heterodyne bat detector (Magenta Bat5), with which it was possible to identify species based on their echolocation frequency.

The common pipistrelle, soprano pipistrelle and Dubenton's bats were recorded in the area. The presence of the Rivers Barrow and Duiske, as well as numerous patches of scrub, hedgerows, treelines and woodland, cumulatively offer attractive foraging and commuting habitats for several species of bats. Two of the potential roost sites identified during the daytime survey showed evidence of roosting soprano pipistrelles. Bat activity (in the form of fly-bys) was recorded at all potential roost sites, which indicates that the area as a whole is an important resource for foraging and/or commuting bats.

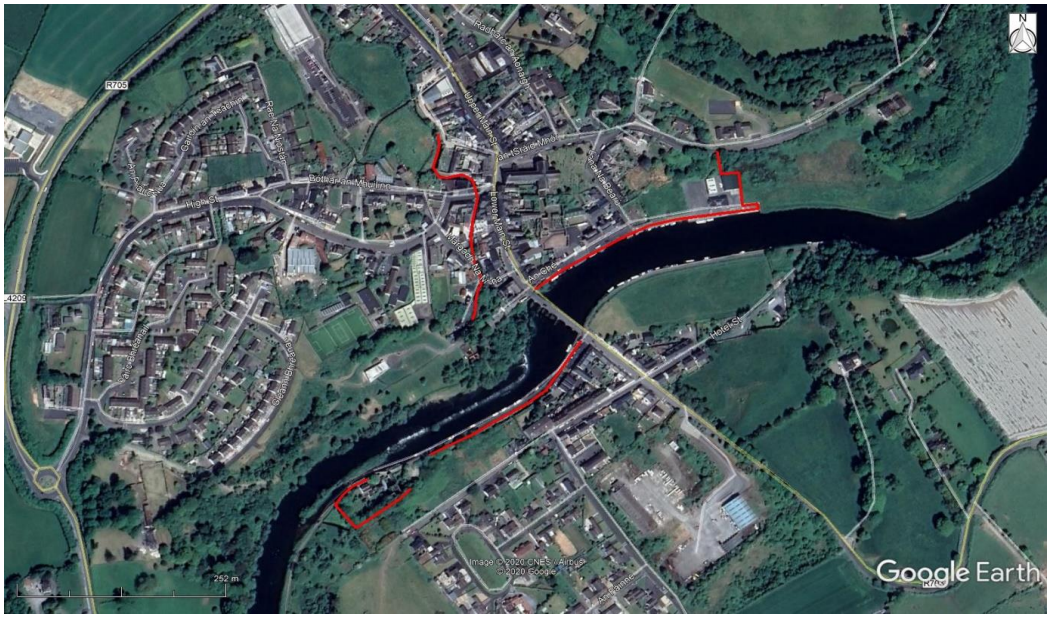

Figure 2. Previous Bat Survey Routes (2020 Survey)

3.1.2. Re-Survey Recommendations

Note that it will have been three years (as of 14th September 2023) since the initial survey was conducted in 2020 and in accordance with the CIEEM Advise Note, a re-survey is suggested to be a requirement once this time period is reached. Further, recent communications from the NPWS (dated 27/06/2023) in response to the submission of the Environmental Impact Assessment (EIA) Scoping Report highlights that several of the specialist ecological survey methods vary from accepted good practice and take place outside of the optimal survey season or do not meet the required number of survey visits. Bats have been included in the list of surveys recommended to be repeated by NPWS, with appropriate Guidance listed. Note our disagreement with this statement, as the 2020 bat survey undertaken within the optimal survey season (May to September), and in accordance with the guidelines suggested by NPWS. Nevertheless, a re-survey is recommended due to the time lapse since the previous survey, and the fact that the Project will likely cause some impact to bat species through tree felling, noise and light.

Trees with suitable holes and spaces can provide summer roost sites for bats and as some trees are required to be felled, they might provide suitable summer bat roosts. A tree survey has been carried out and several trees have been identified by the arborist as having bat roost potential.

It is therefore recommended that an ecologist complete a dedicated roost suitability survey focusing on those trees likely to be impacted by the Scheme. Further, roost suitability surveys and complementary dawn/dust survey are recommended along the initial transect routes surveyed in 2020 (see Figure 2), incorporating bridges to be impacted by the scheme (i.e., bridge downstream from High Street). Additional survey transects will be required where changes to the scheme have been made since the 2020 survey was completed, including along the embankment proposed at Hotel Street and along the riverside treeline at the Hub. The intention is to identify whether the same species and density of bats are recorded in the areas of works and to comment upon the likely impact of the scheme to these species from activities such as tree felling, production of artificial light and noise, and alterations to/within proximity to bridges with roost potential. The surveys would need to be undertaken within the survey season from April to September.

3.2. Breeding & Wintering Birds

3.2.1. Previous Survey (2021)

A wintering bird survey was undertaken between 16th – 18th February 2021 and breeding birds survey on 2nd of April 2021. Both surveys involved line transects along identified routes in the study area, carried out early in the morning, approximately 30 minutes after sunrise. Features of the landscape that were deemed significant for birds (*e.g.*, potential breeding habitats, Kingfisher perches, existing nests *etc*.) were also recorded.

A total of 32 bird species were recorded at the site between the wintering survey and breeding survey, 21 species during the winter survey and 25 during the breeding survey. Of the species identified, 8 are protected under the Wildlife Acts, 5 are listed on BOCCI's Amber list, and 3 are listed in Annex II and III of the EU Birds Directive. Eighteen sites suitable for Kingfisher perches were identified in the study area. These should not be allowed to be impacted by the construction of the scheme.

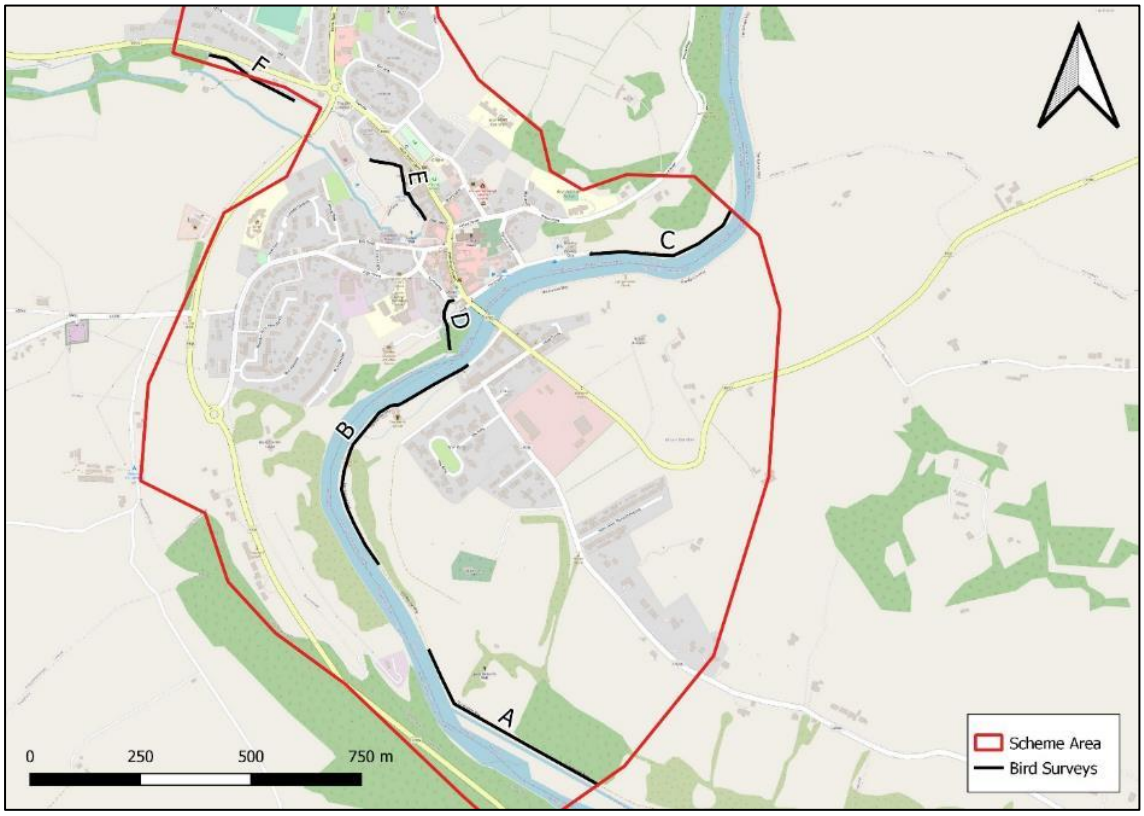

Figure 3. Previous Bird Transect Survey Locations (2021 Survey)

3.2.1. Re-Survey Recommendations

During the August 2023 site walkover survey, a Heron was recorded roosting on a Scot's Pine on the eastern riverbank, south of the Tinnahinch lock gates. Other species recorded include Rook, Jackdaw, Swallow, Mute swan, Blue tit, Mallard, House martin, Chaffinch and House sparrow. The site walkover highlighted the importance of the area for breeding and wintering birds.

Recent communications from the NPWS (dated 27/06/2023) in response to the submission of the EIA Scoping Report highlights that several of the specialist ecological survey methods vary from accepted good practice and take place outside of the optimal survey season or do not meet the required number of survey visits. Breeding and wintering birds have been included in the list of surveys recommended to be repeated by NPWS, with appropriate Guidance listed. Whilst the survey season was optimal for both previous surveys, the comment from NPWS is likely in relation to the numbers of visits. The previous surveys included only for the collection of data across a single visit survey, whereby guidance from the Breeding Bird Survey methodology from the British Trust for Ornithology (BTO)[1] recommends two visits at least. Furthermore, the date of the last round of bird surveys will be approaching 3 years in February 2024.

Breeding bird species are well documented in the study area, and the likely impact to these species will be as a result of vegetation and tree removal to facilitate the scheme, resulting in displacement from roosting and nesting habitat. Birds are volant creatures and can use various habitats for foraging, nesting and roosting within the town and surrounding areas of Graiguenamanagh. Overwintering birds may be present along the banks of the River Barrow outside of the most built-up areas of the town, including the areas of transect A, B and C (see Figure 3). Many of the online records of birds and those recorded during the previous bird survey, overwinter in Ireland. Whilst overwintering birds may not be directly impacted on by the proposed works in the town, it is likely that they could be impacted by noise which would displace them from their overwintering habitat.

Therefore, an updated survey with a list of wintering birds and wintering visitors is recommended and should be undertaken in accordance with up-to-date guidance from the Breeding Bird Survey methodology from the British Trust for Ornithology (BTO). The previous survey transects (see Figure 3) will be reviewed and only those relevant to provide meaningful assessment of the Proposed Scheme as it currently stands, will be surveyed. This will involve a removal of Survey Transect A

[1] https://www.bto.org/our-science/projects/breeding-bird-survey/research-conservation/methodology-and-survey-design

(given the distance from the scheme), alterations to B (shortening) and establishment of an additional transect along Hotel Street, upstream of the bridge.

3.3. Mammals

3.3.1. Previous Survey (2021)

A survey of mammals, including otter, red squirrel, pine marten and badger, was undertaken between 16th – 18th February 2021. This involved the completion of a walkover survey with observations made by qualified ecologists as to the presence of mammals through sightings or evidence (*i.e.,* spraint, holts, setts, tracks, slides *etc.*). Evidence of otter was noted, including a potential couch, a potential holt and a potential spraint. The potential holt was recorded in a section of the River Duiske upstream from Graiguenamanagh Town, and the potential couch and spraint were recorded downstream from the Tinnahinch Castle along the River Barrow. These sightings however were not conclusive.

3.3.1. Re-Survey Recommendations

Note that the date of previous mammal survey will be approaching 3 years in February 2024.

A re-survey of mammals is recommended, including the deployment of mammal tunnels for the recording of tracks. The previous surveys included only for the collection of incremental sightings during a daylight walkover. Observations of any setts and holts should be made, given the time lapse since the previous survey, with notes made on their likely activity and use. These surveys are recommended to inform the EIA and CEMP, with additional surveys recommended as part of the mitigation pre-construction.

As squirrel and pine marten require areas of forest, it is considered that these species will not be present within Graiguenamanagh and further surveys are therefore not required.

3.4. Herpetofauna

3.4.1. Previous Survey (2021)

A herpetofauna survey was undertaken in February 2021. Two separate observations of Common Frog spawn were made, adjacent to the private entrance on the upstream end of Hotel Street, Tinnahinch. The embankment proposed here will be in proximity to these historical observations.

3.4.2. Re-Survey Recommendations

As mentioned previously, recent communications from the NPWS (dated 27/06/2023) in response to the submission of the EIA Scoping Report highlights that several of the specialist ecological survey methods vary from accepted good practice and take place outside of the optimal survey season or do not meet the required number of survey visits. Herpetofauna surveys were mentioned in this response, however observations made during the initial walkover survey and the August 2023 visit did not record any pools/ponds within the survey area. For this reason, an additional herpetofauna survey is not considered a requirement at this stage. However, given historical observations, the EIAR will assume presence of spring-spawning herpetofauna within the project area, and will include appropriate pre-construction mitigation as a matter of course.

3.5. Flora

3.5.1. Previous Survey (2021)

A survey of terrestrial flora was undertaken in February 2021. No floral species of conservation interest were observed; however, there is a significant limitation with regard to the timing of the survey as it was carried out in the winter period when the great majority of plants would have died back.

3.5.2. Re-Survey Recommendations

Note that the date of the previous survey will be approaching 3 years in February 2024.

With this in mind, as well as the previous survey limitations, it is recommended that a floral survey be carried out between May and September to properly document plant species in the area.

3.6. Q values & Invertebrates

3.6.1. Previous Survey (2021)

These surveys involved carrying out an analysis of aquatic invertebrates and computing an evaluation of the quality based on the Q-value provides a valuable synopsis of water quality. In February 2021, Q-value surveys were undertaken at five locations. Q values ranged from 3 to 4 at the five locations sampled. The Q-value rating is assigned based on the relative percentages of pollution-sensitive and tolerant species to less pollution sensitive and more tolerant.

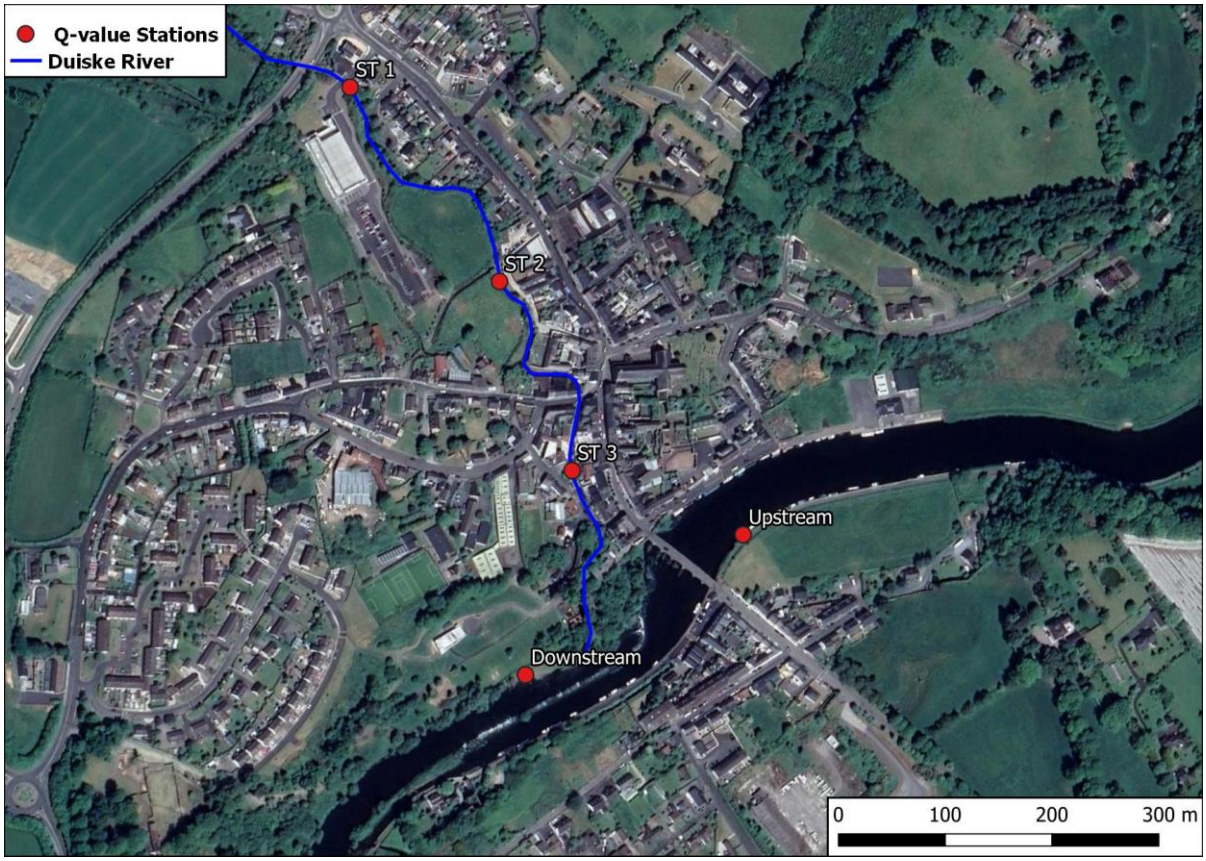

Figure 4. Q-value Survey Locations (2021 Survey)

3.6.2. Re-Survey Recommendations

A review of the latest Environmental Planning Authority (EPA) Q-value monitoring data was completed in preparation of this report; however, it is noted that no monitoring was undertaken in the reporting period for 2022 at any stations located within the study area.

As mentioned previously, recent communications from the NPWS (dated 27/06/2023) in response to the submission of the EIA Scoping Report highlights that several of the specialist ecological survey methods vary from accepted good practice and take place outside of the optimal survey season or do not meet the required number of survey visits. Sampling for invertebrates was mentioned in this response, however it is the opinion of the Lead Ecologist that this survey was undertaken within the optimal survey season and in accordance with practised guidelines.

The August 2023 walkover did not record any notable qualitative changes to any habitats in the study area, and from secondary review, no significant pollution events occurred in either river since 2021. For this reason, additional Q value surveys are not recommended. However, it is recommended that prior to construction, the same 5 sites as sampled in the initial survey are re-

surveyed and reported on and that any additional surveys reported via Inland Fisheries Ireland (IFI) and/or EPA are included in that report.

3.7. Electrofishing

3.7.1. Previous Survey (2021)

Electrofishing surveys were undertaken in 2021 at three sites within the River Duiske. The River Barrow was considered unsuitable for the conduct of electrofishing surveys due to its size. Five species were encountered, namely, brook lamprey (*Lampetra planeri)*, Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta)*, European Eel (*Anguilla anguilla)* and stone loach (*Barbatula barbatula*).

Figure 5. Electrofishing Survey Locations (2021 Survey)

3.7.2. Re-Survey Recommendations

The August 2023 walkover did not record any notable qualitative changes to any habitats in the study area and, from secondary review, no significant pollution events occurred in either river since 2021. For this reason, and the availability of recent electrofishing data, additional electrofishing

surveys are not recommended. However, it is recommended that prior to construction, the same sites as sampled in the initial survey are re-surveyed and reported on and that any additional surveys reported via IFI are included in that report.

3.8. Other Aquatic Fauna

3.8.1. Previous Surveys (2021)

Triturus Environmental Ltd conducted a Stage 1 Freshwater Pearl Mussel Survey (FWPM) and eDNA sampling on the Duiske River in April 2021 *ca.* 350m downstream of the proposed works area. No live or dead freshwater pearl mussels were recorded via bathyscope survey or snorkelling and eDNA samples returned a negative result for freshwater pearl mussel eDNA.

In addition, White-clawed Crayfish Surveys (WCC) and eDNA sampling were undertaken on the Duiske River in April 2021 *ca.* 350m downstream of the proposed works area. No white-clawed crayfish were recorded via hand-searching/sweep netting and eDNA samples returned a negative result for white-clawed crayfish and crayfish plague eDNA.

3.8.2. Re-Survey Recommendations

Given the results of the previous surveys in 2021, a re-survey is not required.

3.9. Trees

A comprehensive tree survey and Arboricultural Impact Assessment has been undertaken by qualified arborists in June 2023 (with updates required in October 2023), with observations made on the suitability of trees for bat roost potential. This survey will be sufficient for the EIAR submission in 2024. As noted above in the section on bats, a dedicated roost-suitability survey of trees that will be felled as part of the Proposed Scheme is recommended.

4. Summary

The historical 2020/2021 ecological surveys undertaken in the towns of Graiguenamanagh and Tinnahinch have been reviewed by Dr. Brendan O'Connor, and recommendations made for where survey repeats/top ups are suggested. The overall intention is to ensure that the environmental

assessment is carried out with reliable and up-to-date baseline information, and that any concerns from stakeholders (namely NPWS) are considered as part of the EIAR.

The following ecological surveys are recommended:

- **Bats:** A Bat Roost suitability survey is recommended with a focus on trees to be felled to facilitate the proposed scheme and at the bridge downstream from High Street (River Duiske), where minor works are proposed. Further, dawn/dust transect surveys are suggested, to identify whether the same species and density of bats are recorded in the areas of proposed felling. The original transect lines should be surveyed, as well as two additional areas where scheme works have since been proposed. These surveys are required to be undertaken with the period April and September 2024.
- **Breeding and wintering birds:** Full breeding and wintering bird surveys are recommended in line with BTO guidance (at least 2 visits for each). The breeding bird season is April – September and wintering bird season is October – March. The original transect lines will require some alteration to make the survey meaningful to the scheme as it currently stands.
- **Flora:** A floral survey during a summer or late spring month is recommended, given the survey season limitations of the previous survey in 2021.
- **Mammals:** A re-survey of mammals is recommended, including the deployment of mammal tunnels for the recording of tracks. Species of particular focus should be otters and badgers.

Additional surveys of herpetofauna, fisheries, Q-values and invertebrates can be addressed in pre-construction surveys, depending on the findings of the EIAR.

As mentioned, the area that this is proposed to encompass the upstream storage of flood water is currently (summer 2023) undergoing ecology surveying (including for breeding and winter birds, herpetofauna, mammal, invertebrates and Q-Values, fisheries habitats and White-Clawed Crayfish) and therefore no further recommendations have been made with regard to the ecological assessment of this area.

Appendix B: Bat Survey Report (Original CFRAM Level Survey) (Ayesa, 2020)

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This report was removed to reduce repetition. Please see Appendix 10-3 of Volume III of this EIAR.

Appendix C: Bat Survey Report (Upstream Storage Area) (VEON, 2024)

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This report was removed to reduce repetition. Please see Appendix 10-4 of Volume III of this EIAR.

Appendix D: Bat Survey Report (Top Up Survey, Graiguenamanagh-Tinnahinch) (VEON, 2024)

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This report was removed to reduce repetition. Please see Appendix 10-5 of Volume III of this EIAR.

Appendix E: Breeding Bird Survey Results

Original CFRAM Survey, 2021

Table E-0-1: Species Abundance (Breeding Survey), 2021

Species	Scientific Name	No. of Transects with +ve ID	Designation
Blackbird	*Turdus merula*	5	N/A
Chaffinch	*Fringilla coelebs*	5	N/A
Great tit	*Parus major*	4	N/A
Rook	*Corvus frugilegus*	4	N/A
Woodpigeon	*Columba palumbus*	4	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III
Blue tit	*Cyanistes caeruleus*	3	N/A
Robin	*Erythacus rubecula*	3	N/A
Song thrush	*Turdus philomelos*	3	N/A
Starling	*Sturnus vulgaris*	3	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Wren	*Troglodytes troglodytes*	3	N/A
Blackcap	*Sylvia atricapilla*	2	N/A
Chiffchaff	*Phylloscopus collybita*	2	N/A
Goldfinch	*Carduelis carduelis*	2	N/A
Great Spotted Woodpecker	*Dendrocopus major*	2	N/A
House Sparrow	*Passer domesticus*	2	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Long-tailed tit	*Aegithalus caudatus*	2	N/A
Magpie	*Pica pica*	2	N/A
Barn Swallow	*Hirundo rustica*	1	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Jackdaw	*Corvus monedula*	1	N/A
Mallard	*Anas platyrhinchos*	1	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III
Pheasant	*Phasianus colchicus*	1	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III
Raven	*Corvus corax*	1	N/A
Treecreeper	*Certhia familiaris*	1	N/A
Whitethroat	*Sylvia communis*	1	N/A
Willow warbler	*Phylloscopus trochilus*	1	N/A

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Table E-0-2: Breeding Bird Survey (02/04/2021)

Transect ID	Date Start/End Time Weather	Species	Visual Distance bands				Aural records	
			0-25m	25-100m	>100m	In flight	+	-
A	02/04/21 08:50-09:17 Clear, dry, 10°C, calm	Blackbird				1	X	
		Willow warbler					X	
		Chaffinch					X	
		Rook				1	X	
		Song thrush	1				X	
		Starling	1				X	
		Robin	1				X	
		Wren	1					X
		Whitethroat	1					X
		Long-tailed tit	2					X
B	02/04/21 08:17-08:47 Clear, dry, 10°C, calm	Blue tit					X	
		Great tit					X	
		Magpie					X	
		Woodpigeon					X	
		Chaffinch					X	
		Chiffchaff					X	
		Wren	1				X	
		Mallard	2					X
		Rook	1			3	X	
		Blackcap	1				X	

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		Great Spotted Woodpecker					X	
		Starling	2					X
		Barn Swallow	6					X
C	02/04/21 07:24-07:54 Clear, dry, 10°C, calm	Rook	20			6	X	
		Chiffchaff					X	
		Woodpigeon					X	
		Blackbird					X	
		Song thrush					X	
		Jackdaw					X	
		Blue tit					X	
		Great tit					X	
		Great Spotted Woodpecker					X	
		Pheasant					X	
D	02/04/21 10:08-10:30 Clear, dry, 10°C, calm	Woodpigeon					X	
		Song thrush					X	
		Blackbird					X	
		Chaffinch	1				X	
		Treecreeper	1					X
		Robin	1					X
E	02/04/21 11:00-11:20 Clear, dry, 10°C, calm	Starling					X	
		Blackbird	1				X	
		Blue tit					X	
		Chaffinch	1				X	
		House Sparrow	3				X	

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		Great tit	1				X	
		Magpie					X	
		Raven	3					X
		Woodpigeon	1					X
		Goldfinch	2					X
F	02/04/21 11:50-12:10 Clear, dry, 10°C, calm	Long-tailed tit	1				X	
		Blackbird	1				X	
		Robin	1				X	
		Chaffinch					X	
		Great tit					X	
		House Sparrow	2				X	
		Goldfinch					X	
		Rook					X	
		Blackcap	1					X
		Wren	1					X

Notes:

1. 10x Barn Swallows recorded circling outside the Waterside Guesthouse along the northern quay. Outside transect.
2. Some Rooks recorded in flight in Transect C were carrying twigs for nest-building
3. 2x House Sparrows recorded in Transect E were building a nest (in Tree ID T37)
4. Lone Mute Swan recorded by main bridge. Outside transect.

The drumming sound attributed to the Great Spotted Woodpecker may be from a Carrion Crow. This information came from a verbal communication with a local passer-by during Transect B.

