Appendix A.8.1

Ecology Field Survey Methodologies

Part 1 2014 - 2018 Surveys

Part 2 2019 Surveys

Part 3 2022 - 2024 Surveys

A.8.1 Part 1 Ecology Field Survey Methodologies 2014 to 2018

ARUP

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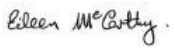
		Signature			
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1 Ecology Field Survey Methodologies

This Appendix presents the field survey methodologies for the following ecological surveys:

- Section 1.1 Habitats
- Section 1.2 Rare and protected plant species
- Section 1.3 Mammals (excluding bats)
- Section 1.4 Bats
- Section 1.5 Invertebrates – White-clawed crayfish, Freshwater pearl mussel, other Annex II molluscan species, Marsh fritillary butterfly
- Section 1.6 Birds – breeding bird and wintering bird surveys
- Section 1.7 Amphibians
- Section 1.8 Reptiles
- Section 1.9 Fish

1.1 Habitat Survey

The habitat surveys comprised a number of different survey elements carried out between July 2013 and June 2017 to gather baseline data of all habitat areas within the ZoI of the proposed road development.

1.1.1 2013 Habitat Surveys

Lough Corrib cSAC – Selected Locations

A habitat survey was carried out by Botanical, Environmental & Conservation Consultants Ltd. (BEC) in 2013 to classify the habitats present in selected locations within the scheme study area[1] (see **Appendix A.8.4**): within the Lough Corrib cSAC east of Menlough Village, at areas adjacent to the River Corrib at Dangan Lower and Menlough, and at areas of limestone pavement at Ballygarraun (to the east of the currently defined Lough Corrib cSAC study area – see **Figures 8.1.1** to **8.1.2**). The habitat map and data from this survey was incorporated into the results from the 2014 surveys.

[1] The term "scheme study area", when used in this chapter, refers to the wider study area at which ecological constraints were initially identified for the constraints and route selection studies for the project (see **Figures 8.1.1** and **8.1.2**). This is the geographic scale at which many of the EIA level ecological surveys were initially carried out. For many of the ecological receptors, surveys were also carried out within a more restricted study area, focussed on assessing potential impacts within the Zone of Influence (ZoI) of the proposed road development.

1.1.2 2014 Habitat Surveys

Petrifying Springs Survey

A dedicated survey for this priority Annex I habitat type – Petrifying springs with tufa formation (*Cratoneurion*) – was carried out by BEC in 2014 (see **Appendix A.8.3**). A combination of desktop review and Geographic Information System (GIS) analysis was used to define the survey sites, which were then visited to establish the presence/absence of a petrifying spring feature. This was supplemented by the additional habitat survey work carried out in 2014 and 2015, as described below. Surveys in 2014 did not include Lackagh Quarry; an area that was subsequently surveyed in 2015 – see 2015, 2016 and 2017 Habitat Surveys, Lackagh Quarry Petrifying Spring Survey section below for details.

Lough Corrib cSAC Survey Area

Habitat surveys were carried out by BEC and Wetland Surveys Ireland Ltd. from May to September 2014 within the Lough Corrib cSAC habitat survey area. The extent of the Lough Corrib cSAC habitat survey area is shown on **Figures 8.1.1** and **8.1.2**. The survey methodology comprised two stages: Stage 1 comprised mapping to level 3 of the Heritage Council habitat codes (Fossitt, 2000 – a summary of the classification is provided in **Appendix A.8.6**) with areas of Annex I habitat also being identified; for Stage 2, all polygons were revisited and indicator species recorded, a rapid quality-assessment score was attributed to each polygon which contained an Annex I habitat type, and relevé data was collected across the survey area to support the habitat classification given during the mapping exercise and to provide additional data on the conservation value of habitats. All habitat polygons were also attributed with an ecological valuation as per the criteria set out in Guidelines for Assessment of Ecological Impacts of National Roads Schemes: Revision 2 (National Roads Authority, 2009).