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Sites deemed suitable for perching Kingfishers were recorded and are shown in Table E-2 and Figures E-1 and E-2 below. Suitable perches are generally narrow, stable structures that allow Kingfishers to perch above flowing water while searching for prey. In total, 18 Kingfisher perches were recorded.

Table E-0-3: Kingfisher Perches

ID	Coordinates (ITM)	Notes
KF1	671422, 643799	Alder branches
KF2/3	671362, 643720	Ash branches
KF4	670806, 643465	Pollarded tree – species unconfirmed (probably willow)
KF5	670605, 643229	Ash branches
KF6	670688, 643377	Overhanging willow
KF7	670785, 643871	Willow branches
KF8	670781, 643876	Alder branches
KF9	670755, 643920	Alder branches
KF10	670744, 643945	Ash and sycamore branches
KF11	670735, 643972	Sycamore branches
KF12	670735, 643972	Overhanging ivy
KF13	670596, 643965	Steel bar associated with concrete structure on mill race
KF14	670572, 644012	Fallen branch (blackthorn) spanning mill race
KF15	670267, 644235	Collection of dead stumps and branches spanning Duiske
KF16	670226, 644244	Alder branches
KF17	670126, 644179	Fallen branches with ivy spanning Duiske
KF18	669975, 644210	Sycamore branches

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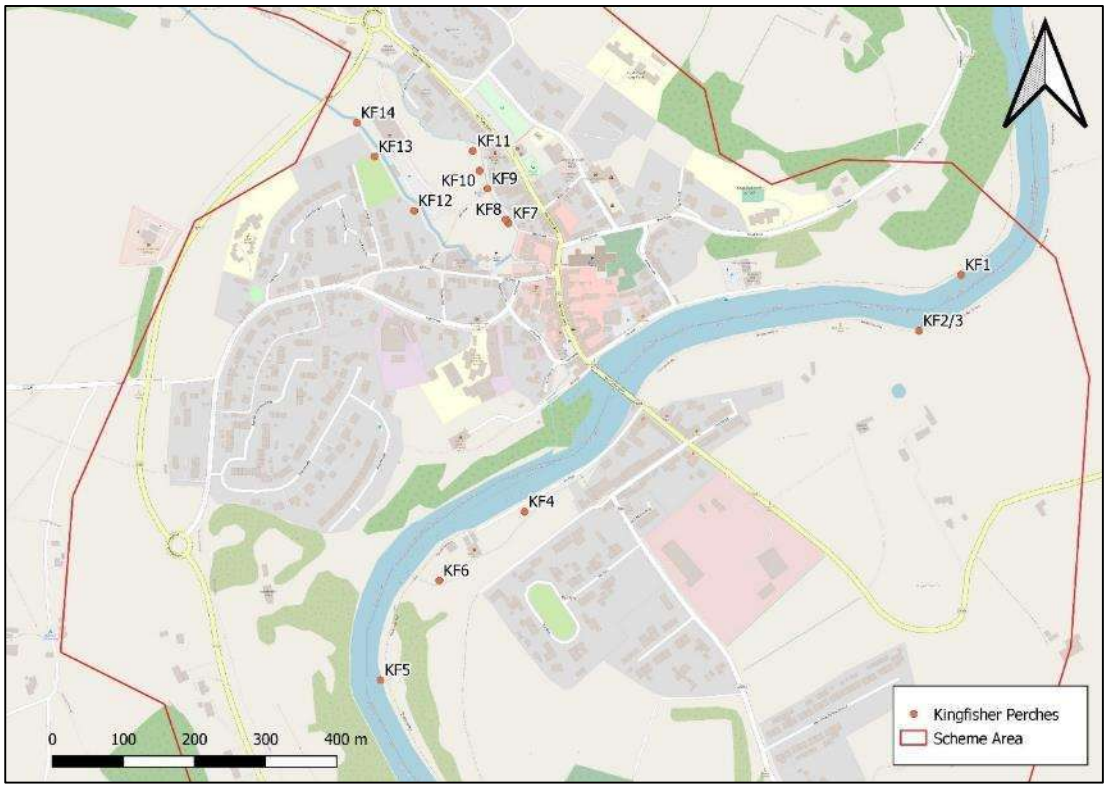

Figure E-1: Kingfisher Perches (KF1-KF14)

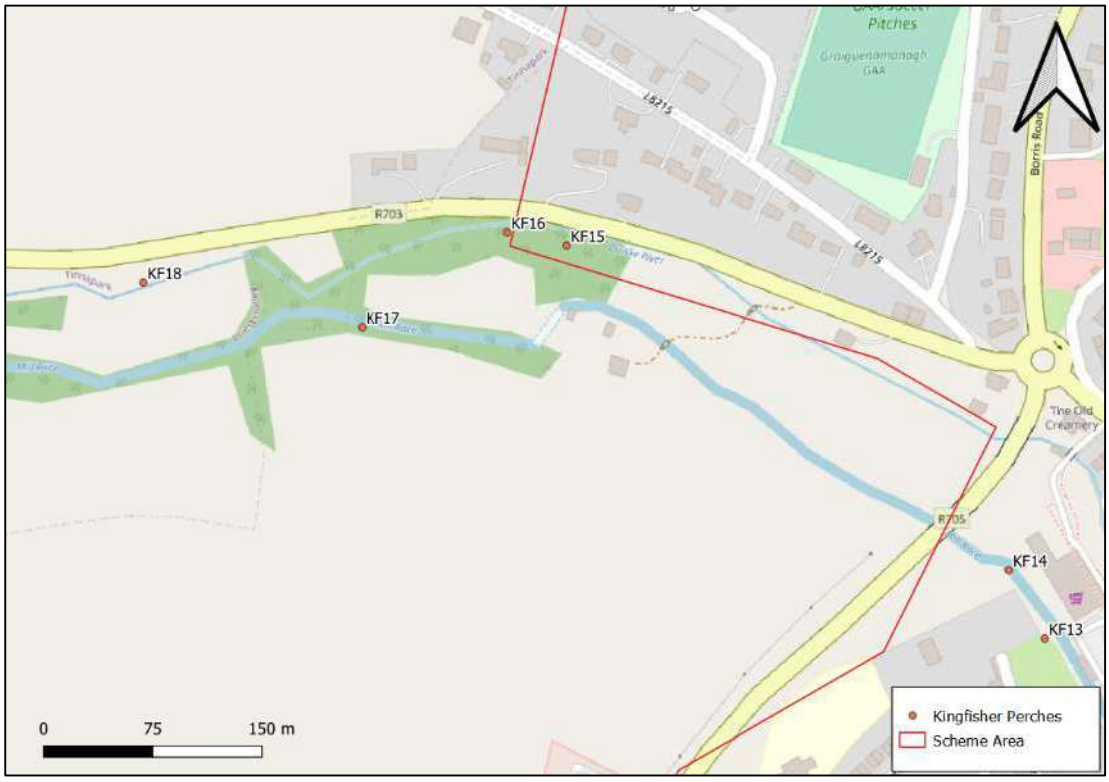

Figure E-2: Kingfisher Perches (KF15-KF18)

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E.1 Survey 1 (9-11/08/2023)

E.1.1 Upstream Storage Area

Table E-0-4: Survey Conditions

Date	Start time	Finish time	Notes	
09/08/2023	06:00	09:00		
Weather, highlight as appropriate				
Cloud cover	1 - (0-33%)		2 - (33-66%) (X)	3 - (66-100%)
Rain	1 - None		2 - Showers	3 – drizzle (X)
Wind	1 - Calm		2 – Light (X)	3 – Breezy
Visibility	1- Good		2 – Moderate	4 – Poor

Table E-0-5: Birds recorded within and adjacent to the project footprint

Common name	Species name	No. counted	Designation
Barn Swallow	*Hirundo rustica*	~49	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List.
Buzzard	*Buteo buteo*	2	Protected under Section 22 of the Wildlife Acts
Coal Tit	*Periparus ater*	1	Protected under Section 22 of the Wildlife Acts
Common Black Bird	*Turdus merula*	1	Protected under Section 22 of the Wildlife Acts
Common Chiffchaff	*Phylloscopus collybita*	2	Protected under Section 22 of the Wildlife Acts
Common Redstart	*Phoenicurus phoenicurus*	1	Protected under Section 22 of the Wildlife Acts
Common Wood Pigeon	*Columba palumbus*	13	Protected Species: Wildlife Acts Protected Species: EU Birds Directive-Annex II; Annex III
Eurasian Magpie	*Pica pica*	3	Protected under Section 22 of the Wildlife Acts
European Robin	*Erithacus rubecula*	9	Protected under Section 22 of the Wildlife Acts
Gold Crest	*Regulus regulus*	3	Protected under Section 22 of the Wildlife Acts
Great Tit	*Parus major*	3	Protected under Section 22 of the Wildlife Acts
Hooded Crow	*Corvus cornix*	2	Protected under Section 22 of the Wildlife Acts
Long Tailed Tit	*Aegithalus caudatus*	2	Protected under Section 22 of the Wildlife Acts
Starling	*Sturnus vulgaris*	~20	Protected under Section 22 of the Wildlife Acts
Spotted Flycatcher	*Musciapa striata*	1	Protected under Section 22 of the Wildlife Acts
Tit Spp**	***	2	

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Common name	Species name	No. counted	Designation
Barn Swallow	*Hirundo rustica*	~49	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List.
Wren	*Troglodytes troglodytes*	6	Protected under Section 22 of the Wildlife Acts

E.2 Survey 2 (28-29/03/2024)

E.2.1 Graiguenamanagh-Tinnahinch Towns (top up survey)

Table E-0-6: Survey Conditions

Date	Start time	Finish time	Notes	
29/03/2024	11:30	3:30	Bright, good visibility, cold (6°C)	
Weather, highlight as appropriate				
Cloud cover	1 - (0-33%)		2 - (33-66%)	3 - (66-100%)
Rain	1 - None		2 - Showers	3 - drizzle
Wind	1 - Calm		2 - Light	3 – Breezy
Visibility	1- Good		2 – Moderate	3 - Poor

Table E-0-7: Birds recorded from Site A – 29/03/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	3	Perched within trees and hedgerow, and aural recording	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	2	Perched within trees	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	3	Perched within trees	Protected Species: Wildlife Acts
Goldfinch	*Carduelis carduelis*	3	Within trees	Protected Species: Wildlife Acts
Great Spotted Woodpecker	*Dendrocopos major*	2	Aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	1	Aural recording	Protected Species: Wildlife Acts
Grey Heron	*Ardea cinerea*	1	Standing on riverbank	Protected Species: Wildlife Acts
Mallard	*Anas platyrhynchos*	6	Within the river and rushes, and aural recordings (including ducklings)	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	10	In flight overhead, perched within trees, and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	3	In flight and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List

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Common name	Species name	No. counted	Description of bird activity	Designation
				EU Birds Directive: Annex II, Annex III
Wren	*Troglodytes troglodytes*	1	Within trees and aural recording	Protected Species: Wildlife Acts

Table E-0-8: Birds recorded from Site B – 29/03/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	10	Perched within trees, hedgerow and riverbank, and aural recording	Protected Species: Wildlife Acts
Blue Tit	*Cyanistes caeruleus*	1	Perched within trees	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	4	Perched within trees	Protected Species: Wildlife Acts
Goldfinch	*Carduelis carduelis*	1	Within trees and in flight between trees	Protected Species: Wildlife Acts
Grey Wagtail	*Motacilla cinerea*	2	Perched on low-lying branches, within river and on riverbank	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	2	In flight overhead	Protected Species: Wildlife Acts
Mallard	*Anas platyrhynchos*	2	On the river	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	10	In flight overhead and aural recording	Protected Species: Wildlife Acts
Song Thrush	*Turdus philomelos*	1	Perched within the trees	Protected Species: Wildlife Acts

Table E-0-9: Birds recorded from Site C – 29/03/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	4	Perched within trees and hedgerow, and aural recording	Protected Species: Wildlife Acts
Chiffchaff	*Phylloscopus collybita*	1	Aural recording	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	2	Perched within trees	Protected Species: Wildlife Acts
Great Tit	*Parus major*	1	Aural recording	Protected Species: Wildlife Acts
Grey Wagtail	*Motacilla cinerea*	2	In flight and on riverbank	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	2	In flight overhead	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	10	In flight, within the trees, perched on buildings and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	9	In flight overhead and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List

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Common name	Species name	No. counted	Description of bird activity	Designation
				EU Birds Directive: Annex II, Annex III
Wren	*Troglodytes troglodytes*	2	Aural recording	Protected Species: Wildlife Acts

Table E-0-10: Birds recorded from Site D – 29/03/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	2	Perched within trees and hedgerow, and aural recording	Protected Species: Wildlife Acts
Chiffchaff	*Phylloscopus collybita*	1	Aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	1	Aural recording	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	Aural recording	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	2	In flight overhead	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	>30	In flight, within the trees, perched on buildings and aural recording	Protected Species: Wildlife Acts
Song Thrush	*Turdus philomelos*	2	Perched within the trees and foraging in grass	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	3	In flight overhead and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Wren	*Troglodytes troglodytes*	2	Aural recording	Protected Species: Wildlife Acts

Table E-0-11: Birds recorded from Site E – 29/03/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	18	Perched within trees and hedgerow, foraging, bathing in river, and aural recording	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	5	Perched within trees and foraging	Protected Species: Wildlife Acts
Collared Dove	*Streptopelia decaocto*	5	In flight overhead	Protected Species: Wildlife Acts
Eurasian Jackdaw	*Corvus monedula*	2	In flight overhead and within trees	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	Perched within trees	Protected Species: Wildlife Acts
Goldfinch	*Carduelis carduelis*	22	Within trees and in flight between trees	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	1	In flight overhead	Protected Species: Wildlife Acts
House Sparrow	*Passer domesticus*	7	Perched within trees and bathing in river	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List

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Common name	Species name	No. counted	Description of bird activity	Designation
Mallard	*Anas platyrhynchos*	2	Within the river	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	3	Perched on electricity wire/within trees, and aural recording	Protected Species: Wildlife Acts
Siskin	*Carduelis spinus*	14	Within trees, in flight between trees and aural recording	Protected Species: Wildlife Acts
Starling	*Sturnus vulgaris*	>15	Perched on electricity wire	Protected Species: Wildlife Acts

E.2.2 Upstream Storage Area

Table E-0-12: Survey Conditions.

Date	Start time	Finish time	Notes	
28/03/2024	9:00	10:55	Bright, good visibility, cold (6°C)	
Weather, highlight as appropriate				
Cloud cover	1 - (0-33%)		2 - (33-66%)	3 - (66-100%)
Rain	1 - None		2 - Showers	3 - drizzle
Wind	1 - Calm		2 - Light	3 – Breezy
Visibility	1- Good		2 – Moderate	3 - Poor

Table E-0-13: Birds recorded from Site A – 28/03/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	4	In flight, within trees	Protected Species: Wildlife Acts
Chiffchaff	*Phylloscopus collybita*	5	Within trees, feeding and aural recording	Protected Species: Wildlife Acts
Eurasian Blue Tit	*Cyanistes caeruleus*	5	Perched within the trees and aural recording	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	2	Perched within trees and aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	1	Perched within trees	Protected Species: Wildlife Acts
Long-tailed Tit	*Aegithalos caudatus*	3	Perched within trees	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	4	In flight overhead, within trees, and aural recording	Protected Species: Wildlife Acts
Song Thrush	*Turdus philomelos*	4	Perched within the trees, foraging in grass, and aural recording	Protected Species: Wildlife Acts
Starling	*Sturnus vulgaris*	1	Perched on electricity wire	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Wood Pigeon	*Columba palumbus*	9	In flight overhead, within the trees and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List

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Common name	Species name	No. counted	Description of bird activity	Designation
				EU Birds Directive: Annex II, Annex III
Wren	*Troglodytes troglodytes*	3	Perched within trees and aural recording	Protected Species: Wildlife Acts

Table E-0-14: Birds recorded from Site B – 28/03/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	3	Foraging in wooded area and aural recording	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	1	Perched within trees	Protected Species: Wildlife Acts
Chiffchaff	*Phylloscopus collybita*	1	Aural recording	Protected Species: Wildlife Acts
Eurasian Magpie	*Pica pica*	1	In flight overhead	Protected Species: Wildlife Acts
Eurasian Treecreeper	*Certhia familiaris*	1	Aural recording	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	2	Perched within trees	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	2	Perched within trees	Protected Species: Wildlife Acts
Great Spotted Woodpecker	*Dendrocopos major*	1	Aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	1	Perched within trees	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	4	In flight overhead	Protected Species: Wildlife Acts
Song Thrush	*Turdus philomelos*	1	Aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	5	In flight overhead and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Wren	*Troglodytes troglodytes*	1	Aural recording	Protected Species: Wildlife Acts

Table E-0-15: Birds recorded from Site C – 28/03/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	1	Aural recording	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	1	Aural recording	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	3	Perched within trees and aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	1	Aural recording	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	2	In flight overhead	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	7	In flight overhead, within trees, and aural recording	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
				Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Wren	*Troglodytes troglodytes*	3	Perched within trees and aural recording	Protected Species: Wildlife Acts

E.3 Survey 3 (22-23/05/2024)

E.3.1 Graiguenamanagh-Tinnahinch Towns (top up survey)

Table E-0-16: Survey Conditions

Date	Start time	Finish time	Notes	
23/05/2024	9:25	13:00	Cloudy with occasional sunshine, strong breeze, chilly in shade (12°C)	
Weather, highlight as appropriate				
Cloud cover	1 - (0-33%)	2 - (33-66%)	3 - (66-100%)	
Rain	1 - None	2 - Showers	3 - drizzle	
Wind	1 - Calm	2 - Light	3 – Breezy	
Visibility	1- Good	2 – Moderate	3 - Poor	

Table E-0-17: Birds recorded from Site A – 23/05/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	7	Foraging and aural recording	Protected Species: Wildlife Acts
Chiffchaff	*Phylloscopus collybita*	3	Aural recording	Protected Species: Wildlife Acts
Common Bullfinch	*Pyrrhula pyrrhula*	2	Perched in tree	Protected Species: Wildlife Acts
Eurasian Magpie	*Pica pica*	1	Aural recording	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	Aural recording	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	1	Perched on fence	Protected Species: Wildlife Acts
Great Black-Backed Gull	*Larus marinus*	1	In flight overhead and catching fish in river	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Goldcrest	*Regulus regulus*	1	Aural Recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	1	Within tree	Protected Species: Wildlife Acts
House Martin	*Delichon urbicum*	15	In flight over river – feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List

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Common name	Species name	No. counted	Description of bird activity	Designation
Mallard	*Anas platyrhynchos*	7	Within the river including two ducklings	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	10	In flight, within trees, and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	13	In flight overhead/over river, foraging in field, and aural recording	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	2	Aural recording	Protected Species: Wildlife Acts

Table E-0-18: Birds recorded from Site B – 23/05/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Barn Swallow	*Hirundo rustica*	8	In flight over river - feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Blackbird	*Turdus merula*	13	Foraging on riverbank, within hedgerows, and aural recording	Protected Species: Wildlife Acts
Blue tit	*Cyanistes caeruleus*	1	Perched within trees	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	4	Perched within trees	Protected Species: Wildlife Acts
Common Bullfinch	*Pyrrhula pyrrhula*	1	Foraging	Protected Species: Wildlife Acts
Eurasian Jackdaw	*Corvus monedula*	2	In flight overhead	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	3	Within tall grass and trees	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	1	Within trees	Protected Species: Wildlife Acts
Grey Wagtail	*Motacilla cinerea*	2	Foraging	Protected Species: Wildlife Acts
House Martin	*Delichon urbicum*	4	In flight over river - feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Mallard	*Anas platyrhynchos*	4	Within and in flight over river	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	>20	In flight overhead, within the trees, perched on buildings, and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	2	In flight overhead, within the trees	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
				EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	1	Aural Recording	Protected Species: Wildlife Acts

Table E-0-19: Birds recorded from Site C – 23/05/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Barn Swallow	*Hirundo rustica*	3	In flight over river - feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Blackbird	*Turdus merula*	3	Foraging on riverbank and within vegetation	Protected Species: Wildlife Acts
Blue tit	*Cyanistes caeruleus*	1	In vegetation along riverbank	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	1	Perched within trees	Protected Species: Wildlife Acts
Eurasian Magpie	*Pica pica*	2	Within trees	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	Aural Recording	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	1	Aural Recording	Protected Species: Wildlife Acts
House Martin	*Delichon urbicum*	15	In flight over river - feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Mallard	*Anas platyrhynchos*	2	Within river	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Pied Wagtail	*Motacilla alba subsp. yarrellii*	1	Foraging on riverbank	Protected Species: Wildlife Acts
Song Thrush	*Turdus philomelos*	1	Aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	6	In flight overhead	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	1	Aural Recording	Protected Species: Wildlife Acts

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Table E-0-20: Birds recorded from Site D – 23/05/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Barn Swallow	*Hirundo rustica*	15	In flight over river and field – feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Blackbird	*Turdus merula*	5	Within trees and aural Recording	Protected Species: Wildlife Acts
Blue tit	*Cyanistes caeruleus*	1	Perched within trees	Protected Species: Wildlife Acts
Chiffchaff	*Phylloscopus collybita*	1	Aural recording	Protected Species: Wildlife Acts
Eurasian Magpie	*Pica pica*	1	Aural Recording	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	Aural recording	Protected Species: Wildlife Acts
House Martin	*Delichon urbicum*	20	In flight over river and field – feeding and seen using nest beneath roof verge on boat club	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Mallard	*Anas platyrhynchos*	5	Within the river	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Pied Wagtail	*Motacilla alba subsp. yarrellii*	2	Perched on boat and in flight over river	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	>15	In flight overhead, perched within trees and on buildings, and aural recording	Protected Species: Wildlife Acts
Song Thrush	*Turdus philomelos*	1	Perched within the trees	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	2	Aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Wren	*Troglodytes troglodytes*	1	Aural recording	Protected Species: Wildlife Acts

Table E-0-21: Birds recorded from Site E – 23/05/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Barn Swallow	*Hirundo rustica*	19	In flight overhead – feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Blackbird	*Turdus merula*	9	Foraging on path, within hedgerows and trees, including one juvenile within	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
			the hedgerow, and aural recording	
Blackcap	*Sylvia atricapilla*	1	Within trees	Protected Species: Wildlife Acts
Eurasian Blue Tit	*Cyanistes caeruleus*	5	Within trees	Protected Species: Wildlife Acts
Eurasian Jackdaw	*Corvus monedula*	2	In flight overhead	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	2	In flight overhead	Protected Species: Wildlife Acts
House Martin	*Delichon urbicum*	10	In flight between stone buildings and trees, and in flight – feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
House Sparrow	*Passer domesticus*	5	Within trees including three juveniles	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Mallard	*Anas platyrhynchos*	4	In flight, within river and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	7	In flight overhead, perched on buildings, and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	5	Perched on telephone wire, within trees, in flight overhead, and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Wren	*Troglodytes troglodytes*	2	Aural Recording	Protected Species: Wildlife Acts

E.3.2 Upstream Storage Area

Table E-0-22: Survey Conditions.

Date	Start time	Finish time	Notes	
22/05/2024	12:05	13:30	Rain showers, overcast, visibility poor, and mild (14°C)	
Weather, highlight as appropriate				
Cloud cover	1 - (0-33%)		2 - (33-66%)	3 - (66-100%)
Rain	1 - None		2 - Showers	3 - drizzle
Wind	1 - Calm		2 - Light	3 – Breezy

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Visibility	1- Good	2 – Moderate	3 - Poor

Table E-0-23: Birds recorded from Site A – 22/05/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Barn Swallow	*Hirundo rustica*	2	In flight overhead - feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Blackbird	*Turdus merula*	2	Aural recording	Protected Species: Wildlife Acts
Chiffchaff	*Phylloscopus collybita*	1	Aural recording	Protected Species: Wildlife Acts
House Martin	*Delichon urbicum*	5	In flight over head– feeding and on telephone wire	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Rook	*Corvus frugilegus*	15	In flight overhead, within trees and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	7	In flight overhead and between trees, and aural recording	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	1	Aural Recording	Protected Species: Wildlife Acts

Table E-0-24: Birds recorded from Site B – 22/05/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	1	In flight	Protected Species: Wildlife Acts
Common Buzzard	*Buteo buteo*	2	In flight overhead and aural recording	Protected Species: Wildlife Acts
Eurasian Treecreeper	*Certhia familiaris*	1	Aural recording	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	2	Within trees and aural recording	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	1	Aural Recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	1	Aural Recording	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	6	Aural Recording	Protected Species: Wildlife Acts

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Table E-0-25: Birds recorded from Site C – 22/05/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Barn Swallow	*Hirundo rustica*	8	In flight overhead - feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Blackbird	*Turdus merula*	6	Within tree and aural recording	Protected Species: Wildlife Acts
Blue tit	*Cyanistes caeruleus*	1	Within trees	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	1	Perched within trees	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	Within trees and aural recording	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	1	Aural recording	Protected Species: Wildlife Acts
Great Spotted Woodpecker	*Dendrocopos major*	1	Aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	2	Within trees	Protected Species: Wildlife Acts
Song Thrush	*Turdus philomelos*	1	Within trees	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	7	In flight overhead	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	1	Aural recording	Protected Species: Wildlife Acts

E.4 Survey 4 (26-27/06/2024)

E.4.1 Graiguenamanagh-Tinnahinch Towns (top up survey)

Table E-0-26: Survey Conditions

Date	Start time	Finish time	Notes	
26/06/2024	13:20	16:20	Cloudy with occasional sun, light breeze but warm (21°C)	
Weather, highlight as appropriate				
Cloud cover	1 - (0-33%)		2 - (33-66%)	3 - (66-100%)
Rain	1 - None		2 - Showers	3 - drizzle
Wind	1 - Calm		2 - Light	3 – Breezy
Visibility	1- Good		2 – Moderate	3 - Poor

Table E-0-27: Birds recorded from Site A – 26/06/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Barn Swallow	*Hirundo rustica*	10	In flight - feeding	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
				Birds of Conservation Concern: Amber List
Blackbird	*Turdus merula*	11	In flight and aural recording	Protected Species: Wildlife Acts
Eurasian Blue Tit	*Cyanistes caeruleus*	1	Aural Recording	Protected Species: Wildlife Acts
Eurasian Magpie	*Pica pica*	1	Aural Recording	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	2	Aural Recording	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	1	Aural Recording	Protected Species: Wildlife Acts
Goldfinch	*Carduelis carduelis*	5	Perched within trees and in flight between trees	Protected Species: Wildlife Acts
Grey Heron	*Ardea cinerea*	1	Standing on weir	Protected Species: Wildlife Acts
House Martin	*Delichon urbicum*	3	In flight – feeding and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Long-tailed Tit	*Aegithalos caudatus*	10	Perched within trees and in flight between trees	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	1	In flight overhead	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	9	In flight overhead, and aural Recording	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	1	Aural recording	Protected Species: Wildlife Acts

Table E-0-28: Birds recorded from Site B – 26/06/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Barn Swallow	*Hirundo rustica*	>15	In flight over river - feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Blackbird	*Turdus merula*	10	Within trees, in flight, and aural recording	Protected Species: Wildlife Acts
Blackcap	*Sylvia atricapilla*	1	Within trees	Protected Species: Wildlife Acts
Blue tit	*Cyanistes caeruleus*	1	Perched within trees	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	2	Perched within trees	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	Aural Recording	Protected Species: Wildlife Acts
Grey Heron	*Ardea cinerea*	3	In flight and standing on weir	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	4	In flight overhead and perched on buildings	Protected Species: Wildlife Acts
House Martin	*Delichon urbicum*	2	In flight over river - feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Mallard	*Anas platyrhynchos*	14	Standing on weir and within the river (Juveniles)	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III

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Common name	Species name	No. counted	Description of bird activity	Designation
Rook	*Corvus frugilegus*	2	In flight overhead	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	2	In flight	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III

Table E-0-29: Birds recorded from Site C – 26/06/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Barn Swallow	*Hirundo rustica*	1	In flight over river – feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Blackcap	*Sylvia atricapilla*	1	Aural recording	Protected Species: Wildlife Acts
Common Buzzard	*Buteo buteo*	2	In flight overhead and aural recording	Protected Species: Wildlife Acts
Goldfinch	*Carduelis carduelis*	2	In flight between trees	Protected Species: Wildlife Acts
Grey Heron	*Ardea cinerea*	1	Aural recording	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	4	In flight overhead, perched within the trees, and aural recording	Protected Species: Wildlife Acts
House Martin	*Delichon urbicum*	1	In flight over river - feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Mallard	*Anas platyrhynchos*	1	In river	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	7	In flight and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	3	Aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III

Table E-0-30: Birds recorded from Site D – 26/06/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Barn Swallow	*Hirundo rustica*	>10	In flight - feeding	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Blackcap	*Sylvia atricapilla*	1	Aural Recording	Protected Species: Wildlife Acts
Chiffchaff	*Phylloscopus collybita*	1	Aural recording	Protected Species: Wildlife Acts
Common Buzzard	*Buteo buteo*	1	In flight overhead	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
Eurasian Magpie	*Pica pica*	1	Aural Recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	1	Aural recording	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	13	In flight overhead and perched on rowing club	Protected Species: Wildlife Acts
House Martin	*Delichon urbicum*	>20	In flight – feeding and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Mallard	*Anas platyrhynchos*	3	On the river	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	6	In flight and aural recording	Protected Species: Wildlife Acts
Wren	*Troglodytes troglodytes*	1	Aural recording	Protected Species: Wildlife Acts

Table E-0-31: Birds recorded from Site E – 26/06/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Barn Swallow	*Hirundo rustica*	10	In flight overhead	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Blackbird	*Turdus merula*	2	In flight and within vegetation	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	5	Perched within trees, foraging, and aural recording (Juveniles)	Protected Species: Wildlife Acts
Common Starling	*Sturnus vulgaris*	>30	Foraging on grass and within trees	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Common Swift	*Apus apus*	6	In flight overhead	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Eurasian Collared Dove	*Streptopelia decaocto*	2	In flight and perched on telephone wire	Protected Species: Wildlife Acts
Eurasian Jackdaw	*Corvus monedula*	1	In flight overhead	Protected Species: Wildlife Acts
European Goldfinch	*Carduelis carduelis*	6	In flight, perched within the trees and on telephone wire, and aural recording (Juveniles)	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	2	Perched within trees	Protected Species: Wildlife Acts
Great Tit	*Parus major*	5	Within vegetation and foraging (Juveniles)	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	1	In flight	Protected Species: Wildlife Acts
House Martin	*Delichon urbicum*	>20	In flight overhead and entering abandoned building	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
House Sparrow	*Passer domesticus*	7	Within vegetation and foraging	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
				Birds of Conservation Concern: Amber List
Rook	*Corvus frugilegus*	6	In flight and aural recording	Protected Species: Wildlife Acts
Siskin	*Carduelis spinus*	1	Within trees	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	6	Within trees, in flight, and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III

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Appendix F: Breeding Bird Survey Photographs (2024)

Figure F-1: Male Chaffinch spotted in Graiguenamanagh Town – 29/03/2024

Figure F-2: House Martin nest seen at the top of the verge soffit on Graiguenamanagh-Tinnahinch Rowing Club. Birds seen exiting and entering - 23/05/2024.

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Figure F-3: House Martin nest seen at the top of the verge soffit on Graiguenamanagh-Tinnahinch Rowing Club. Birds seen exiting and entering - 23/05/2024.

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Appendix G: Wintering Bird Survey Results

Original CFRAM Survey, 2021

Table G-0-1: Species Abundance (Wintering Survey), 2021

Species	Scientific Name	No. of Transects with +ve ID	Designation
Rook	*Corvus frugilegus*	5	N/A
Blackbird	*Turdus merula*	4	N/A
Chaffinch	*Fringilla coelebs*	4	N/A
House Sparrow	*Passer domesticus*	4	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Blue tit	*Cyanistes caeruleus*	3	N/A
Great tit	*Parus major*	3	N/A
Coal tit	*Periparus ater*	2	N/A
Collared Dove	*Streptopelia decaocto*	2	N/A
Jackdaw	*Corvus monedula*	2	N/A
Magpie	*Pica pica*	2	N/A
Mallard	*Anas platyrhinchos*	2	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III
Pied wagtail	*Motacilla alba yarrellii*	2	N/A
Wren	*Troglodytes troglodytes*	2	N/A
Buzzard	*Buteo buteo*	1	N/A
Cormorant	*Phalacrocorax carbo*	1	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Great Spotted Woodpecker	*Dendrocopus major*	1	N/A
Greenfinch	*Carduelis chloris*	1	N/A
Mute swan	*Cygnus olor*	1	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Robin	*Erythacus rubecula*	1	N/A
Song thrush	*Turdus philomelos*	1	N/A
Woodpigeon	*Columba palumbus*	1	Protected Species: Wildlife Acts EU Birds Directive - Annex II, Annex III

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Table G-0-2: Wintering Survey (16-18/02/2021)

Transect ID	Date Start/End Time Weather	Species	Visual Distance bands				Aural records	
			0-25m	25-100m	>100m	In flight	+	-
A	16/02/21 09:30-09:52 Overcast, dry, 8°C, calm	Cormorant		1				X
		Great tit					X	
		Rook					X	
		Coal tit					X	
		Magpie					X	
		Wren					X	
		Robin					X	
		Blue tit					X	
		Mallard	2					X
		Buzzard		1				X
B	17/02/21 08:05-08:26 Light rain from 09:05 to end, 6°C, windy	Rook		6		4	X	
		Chaffinch					X	
		Collared Dove					X	
		Robin	1					X
		Blackbird	1					X
		Pied wagtail	1					X
C	16/02/21 08:30-08:50 Overcast, dry, 8°C, calm	Robin					X	
		Rook	1	6		7	X	
		Magpie					X	
		Chaffinch					X	
		Song thrush					X	

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		Great Spotted Woodpecker					X	
		House Sparrow					X	
		Wren	1					X
		Mallard	4					X
D	17/02/21 08:40-09:53 Overcast, dry, 6°C, windy	Jackdaw	1				X	
		Chaffinch					X	
		Blue tit					X	
		Rook	2			3	X	
		Robin					X	
		Great tit				1	X	
		Greenfinch					X	
		Collared dove		1			X	
		Blackbird	4					X
E	17/02/21 10:12-10:32 Overcast, dry, 6°C, windy	House sparrow	10				X	
		Jackdaw	2	6			X	
		Blackbird					X	
		Great tit					X	
		Pied wagtail	6					X
		Mute swan	1					X
F	18/02/21 09:09-09:29 Clear, dry, 7°C, calm	Chaffinch					X	
		Blue tit					X	
		House Sparrow					X	
		Coal tit					X	
		Woodpigeon	1				X	
		Blackbird	1					X

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		House Sparrow	3					X
		Rook	1					X

Notes:

3x house sparrows recorded near old forge (Between transect D and E)

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G.1 Survey 1 (19-20/12/2023)

G.1.1 Graiguenamanagh-Tinnahinch Towns (top up survey)

Table G-0-3: Survey Conditions

Date	Start time	Finish time	Notes	
20/12/2023	09:00	12:40	Temperature: 9°C	
Weather, highlight as appropriate				
Cloud cover	1 - (0-33%)		2 - (33-66%)	3 - (66-100%)
Rain	1 - None		2 - Showers	3 - drizzle
Wind	1 - Calm		2 - Light	3 – Breezy
Visibility	1- Good		2 – Moderate	3 - Poor

Table G-0-4: Birds recorded from Site A – 20/12/2023.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	2	Within the trees and In flight	Protected Species: Wildlife Acts
Common Kingfisher	*Alcedo atthis*	1	In flight over river	Protected Species: Wildlife Acts EU Birds Directive: Annex I Birds of Conservation Concern - Amber List
Eurasian Magpie	*Pica pica*	1	Within trees and Aural Recording	Protected Species: Wildlife Acts
Eurasian Siskin	*Carduelis spinus*	1	Visual and Aural Recording	Protected Species: Wildlife Acts
Goldfinch	*Carduelis carduelis*	33	In flight and perched within tree	Protected Species: Wildlife Acts
Great Black-Backed Gull	*Larus marinus*	1	In flight overhead	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Great Cormorant	*Phalacrocorax carbo*	3	In flight over the river and within the river	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Greenfinch	*Chloris chloris*	9	Perched in tree and In flight	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	1	Aural Recording	Protected Species: Wildlife Acts
Long-tailed Tit	*Aegithalus caudatus*	1	Perched on tree	Protected Species: Wildlife Acts
Redwing	*Turdus iliacus*	1	In flight	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	10	In flight overhead and Aural Recording	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
Thrush Sp*	*Turdidae sp.*	1	Perched in Tree	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	6	In flight overhead and Aural recording	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List

Table G-0-5: Birds recorded from Site B – 20/12/2023.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	11	Within trees, foraging and In flight	Protected Species: Wildlife Acts
Blue tit	*Cyanistes caeruleus*	1	Perched within tree	Protected Species: Wildlife Acts
Eurasian Collared Dove	*Streptopelia decaocto*	3	In flight	Protected Species: Wildlife Acts
Eurasian Magpie	*Pica pica*	2	Within trees	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	2	Perched within tree	Protected Species: Wildlife Acts
Grey Heron	*Ardea cinerea*	3	Standing within river and In flight over river	Protected Species: Wildlife Acts
Grey Wagtail	*Motacilla cinerea*	1	Foraging in grass	Protected Species: Wildlife Acts
Mallard	*Anas platyrhynchos*	5	In river	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	>20	In flight overhead	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	9	In flight	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	1	Within tree	Protected Species: Wildlife Acts

Table G-0-6: Birds recorded from Site C – 20/12/2023.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	1	In flight	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	In tree and Aural Recording	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
Goldcrest	*Regulus regulus*	1	Aural Recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	1	Perched in tree	Protected Species: Wildlife Acts
Gull Sp*	*Laridae sp.*	1	Aural Recording	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	>45	In flight overhead and Aural Recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	6	In flight and Aural Recording	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List

Table G-0-7: Birds recorded from Site D – 20/12/2023.

Common name	Species name	No. counted	Description of bird activity	Designation
Common Starling	*Sturnus vulgaris*	1	Aural Recordings	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Hooded Crow	*Corvus cornix*	3	In flight and Foraging on riverbank	Protected Species: Wildlife Acts
Gull Sp*	*Laridae sp.*	1	In flight overhead	Protected Species: Wildlife Acts
Long-tailed Tit	*Aegithalus caudatus*	1	In flight over river	Protected Species: Wildlife Acts
Mallard	*Anas platyrhynchos*	1	In flight over river	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Pied Wagtail	*Motacilla alba subsp. Yarrellii*	1	Perched within tree	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	>100	In flight overhead	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	4	In flight and Aural Recording	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	1	Within tree	Protected Species: Wildlife Acts

Table G-0-8: Birds recorded from Site E – 20/12/202.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	8	Within the trees, foraging, and In flight	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
Chaffinch	*Fringilla coelebs*	11	Within the trees	Protected Species: Wildlife Acts
Common Starling	*Sturnus vulgaris*	1	Aural Recordings	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Dunnock	*Prunella modularis*	1	Foraging	Protected Species: Wildlife Acts
Eurasian Collared Dove	*Streptopelia decaocto*	5	Within the trees and In flight	Protected Species: Wildlife Acts
European Goldfinch	*Carduelis carduelis*	14	Within the trees and Foraging	Protected Species: Wildlife Acts
European Greenfinch	*Carduelis chloris*	1	Within the trees	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	3	Perched in tree and Aural Recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	6	Perched in tree and Foraging	Protected Species: Wildlife Acts
House Sparrow	*Passer domesticus*	6	Within the trees	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Mallard	*Anas platyrhynchos*	2	In river	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Pied Wagtail	*Motacilla alba subsp. yarrellii*	1	Foraging	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	10	In flight overhead	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	7	In flight, foraging, and within the trees	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List

G.1.1 Upstream Storage Area

Table G-0-9: Survey Conditions.

Date	Start time	Finish time	Notes	
19/12/2023	10:00	12:10	Temperature: 6°C	
Weather, highlight as appropriate				
Cloud cover	1 - (0-33%)		2 - (33-66%)	3 - (66-100%)
Rain	1 - None		2 - Showers	3 - drizzle
Wind	1 - Calm		2 - Light	3 – Breezy
Visibility	1- Good		2 – Moderate	3 - Poor

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Table G-0-10: Birds recorded from Site A – 19/12/2023.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	3	Within the trees and Aural Recording	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	3	Perched within tree	Protected Species: Wildlife Acts
Eurasian Magpie	*Pica pica*	1	Within the trees	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	Aural Recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	5	In flight overhead	Protected Species: Wildlife Acts
Long-tailed Tit	*Aegithalus caudatus*	1	In flight	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	>20	In flight overhead	Protected Species: Wildlife Acts
Thrush Sp*	*Turdidae sp**	4	Within the tree and In flight	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	3	In flight overhead	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	6	Within trees and Aural Recording	Protected Species: Wildlife Acts

Table G-0-11: Birds recorded from Site B – 19/12/2023.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	2	In flight	Protected Species: Wildlife Acts
Coal Tit	*Periparus ater*	2	Visual and Aural Recordings	Protected Species: Wildlife Acts
Eurasian Collared Dove	*Streptopelia decaocto*	1	In flight	Protected Species: Wildlife Acts
Eurasian Magpie	*Pica pica*	1	In flight	Protected Species: Wildlife Acts
Eurasian Treecreeper	*Certhia familiaris*	1	Within tree	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	2	Aural Recording	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	1	Aural Recording	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	1	Aural Recording	Protected Species: Wildlife Acts
Pied Wagtail	*Motacilla alba subsp. yarrellii*	1	In flight	Protected Species: Wildlife Acts
Redwing	*Turdus iliacus*	1	In trees	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	9	In flight overhead	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	2	In flight overhead and Aural Recording	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III

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Common name	Species name	No. counted	Description of bird activity	Designation
				Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	3	Perched within tree	Protected Species: Wildlife Acts

Table G-0-12: Birds recorded from Site C – 19/12/2023.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	1	Aural Recording	Protected Species: Wildlife Acts
Coal Tit	*Periparus ater*	1	Within the trees	Protected Species: Wildlife Acts
Eurasian Collared Dove	*Streptopelia decaocto*	1	In flight	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	Aural Recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	1	In flight	Protected Species: Wildlife Acts
Gull Sp*	*Laridae sp.*	1	In flight overhead	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	2	In flight overhead and Aural Recording	Protected Species: Wildlife Acts
Long-tailed Tit	*Aegithalus caudatus*	8	Within the trees	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	>30	In flight overhead	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	1	In flight overhead	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	2	In the rushes, within the trees and Aural Recording	Protected Species: Wildlife Acts

G.2 Survey 2 (16-17/01/2024)

G.2.1 Graiguenamanagh-Tinnahinch Towns (top up survey)

Table G-0-13: Survey Conditions

Date	Start time	Finish time	Notes
17/01/2024	09:20	12:50	Temperature: -2°C Poor visibility with cold fog in some locations, sun appeared in the latter half of the survey

Weather, highlight as appropriate			
Cloud cover	1 - (0-33%)	2 - (33-66%)	3 - (66-100%)
Rain	1 - None	2 - Showers	3 - drizzle

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Wind	1 - Calm	2 - Light	3 – Breezy
Visibility	1- Good	2 – Moderate	3 - Poor

Table G-0-14: Birds recorded from Site A – 17/01/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	4	Within the trees and foraging	Protected Species: Wildlife Acts
Blue tit	*Cyanistes caeruleus*	3	Perched within trees and on telephone pole	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	1	Perched within tree	Protected Species: Wildlife Acts
Common Bullfinch	*Pyrrhula pyrrhula*	1	Perched in tree	Protected Species: Wildlife Acts
Common Starling	*Sturnus vulgaris*	2	On building; flying in and out of air vent	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
European Goldfinch	*Carduelis carduelis*	7	In flight and perched within the trees	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	1	Within the tree and aural recording	Protected Species: Wildlife Acts
Great Cormorant	*Phalacrocorax carbo*	1	In flight over the river	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Great Tit	*Parus major*	1	Foraging on grass	Protected Species: Wildlife Acts
Grey Heron	*Ardea cinerea*	2	In flight over river, standing within the river and aural recording	Protected Species: Wildlife Acts
Long-tailed Tit	*Aegithalus caudatus*	8	Foraging on grass and within the trees	Protected Species: Wildlife Acts
Mallard	*Anas platyrhynchos*	6	Within the river, standing on the weir	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Pipit sp*	*Anthus sp**	1	Perched on wall	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	>20	In flight overhead, within the trees, perched on buildings, and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	1	In flight overhead	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	4	Foraging on grass, within trees and aural recording	Protected Species: Wildlife Acts

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Table G-0-15: Birds recorded from Site B – 17/01/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	16	In flight, within the trees and foraging	Protected Species: Wildlife Acts
Blue tit	*Cyanistes caeruleus*	1	Perched within trees	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	2	Perched within tree	Protected Species: Wildlife Acts
Dunnock	*Prunella modularis*	1	Foraging on riverbank	Protected Species: Wildlife Acts
Eurasian Collared Dove	*Streptopelia decaocto*	1	Perched on telephone wire	Protected Species: Wildlife Acts
European Goldfinch	*Carduelis carduelis*	1	Foraging on riverbank	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	2	Within the trees, foraging, and aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	1	Foraging	Protected Species: Wildlife Acts
Grey Heron	*Ardea cinerea*	1	In flight over river and aural recording	Protected Species: Wildlife Acts
Grey Wagtail	*Motacilla cinerea*	1	Standing on riverbank and aural recording	Protected Species: Wildlife Acts
Kingfisher	*Alcedo atthis*	1	In flight over river	Protected Species: Wildlife Acts EU Birds Directive: Annex I Birds of Conservation Concern - Amber List
Mallard	*Anas platyrhynchos*	2	In flight over river	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	>10	In flight overhead, within the trees, perched on buildings, and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	1	Aural recording	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	1	Foraging in wooded area	Protected Species: Wildlife Acts

Table G-0-16: Birds recorded from Site C – 17/01/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	2	In flight	Protected Species: Wildlife Acts
Blue tit	*Cyanistes caeruleus*	2	Perched within trees	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
Chaffinch	*Fringilla coelebs*	2	Perched within trees	Protected Species: Wildlife Acts
Common Starling	*Sturnus vulgaris*	>10	Foraging on grass	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Great Cormorant	*Phalacrocorax carbo*	1	In flight over the river	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Great Tit	*Parus major*	1	Within tree	Protected Species: Wildlife Acts
Mallard	*Anas platyrhynchos*	1	In flight over river	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	>40	In flight overhead, within the trees, perched on buildings, and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	4	In flight overhead	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	1	Foraging on riverbank	Protected Species: Wildlife Acts

Table G-0-17: Birds recorded from Site D – 17/01/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	2	In flight over river	Protected Species: Wildlife Acts
Common Starling	*Sturnus vulgaris*	>15	Foraging on grass and within trees	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Duck sp*	*Anatidae sp.*	1	Aural recording	Protected Species: Wildlife Acts
Eurasian Magpie	*Pica pica*	4	In flight overhead/ over the river, and within trees	Protected Species: Wildlife Acts
European Goldfinch	*Carduelis carduelis*	2	In flight and perched within the trees	Protected Species: Wildlife Acts
Great Cormorant	*Phalacrocorax carbo*	2	In flight over the river	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Kingfisher	*Alcedo atthis*	1	In flight over river	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
				EU Birds Directive: Annex I Birds of Conservation Concern - Amber List
Mallard	*Anas platyrhynchos*	2	In flight over river	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	>40	In flight overhead, within the trees, perched on buildings, and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	4	In flight over river/ overhead, within trees, and aural recording	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	3	Within trees and aural recording	Protected Species: Wildlife Acts

Table G-0-18: Birds recorded from Site E – 17/01/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	5	In flight, within trees, foraging, and aural recording	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	>20	Perched within trees and foraging	Protected Species: Wildlife Acts
Common Starling	*Sturnus vulgaris*	4	Perched within trees and aural recordings	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Common Bullfinch	*Pyrrhula pyrrhula*	4	Perched within trees	Protected Species: Wildlife Acts
Eurasian Collared Dove	*Streptopelia decaocto*	2	In flight and within trees	Protected Species: Wildlife Acts
European Goldfinch	*Carduelis carduelis*	>25	Perched within trees and in flight	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	2	Within the trees, foraging, and aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	4	Within the trees and aural recording	Protected Species: Wildlife Acts
European Greenfinch	*Carduelis chloris*	1	Within tree	Protected Species: Wildlife Acts
House Sparrow	*Passer domesticus*	3	Within the trees and on wall	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List
Meadow Pipit	*Anthus pratensis*	1	Within tree	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
Rook	*Corvus frugilegus*	4	In flight overhead, and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	3	Within trees, in flight and aural recording	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List

G.2.2 Upstream Storage Area

Table G-0-19: Survey Conditions

Date	Start time	Finish time	Notes	
16/01/2024	09:20	12:50	Temperature: -1°C Clear skies, good visibility, and very cold	
Weather, highlight as appropriate				
Cloud cover	1 - (0-33%)		2 - (33-66%)	3 - (66-100%)
Rain	1 - None		2 - Showers	3 - drizzle
Wind	1 - Calm		2 - Light	3 – Breezy
Visibility	1- Good		2 – Moderate	3 - Poor

Table G-0-20: Birds recorded from Site A – 16/01/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	6	Within trees, in flight between trees and aural recording	Protected Species: Wildlife Acts
Blue tit	*Cyanistes caeruleus*	8	Perched within trees	Protected Species: Wildlife Acts
Eurasian Magpie	*Pica pica*	1	Aural recording	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	Within the trees	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	2	Within trees and aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	7	In flight between trees,	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	7	Within trees and in flight overhead	Protected Species: Wildlife Acts
Thrush Sp*	*Turdidae sp.*	1	Within trees and in flight	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	1	In flight overhead	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List

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Common name	Species name	No. counted	Description of bird activity	Designation
Wren	*Troglodytes troglodytes*	1	Within trees and aural recording	Protected Species: Wildlife Acts

Table G-0-21: Birds recorded from Site B– 16/01/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	3	In flight, within trees, and aural recording	Protected Species: Wildlife Acts
Coal Tit	*Periparus ater*	2	Within trees and aural recordings	Protected Species: Wildlife Acts
Common Pheasant	*Phasianus colchicus*	1	Foraging on woodland floor	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	3	Foraging, within trees, and aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	9	In flight between trees, within the trees	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	1	Aural recording	Protected Species: Wildlife Acts
Long-tailed Tit	*Aegithalus caudatus*	1	Aural recording	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	5	In flight overhead and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	7	In flight within the woodland, and aural recording	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List

Table G-0-22: Birds recorded from Site C– 16/01/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	1	In flight, and aural recording	Protected Species: Wildlife Acts
Common Buzzard	*Buteo buteo*	1	Perched on tree and in flight	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	Aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	2	Within the trees	Protected Species: Wildlife Acts
Redwing	*Turdus iliacus*	1	Within the trees	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	2	In flight overhead and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	>6	In flight overhead	Protected Species: Wildlife Acts EU Birds Directive: Annex II, Annex III Birds of Conservation Concern: Amber List
Wren	*Troglodytes troglodytes*	1	Within trees	Protected Species: Wildlife Acts

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G.3 Survey 3 (22-23/02/2024)

G.3.1 Graiguenamanagh-Tinnahinch Towns (top up survey)

Table G-0-23: Survey Conditions

Date	Start time	Finish time	Notes
23/02/2024	9:10	12:20	Temperature: 3°C Cloudy skies, moderate visibility, light winds and cold

Weather, highlight as appropriate			
Cloud cover	1 - (0-33%)	2 - (33-66%)	3 - (66-100%)
Rain	1 - None	2 - Showers	3 - drizzle
Wind	1 - Calm	2 - Light	3 – Breezy
Visibility	1- Good	2 – Moderate	3 - Poor

Table G-0-24: Birds recorded from Site A – 23/02/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	1	Within trees	Protected Species: Wildlife Acts
Cormorant	*Phalacrocorax carbo*	2	In flight over river	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Dunnock	*Prunella modularis*	1	Aural recording	Protected Species: Wildlife Acts
Eurasian Blue Tit	*Cyanistes caeruleus*	1	Within trees, and in flight	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	2	Aural recording	Protected Species: Wildlife Acts
Grey Heron	*Ardea cinerea*	1	Perched high in tree and in flight over river	Protected Species: Wildlife Acts
Grey Wagtail	*Motacilla cinerea*	1	In flight over river	Protected Species: Wildlife Acts
Great Tit	*Parus major*	2	Within trees and aural recording	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	1	Aural recording	Protected Species: Wildlife Acts
Goldfinch	*Carduelis carduelis*	9	Within trees and in flight between trees	Protected Species: Wildlife Acts
Long-tailed Tit	*Aegithalus caudatus*	1	Within trees, and aural recording	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	12	In flight overhead, perched within trees and aural recording	Protected Species: Wildlife Acts
Song Thrush	*Turdus philomelos* subsp. *clarkei*	2	Perched within trees and in flight	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	6	In flight overhead, within trees, and aural recording	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
				Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III

Table G-0-25: Birds recorded from Site B – 23/02/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	11	Within trees, foraging, and aural recording	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	3	Within trees, and aural recording	Protected Species: Wildlife Acts
Cormorant	*Phalacrocorax carbo*	2	In flight over river	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Eurasian Blue Tit	*Cyanistes caeruleus*	1	Within trees	Protected Species: Wildlife Acts
Eurasian Collared Dove	*Streptopelia decaocto*	2	In flight and perched within tree	Protected Species: Wildlife Acts
Eurasian Jackdaw	*Corvus monedula*	2	In flight between trees	Protected Species: Wildlife Acts
Eurasian Magpie	*Pica pica*	8	Within trees, and aural recording	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	4	In flight overhead, foraging, perched within trees, and aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	1	Within trees, and aural recording	Protected Species: Wildlife Acts
Mallard	*Anas platyrhynchos*	8	Within the river, standing on the riverbank, and in flight over river	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	17	In flight overhead, perched within trees and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	14	In flight overhead and between trees, within trees, and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III