The conservation status of each Annex I habitat within the Lough Corrib cSAC Survey Area was assessed. The assessment was based on guidelines available from the National Parks and Wildlife Service (NPWS) and on the approach used for the national conservation assessment of Annex I habitats, which is carried out according to guidelines published by the EU (Evans & Arvela, 2011).

Assessment criteria were available from NPWS for the majority of the Annex I habitats recorded but where not available, the criteria relating to similar habitats were used. Annex I habitats were defined with reference to recent national studies co-ordinated by NPWS and the Interpretation manual of European Union Habitats EUR28 (CEC, 2013). Vegetation communities were assigned to Annex I habitat areas based on the relevé data gathered and on published definitions. In cases where published vegetation community definitions were not available, novel classifications were assigned.

The full details of the survey and assessment methodologies used - including the assessment criteria, Annex I habitat definitions, and novel vegetation community classifications – are described in **Appendix A.8.5**.

Ecological Sites

The aim of the ecological sites habitat survey was to describe, classify and map the habitats of the Ecological Sites based on the Heritage Council classification (Fossitt 2000), with particular emphasis on habitats conforming to Annex I habitats (as listed in the EU Habitats Directive), and to assess their ecological importance. Any plant species of restricted distribution and ecological importance were noted.

Ecological Sites, in this case, were sites of potential ecological value; the boundaries of which were initially defined based on interpretation of orthophotography and collation of available existing habitat information, in conjunction with a ground truthing exercise to verify the orthophotography interpretation. These boundaries were then refined, where appropriate, based on the findings of the various habitat surveys undertaken.

The surveys were carried out by Dr Joanne Denyer, Dr John Conaghan, Dr Janice Fuller, Katharine Duff and Eamon O'Sullivan from the 15 June to the 15 October 2014. The locations of the Ecological Sites surveyed are shown on **Figures 8.1.1** and **8.1.2**.

Annex I Habitat Classification

Reference was made to the National and Regional habitat survey reports, in terms of the criteria for classifying the different Annex I habitats and assessing their condition:

- *Turloughs over 10 ha: vegetation survey and evaluation* (Goodwillie, R., 1992)
- *Turlough Hydrology, Ecology and Conservation* (Waldren, S. 2015, Ed.)
- *Summary of findings from the Survey of Potential Turloughs 2015* (O'Neill, F.H. & Martin, J.R., 2015)
- *The Irish semi-natural grasslands survey 2007-2012. Irish Wildlife Manuals, No. 78* (O'Neill et al., 2013)
- *Results of monitoring survey of old sessile oak woods and alluvial forests. Irish Wildlife Manuals, No. 71* (O'Neill, F.H. & Barron, S.J., 2013)
- *National survey of limestone pavement and associated habitats in Ireland. Irish Wildlife Manuals, No. 73* (Wilson, S. and Fernández, F., 2013)
- *Coolagh Lakes, Lough Corrib SAC, Co. Galway: Wetland Survey and Conservation Assessment* (Crushell, P. & Foss, P., 2014a: unpublished report)
- *Coolanillaun Bog, Lough Corrib SAC, Co. Galway: Wetland Survey and Conservation Assessment* (Crushell, P. & Foss, P., 2014b: unpublished report)
- *Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland. Version 2.0. Irish Wildlife Manuals, No. 79* (Perrin et al., 2014)

Assessment criteria for *Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* [7210] which were developed during the Constraints Study (by Crushell and Foss 2014a and 2014b) were used. The Annex I habitats surveyed are listed in **Table 1**.

Table 1: Annex I habitats recorded, the reference for assessment criteria used, and size of the assessment relevé