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Table G-0-26: Birds recorded from Site C – 23/02/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Common Buzzard	*Buteo buteo*	1	In flight overhead	Protected Species: Wildlife Acts
Cormorant	*Phalacrocorax carbo*	2	In flight over river	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List
Eurasian Magpie	*Pica pica*	1	In flight overhead	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	4	Aural recording	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	1	Within trees and aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	4	Within trees and aural recording	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	3	Within trees, foraging on riverbank, and aural recording	Protected Species: Wildlife Acts
Mallard	*Anas platyrhynchos*	4	Within the river	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	20	In flight overhead, perched within trees and on buildings, and aural recording	Protected Species: Wildlife Acts
Song Thrush	*Turdus philomelos* subsp. *clarkei*	1	Perched within trees	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	5	Within trees, in flight, and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Wren	*Troglodytes troglodytes*	1	Within trees	Protected Species: Wildlife Acts

Table G-0-27: Birds recorded from Site D – 23/02/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	1	Within the scrub	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	2	Aural recording	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	1	Aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	2	Within the trees	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
Gull Sp*	*Laridae sp.*	2	In flight overhead	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	1	Perched on top of boat	Protected Species: Wildlife Acts
Mallard	*Anas platyrhynchos*	8	Within the river, standing on the riverbank, and in flight over river	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Rook	*Corvus frugilegus*	10	Perched within trees/on top of buildings, in flight, and aural recording	Protected Species: Wildlife Acts
Tit Sp*	*Paridae sp.*	3	Within trees	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	4	Perched within trees/on top of buildings, and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Wren	*Troglodytes troglodytes*	1	Aural recording	Protected Species: Wildlife Acts

Table G-0-28: Birds recorded from Site E – 23/02/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	4	Perched within trees	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	5	Within trees and foraging on grass	Protected Species: Wildlife Acts
Coal Tit	*Periparus ater*	1	Perched within trees	Protected Species: Wildlife Acts
Dunnock	*Prunella modularis*	4	Perched within trees	Protected Species: Wildlife Acts
Eurasian Blue Tit	*Cyanistes caeruleus*	1	Within trees	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	3	Perched within low-lying branches, foraging, and aural recording	Protected Species: Wildlife Acts
Goldfinch	*Carduelis carduelis*	14	Within trees and in flight between trees	Protected Species: Wildlife Acts
Great Tit	*Parus major*	1	Perched within trees	Protected Species: Wildlife Acts
Hooded Crow	*Corvus cornix*	1	In flight overhead	Protected Species: Wildlife Acts
House Sparrow	*Passer domesticus*	5	In flight	Protected Species: Wildlife Acts Birds of Conservation Concern - Amber List

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Common name	Species name	No. counted	Description of bird activity	Designation
Kingfisher	*Alcedo atthis*	1	In flight over the river and perched upon bridge railing	Protected Species: Wildlife Acts EU Birds Directive: Annex I Birds of Conservation Concern - Amber List
Mallard	*Anas platyrhynchos*	6	In flight overhead and within the river	Protected Species: Wildlife Acts EU Birds Directive: Annex II and Annex III
Rook	*Corvus frugilegus*	3	In flight overhead and aural recording	Protected Species: Wildlife Acts
Song Thrush	*Turdus philomelos* subsp. *clarkei*	1	Perched within trees	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	7	In flight overhead, perched within trees, and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Yellow-hammer	*Emberiza citrinella*	1	Perched within trees	Protected Species: Wildlife Acts Birds of Conservation Concern: Red List

G.3.2 Upstream Storage Area

Table G-0-29: Survey Conditions

Date	Start time	Finish time	Notes	
22/02/2024	10:05	11:55	Temperature: 4°C Cloudy skies, poor to moderate visibility, light winds and cold	
Weather, highlight as appropriate				
Cloud cover	1 - (0-33%)		2 - (33-66%)	3 - (66-100%)
Rain	1 - None		2 - Showers	3 - drizzle
Wind	1 - Calm		2 - Light	3 – Breezy
Visibility	1- Good		2 – Moderate	3 - Poor

Table G-0-30: Birds recorded from Site A – 22/02/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	6	Perched within/flying between trees, foraging, and aural recording	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	1	Perched within trees	Protected Species: Wildlife Acts

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Common name	Species name	No. counted	Description of bird activity	Designation
Common Bullfinch	*Pyrrhula pyrrhula*	1	Perched within trees	Protected Species: Wildlife Acts
Dunnock	*Prunella modularis*	1	Perched within trees	Protected Species: Wildlife Acts
Eurasian Blue Tit	*Cyanistes caeruleus*	6	Within trees, in flight, and aural recording	Protected Species: Wildlife Acts
Eurasian Magpie	*Pica pica*	1	Aural recording	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	Aural Recording	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	1	Perched within trees	Protected Species: Wildlife Acts
Long-tailed Tit	*Aegithalus caudatus*	1	Perched within trees and aural recording	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	4	Within trees, in flight overhead, and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	12	In flight overhead and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Wren	*Troglodytes troglodytes*	2	Perched within the trees, and aural recording	Protected Species: Wildlife Acts

Table G-0-31: Birds recorded from Site B– 22/02/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	2	Aural recording	Protected Species: Wildlife Acts
Common Buzzard	*Buteo buteo*	1	In flight overhead	Protected Species: Wildlife Acts
Eurasian Magpie	*Pica pica*	1	Aural recording	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	Aural Recording	Protected Species: Wildlife Acts
Eurasian Treecreeper	*Certhia familiaris*	1	Aural recording	Protected Species: Wildlife Acts
Long-tailed Tit	*Aegithalus caudatus*	1	Aural recording	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	10	In flight overhead, and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	5	In flight overhead and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III

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Table G-0-32: Birds recorded from Site C– 22/02/2024.

Common name	Species name	No. counted	Description of bird activity	Designation
Blackbird	*Turdus merula*	1	Aural recording	Protected Species: Wildlife Acts
Chaffinch	*Fringilla coelebs*	1	Aural recording	Protected Species: Wildlife Acts
Common Buzzard	*Buteo buteo*	3	In flight overhead and perched on top of tree	Protected Species: Wildlife Acts
Dunnock	*Prunella modularis*	1	Perched on telephone wire	Protected Species: Wildlife Acts
Eurasian Blue Tit	*Cyanistes caeruleus*	2	Within/in flight between trees	Protected Species: Wildlife Acts
Eurasian Magpie	*Pica pica*	1	In flight overhead	Protected Species: Wildlife Acts
European Robin	*Erithacus rubecula*	1	Aural Recording	Protected Species: Wildlife Acts
Goldcrest	*Regulus regulus*	1	Aural recording	Protected Species: Wildlife Acts
Great Tit	*Parus major*	5	Within/in flight between trees and aural recording	Protected Species: Wildlife Acts
Long-tailed Tit	*Aegithalus caudatus*	5	Perched within trees	Protected Species: Wildlife Acts
Rook	*Corvus frugilegus*	12	In flight overhead, and aural recording	Protected Species: Wildlife Acts
Wood Pigeon	*Columba palumbus*	2	In flight overhead, and aural recording	Protected Species: Wildlife Acts Birds of Conservation Concern: Amber List EU Birds Directive: Annex II, Annex III
Wren	*Troglodytes troglodytes*	1	Perched within the trees	Protected Species: Wildlife Acts

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Appendix H: Wintering Bird Survey Photographs (2023/2024)

Figure H-1: Grey Heron since on the bank of the River Barrow in Graiguenamanagh – Tinnahinch - 17/01/2024.

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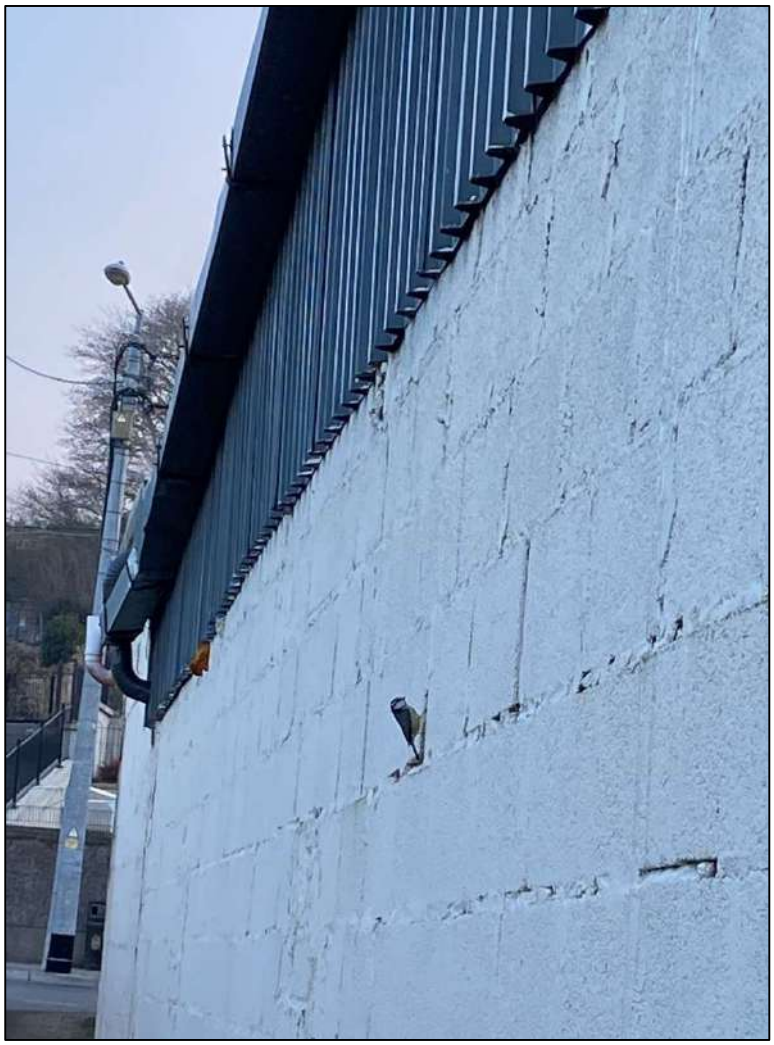

Figure H-2: Blue Tit seen climbing wall and entering the corrugated steel cladding in Graiguenamanagh – Tinnahinch - 17/01/2024.

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Figure H-3: Goldfinch observed in Graiguenamanagh – Tinnahinch - 17/01/2024.

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Figure H-4: Bullfinch observed in Graiguenamanagh – Tinnahinch - 17/01/2024.

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Appendix I: Mammal Survey Photographs (2023/2024)

Figure 0-1. Mammal Tunnel

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Figure 0-2. Mammal footprints in mammal tunnel

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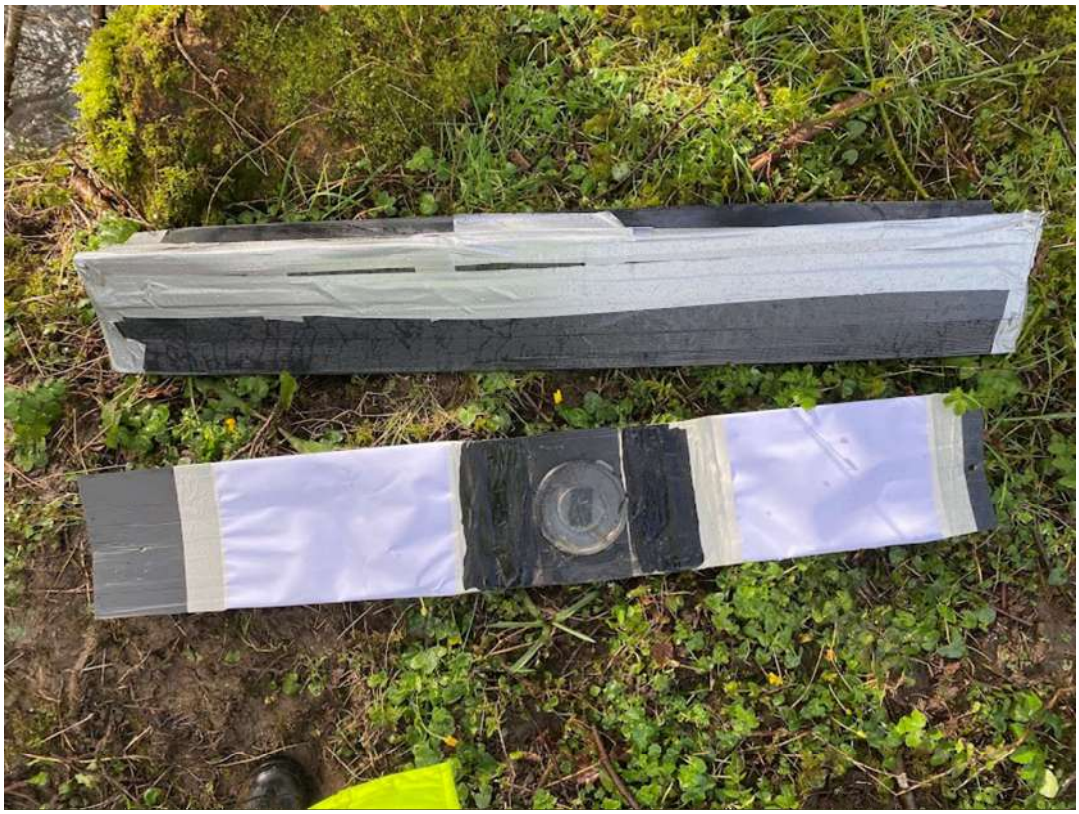

Figure 0-3. Mammal Tunnel

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Figure 0-4. Mammal faeces

Figure 0-5. Mammal faeces

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Figure 0-6. Mammal bone remains

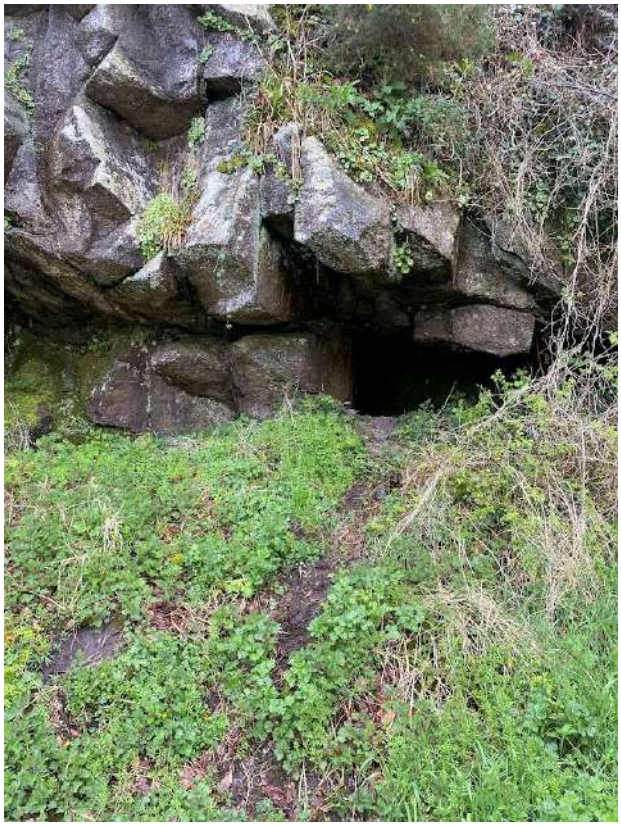

Figure 0-7. Mammal Trail with potential den

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Figure 0-8. Potential mammal burrowing

Figure 0-9. Mammal food remains – 28/03/2024

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Figure 0-10. Potential Badger footprints - 28/03/2024

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Appendix J: Q-Value Survey (Original CFRAM Survey) (AQUAFACT, 2021)

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This report was removed to reduce repetition. Please see Appendix 10-7 of Volume III of this EIAR.

Appendix K: Aquatic Surveys Report (Upstream Storage Area) (APEM, 2023)

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This report was removed to reduce repetition. Please see Appendix 10-10 of Volume III of this EIAR.

Appendix L: Q-Value Survey Photographs (2024)

Figure L.1: Kick Sample equipment and set up for examining invertebrates – 27/06/2024.

Figure L.2: ST1 Group A invertebrates – 27/06/2024.

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Figure L.3: ST1 Group B invertebrates – 27/06/2024.

Figure L.4: ST1 Group C invertebrates – 27/06/2024.

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Figure L.5: ST1 Group D invertebrates – 27/06/2024.

Figure L.6: ST1 Group E invertebrates – 27/06/2024.

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Figure L.7: ST2 Group A invertebrates – 27/06/2024.

Figure L.8: ST2 Group B invertebrates – 27/06/2024.

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Figure L.9: ST2 Group C invertebrates – 27/06/2024.

Figure L.10: ST2 Group D invertebrates – 27/06/2024.

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Figure L.11: ST2 Group E invertebrates – 27/06/2024.

Figure L.12: ST3 Group A invertebrates – 27/06/2024.

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Figure L.13: ST3 Group B invertebrates – 27/06/2024.

Figure L.15: ST3 Group D invertebrates – 27/06/2024.

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Figure L.16: ST3 Group E invertebrates – 27/06/2024.

Figure L.17: ST4 Group A invertebrates – 27/06/2024.

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Figure L.18: ST4 Group B invertebrates – 27/06/2024.

Figure L.19: ST4 Group C invertebrates – 27/06/2024.

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Appendix M: Electrofishing Survey Report (Original CFRAM Survey) (AQUAFACT, 2021)

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This report was removed to reduce repetition. Please see Appendix 10-6 of Volume III of this EIAR.

Appendix N: White-Clawed Crayfish Survey Report (Original CFRAM Survey) (Triturus Environmental Ltd., 2021)

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Appendix O: Freshwater Pearl Mussel Survey Report (Original CFRAM Survey) (Triturus Environmental Ltd., 2021)

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This report was removed to reduce repetition. Please see Appendix 10-9 of Volume III of this EIAR.

Appendix 14-1 TII Carbon Tool Assessment Results

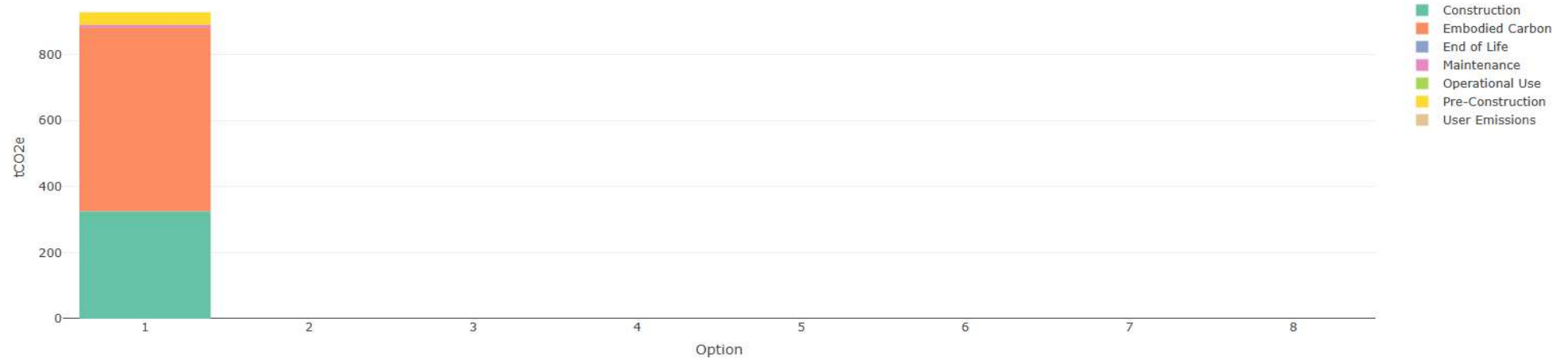
Option	Name	Pre-Construction	Embodied Carbon	Construction Activities	Construction Waste	Operational Use	User Emissions	Maintenance	End of Life	Total
1		38.51472981	555.02533	325.5899	0	0	0	8.6	0	927.7299598

Road Summary & Dashboard

Transport Infrastructure Ireland

Emissions Breakdown By Stage | Embodied Carbon Emissions Breakdown | Detailed Breakdown | Emissions Intensity | Carbon Savings Options | Pie Charts | Export All Tables

Show/Hide Graph | Export Table



Show 5 entries | Search:

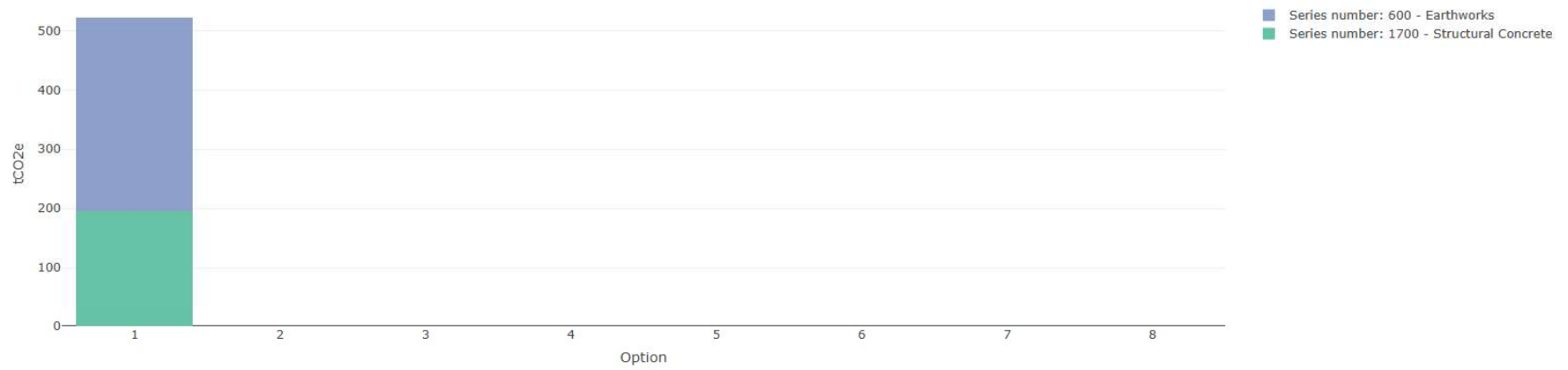
Option	Name	Pre-Construction	Embodied Carbon	Construction Activities	Construction Waste	Operational Use	User Emissions	Maintenance	End of Life	Total
All	All	All	All	All	All	All	All	All	All	All
1		38.5	555.0	325.6	0.0	0.0	0.0	8.6	0.0	927.7

Showing 1 to 1 of 1 entries | Previous 1 Next

Option	Name	Series number: 300 - Fencing and Environmental Noise Barriers	Series number: 400 - Safety Barrier Systems	Series number: 500 - Drains, Sewers, Piped Culverts and Service Ducts	Series number: 600 - Earthworks	Series number: 700 - Pavements	Series number: 1100 - Kerbs, Footways and Paved Areas	Series number: 1200 - Traffic Signs and Road Markings	Series number: 1300 - Road Lighting Columns and Brackets	Series number: 1400 - Electrical Work for Road Lighting and Traffic Signs	Series number: 1700 - Structural Concrete	Series number: 2000 - Waterproofing for structures	Series number: 2100 - Bearings	Series number: 2300 - Bridge Expansion Joints and Sealing of Gaps	Series number: 2400 - Brickwork, Blockwork and Stonework	Series number: 2700 - Watermains, Utilities and Accommodation Works	Other
1		0	0	0	327.0304	0	0	0	0	0	195.525	0	0	0	0	0	

Emissions Breakdown By Stage | Embodied Carbon Emissions Breakdown | Detailed Breakdown | Emissions Intensity | Carbon Savings Options | Pie Charts | Export All Tables

Show/Hide Graph | Export Table



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Option	Name	Series number: 300 - Fencing and Environmental Noise Barriers	Series number: 400 - Safety Barrier Systems	Series number: 500 - Drains, Sewers, Piped Culverts and Service Ducts	Series number: 600 - Earthworks	Series number: 700 - Pavements	Series number: 1100 - Kerbs, Footways and Paved Areas	Series number: 1200 - Traffic Signs and Road Markings	Series number: 1300 - Road Lighting Columns and Brackets	Series number: 1400 - Electrical Work for Road Lighting and Traffic Signs	Series number: 1700 - Structural Concrete	Series number: 2000 - Waterproofing for structures	Series number: 2100 - Bearings	Series number: 2300 - Bridge Expansion Joints and Sealing of Gaps
,		All	All	All	All	All	All	All	All	All	All	All	All	All
1		0.0	0.0	0.0	327.0	0.0	0.0	0.0	0.0	0.0	195.5	0.0	0.0	0.0

Option	Name	Materials	Material Transport	Clearance and demolition	Land Use Change and Vegetation Loss	Clearance and Demolition Water Use	Excavation	Construction Water Use	Plant Use	Construction Worker Travel to Site	Construction Waste Disposal	Construction Waste Transport	Operational Energy	Operational Water	Operational Waste Disposal	Operational Waste Transport	Landscaping and Vegetation	Maintenance Material	Maintenance Plant	Customer Use (Road Vehicle Use)	Decommissioning Emissions	Decommissioning Waste Disposal	Decommissioning Waste Transport	Total
1		522.5554	32.46993	0.280514374	38.2311	0.003115433	4.0316	0	229.8929	91.6654	0	0	0	0	0	0	0	0	8.6	0	0	0	0	927.73

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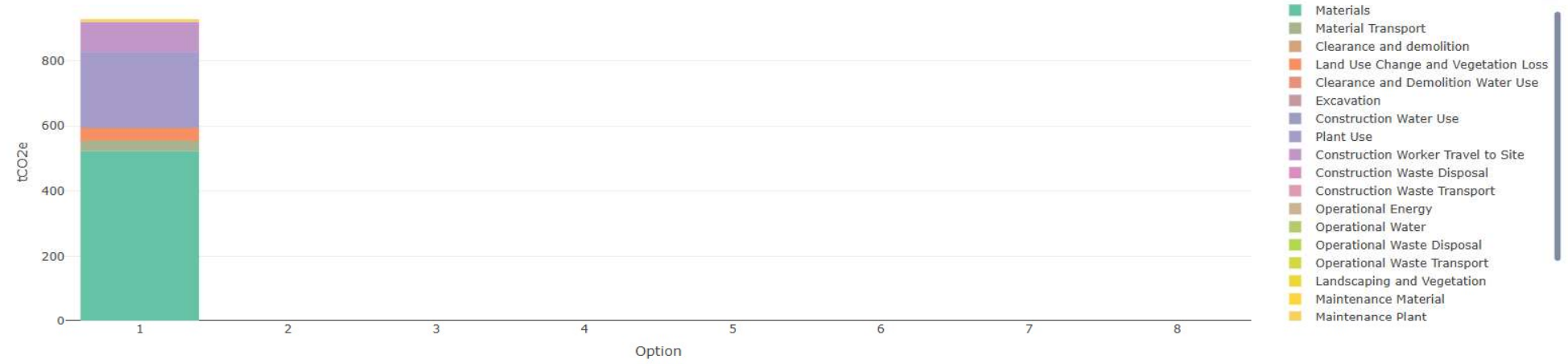
Export Table



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Search:

		Embodied Carbon		Construction Activities						Construction Waste		Road Use	
Option	Name	Materials	Material Transport	Clearance and demolition	Land Use Change and Vegetation Loss	Clearance and Demolition Water Use	Excavation	Construction Water Use	Plant Use	Construction Worker Travel to Site	Construction Waste Disposal	Construction Waste Transport	Operational Energy	Operatio Wa
		All	All	All	All	All	All	All		All	All	All	All	All
1		522.6	32.5	0.3	38.2	0.0	4.0	0.0	229.9	91.7	0.0	0.0	0.0	

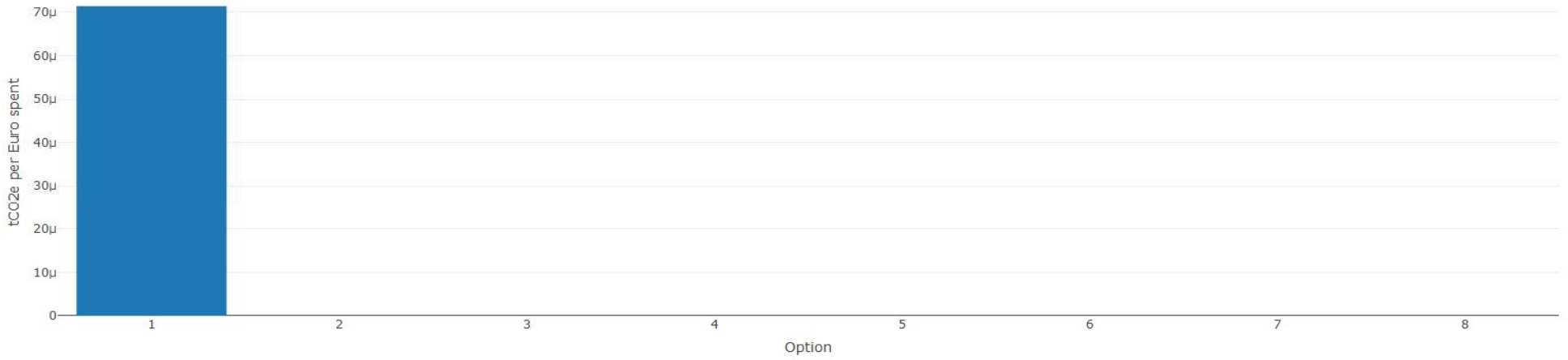
Option	Name	tCO2e per km of road	tCO2e per Euro spent
1		0	7.13638E-05

Road Summary & Dashboard

Transport Infrastructure Ireland

Emissions Breakdown By Stage | Embodied Carbon Emissions Breakdown | Detailed Breakdown | Emissions Intensity | Carbon Savings Options | Pie Charts | Export All Tables

Show/Hide Graph | Export Table



Show 5 entries | Search:

Option	Name	tCO2e per km of road	tCO2e per Euro spent
All	All	All	All
1		0.00000	0.00007

Showing 1 to 1 of 1 entries

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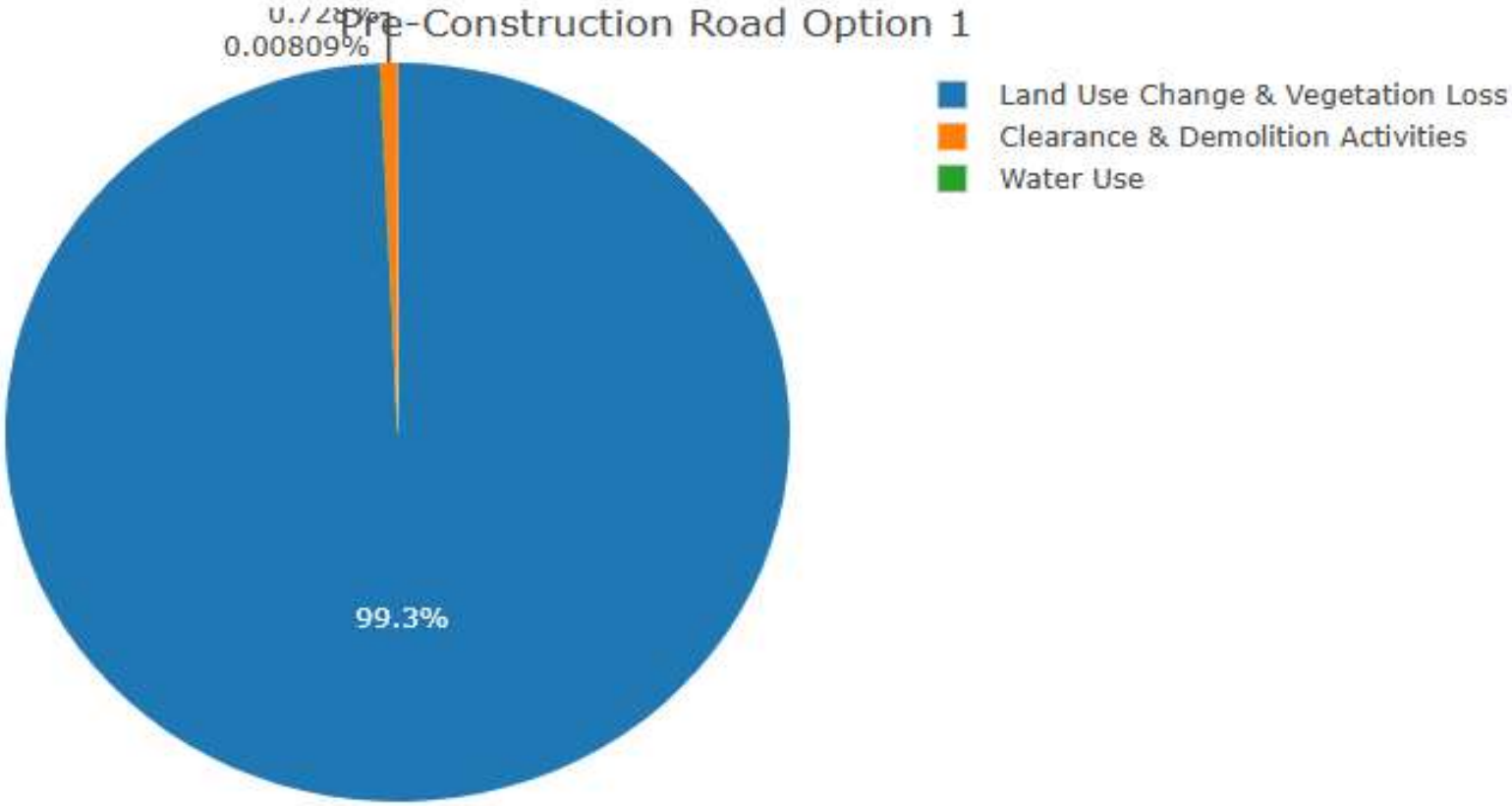
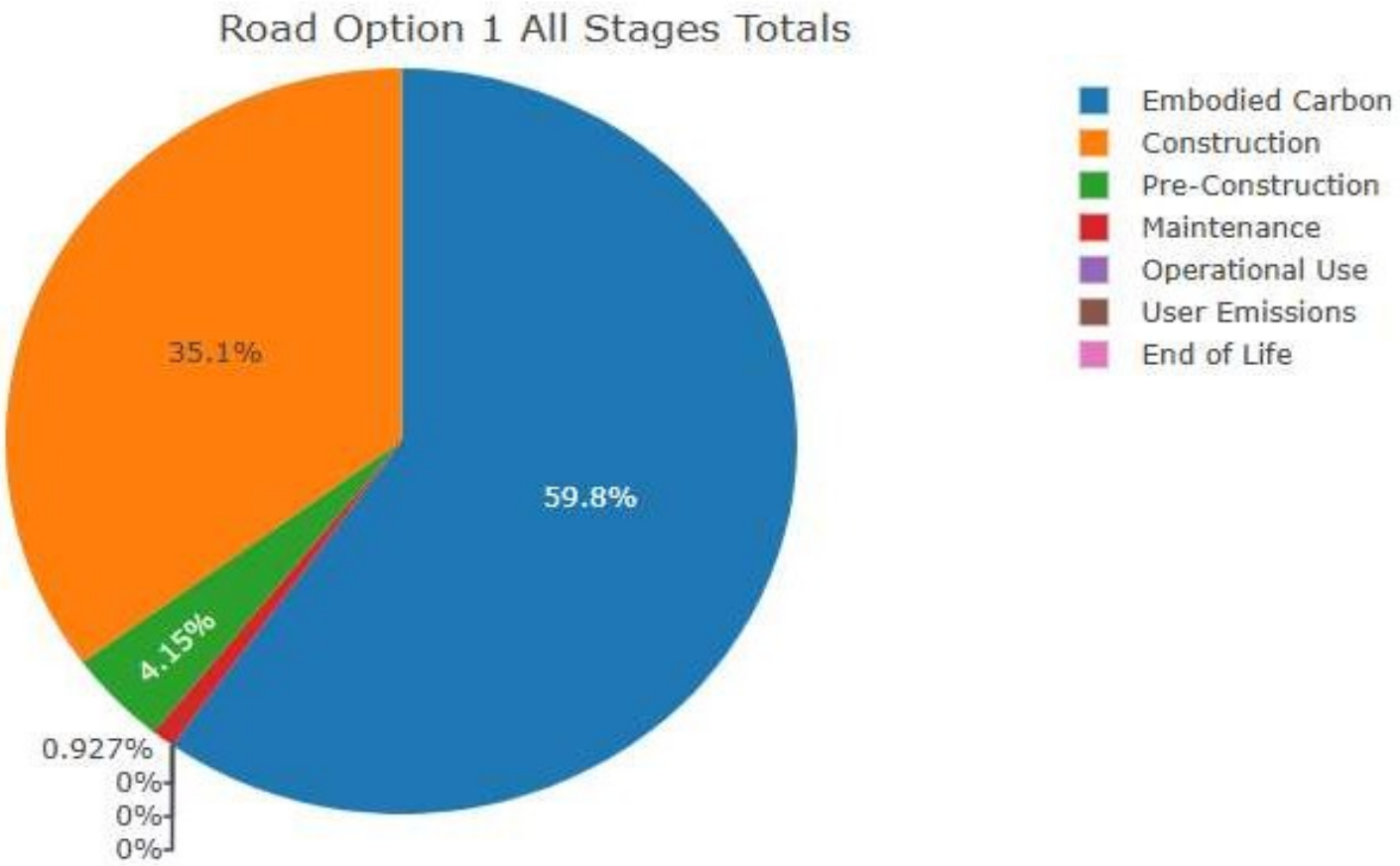
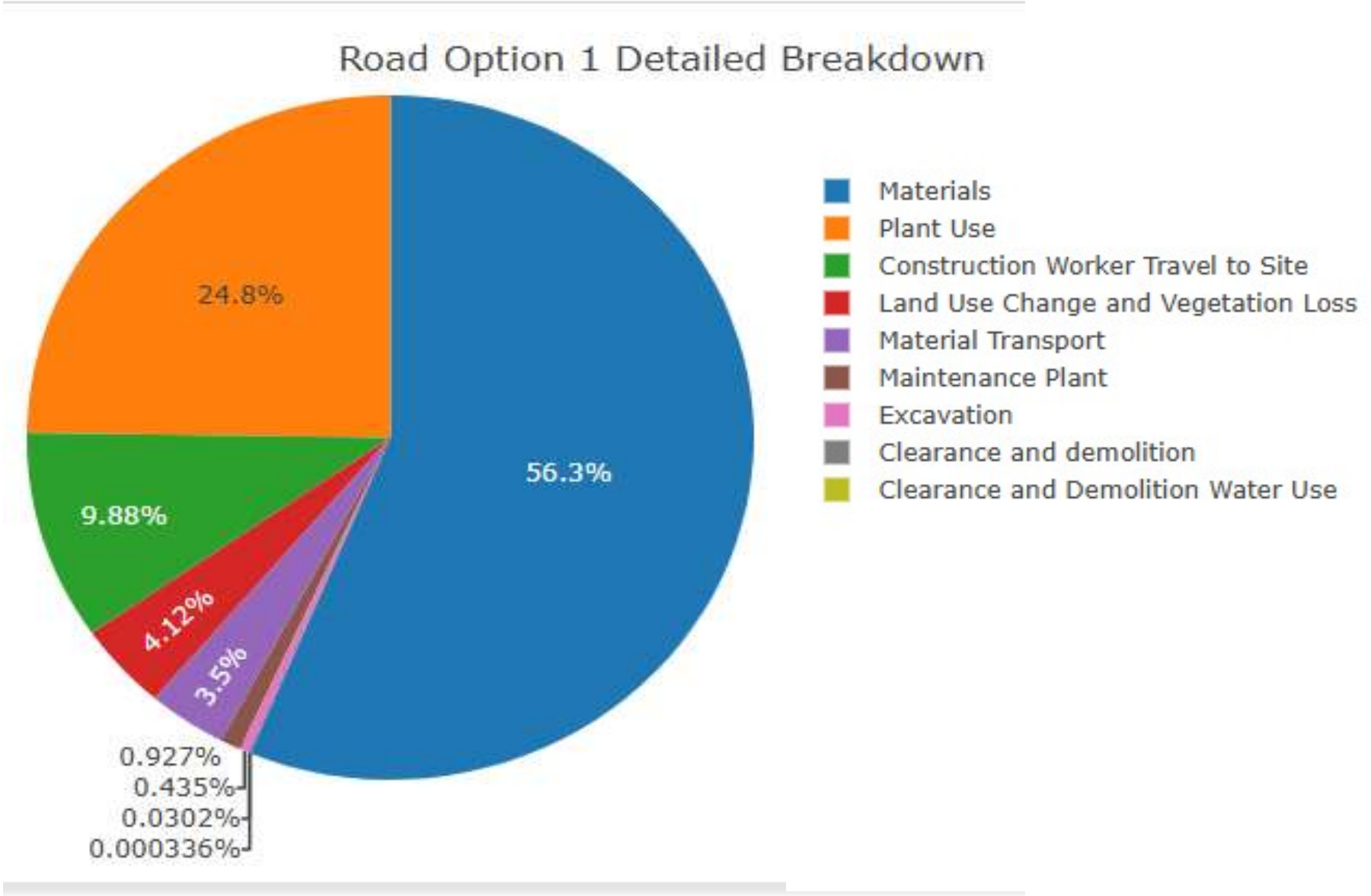
Road Option Number

1




Road Option 1 All Stages Totals
35.1%
59.8%
4.15%
0.927%
0%
0%
0%
Embodied Carbon
Construction
Pre-Construction
Maintenance
Operational Use
User Emissions
End of Life


Road Option 1 Detailed Breakdown
24.8%
56.3%
9.88%
4.12%
3.5%
0.927%
0.435%
0.0302%
0.000336%
Materials
Plant Use
Construction Worker Travel to Site
Land Use Change and Vegetation Loss
Material Transport
Maintenance Plant
Excavation
Clearance and demolition
Clearance and Demolition Water Use

AI Overview

In the EU, the cost for carbon emissions in 2025 is projected to average around **€75 per tonne of CO2 equivalent**, according to Homaio. The EU's Emissions Trading System (ETS) sets a cap on emissions and allows companies to trade emission allowances, influencing the price. The cost is expected to increase in the coming years, particularly from 2026 onwards, as emission limits are tightened.

Here's a more detailed breakdown:

Average Price:

The projected average cost for carbon allowances (EUAs) in the EU carbon market for

Show more

Total Carbon = 927.7299598 tCo2e

Total Cost = = 927.73 x €75 = 69579.75

Total Carbon Cost = €69,579.75

Appendix 14-2 Scheme Climate Change Adaption Plan

Scheme Climate Change Adaption Plan

Graiguenamanagh-Tinnahinch Flood Relief Scheme

Report No. W3451-AYE-W-016

28 March 2025

Revision 01

Kilkenny County Council

Document Control

Project

Scheme Climate Change Adaption Plan

Client

Kilkenny County Council

Document

Scheme Climate Change Adaption Plan

Report Number:

W3451-AYE-W-016

Document Checking:

Date	Rev	Details of Issue	Prepared by	Checked by	Approved by
19 February 2025	00	1st Draft	Jordan Ross/ Seán Harrington	Orla Hannon / Ravi Masuti	Seán Harrington
19 March 2025	01	Address client comments	Olivia Keady	Seán Harrington	Seán Harrington

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Glossary

Adaptation Measure	A potential amendment or addition to a flood relief scheme to mitigate potential future increases in flood risk, typically assessed for either the Mid-Range Future Scenario or the High-End Future Scenario.
Adaptation Pathway	A combination of one or more Adaptation Measures required over a period of time to mitigate potential future increases in flood risk.
Adaptation Pathway Process	The process of assessing Potential Options and the Preferred Option, through the identification and evaluation of Adaptation Measures including cost benefit analysis and a Preliminary Viability Review, and subsequent mapping out of Adaptation Pathways.
Current Scenario	The present-day flood risk that exists, with no inclusion for climate change.
Current Scheme	The flood relief scheme being developed to manage present-day flood risk, or the flood risk that exists in the Current Scenario.
High-End Future Scenario (HEFS)	The more extreme of two indicative potential futures adopted by the OPW for use in flood risk assessment. Based on information available on climate projections, these indicative futures are used to assess the vulnerability of a community to potential future increase in flood risk.
HEFS Scheme	The flood relief scheme developed to manage present-day flood risk and adapted to flood risk that exists in the HEFS.
Mid-Range Future Scenario (MRFS)	The less extreme of two indicative potential futures adopted by the OPW for use in flood risk assessment. Based on information available on climate projections, these indicative futures are used to assess the vulnerability of a community to potential future increase in flood risk.
MRFS Scheme	The flood relief scheme developed to manage present-day flood risk and adapted to flood risk that exists in the MRFS.
Preliminary Viability Review	A preliminary review of the potential future viability of identified Adaptation Measures, used as a tool to support and document the evaluation of the climate change adaptability of the Preferred Option only.
Scheme Climate Change Adaptation Plan	The final plan setting out the findings of the Adaptation Pathway Process, produced for the Preferred Option only.

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[1] Introduction

[1.1] Background

The Climate Change Sectoral Adaptation Plan for Flood Risk Management (OPW, 2019) set out a requirement (Action 2.B) to assess the potential impacts of climate change and subsequently prepare a Scheme Climate Change Adaptation Plan (SCCAP) on foot of such assessment, for all new OPW-funded flood relief schemes (Scheme / FRS).

The National Climate Policy Position establishes the fundamental national objective of "achieving a competitive, low-carbon, climate-resilient and environmentally sustainable economy by 2050". With this context, the need for SCCAPs has been identified. The purpose of a SCCAP is to ensure that flood risk management interventions designed to address current, or present-day, flood risk are also planned with consideration of the potential increase in flood risk that could arise in the future due to climate change, and to ensure that the proposed interventions are flexible and adaptable to possible climate change scenarios. The SCCAP identifies what actions could be taken to manage flood risk in the future, what should trigger a future decision on these actions, and when that decision may be required.

In developing the SCCAP for Graiguenamanagh-Tinnahinch FRS, the Scheme Climate Change Adaptation Plans Technical Methodology Note for new Flood Relief Schemes, December 2023 has been used as reference document.

[1.2] Introduction

The towns of Graiguenamanagh in County Kilkenny and Tinnahinch in County Carlow have a history of flooding. The two towns are separated by the River Barrow which causes flooding when the channel exceeds its capacity. Additionally, Graiguenamanagh experiences flooding from the River Duiske. Kilkenny County Council (KCC) as the Lead Authority, in partnership with Carlow County Council (CCC) and The Office of Public Works (OPW) are now advancing the Graiguenamanagh-Tinnahinch Flood Relief Scheme (GTFRS) to address and mitigate the flood risk.

KCC has developed a flood relief scheme to mitigate the flood risk and intends to seek statutory approval for is construction from An Bord Pleanála.

[1.3] This Plan

In accordance with the SCCAP Technical Methodology (2023) the SCCAP must be prepared for the emerging option. This plan is also considered a 'live' document, and it is intended to monitor, review and amend it as the scheme progresses through to completion and the operational phase.

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[2] Climate Change & Dealing with Uncertainty

[2.1] Global Climate Change & Impacts in Ireland

Impacts of climate change have been well documented. A review as part of the SCCAP Technical Methodology (2023) noted the following potential impacts on flood risk.

- Annual average rainfall was 7% higher in the period 1990-2019, compared with the 30- year period 1961-1990[1].
- An analysis of monthly rainfall shows the decade from 2006 to 2015 was the wettest on record and there is evidence of a trend towards an increase in winter rainfall[2].
- Met Éireann has predicted that in Ireland the autumns and winters may become wetter, with a possible increase in heavy precipitation events of approximately 20%[3], which could increase both fluvial and groundwater flooding.
- Climate change is not only reflected in terms of the average temperature, precipitation, etc., but also in the frequency and intensity of extreme weather conditions. The consensus among different modelling approaches is that extreme rainfall events are likely to increase in frequency in autumn and winter, although uncertainty remains in these projections and further research is required[4].
- Satellite observations indicate that the sea level around Ireland has risen by approximately 2-3mm per year since the early 1990s[1].
- The Intergovernmental Panel on Climate Change[5] has reported that it is virtually certain that global mean sea level will continue to rise over the 21st century. The likely global mean sea level rise by 2100 is 0.28-0.55 metres under a very low emissions scenario (SPP1-1.9), and 0.98-1.88 metres under a very high emissions scenario (SSP5-8.5).
- The number of very intense storms is projected to increase over the North Atlantic Region[6], and the winter track of these storms may extend further south and over Ireland more often.

---

[1] Cámaro Garcia, Walther C.A., Dwyer, N., and Gault, J. (2021) The Status of Ireland's Climate, 2020, EPA Research Report 386, Johnstown Castle, Co. Wexford

[2] Murphy, C., Broderick, C., Burt, T.P. et al. (2018) A 305-year continuous monthly rainfall series for the island of Ireland (1711-2016). Climate of the Past 14: 413-440.

[3] Nolan, P. (2015), Ensemble of regional climate model projections for Ireland, EPA Research Report No. 159, Environmental Protection Agency, Johnstown Castle, Co. Wexford.

[4] Dunne, S., Hanafin, J., Lynch, P., McGrath, R., Nishimura, E., Nolan, P., Ratnam, J.V., Semmler, T., Sweeney, C. and Wang, S. (2009) Ireland in a Warmer World, Scientific Predictions of the Irish Climate in the Twenty-First Century. (R. McGrath and P. Lynch, eds.), Community Climate Change Consortium for Ireland.

[5] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 3–32, doi:10.1017/9781009157896.001.

[6] IPCC, 2014: Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chaterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

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- An increase in the number of intense storms over the North Atlantic could have a direct impact on storm surges, although there is uncertainty around the impact on storm surges[7].
- In the southwest of Ireland, significant wave heights have increased by 0.8 metres per decade although there is still uncertainty around the impacts of climate change on wave heights in the longer term

While uncertainty exists with regards to the rate and degree of change there is a clear risk that flooding, arising from the projected change in climatic parameters, is likely to become more frequent and severe in the future.

[2.2] Uncertainty of Climate Change Impacts

Climate projections are based on computer models attempting to simulate complex natural systems, with different models leading to different projections in terms of the impacts on climatic parameters. A key factor in making climate projections are the future global emissions of Green-House Gases (GHGs), and there is great uncertainty as to how emissions of GHGs will increase or decrease in the future.

While the uncertainty in impacts must not be a barrier to action and the potential for change cannot be ignored, care is also required to avoid 'maladaptation' whereby, based on assumed possible future impacts, actions are taken now and resources spent that may ultimately not be required. Such actions may act to restrict future adaptation measures and/or have unforeseen detrimental impacts on other objectives.

[2.3] Scenario Based Approach

A scenario-based approach to the assessment of the impacts of climate change has been embedded within flood risk management in Ireland since the commencement of the Catchment-based Flood Risk Assessment and Management (CFRAM) Programme in 2005.

Two potential future scenarios have typically been used to date and will be adopted for use within this SCCAP; namely the Mid-Range Future Scenario (MRFS) and the High-End Future Scenario (HEFS).

The scenarios are not time-bound projections, i.e., they are not projections of what is likely to happen at a defined point in time but rather reflect potential 'flood futures' that could arise at some time in the future. The scenarios can be used to assess the vulnerability of communities and to inform what future interventions (adaptation measures) may be required should the scenarios be realised. It should be noted that it is quite possible that the impacts of climate change on fluvial flood risk and coastal flood risk are realised at different rates.

The advantages of adopting a scenario-based approach are:

- It is independent of specific climate models and emissions scenarios and reflects the overall range of potential outcomes in terms of the parameters that are most relevant to flood risk

[7] 7 Palmer, M., Howard, T., Tinker, J., Lowe, J., Bricheno, L., Calvert, D., Edwards, T., Gregory, J., Harris, G., Krijnen, J., Pickering, M., Roberts, C. and Wolf, J. (2018). United Kingdom Climate Projections 2018 Marine Report

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management, and so they are less sensitive to debate around the merits of different models or the likelihood of different emissions scenarios.

- By fixing the climate change variables (e.g., sea level rise, peak flood flow), rather than fixing the rate at which climate change occurs, it is possible to test the vulnerability of communities and potential adaptive measures required for different climate change timelines efficiently without undertaking additional hydraulic modelling.
- It provides different scenarios to inform vulnerability and assess appropriate responses within the community-specific context, rather than designing to fixed projections, reducing the risk of maladaptation.

The climate change scenarios testing as part of the GTFRS are as per the SCCAP Technical Methodology (2023) and are outlined below in Table 2-1 below.

Table 2-1: Allowance in flood parameters for the MRFS and HEFS.

Parameter	MRFS	HEFS
Extreme Rainfall Depths	+ 20%	+ 30%
Peak Flood Flows	+ 20%	+ 30%
Mean Sea Level Rise	+ 500 mm	+ 1000 mm
Land Movement	- 0.5 mm / year	- 0.5 mm / year
Urbanisation	*No General Allowance – Review on Case-by-Case Basis*	*No General Allowance – Review on Case-by-Case Basis*
Forestation	- 1/6 Tp	- 1/3 Tp + 10% SPR

Timelines for the occurrence of the MRFS and HEFS are adopted for use are per the SCCAP Technical Methodology (2023) to assist on identifying when adaptation may be required. Each timeline is scenario-based e.g. estimated year in which each defined scenario (MRFS and HEFS) occurs, rather than estimating the change in a key indicator in a given year.

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Table 2-2: Trajectories for scenario-based climate change timelines for Ireland.

Trajectory	Indicative IPCC Scenario	Current	MRFS	HEFS
Most Optimistic Case	SSP1-1.9	2020	2130	2270
Slower Onset	SSP2-4.5	2020	2100	2160
Medium Onset	SSP5-8.5	2020	2085	2120
Faster Onset	SSP5-8.5, including ice-sheet instability	2020	2060	2080

The Slower, Medium, and Faster Onset trajectories outlined above broadly reflect the midrange projection of the SSP2-4.5, SSP5-8.5, and SSP5-8.5 including ice-sheet instability. The Most Optimistic Case is provided for comparative purposes only and broadly reflects the SSP1-1.9 emissions scenario. It is not used for the GTFRS SCCAP.

[2.4] The '4As' Approach

The SCCAP Technical methodology (2023) outlines that there are a range of design philosophies or approaches that can be taken in assessing how potential changes in flood hazard and risk can or should be managed that are captured within the '4A's framework:

- The ***Assumptive*** approach, where an allowance is designed and built into what is constructed now to provide for a degree of future change. Examples of this would include incorporating additional height on a flood defence wall or embankment, provision of additional capacity in by-pass channels or culverts or additional storage capacity in flood attenuation reservoirs. There is a risk of maladaptation with this approach, given that a fixed allowance is included, but it may be appropriate to provide for a foreseen minimum degree of change or apply this approach in circumstances where an Adaptive approach (see below) would be difficult to apply or would be disproportionately expensive, such as the construction of a culvert.
- The ***Adaptive*** approach, where provision to facilitate cost-efficient adaptation of a structure is designed for and built into what is constructed now. Examples of this would include designing and building the foundations of a flood defence wall now to provide for an increased height of defence, above that which is built now, or over-widening the footprint and/or crest-width of an embankment to allow for an increase in the height of the embankment in the future. This approach offers greater flexibility with regards to future interventions and reduces the risk of potential abortive costs associated with maladaptation but may still limit the extent of future change depending on the adaptive allowance designed for.
- The ***Alternative*** approach, where it is not intended to provide for the impacts of climate change through making changes to what is built now, or to adapt or modify those structures in the future, but rather to implement different measures, potentially in other locations, to

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manage a potential increase in risk. Examples of this would include introducing storage or nature-based solutions (NbS) upstream to offset potential future increases in flood flow to a given community downstream, or by providing increased conveyance to complement existing defences. This approach provides a significant degree of flexibility and limited risk of maladaptation as it does not involve any fixed change / provision in what is built today but may require the protection of certain areas to ensure that the foreseen alternatives are not impeded by future development.