Annex I Habitat Code [1]	Habitat Name [2]	Reference	Relevé size (metres)
1220	Perennial vegetation of stony banks	n/a	n/a
1330	Atlantic salt meadows	McCorry & Ryle (2009)	2x2
4010	Wet heath	Perrin et al. (2014)	2x2
4030	Dry heaths	Perrin et al. (2014)	2x2
6210 *6210	Orchid-rich calcareous grassland (* important orchid sites)	O'Neill et al. (2013) O'Neill et al. (2013)	2x2 2x2
*6230	Species-rich *Nardus* upland grassland	O'Neill et al. (2013)	2x2
6410	*Molinia* meadows	O'Neill et al. (2013)	2x2
6430	Hydrophilous tall herb	O'Neill et al. (2013)	2x2
6510	Lowland hay meadows	O'Neill et al. (2013)	2x2
*7130	Blanket bog (active)*	Perrin et al. (2014	2x2
7140	Transition mires	Perrin et al. (2014)	2x2
7150	*Rhynchosporion* depressions	Perrin et al. (2014)	2x2
*7210	*Cladium* fen*	Crushell & Foss (2014a & 2014b); criteria developed for GCTP project	2x2
*7220	Petrifying springs*	Lyons & Kelly (2016)	n/a
7230	Alkaline fens	Perrin et al. (2014)	2x2
*8240	Limestone pavement*	Wilson & Fernández (2013)	5x5
*91E0	Residual alluvial forests	O'Neill & Barron (2013)	10x10
*3180	Turloughs*	Goodwillie (1992) Waldren, (2015, Ed.)	2x2

[1]Priority habitats, which are indicated with an asterisk, are those which the EU considers require particular protection because their global distribution largely falls within the EU and they are danger of disappearance

[2]Abbreviated Annex I habitat names are after NPWS (2013a, 2013b & 2013c), full Annex I habitat titles are available in *Interpretation manual of European Union Habitats EUR28 (*CEC**,** 2013). To distinguish between them, the term Calcareous grassland is used to refer to the non-priority variant of the 6210 Annex I habitat type with the full title referring to the priority variant.

Field sheets were prepared in advance for recording site notes and habitat descriptions, which included condition assessment criteria. Vascular plant nomenclature follows that of the New Flora of the British Isles 3rd Edition (Stace, 2010); bryophyte nomenclature follows the Checklist of British and Irish bryophytes (BBS, 2009).

Ecological Evaluation

The ecological importance of habitats was assessed using the criteria listed in the Guidelines for Assessment of Ecological Impacts of National Roads Schemes (National Roads Authority, 2009). For Annex I habitats recorded, a further rapid

quality assessment of the Annex I habitat (scale 1, 2, or 3) was made, based on the following criteria, whereby:

1 = the habitat was a poor example of the Annex I habitat
2 = the habitat was a good example of the Annex I habitat
3 = the habitat was an excellent example of the Annex I habitat

Field Survey

Field survey maps were prepared from aerial photographs of the Ecological Sites (1:5,000 scale minimum). The Ecological Sites were subject to a walkover survey by experienced botanists. Each habitat present was described and classified (after Fossitt for non-Annex habitats or for Annex I habitats, as per NPWS guidance from the relevant national Annex I habitat surveys) and the main plant species were listed on the habitat recording form. The habitat extent was mapped onto the aerial photograph, with GPS points taken where a habitat extent could not clearly be identified from the aerial photograph. For each Annex I habitat type encountered, a relevé(s) was (were) taken using a prepared form. The relevé size was $2m^2$ for all Annex I habitats except for woodland and limestone pavement habitats. The relevé form included a habitat condition assessment based on criteria which were drawn from the relevant national habitat surveys for the National Parks and Wildlife Service (NPWS). Where applicable, the Annex I habitat was assigned to a vegetation community.

A photographic record of the habitats and relevé(s) for each ecological site was taken; two photos per relevé – one for the relevé and one for a view from the relevé. Notes on management, threats and habitat condition were also taken.

For each Ecological Site the following were completed:

a) Site form: summary description of the Ecological Site, list of habitats and notable features
b) Habitat map: hand drawn polygons (attributed with the corresponding habitat codes) on aerial photograph
c) Field survey notes: hand written on habitat recording forms
d) Relevé forms: hand written and completed for Annex I habitats
e) Photographs: photographic record (digital) of habitats and relevé(s)
f) Habitat table: tabulated summary of all habitats, including habitat description, classification (Fossitt and Annex I), plant species list, habitat condition and ecological evaluation/importance

Other Areas

Within the scheme study area, those areas not covered by the surveys described above were subject to a walkover survey; the purpose of which was to determine the nature of the habitats present and establish whether any areas corresponded with Annex I habitat types. The survey was confined to terrestrial habitats in greenfield areas and excluded residential properties and associated gardens, and commercial and industrial complexes.