- The ***Acceptance*** approach, where a reduced standard of protection in the future is accepted and it is not intended to provide protection against all future increases in flood risk, but rather to address some or all of the increasing risk through non-structural risk reduction and property and community resilience measures, such as enhanced forecasting and response, property flood resistance or resilience, relocation, etc. In certain cases, adaptation of a Scheme may address some of the increase in flood risk, but this may only be possible up to a point, beyond which the increased flood risk may need to be accepted. It has been found to date there is typically a strong preference within at-risk communities for protection measures to be constructed, rather than accepting that floods will happen and relying on resilience, and so the adoption of this approach would require thorough engagement with the community and may only be locally acceptable where the other approaches are not technically viable or would entail significant impacts on other sectoral values or objectives.

A mix of approaches is required to consider for inclusion for different elements of the GTFRS.

[2.5] Freeboard

Flood relief schemes incorporate a freeboard allowance to address sensitivity and uncertainty with regard to the design flood parameters, including flow and level as appropriate. This freeboard does not form part of the Standard of Protection, but instead mitigates the risk associated with the residual uncertainty e.g. if the peak flow of the design flood event is actually higher than that estimated.

In many cases, this freeboard allowance will also include a settlement allowance whereby the constructed defence or the ground beneath the constructed defence is anticipated to settle or compress over time.

For the purpose of the Adaptation Pathway Process, and in particular determining the standard of protection provided in the future, an ‘operational freeboard allowance’ is commonly assumed and excluded from the as-built defence level. This can be assumed to be the design freeboard allowance minus any settlement allowance included within that.

For example, if there is a 350mm design freeboard allowance, and 150mm of that is related to an allowance for settlement, the ‘operational freeboard allowance’ would be 200mm. Therefore, a defence which is constructed to a level of 38.15mOD would be assumed to settle to a level of 38.0mOD. The post-settlement level of 38.0mOD would be assessed as being at 37.8mOD for the purpose of the Adaptation Pathway Process, when the 200mm ‘operational freeboard allowance’ is taken into account.

Similarly, if an adaptation measure needs to be constructed to 38.2mOD to reinstate the Target Standard of Protection, it shall be costed to include the ‘operational freeboard allowance’ i.e. 38.4mOD. This approach is more appropriate than ignoring freeboard allowances altogether.

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However, the GTFS scheme began prior to the OPW SCCAP Technical Methodology, and it is not appropriate at this juncture to adopt the approach in full. Instead, the approach taken in this assessment has been to complete the modelling of the preferred option for the future scenarios with the operational freeboard retained in the model. This has a number of disadvantages:

- The damages that are calculated for the climate change scenarios where freeboard is retained in the modelling is underestimated as the defences do not overtop immediately once the scheme SoP is met.
- As a result of the above, the proposed flood extent can be different to the typical approach recommended by OPW as flood water can flow around the defences, rather than overtopping them.

On the contrary, whilst it is accepted that the OPW SCCAP Technical Methodology is preferred, the following advantages arise when freeboard is retained in the climate change modelling:

- The scheme ultimately gets built with the freeboard in place, so the extent mapping and nature of the and flood risk arising when floods greater than the SOP occur is more accurate. i.e. the scale of the event or its accuracy in terms of return period uncertainty is less important than the physical flood routes that will occur onsite and lead to the damages that occur.

In addition, the 'difference' in the damages for the pre scheme model for the current, MRFS and HEFS can still be used to inform on the additional damages, combined with the preferred option modelling.

Finally, notwithstanding any of the above, it is still possible to obtain accurate estimation of the necessary increases in flood heights to current scheme measures regardless of whether freeboard is excluded or included in the model. As the purpose of the adaptation planning is to define the proposed adaptation pathways, the objective are not compromised by the proposed approach.

More detailed appraisal of adaptation measures will need to be undertaken in the future once the need to adapt is established, which should include a detailed assessment of future freeboard requirements, and more complete adherence to guidance of the time.

For GTFRS, a freeboard of 350mm has been established as part of the development of the scheme. A 200mm allowance for settlement has been include in the soft (earthen embankment) defences.

[2.6] Identification of Tipping Points and Trigger Points

An understanding of when adaptation is required is essential to enable timely assessment and intervention to proactively manage the potential impacts of climate change on flood risk. Tipping point(s) and trigger point(s) are identified to facilitate this. The tipping point relates to the target standard of protection of the flood relief scheme. Two tipping points, Tipping Point 1 and Tipping Point 2, should be established in line with the definitions below:

- Tipping Point 1 - The time at which the design flood level exceeds the surveyed Crest Level minus the operational freeboard allowance at any location (i.e., operational freeboard retained).
- Tipping Point 2 - The time at which the design flood level exceeds the surveyed Crest Level (i.e., no operational freeboard).

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The design flood level and surveyed Crest Level can apply to a variety of flood risk management measures including flood walls, embankments, bypass channels, culverts, and impoundment structures, either in isolation or in combination.

The design flood level will typically be the 1% AEP flood event for fluvial flooding, or the 0.5% AEP flood event for coastal flooding. Both of the above tipping points can be determined using the estimated onset of flooding e.g., typically when the respective design flood level exceeds the surveyed Crest Level (or surveyed Crest Level minus the operational freeboard allowance), and do not necessarily require exceedance events to be modelled.

Ensuring the design flood level never exceeds Tipping Point 1, by implementing adaptation measures in a timely manner, will assist in promoting sustainable communities and supporting our environment through the effective management of the potential impacts of climate change on flooding and flood risk. However, it is noted that it may not always be viable to achieve this goal at all times, and so Tipping Point 2 is included.

These tipping points can be amended on a scheme-by-scheme basis where appropriate to do so, however Tipping Point 1 and 2 should be adopted unless there is clear justification to deviate from these. Trigger points relate to when the planning to implement an adaptation measure needs to commence in order to avoid the tipping point being reached.

The trigger point will always precede the tipping point as it must account for the lead-in time, i.e., the time taken to verify the need for the adaptation measure to be adapted and to appraise, design, and construct an adaptation measure. This should be estimated using professional judgement and experience of delivering flood relief schemes in Ireland, and with consideration for the complexity of the adaptation measures proposed for the Scheme. As such, it will be identified following the development of potentially viable adaptation measures.

An adaptation measure which, for example, requires raising an existing wall by 100mm over a 50m length will be much quicker to implement than an adaptation measure that requires the construction of a new tidal barrier. Similarly, in the case of NbS, the time for these measures to mature (e.g. tree planting) may need to be factored into the required lead-in time and therefore the trigger point.

The adaptation measure with the longest lead-in time should always be used to determine the trigger point to ensure a conservative approach to future adaptation. The trigger point will typically be determined as a defined period of time (in years) prior to the tipping point. Figure 2-1 illustrates the relationship between tipping points and trigger points, with specific reference to Trigger Point 1, Trigger Point 2, Tipping Point 1, and Tipping Point 2.

The green line illustrates how the standard of protection will change over time if an adaptation measure is implemented to avoid Tipping Point 1 being exceeded. The yellow line illustrates how the standard of protection will change over time if an adaptation is implemented to avoid Tipping Point 2 being exceeded.

In Figure 3-1, an assumptive allowance for climate change has been provided in both cases to ensure that Tipping Point 1 and 2 are pushed out to ensure the next adaptation is not required for some time. If no assumptive allowance is included, the standard of protection will never go above the threshold for Tipping Point 1. The date that each Trigger Point and Tipping Point occurs will vary for each climate change timeline.

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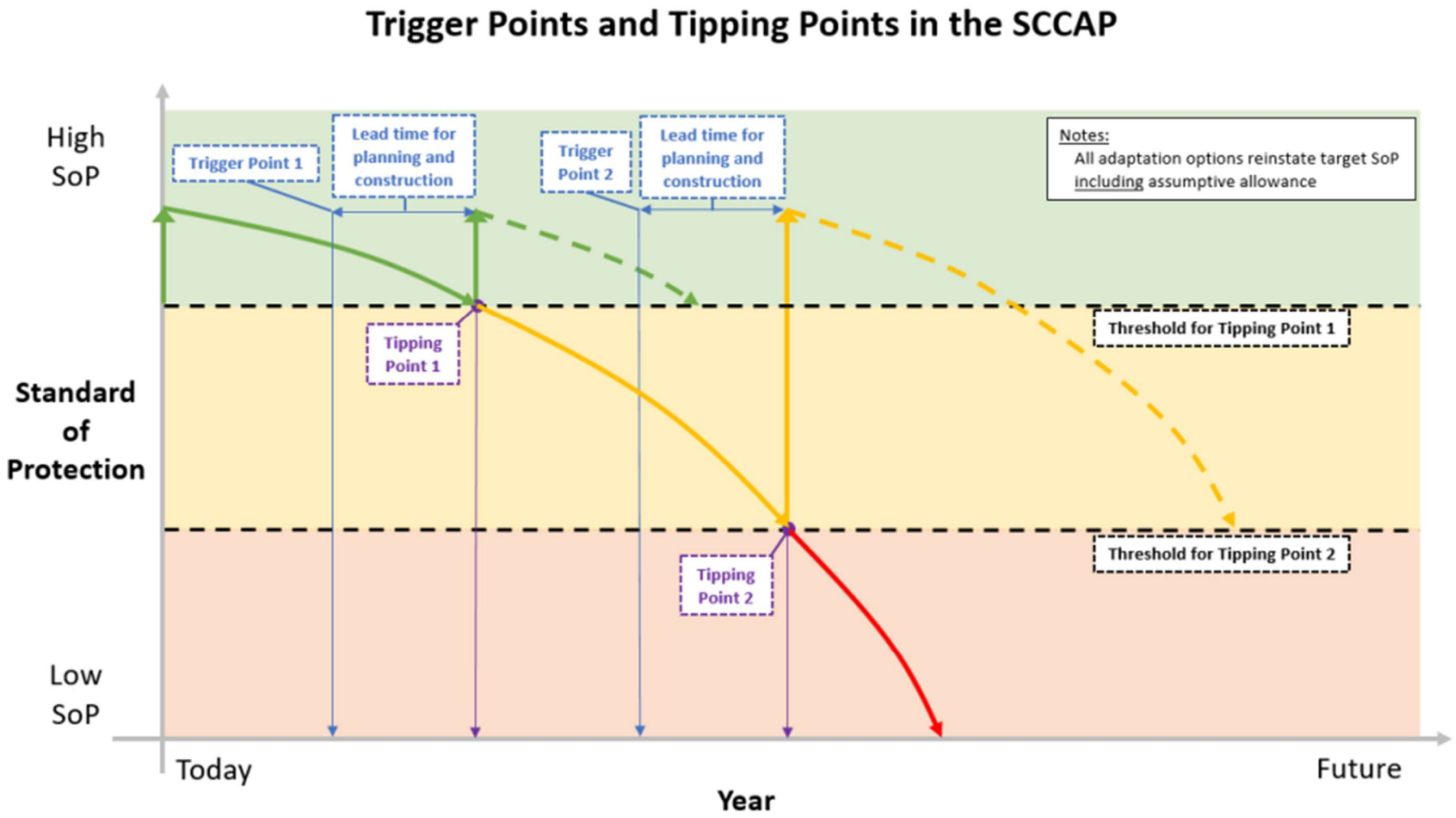

Figure 2-1: Schematic diagram to illustrate the Trigger Point and Tipping Point approach adopted in the SCCAP Technical Methodology

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[3] Description of the Preferred Scheme

[3.1] Option Report

An Option Report has been produced for the scheme that contains a detailed description of the measures considered and the final emerging preferred scheme. In addition, a full set of planning drawings containing technical engineering drawings has been assembled and further describes the proposed scheme.

The proposed scheme is summarised below and illustrated in Figure 3-1 overleaf.

[3.2] River Barrow Measures

The defences along the Barrow include those listed below.

Right Bank Defences

- A new raised defence on the right bank from upstream of the boat club to tie into Graiguenamanagh Bridge, including glass sections and flood gates to maintain access.
- Public Realm, Streetscaping and landscaping works along the entire right bank of the River Barrow.
- A new raised defence on the right bank downstream of Graiguenamanagh Bridge to tie into the Bridge leading into the Hub.
- A new raised defence within the grounds of the Hub along its northern boundary.
- A new raised defence on the left bank of the River Duiske between the access bridge to the Hub and Turf Market Bridge.
- A new raised defence on the right bank of the River Duiske between the access bridge to the Hub and Turf Market Bridge (Past Peg's Lane).
- Installation of non-return valves on outfalls to the River Barrow.
- Behind wall drainage systems and a pumping station at The Dock.

Left Bank Defences

- A new raised defence on the left bank upstream of Graiguenamanagh Bridge.
- A new raised defences on the left bank downstream of Graiguenamanagh Bridge to start of Mill Race (end of carpark).
- Streetscaping to the public area on Tinnahinch Quay.
- Installation of non-return valves on outfalls to the River Barrow.
- Behind wall drainage improvements/pumping stations

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[3.3] River Duiske Measures

- A new upstream Storage Reservoir.
- Debris Trap at Well Lane.
- A new raised defence on the left bank from Clapper Bridge to High Street Bridge.
- Raising of existing footbridge at The Mass Path.
- A new raised defence on the left bank from High Street Bridge downstream for circa 15m.
- A new pedestrian access bridge 15m downstream from High Street Bridge to replace existing bridge.
- Improvements to the existing stone river walls on the left bank on the River Duiske.
- Provision of sump and pumps to various properties on left bank of River Duiske at Turfmarket.
- Provision of flood doors to various properties on left bank of River Duiske at Turfmarket.

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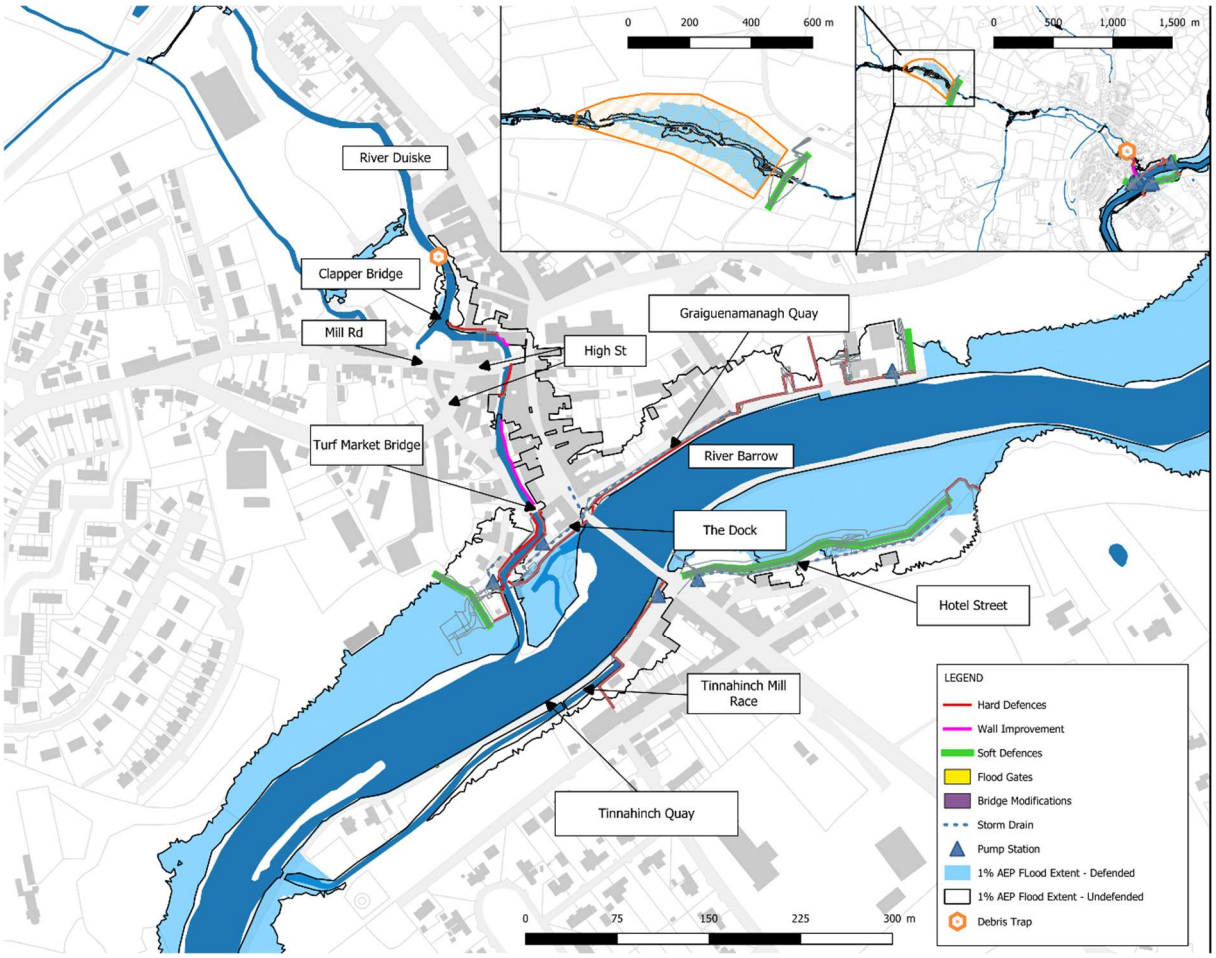

Figure 3-1: Outline of the Preferred Scheme for Graiguenamanagh-Tinnahinch

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[4] Adaption Plan

[4.1] Adaptation Pathway Process

The Adaptation Pathway Process is represented as a stepped approach and involves identifying the need for future adaptation, identifying potential adaptation measures, assessing the viability of these adaptation measures, and mapping out adaptation pathways. The steps, as described in the SCCAP Technical Methodology (2023), are shown in Table 4-1 below.

As mentioned in Section [3.1], an Option Report has been produced for the scheme that contains a detailed description of the measures considered and the final emerging preferred scheme, which are the first two steps in the process. The GTFRS SCCAP deals with Step 3 to 8 of the process.

Table 4-1: Stepped approach to the Adaptation Pathway Process

Step	Description
All Potential Options:	
1 - Baseline Economic Assessment	Determine the Standard of Protection for the Potential Options for 'Current Scheme' in the Current Scenario, MRFS and HEFS using the existing hydraulic model and hydrological / hydraulic assessments. Use existing damage assessment information to estimate the Present Value Damages (PVd) for the 'No Scheme' baseline for the Current Scenario, MRFS and HEFS. Use the SoP of the 'With Current Scheme', and the benefit area to estimate potential 'With Current Scheme' PVd and Present Value of Benefits (PVb) for each Potential Option for the Current Scenario, MRFS, and HEFS using the 'damages avoided' approach.
2 - Initial Screening Assessment	Undertake a high-level screening assessment of the viability of potential physical and non-physical adaptation measures for each Potential Option to maintain / restore the Target Standard of Protection (physical) or manage the residual risk (physical and / or non-physical) where the Target Standard of Protection cannot be maintained, for the MRFS and HEFS. Non-viable adaptation measures should be screened out
Preferred Option Only:	
3 - Adaptation measure Cost Benefit Analysis	Use existing damage assessment information, the SoP of the 'Current Scheme', and the benefitting area to estimate indicative 'MRFS Scheme' and 'HEFS Scheme' PVd and PVb for the MRFS and HEFS respectively using the 'damages avoided' approach. Detailed economic assessment (e.g. modelling the adaptation measure for eight AEP flood events) is not required. Develop potential adaptation measures (measures not screened out at Step 2), to determine key design parameters e.g. length, volume, height etc., to enable the estimation of Present Value Costs (PVc) for each adaptation measure in isolation. MRFS adaptation measures (Step 3a) should be developed prior to HEFS adaptation measures (Step 3b).
4 - Adaptation measure Preliminary Viability Review	Undertake a preliminary viability review for each potentially viable adaptation measure developed in isolation (measures not screened out at Step 2) using

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	existing information gathered during scheme development to assist. MRFS adaptation measures (Step 4a) should be reviewed prior to HEFS adaptation measures (Step 4b).
5 - Adaptation Pathway Assessment	Map potential adaptation pathways to identify potentially viable adaptation pathways and assess the adaptability and flexibility of the Preferred Option.
6 - Timing of Future Adaptation	Establish the timing of Trigger Point 1, Trigger Point 2, Tipping Point 1, and Tipping Point 2 under each climate change timeline.
7 - Climate Change Provision in the Preferred Option	Determine an appropriate climate change provision in the design of the Preferred Option based on the likely impacts associated with climate change, the timing of the trigger and tipping points, and the adaptability and flexibility of the Scheme. Use the findings of the Adaptation Pathway Process to confirm and/or refine the Preferred Option.
8 - Finalisation of the assessment	Summarise the findings of the Adaptation Pathway Process for the Preferred Option only in the draft Scheme Climate Change Adaptation Plan. Clarify decisions made in relation to climate change allowance (Step 7) and, where necessary, re-map the adaptation pathways for the Preferred Option (developed in Step 5) where an assumptive or adaptive allowance has been included.

[4.2] River Barrow

The development of options has been carried out with consideration of climate change adaptability. Figure 4-1 shows the increase in water levels across the urban area including the changes on the River Barrow with the Current Scheme in place.

The figure also shows the 1% AEP flood extent for the current, mid-range and high-end scenarios with the Current Scheme in place. As discussed in Section [2.5] above, these results are inclusive of freeboard or indeed 'additional' height to walls where heights greater than the SoP have been provide for other reasons (e.g. site security or safety).

The average increase in flood level for the MRFS within the town area on the River Barrow is 0.34m, with a range from 0.31m to 0.36m.

The increase above the current day scenario for the HEFS is 0.49m on average, with a range from 0.46m to 0.51m.

The typical increases observed longitudinally along the River Barrow do not vary considerably. Overall, flood levels on the River Barrow are not considered to be overly sensitive to climate change.

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id	1% AEP PD Water Level (m)	1% AEP MRFS Water Level (m)	1% AEP HEFS Water Level (m)
1	11.95	12.29	12.44
2	11.94	12.28	12.43
3	11.9	12.24	12.38
4	11.91	12.27	12.42
5	11.75	12.08	12.22
6	11.63	11.97	12.13
7	12.02	12.36	12.52
8	11.9	12.25	12.4
9	11.9	12.21	12.36
10	14.63	14.82	14.86
11	12.04	12.39	12.53
12	13.14	13.6	13.68
13	11.97	12.38	12.51
14	14.06	14.47	14.58
15	11.45	11.79	11.93

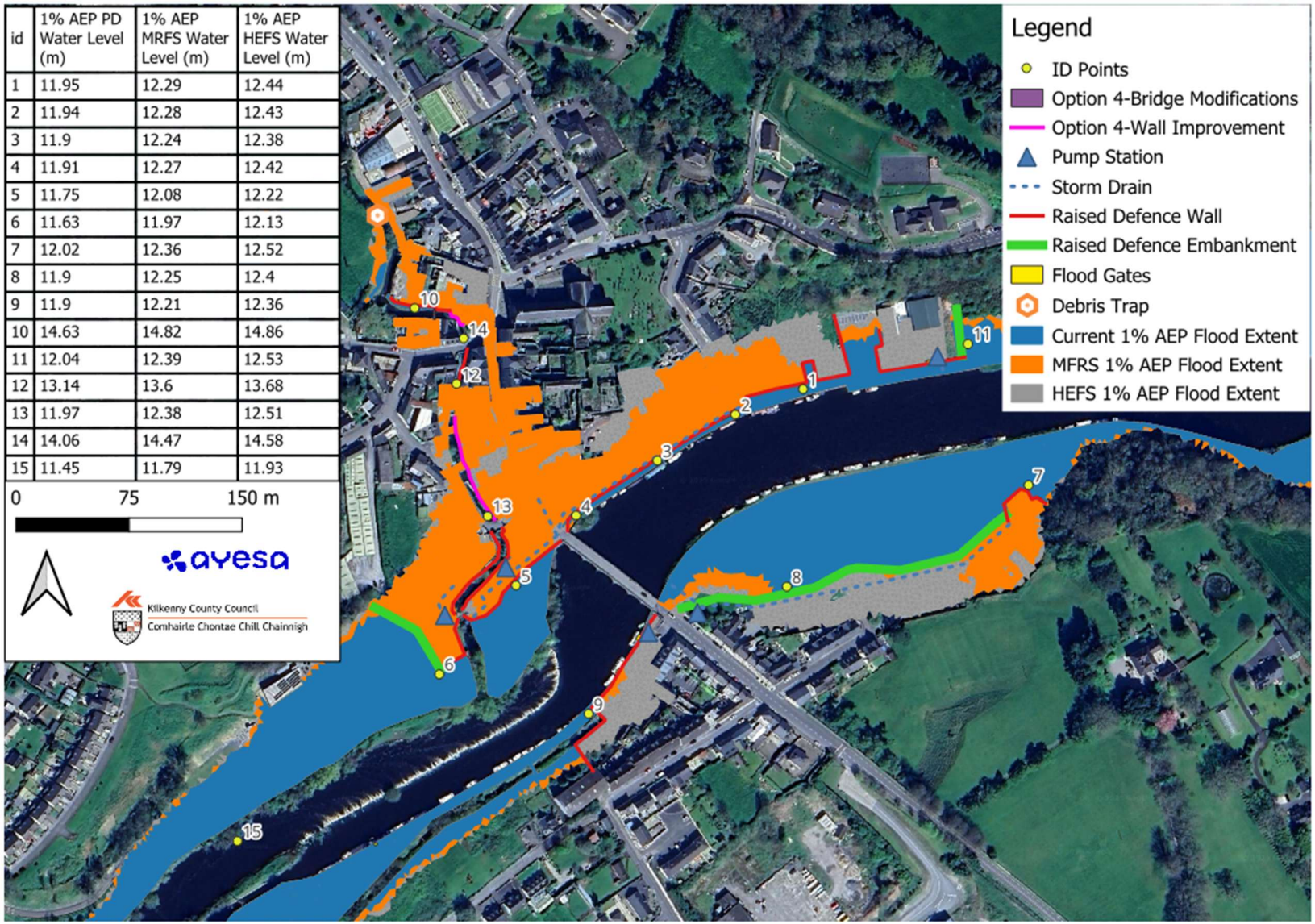

Figure 4-1: River Barrow and Lower Duiske – Increase in Flood Levels for Climate Change Scenarios with the Current Scheme

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Based on the observed increase in flooding for the MRFS and the HEFS, the following additional measures have been identified as being necessary to address future flood risk on the River Barrow. As such, increasing the existing defence heights is the only option for adaption on the River Barrow.

Table 4-2 Proposed Adaptations for River Barrow in Graiguenamanagh-Tinnahinch

Climate Change Scenario	Adaption Measure
Present Day	Design wall foundations for future flood defence heights to allow economic adaption in future.
MRFS	• Increase defences in town area by 0.35m • Replace flood gates to increase by 0.35m • Add new flood gate at Graiguenamanagh Bridge where proposed wall ties into high ground • No significant extra lengths of wall as all tie in points are to suitable high ground already – allow for normal changes.
HEFS	As above, but an additional circa 150mm to be added over and above the MFRS.

The above table assumes that there are no changes in the management of stormwater. Increased rainfall will potentially necessitate increases to the pipe sizes for the proposed drainage and upgrades to the pumping stations. However, there is also potential to implement long term strategies that will reduce run-off rates, offsetting increased rainfall intensity. As such it is assumed that such measures will be implemented by the Local Authority over time from the onset of the flood scheme, and specific stormwater adaption measures are thus not addressed further.

Figure 4-2 and Figure 4-3 below show a comparison between the existing (pre-scheme) and proposed (post current scheme) flood risk for the MRFS and HEFS respectively. As demonstrated by the purple areas, the proposed scheme provides some residual benefit for the MRFS but little residual benefit for the HEFS.

Economic assessment is provided jointly with the Duiske area below.

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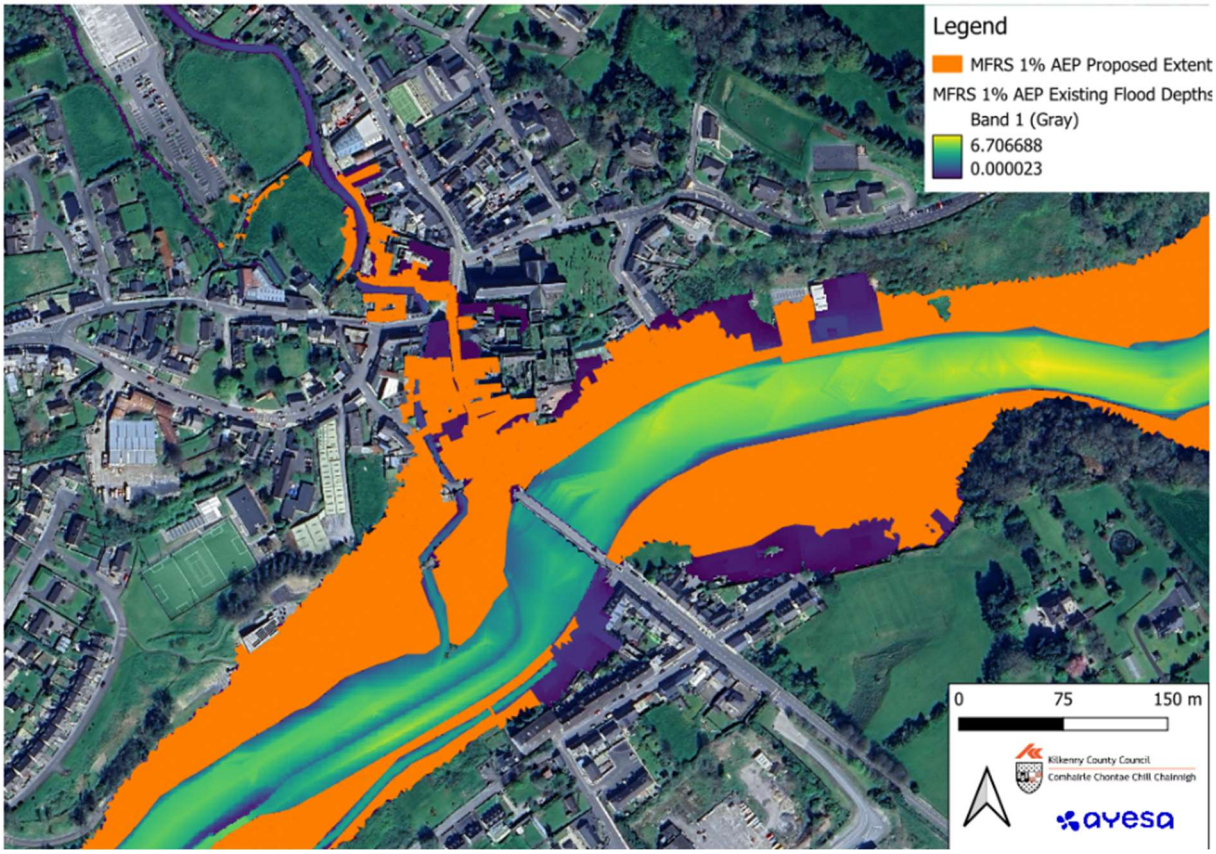

Figure 4-2: River Barrow – Comparison between existing MRFS and proposed MFRS flood risk with the current scheme

Figure 4-3: River Barrow – Comparison between existing HEFS and proposed HEFS flood risk with the current scheme

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[4.3] River Duiske

The development of options has been carried out with consideration of climate change adaptability. Figure 4-4 shows the increase in water levels across the upstream storage area on the River Duiske with the current scheme in place. As discussed in Section [2.5] above, these result as inclusive of freeboard.

The modelling shows that there is very little difference in flood levels at the upstream extent of the storage area. At the dam structure, the increase from the current scenario to the MFRS is circa 1m. This does not get significantly higher for the HEFS as the embankment overflows.

As flow increases downstream, additional areas of flooding will be observed in the lower Duske area, upstream of the influence of the Barrow. These areas can be seen in Figure 4-1 above.

Overall, flood event water levels are not considered to be overly sensitive to climate change on the River Duiske.

Based on the observed increase in flooding for the MRFS and the HEFS, the following additional measures have been identified as being necessary to address future flood risk on the River Duiske. There are two main options for adaption on the Duiske – 1) providing additional defences in town area and increased wall heights and 2) maximalising the storage area to restrict the flows downstream to maintain the existing effectiveness of the preferred scheme flood defences.

As there are meaningful flows into the Duiske below the storage area, there will always need to be some improvements to the walls in the Lower Duiske.

Table 4-3 Proposed Adaptations for River Duiske

Climate Change Scenario	Adaption Pathway 1 – Additional Storage & Minor Wall Adaptations	Adaption Pathway 2 – Increase in Wall Heights & New Walls
Present Day	Design wall foundations for future flood defence heights to allow economic adaption in future.	
MRFS	• Increase volume stored in storage area – increase height by 1m. • Localised increase in wall heights	• Increase in walls hights by up to 200mm upstream of High Street Bridge • Increase in walls heights by up to 500mm downstream of High Street Bridge • New walls, c.34m in length, on left bank at Well Lane • New walls, c49m in length, on right bank at Mass Path • New Wall, c96m in length, on right bank at Turfmarket • New Wall, c35m in length, on left bank at Turfmarket • See Figure 4-5 of additional flood defence walls.

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HEFS	• Increase volume stored in storage area – increase height by circa 1m. • Localised increase in wall heights	• Increase in walls hights by up to 300mm upstream of High Street Bridge • Increase in walls heights by up to 550mm downstream of High Street Bridge • New walls on left bank at Well Lane • New walls on right bank at Mass Path • New Wall on right at Turfmarket

The above table assumes that there are no changes in the management of stormwater. Increased rainfall will potentially necessitate increases to the pipe sizes for the proposed drainage and upgrades to the pumping stations. However, there is also potential to implement long term strategies that will reduce run-off rates, offsetting increased rainfall intensity. As such it is assumed that such measures will be implemented by the Local Authority over time from the onset of the flood scheme, and specific stormwater adaption measures are thus not addressed further.

The economic assessment is provided jointly with the Duiske area are presented below.

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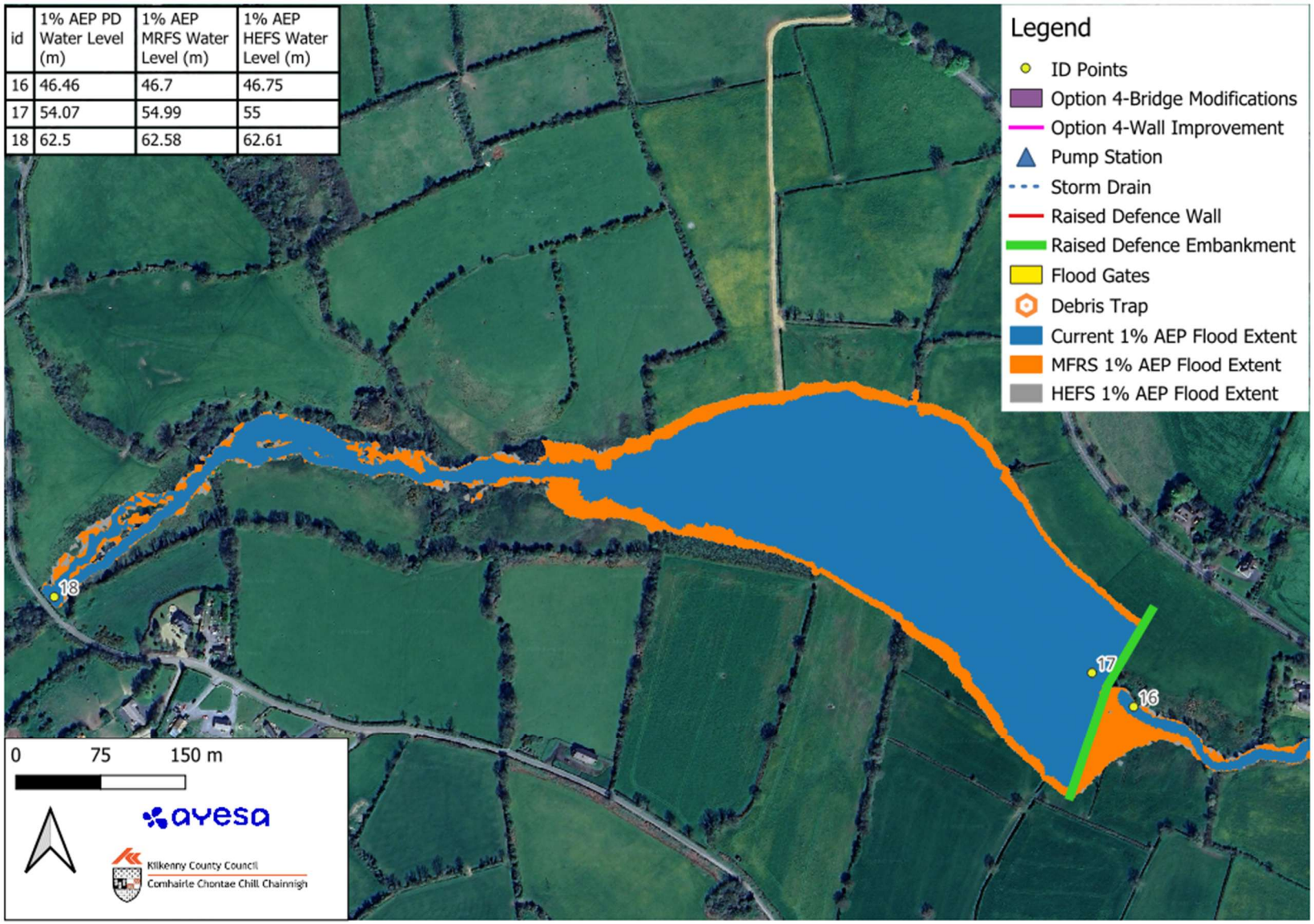

Figure 4-4: River Duiske – Flood Levels (m OD) for Climate Change Scenarios with Current Scheme in Place

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[4.4] Economic Flood Damages for Adaption Measures

[4.4.1] Damages

The Current Scheme protects properties up to and including the 1% AEP event. This approximates to somewhere between the 5% and 2% AEP event for the MFRS, based on a cross check of a number of properties.

The 5% AEP event has been taken as the level that the scheme Standard of Protection (SoP) retreats to for the MRFS. Similarly, for transition from the MFRS to the HEFS, the 1% AEP Scheme SoP would retreat to a 2% AEP event under the HEFS climate scenario.

For the purpose of the Adaptation Pathway Process, the Annual Average Damages (AAD), Present Value Damages (PVd), and Present Value Benefits (PVb) are estimated by a simplified 'damages avoided' approach to the economic assessment. The 'damages avoided' approach is based on the assumption that potential economic benefits can be assumed to include the avoidance of all potential economic damages up to and including the SoP provided following proof of concept, and no potential economic benefits (potential damages avoided) above this level.

The resulting economic damages and associated benefits are presented below for the MRFS and the HEFS on a 'damages avoided' basis.

Table 4-4 MFRS Potential Economic Benefits

MRFS	
PVb (Current Scheme) =	**€14,119,379**
PVd (No Scheme) -	€27,514,524
PVd (Current Scheme)	€13,395,145
PVb (MRFS Adaption) =	**€13,022,199**
PVd (Current Scheme) -	€13,395,145
PVd (MRFS Scheme)	€372,946

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PVb (MRFS) =	**€27,141,578**
PVb (Current Scheme) +	€14,119,379
PVb (MRFS Adaptation)	€13,022,199

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Table 4-5 HEFS Potential Economic Benefits

MRFS	
PVb (MRFS) =	**€27,279,249**
PVd (No Scheme) -	€31,556,807
PVd (MRFS)	€4,277,558
PVb (HEFS Adaption) =	**€3,438,495**
PVd (MRFS) -	€4,277,558
PVd (HEFS Scheme)	€839,063
PVb (HEFS) =	**€30,717,744**
PVb (MRFS) +	€27,279,249
PVb (HEFS Adaptation)	€3,438,495

[4.4.2] Costs

Review of the MFRS flood risk for the preferred scheme was undertaken and Figure 4-5 overleaf illustrates the additional defences that would be needed for Adaption Pathway 1. Increases in heights to existing walls would also be required.

Adaption Pathway 1 represents a worst-case scenario pathway. Adaption Pathway 2 is an alternative pathway whereby it may be possible to reduce the length and height increases required for the defences on the Duiske if optimisation of the storage area is completed. Adaption Pathway 2 has been estimated to cost less than Pathway 1.

Review of the potential additional wall lengths required indicated that there was also no difference between the MFRS and HEFS. The main difference between adaption for the MFRS and HEFS would thus be for increasing defence heights.

For this reason, a detailed cost estimate was prepared for the MFRS adaptions required, indicating a present-day cost of €2,342,830. This has been calculated by estimating the cost of the MFRS scheme and the proposed current scheme and taking the difference as the

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adaptation cost. It was then assumed that adaption from the MRFS scheme to the HEFS scheme would entail similar expenditure. This is considered conservative, as the wall height increases required for the HEFS adaptations are less than those required for the MRFS adaptations and there are no increases in length. A breakdown of the MFRS cost estimate is included in Appendix A.

There are also a small number of walls that have been included in the costings where raising may not be needed. This applied to the walls at Lower Turf Market and along the dock, where minimum heights were selected for safeguarding in some sections.

Overall, it is considered that the allowances for adaptation are conservative.

[4.4.3] Benefit Cost Ratio (BCR)

The resulting BCR for various pathways are outlined in the adaption pathways in Figure 4-6 below. Scenarios for the Current (C), MFRS (M) and HEFS (H) are outlines in that figure representing various adaption pathways. The result indicate that all action pathways contain adaptation options that ensure the scheme is cost beneficial following adaption.

The only adaptation pathways that result in below unity BCR are the ‘no action’ pathways where the scheme SoP is eroded by climate change.

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Table 4-6 MFRS Adaption Measures Damages & Benefit

Option	SoP	Captial Cost	O&M	Total Cost	Residual Damage	Benefit	BCR
No Scheme (M0)		-	-	-	€27,514,524		
With Preferred Scheme (M1)	5% AEP	€18,601,884	€3,003,165	€21,605,049	€13,395,145	€14,119,379	0.65
MRFS Adpation (M2/3)	1% AEP	€2,004,147	€338,682	€2,342,830	€372,946	€13,022,199	5.56

Table 4-7 HEFS Adaption Measures Damages & Benefit

Option	SoP	Captial Cost	O&M	Total Cost	Residual Damage	Benefit	BCR
No Scheme (H0)		-	-	-	€31,556,807		
With Preferred Scheme (H1)	20% AEP	€20,581,902	€3,365,977	€23,947,879	€27,049,188	€4,507,619	0.19
With MFRS Scheme (H2)	2% AEP	€2,004,147	€338,682	€2,342,830	€4,277,558	€22,771,630	9.72
HEFS Adpation (H3/4)	1% AEP	€2,004,147	€338,682	€2,342,830	€839,063	€3,438,495	1.47

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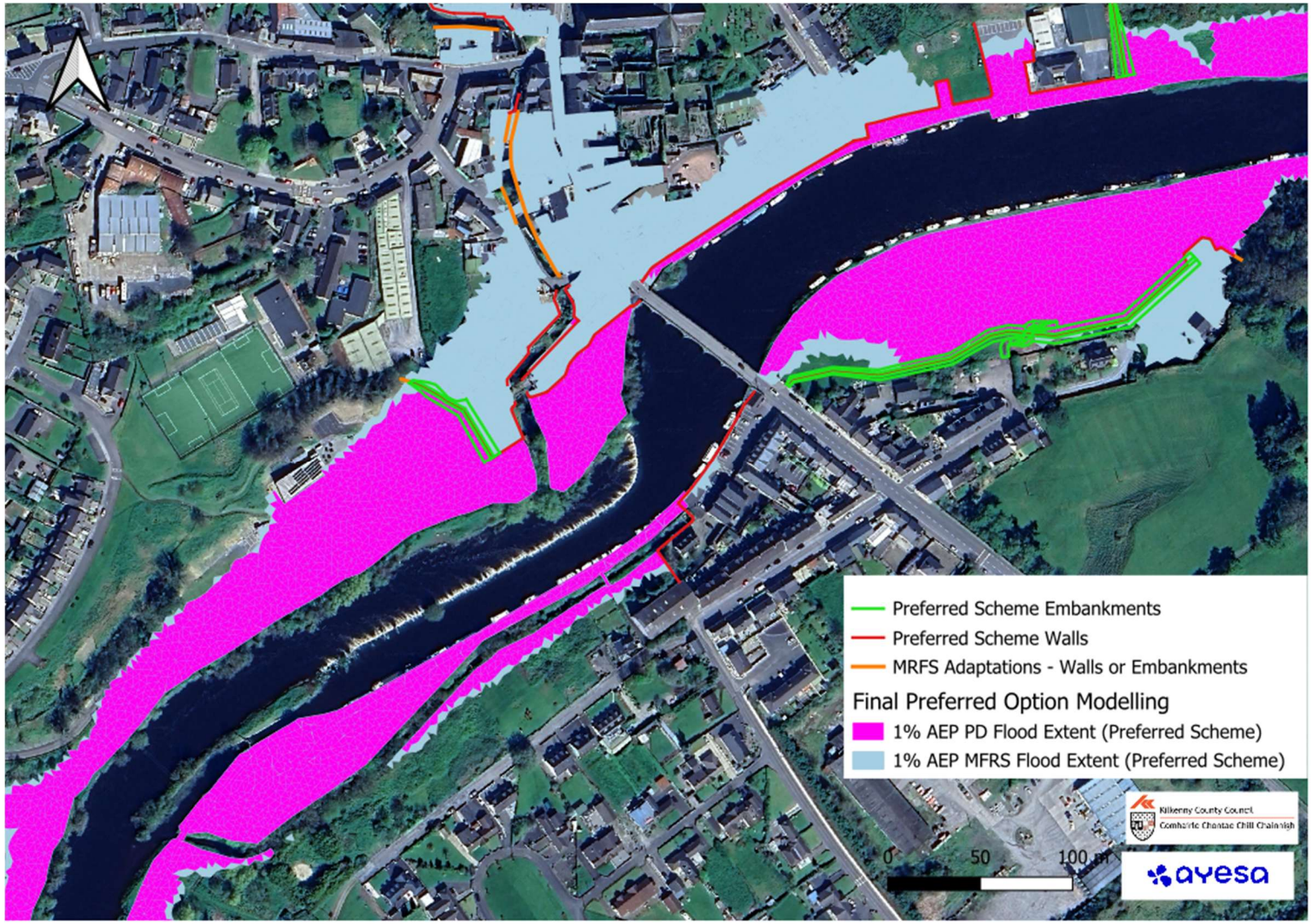

Figure 4-5: Adaptations for the MFRS in the Scheme Area – Adaption Pathway 1 (Pathway 2 is similar, but includes upstream adjustment to the storage area embankment)

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[4.5] Appraisal of Adaptation Options

Scheme appraisal for the preferred scheme included consideration of both a multi-criteria assessment (MCA), environmental appraisal and a general professional judgement assessment as outlined in the Options Report.

There is only one pathway presented in this SCCAP for the River Barrow measures, but there are two potential pathways on the River Duiske.

The potential pathways for adaptation to the MRFS scheme are assessed at a high-level as appropriate in Table 4-8 below under the following headings, corresponding to the general headings used in the Options Report:

- Statutory Delivery
- Constructability
- Environmental
- Social
- Economic

Table 4-8: Consideration of Adaptation Pathways for MRFS

Adaption Consideration	MFRS Adaption Route		
	No Adaptation	Pathway 1 - Blue	Pathway 2 - Green
Statutory Delivery	Not required	Via An Bord Pleanála	Via An Bord Pleanála
Constructability	Not required	Walls along Barrow very easily increased/lengthened. Walls adaptation on Duiske are challenging. Will require flood gates and working in very restrictive spaces. O&M of scheme will increase in terms of operational protocol and maintenance.	Walls along Barrow very easily increased/lengthened. Less walls adaptation on Duiske. Work to storage area readily achieved. O&M of scheme will increase in terms of operational protocol and maintenance.
Environmental	Increased flood risk and associated impact on environment receptors	No significant long-term change. Some visual impact. Temporary impact during construction	No significant long-term change. Visual impact less than Pathway 1. Temporary impact during construction
Social	Increased flood risk and associated social impacts	Increase in wall heights on Quay will result in socially negative outcome.	Increase in wall heights on Quay will result in socially negative outcome.

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Adaption Consideration	MFRS Adaption Route		
		May force consideration of alternative defence types.	May force consideration of alternative defence types.
Economic	No capital outlay, but damages increase, and scheme become less beneficial.	Positive BCR	Positive BCR

This plan is not intended to identify the preferred pathway for the reason outlined previously, but in general, adaption via the green pathway appears to be preferred.

[4.6] Adaption Pathways & Timing

Possible adaptive pathways have been identified to demonstrate how the scheme may evolve in the future.

The adaptation pathways are shown in Figure 4-6 below. The difference in action adaption pathways for the MFRS is solely down to providing increased defences (Pathway 1 - M2) and increased defences combined with storage area optimisation (Pathway 2 - M3). Regardless of which of these adaption pathways is selected, the same pathway adaptions remain available for the HEFS, illustrating the flexible nature of the scheme to future adaption.

Historically, culverts and bridge would be designed to include climate change considerations as the nature of such measures does not lend itself to adaptation as adaption typically entails complete replacement/upsizing. The same could be said of new channels where they are heavily engineered. Earthworks, walls and natural channels can be increased in size relatively economically on the other hand. In this scheme, all the measures selected are readily adaptable. Foundations will be designed on an assumptive approach, to allow future adaptations, but no other MFRS measures are included in the current scenario design.

It will be possible to observe the scheme performance and monitor any degradation in scheme SoP. The typical Tipping points outlined in Section [2.6] will be sufficient to trigger any detailed assessment as the scheme generally contains the MFRS floods with freeboard is considered.

The flow gauges outlined in Table 4-9 below are local to Graiguenamanagh-Tinnahinch are availability to support future assessment of climate change and adaption assessment. These gauges can be used to review and capture tipping points and trigger points to assist adaptation measures. The adaption pathways can all be delivered in a relatively short time period and no long lead in planning periods are anticipated.

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Table 4-9: Flow and Water Level Gauges for future review of Climate Change

Gauge Ref.	Location	Comment
14028	Royal Oak	Flow and WL – can inform of any trends/changes in flows
14029	Graiguenamanagh U/S	Flow and WL – can inform of any trends/changes in flows. Use for tipping/trigger point for Barrow Defences
14067	St. Mullins	Tidal – of limited use
14123	Coolroe	No Q-WL relationship developed. Currently about 4 years of Annual Max data. Good for future Qmed reviews
14122	Turf Market	Q-WL relationship developed as part of the scheme. Currently about 4 years of Annual Max data. Good for future Qmed reviews. Use for tipping/trigger point for Barrow Defences

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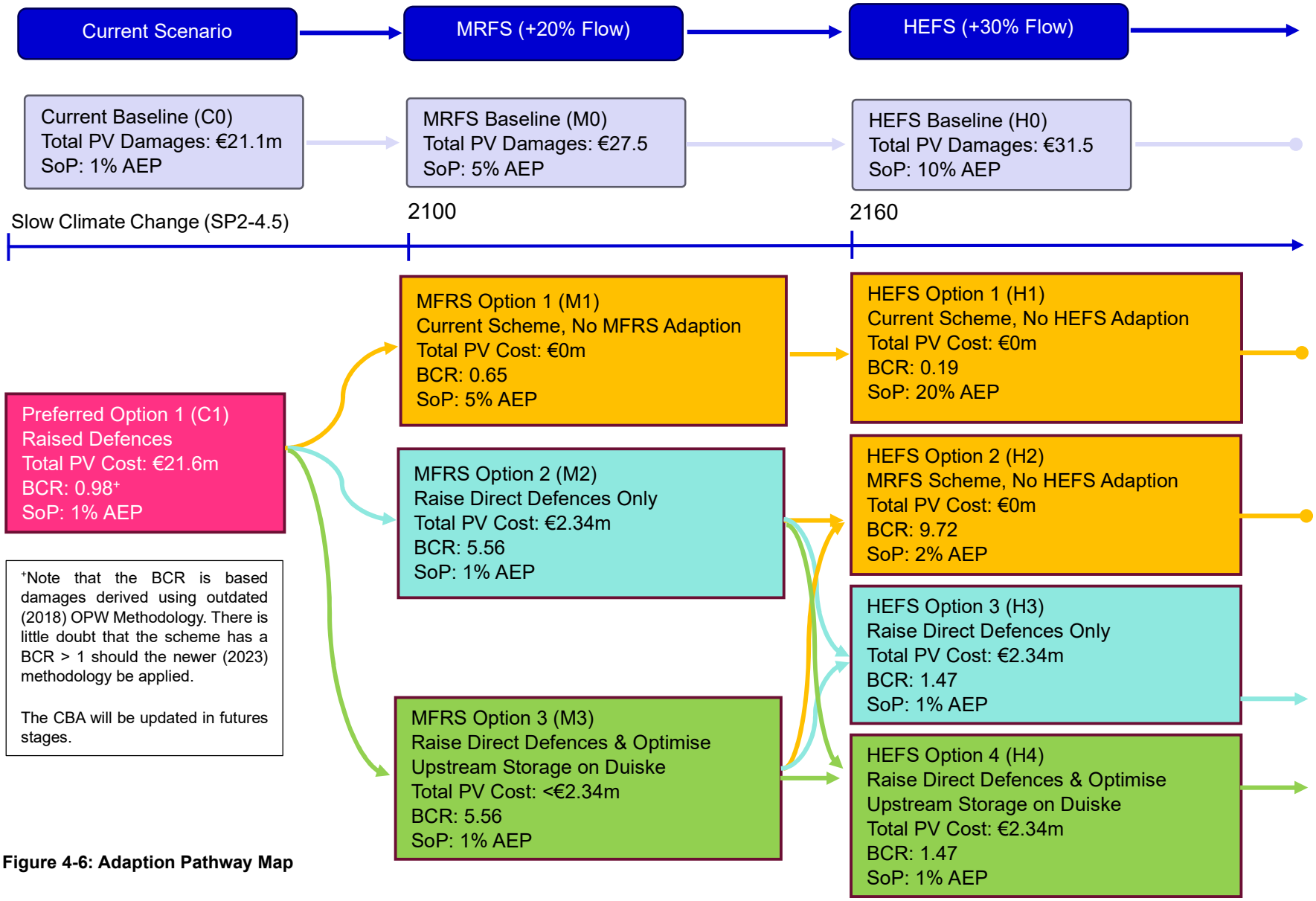

Figure 4-6: Adaption Pathway Map

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[5] Future Monitoring of the GTFRS SCCAP

Future monitoring of the GTFRS SCCAP is essential to ensure the plan is reviewed and updated, where necessary, to enable timely adaptation to proactively manage the potential impacts of climate change on flood risk, noting that the uncertainty associated with the potential impacts of climate change will reduce over time.

Tracking the impact of climate change by using the gauges referenced above will provide additional confidence in the scheme in the long term and will permit action to be taken when Trigger Point 1, noted in Section [2.6] and Figure 2-1 is observed. The outcome of this review shall assist in determining the need to initiate an adaptation measure at that stage, or when the next review should occur.

Additional monitoring may be recommended before that, but this may be on a more ad-hoc basis when future assessments of the potential impacts of climate change occur at a global, national, regional, or local scale. For example, new research on climate change may trigger a high-level review of the trigger/tipping timelines.

Following completion of the Scheme, the OPW Risk Management and Climate Adaptation (RMCA) Division will be responsible for assessing potential reductions in the Standard of Protection provided by the Scheme due to climate change, identifying when trigger points have been met, and updating the SCCAP as necessary.

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Appendix A – Current Scenario and MFRS Scheme Costs

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Preliminary Cost Estimates

Graiguenamanagh FRS

Date: 28/03/2025

By: JR

Checked: SH

	Option 3: Raised Defences and River Duiske Storage without Tinnahinch Castle Works (Current Scenario)	Option 3: Raised Defences and River Duiske Storage without Tinnahinch Castle Works (w/Climate Change Adaption to MFRS)
Capital Cost		
Construction Cost Estimate(Incl. for unmeasured & Prelims)	€11,913,688	€13,227,499
Archaeology[+] (7.5-15%)	€1,191,369	€1,322,750
Environmental Monitoring/Mitigation (5%)	€595,684	€661,375
Sub-total for Construction Cost	**€13,700,741**	**€15,211,624**
Other Related Costs		
Fees and Supervision (10%)	€1,370,074	€1,521,162
Land Acquisition*	€440,000	€460,000
Art (1% up to €125k)	€125,000	€125,000
Surveys	€100,000	€120,000
Site investigation	€356,328	€356,328
Sub-total	**€16,092,144**	**€17,794,115**
Optimism Bias (20%)	€2,740,148	€3,042,325
Maintenance Costs (incl 20% Optimism Bias)	€3,071,185	€3,409,867
Total Project Cost	**€21,903,476**	**€24,246,306**

* Estimated individually based on anticipated landtake/cost of access, rounded up to nearest €25,000

[+] 15 percent as standard, 10% where work on at River Duiske is reduced, 7.5% where it is avoided at Turf Market

Project Name: Graiguenamanagh Tinnahinch Flood Relief Scheme
Project No.: W3451
Date: 28/03/2025
Rates are based on asssement of recent tender prices, Spons Rates and the OPW Unit Cost Database (Oct 2013)
Construction Price Index (CPI) of 1.463 applied to amend OPW Unit rates for Oct 2021

COST ESTIMATE - Option 3: Raised Defences and River Duiske Storage - Current Scenario

Item No.	Description	Quantity	Units	Rate	Amount (€)
	Contract Costs				
1	Wall 1 - Retaining wall, Urban (with stone cladding), >100m in length, 1.2-2m in height	233	m	€2,710	€631,343
2	Flood Gate on Wall 1 - 7.5m length sliding gate, 1.4m height	1	m	€49,160	€49,160
3	Wall 2 - Retaining wall, Urban (with stone cladding), >100m in length, 1.2-2m in height	148	m	€2,710	€401,025
4	Flood Gate between Wall 1 & Wall 2 - 4.5 meter length, 1.2 meter height single hinge swing gate	1	m	€24,872	€24,872
5	Wall 3 - Retaining wall, Urban (with stone cladding), <100m in length, 0.6-1.2m in height	75	m	€2,866	€214,963
6	Wall 4 - Retaining wall, Urban (with stone cladding), <100m in length, 1.2-2m in height	20	m	€2,866	€57,324
7	Wall 5 - Retaining wall, Urban (with stone cladding), <100m in length, 0 - 0.6m in height	45	m	€1,839	€81,932
8	Wall 6 - Retaining wall, Urban (with stone cladding), <100m in length, 0 - 0.6m in height	38	m	€1,839	€69,886
9	Wall 7 - Retaining wall, Urban (with stone cladding), <100m in length, 2 - 3m in height	25	m	€4,143	€103,586
10	Wall 8A - Retaining wall, Urban (with stone cladding), >100m in length, 0.6m in height (plus wall improvements)	300	m	€1,745	€523,637
11	Demountable Flood barriers on Wall 8	9	No	€2,736	€24,624
12	Flood Gate on Wall 8A - 4m width swing gate, 1.2m height	1	Sum	€24,872	€24,872
13	Duiske Wall 1 - Retaining wall, Urban (with stone cladding), <100m in length, 1.2-2m in height	10	m	€2,866	€28,662
14	Duiske Wall 2 - Retaining wall, Urban (with stone cladding), <100m in length, 1.2-2m in height	44	m	€2,866	€126,112
15	Wall improvement	32	m	€1,433	€45,645
16	Embankment 1 - Rural clay embankment <100m, formed from imported material, height 1 - 2m	45	m	€440	€19,817
17	Embankment 2 - Rural clay embankment <100m, formed from imported material, height ranging from <1 - 3m	63	m	€361	€22,767
18	Embankment 3 - Rural clay embankment 100m - 1000m, formed from imported material, height 1 - 2m	240	m	€417	€100,075
19	Storage Embankment - Rural clay embankment <100m, formed from imported r	152	m	€1,208	€183,345
20	Storage Embankment - Flow Control Structure - Structural	1	Sum	€146,308	€146,308
21	Storage Embankment - Flow Control Structure - M&E	1	Sum	€146,308	€146,308
22	New Pumping station on Barrow Right Bank (Graig Quay) - 275 l/s	1	No	€523,856	€523,856
23	New Pumping station on Barrow Right Bank (Boat Club) - 50 l/s	1	No	€106,366	€106,366
24	Drainage to pumping station on right bank (Graig Quay - 525mm pipe diameter)	305	m	€732	€223,120
25	Drainage to pumping station on RB - Boat club (300mm diameter)	10	m	€439	€4,389
26	New Pumping station on Barrow Right Bank (The Hub) - 50 l/s	1	Sum	€106,366	€106,366
27	Drainage to pumping station on RB - Bthe Hub (300mm diameter)	45	m	€439	€19,752
28	Ground Raising required at Barrow defences	703	m2	€146	€102,835
29	Drainage LB	249	m	€732	€182,154
30	Duiske Wall 1 - Accommodation works associated with land owners	1	Sum	€73,154	€73,154
31	Pump station LB - Tinahinch car park (50L/s)	1	Sum	€106,366	€106,366
32	Installation of NRV's	1	Sum	€292,616	€292,616
33	Allowance for Mobile Pumps	2	Sum	€146,308	€292,616
34	Duiske Debris Trap	1	Sum	€87,785	€87,785
35	Interlocking Sheet Piling Barrow RB	4732.35	m2	€179	€847,706
36	Interlocking Sheet Piling Barrow LB	2,513	m2	€179	€450,154
37	Pump station LB - 450 L/s	1	sum	€664,312	€664,312
38	Bored Sheet Piling Barrow RB	258	nr	€455	€117,390
39	Ramps at Boat Club	1	Sum	€146,308	€146,308
40	Retaining Wall at Embankment 3	32	m2	€439	€14,046
41	Permanent Fencing (Miscellaneous)	1	Sum	€29,262	€29,262
42	Public Realm	1	Sum	€1,170,465	€1,170,465
43	Flood gate on wall 8B - 4m wide swing gate, 0.8m height	1	sum	€22,093	€22,093
44	Flood gate on wall 3 -4m length, single hinge swing gate, 1.4m height	1	Sum	€24,872	€24,872
45	Bridge Modifications	1	Sum	€43,892	€43,892
46	Access to Storage Embankment	160	m	€293	€46,819
47	Allowance for wall and tieing into high ground at end of Tinnahinch Carpark	1	Sum	€100,000	€100,000
	Sub-Total				**€8,824,954**
	Preliminary & General Items		15%		€1,323,743
	Unmeasured Items/Risk		20%		€1,764,991
	Construction Works (CW) Sub-Total				**€11,913,688**
	Regional Multiplier		1.00		€11,913,688
	Construction Works (CW) Total				**€11,913,688**
	Design team Fees and Expenses (Incl. Supervision)				€200,000
	Nett Works Total				**€12,113,688**
	Non-Contract Costs				
	NPV for Maintenance (1% of CST at 4% over 50 years) less existing Maintenance Costs		21.48		€2,559,320
	Environmental Monitoring & Mitigation and Archaeology		5%		€595,684
	Total Non-Contract Costs				**€3,155,005**
	Total All-In Scheme Cost (to be used in CBA)				**€15,268,693**

Project Name: Graiguenamanagh Tinnahinch Flood Relief Scheme
Project No.: W3451
Date: 28/03/2025
Rates are based on asssement of recent tender prices, Spons Rates and the OPW Unit Cost Database (Oct 2013)
Construction Price Index (CPI) of 1.463 applied to amend OPW Unit rates for Oct 2021

COST ESTIMATE - Option 3: Raised Defences and River Duiske Storage - MFRS

Item No.	Description	Quantity	Units	Rate	Amount (€)
	Contract Costs				
1	Wall 1 - Retaining wall, Urban (with stone cladding), >100m in length, 2.35m in height	233	m	€3,117	€726,317
2	Flood Gate on Wall 1 - 7.5m length sliding gate, 1.8m height	1	m	€68,472	€68,472
3	Wall 2 - Retaining wall, Urban (with stone cladding), >100m in length, 1.2-2m in height	148	m	€2,710	€401,025
4	Flood Gate between Wall 1 & Wall 2 - 4.5 meter length, 1.55 meter height single hinge swing gate	1	m	€26,409	€26,409
5	Wall 3 - Retaining wall, Urban (with stone cladding), <100m in length, 1.7m in height	75	m	€2,866	€214,963
6	Wall 4 - Retaining wall, Urban (with stone cladding), <100m in length, 1.2-2m in height	20	m	€2,866	€57,324
7	Wall 5 - Retaining wall, Urban (with stone cladding), <100m in length, 0 - 0.6m in height	45	m	€1,951	€86,912
8	Wall 6 - Retaining wall, Urban (with stone cladding), <100m in length, 0 - 0.6m in height	38	m	€1,951	€74,134
9	Wall 7 - Retaining wall, Urban (with stone cladding), <100m in length, 2 - 3m in height	25	m	€4,143	€103,586
10	Wall 8A - Retaining wall, Urban (with stone cladding), >100m in length, 0.6m in height (plus wall improvements)	300	m	€1,755	€526,630
11	Demountable Flood barriers on Wall 8	9	No	€3,277	€29,496
12	Flood Gate on Wall 8A - 4m width swing gate, 1.2m height	1	Sum	€26,409	€26,409
13	Duiske Wall 1 - Retaining wall, Urban (with stone cladding), <100m in length, 2.15m in height	10	m	€3,058	€30,578
14	Duiske Wall 2 - Retaining wall, Urban (with stone cladding), <100m in length, 2.5m in height	44	m	€3,505	€154,212
15	Wall improvement	32	m	€1,433	€45,645
16	Embankment 1 - Rural clay embankment <100m, formed from imported material, height 2 - 3m	45	m	€789	€35,487
17	Embankment 2 - Rural clay embankment <100m, formed from imported material, height ranging from <1 - 3m	1	Sum	€42,369	€42,369
18	Embankment 3 - Rural clay embankment 100m - 1000m, formed from imported material, height 1 - 2m	240	m	€755	€181,188
19	Embankment 4 - Rural clay embankment <100m, formed from imported material, height ranging from <1 - 2m	0	m		€0
20	Storage Embankment - Rural clay embankment <100m, formed from imported r	1	Sum	€250,635	€250,635
21	Storage Embankment - Flow Control Structure - Structural	1	Sum	€146,308	€146,308
22	Storage Embankment - Flow Control Structure - M&E	1	Sum	€146,308	€146,308
23	Sluice Gates on Barrow LB	0	No	€24,928	€0
24	Inlet structure for Sluice gate on Barrow incl. Automated Actuators	0	Sum	€102,416	€0
25	New Pumping station on Barrow Right Bank (Graig Quay) - 275 l/s	1	No	€523,856	€523,856
26	New Pumping station on Barrow Right Bank (Boat Club) - 50 l/s	1	No	€106,366	€106,366
27	Drainage to pumping station on right bank (Graig Quay - 525mm pipe diameter)	305	m	€732	€223,120
28	Drainage to pumping station on RB - Boat club (300mm diameter)	10	m	€439	€4,389
29	New Pumping station on Barrow Right Bank (The Hub) - 50 l/s	1	Sum	€106,366	€106,366
30	Drainage to pumping station on RB - Bthe Hub (300mm diameter)	45	m	€439	€19,752
31	Ground Raising required at Barrow defences	703	m2	€146	€102,835
32	Drainage LB	249	m	€732	€182,154
33	Duiske Wall 1 - Accommodation works associated with land owners	1	Sum	€73,154	€73,154
34	Pump station LB - Tinahinch car park (50L/s)	1	Sum	€106,366	€106,366
35	Installation of NRV's	1	Sum	€292,616	€292,616
36	Allowance for Mobile Pumps	2	Sum	€146,308	€292,616
37	Duiske Debris Trap	1	Sum	€87,785	€87,785
38	Interlocking Sheet Piling Barrow RB	4,732	m2	€179	€847,706
39	Interlocking Sheet Piling Barrow LB	2,513	m2	€179	€450,154
40	Pump station LB - 450 L/s	1	sum	€664,312	€664,312
41	Bored Sheet Piling Barrow RB	258	nr	€455	€117,390
43	Ramps at Boat Club	1	Sum	€146,308	€146,308
44	Retaining Wall at Embankment 3	32	m2	€439	€14,046
45	Permanent Fencing (Miscellaneous)	1	Sum	€29,262	€29,262
46	Public Realm	1	Sum	€1,170,465	€1,170,465
47	Flood gate on wall 8B - 4m wide swing gate, 0.8m height	1	sum	€22,093	€22,093
48	Flood gate on wall 3 -4m length, single hinge swing gate, 1.4m height	1	Sum	€26,409	€26,409
49	Bridge Modifications	1	Sum	€43,892	€43,892
50	Access to Storage Embankment	160	m	€293	€46,819
51	Wall 9 added to embankment 2 for climate change adaptation. Retaining wall, Urban (with stone cladding), <100m in length, 0 - 0.6m in height	6	m	€1,839	€11,035
52	Duiske Wall 3 Extention of wall Duisk 2 for climate change adaptation, Retaining wall, Urban, <100m in length, 2.5m in height	95	m	€3,505	€332,957
53	Duiske Wall 4 Climate change adaptation, Retaining wall, Urban, <100m in length, 2.5m in height	15	m	€3,505	€52,572
54	Duiske Wall 5 Climate change adaptation, Retaining wall, Urban, <100m in length, 2.5m in height	20	m	€3,505	€70,096
55	Duiske Wall 6 Climate change adaptation, Retaining wall, Urban, <100m in length, 2.15m in height	34	m	€3,058	€103,964
56	Duiske Wall 7 Climate change adaptation, Retaining wall, Urban, <100m in length, 2.15m in height	50	m	€3,058	€152,888
	Sub-Total				**€9,798,147**
	Preliminary & General Items		15%		€1,469,722
	Unmeasured Items/Risk		20%		€1,959,629
	Construction Works (CW) Sub-Total				**€13,227,499**
	Regional Multiplier		1.00		€13,227,499
	Construction Works (CW) Total				**€13,227,499**
	Design team Fees and Expenses (Incl. Supervision)				€200,000
	Nett Works Total				**€13,427,499**
	Non-Contract Costs				
	NPV for Maintenance (1% of CST at 4% over 50 years) less existing Maintenance Costs		21.48		€2,841,556
	Environmental Monitoring & Mitigation and Archaeology		5%		€661,375
	Total Non-Contract Costs				**€3,502,931**
	Total All-In Scheme Cost (to be used in CBA)				**€16,930,430**

Appendix 15-1 Equipment Calibration Certificates

NSAI
National Metrology Laboratory

Certificate of Calibration

Issued to

Amplitude Acoustics
G2 The Steelworks
Foley Street
Dublin

Certificate Number	**25-4547**
Item Calibrated	Larson Davis CAL200 Sound Level Calibrator
Serial Number	13592
ID Number	None
Order Number	PO0029
Date Received	16 Apr 2025
NML Procedure Number	TFAP-NM-11 Rev 1.5
Method	The above calibrator was allowed to stabilize for a suitable period in laboratory conditions. It was then calibrated by measuring the sound pressure level generated in its measuring cavity (half-inch configuration). The calibrator's operating frequency was also measured.
Calibration Standards	Norsonic 1504A Calibration System incorporating: Agilent 34401A, No. 0736 (Cal. Due Date: 25 Mar 2026) B&K 4180, No. 1069 (Cal. Due Date: 15 Sep 2025) B&K 4228, No. 0741 (Cal. Due Date: 14 Sep 2025)

Calibrated by

David Fleming

Approved by

Dubhaltach MacLochlainn

Date of Calibration 15 May 2025

Date of Issue 16 May 2025

CIPM MRA

This certificate is consistent with Calibration and Measurement Capabilities (CMCs) that are included in Appendix C of the Mutual Recognition Arrangement (MRA) drawn up by the International Committee for Weights and Measures (CIPM). Under the MRA, all participating institutes recognize the validity of each other's calibration certificates and measurement reports for quantities, ranges and measurement uncertainties specified in Appendix C (for details see www.bipm.org)

Glas Naíon | Baile Átha Cliath 11 | Eire
Glasnevin | Dublin 11 | Ireland T+353 1 808 2609 | F+353 1 808 2603 | NSAI.ie

Statement of Calibration

Issued to:	Calibration Reference
Amplitude Acoustics G2 The Steelworks Foley Street Dublin	SLM240244

Test Date: 05/06/2024
Procedure: TP-SLM-1

Equipment

Item Calibrated:	Sound Level Meter	**Model**	971
Make:	Svantek	**Serial Number:**	77789

Calibration Procedure

The sound level meter was allowed to stabilize for a suitable period, as described in the manufacturer's instruction manual, in laboratory conditions. The sound level meter was calibrated by carrying out the verification tests detailed in IEC 61672-3 (2006), Periodic tests, specification of sound level meters. Tolerances for verification procedures are specified in IEC 61672-1 (2003).

Calibration Standards

Description	Serial Number
National Instruments PXI-4461	20D2877
Stanford Research DS360	123803

The standards used in this calibration are traceable to NIST and/or other National Measurement Institutes (NMI's) that are signatories of the International Committee of Weights and Measures (CIPM) mutual recognition agreement (MRA).

Signed on behalf of Sonitus Systems:

SONITUS SYSTEMS

Calibration Report

Equipment Description

Model:	Svantek	**Serial Number:**	77789
Model:	971	**Microphone Model:**	SV18 72287

Ambient Conditions

Measurement conditions were within the tolerances defined in IEC 61672-1 and IEC 60942.

Barometric Pressure:	1009 hPa
Temperature:	21.0 °C
Relative Humidity:	47 %

Results Summary

IEC 61672 Test #	Test Description	Result
10	Self-generated noise	-
11	Frequency weighting (acoustical)	PASS
12	Frequency weighting (electrical)	PASS
13	Frequency and time weighting (1kHz)	PASS
14	Level linearity on reference level range	PASS
15	Level linearity with level range control	PASS
16	Toneburst response	PASS
17	Peak C sound level	PASS
18	Overload indication	PASS

As public evidence was available, from a testing organization responsible for approving the results of pattern evaluation tests, to demonstrate that the model of sound level meter fully conformed to the requirements for pattern evaluation described in IEC 61672:2003, the sound level meter tested is considered to conform to all the Class 1 requirements of IEC 61672:2003

The manufacturer's guidelines concerning appropriate set up for measurement under various conditions should be observed during usage.

Prior to carrying out the verification tests the sound level meter was adjusted to read correctly using the acoustic calibrator held by the testing lab (Cirrus CR515, Serial number: 94839). The calibration procedure is described in the manufacturer's instruction manual.

Self-generated noise - IEC 61672-3 Test #10
SLM Measuring Mode: Leq

SLM Configuration	Freq. Weighting Network	SLM Reading
Microphone Installed	A	19.9
Microphone replaced by electrical input device fitted with short circuit	A	11.8
	C	11.8
	Z	16.8

Acoustical signal test of a frequency weighting - IEC 61672-3 Test #11
Range: reference level range
Frequency Weighting: C
Time Weighting: Slow

Input	Freq	Expected Level	Deviation	Tol +/-
94 dB	125 Hz	93.7	0.4	1.0
	1000 Hz	94.0	0.0	1.0
	4000 Hz	92.3	0.2	1.0

The frequency response was tested using an electrostatic actuator. Appropriate correction factors were applied as detailed in the manufacturer's instruction manual.

Electrical tests of frequency weighting - IEC 61672-3 Test #12
Range: reference level range

A-weighting

Freq	Expected Level	SLM Reading	Deviation	Tol +	Tol -
63	80.0	79.2	-0.8	1.5	-1.5
125	80.0	79.1	-0.9	1.5	-1.5
250	80.0	79.0	-1.0	1.4	-1.4
500	80.0	79.0	-1.0	1.4	-1.4
1000	80.0	79.0	-1.0	1.1	-1.1
2000	80.0	78.7	-1.3	1.6	-1.6
4000	80.0	79.0	-1.0	1.6	-1.6
8000	80.0	79.2	-0.8	2.1	-3.1
16000	80.0	79.0	-1.0	3.5	-17.0

C-weighting

Freq	Expected Level	SLM Reading	Deviation	Tol +	Tol -
63	80.0	79.2	-0.8	1.5	-1.5
125	80.0	79.5	-0.5	1.5	-1.5
250	80.0	79.1	-0.9	1.4	-1.4
500	80.0	79.1	-0.9	1.4	-1.4
1000	80.0	79.0	-1.0	1.1	-1.1
2000	80.0	78.8	-1.2	1.6	-1.6
4000	80.0	79.0	-1.0	1.6	-1.6
8000	80.0	79.2	-0.8	2.1	-3.1
16000	80.0	79.0	-1.0	3.5	-17.0

Linear

Freq	Expected Level	SLM Reading	Deviation	Tol +	Tol -
63	80.0	79.2	-0.8	1.5	-1.5
125	80.0	79.2	-0.8	1.5	-1.5
250	80.0	79.1	-0.9	1.4	-1.4
500	80.0	79.1	-0.9	1.4	-1.4
1000	80.0	79.0	-1.0	1.1	-1.1
2000	80.0	78.7	-1.3	1.6	-1.6
4000	80.0	79.0	-1.0	1.6	-1.6
8000	80.0	79.1	-0.9	2.1	-3.1
16000	80.0	79.3	-0.7	3.5	-17.0

Frequency and Time Weightings at 1 kHz IEC 61672-3 Test #13
Range: reference level range

Time Weighting	Freq. Weighting	Expected Level	Deviation	Tol +/-
Fast	A	94.0	ref	
	C	94.0	0.0	0.2
Slow	A	94.0	0.0	0.2
LEQ	A	94.0	0.0	0.2

Linearity level on reference range - IEC 61672-3 Test #14
Input frequency: 8 kHz
SLM Measuring Mode: SPL

Range	Expected Level	SLM Reading	Deviation	Tol +/-
	94.0	94	0.0	1.1
	99.0	99.0	0.0	1.1
	104.0	104.0	0.0	1.1
	109.0	109.0	0.0	1.1
	114.0	114.0	0.0	1.1
	119.0	119.0	0.0	1.1
	120.0	120.0	0.0	1.1
	121.0	121.0	0.0	1.1
	122.0	122.0	0.0	1.1
	123.0	123.0	0.0	1.1
	124.0	123.4	-0.6	1.1
	89.0	89.0	0.0	1.1
	84.0	84.0	0.0	1.1
	79.0	79.0	0.0	1.1
	74.0	74.0	0.0	1.1
	69.0	68.9	-0.1	1.1
	64.0	63.9	-0.1	1.1
	59.0	59.0	0.0	1.1
	54.0	54.0	0.0	1.1
	49.0	49.0	0.0	1.1
	44.0	44.0	0.0	1.1
	39.0	39.0	0.0	1.1
	34.0	33.9	-0.1	1.1
	30.0	29.8	-0.2	1.1
	29.0	28.7	-0.3	1.1
	28.0	27.6	-0.4	1.1
	27.0	26.5	-0.5	1.1
	26.0	25.5	-0.5	1.1
	25.0	24.3	-0.7	1.1

Level linearity including level range control - IEC 61672-3 Test #15
Input frequency: 1 kHz
SLM Measuring Mode: SPL

Range	Expected Level	SLM Reading	Deviation	Tol +/-
137	94.0	94.0	0.0	1.1
137	132.0	132.0	0.0	1.1

Toneburst response - IEC 61672-3 Test #16
Range: reference level range

Burst Type	Response	Expected Level	SLM Reading	Deviation	Tol +	Tol -
0.25 ms	LAF_{MAX}	95.0	94.7	-0.3	0.8	-0.8
2.0 ms	LAF_{MAX}	104.0	103.9	-0.1	1.3	-1.3
200 ms	LAF_{MAX}	121.0	121.0	0.0	1.3	-3.3
2.0 ms	LAS_{MAX}	114.6	114.8	0.2	0.8	-0.8
200 ms	LAS_{MAX}	95.0	95.2	0.2	1.3	-3.3

Peak C sound level - IEC 61672-3 Test #17
Range: reference level range

Pulse Type	Freq	Expected Level	SLM Reading	Deviation	Tol +/-
1 cycle	8 kHz	119.4	119.3	-0.1	2.4
Pos ½ cycle	500 Hz	121.4	121.3	-0.1	1.4
Neg ½ cycle	500 Hz	121.4	121.3	-0.1	1.4

Overload indication IEC 61672-3 Test #18

Test Description	Overload at	Meas. Diff. (Pos – Neg)	Tol +/-
Pos. ½ cycle at 4 kHz	124.8		
Neg. ½ cycle at 4 kHz	124.4		
Level difference		0.4	1.8

Calibration Notes

1. The manufacturer's instruction manual was accessed through the manufacturer's website
2. The sound level meter was powered by internal batteries