Notes were taken on the habitat types present (according to the habitat categories described in Fossitt, 2000) and where habitat plots were assessed to be of a high ecological value, with the potential to correspond to an Annex I habitat type, these

were subject to more detailed survey as described above under Ecological Sites. If appropriate, these were then incorporated into Ecological Sites for consideration as part of the route selection process.

Aquatic Habitats

Aquatic habitats were surveyed for the presence of Annex I habitat types by Cilian Roden, from the 16 June 2014 to the 8 September 2014.

The survey sites included the River Corrib corridor, Coolagh Lakes, Lough Inch, Ballindooley Lough, and the Terryland Stream. The locations of the survey sites are shown on **Figures 8.1.1** and **8.1.2**.

Sites were accessed either from the shore or by boat. Sub-littoral vegetation was examined by snorkelling. Smaller sites (such as the Terryland Stream) were examined by wading or by shore-based sampling. A list of species present, the depth of the sub-littoral vegetation and the exact position of each site was determined. Depths were measured using a SCUBAPRO depth gauge accurate to 0.1m and position determined using a hand held GPS recorder. GPS position shows approximate area surveyed by snorkel. Species present were recorded on an underwater writing slate. Samples for later examination were stored in plastic bags and identified within one day of collection. Underwater photographs were taken with a Panasonic Lumix DMC-FT3 underwater camera.

1.1.3 2015, 2016, 2017 and 2018 Habitat Surveys

Lackagh Quarry Petrifying Spring Survey

A dedicated survey of seepage lines in Lackagh Quarry to record the presence of Petrifying spring habitat was carried out by Dr Rory Hodd on the 3rd June 2015.

The aim of the survey was to determine whether or not any of these features corresponded with the priority Annex I habitat type **Petrifying springs with tufa formation (Cratoneurion)* [7220]. Plant species associated with each of the seepage lines were recorded and compared with the current definitions of the plant communities associated with this Annex I habitat type (CEC, 2013; and, NPWS, 2013b).

EIA Habitat Survey

The additional habitat surveys that were undertaken to supplement the baseline data already collected for the purposes of the EIA of the proposed road development, consisted of the following elements:

- Habitats within the ZoI of the proposed road development that were surveyed in detail in 2013/2014 (i.e. Lough Corrib cSAC Study Area and the Ecological Sites) were rechecked. Where habitats had changed from the 2013/14 baseline, they were resurveyed as per the methodology described above under 2014 Habitat Surveys – Ecological Sites.
- Areas that had not been surveyed in 2013/14 were subject to a full habitat survey as per the methodology described above under *Habitat Surveys 2014 – Ecological Sites*. This was carried out in 2015 with additional areas included in

2016 and 2017 as a result of changes to the proposed development boundary as a result of the on-going iterative design process. These surveys were carried out by Dr Janice Fuller, Eamon O'Sullivan, Michelle O'Neill, Dr Roger Goodwillie and Dr Mary O'Connor between September 2015 and October 2016, and by Scott Cawley Ltd in 2017.

- A review of wooded Limestone pavement polygons in the Menlough area was carried out by BEC in May/June 2017

1.2 Rare and protected plant species

Dedicated surveys for the following protected plant species were carried out: Slender naiad *Najas flexilis* and Varnished hook-moss *Hamatocaulis vernicosus*. Both of these plant species are listed on Annex II of the Habitats Directive and listed as qualifying interest species of Lough Corrib cSAC (with Slender naiad also listed on Annex IV of the Habitats Directive), and are protected under the Flora (Protection) Order, 2015.

Slender naiad

The Slender naiad survey was carried out by Dr Cillian Roden over the period June to September 2014, as part of the aquatic Annex I habitat survey, as described above under that section.

As a submerged aquatic plant species of clear, low-nutrient lakes, potential survey sites within the scheme study area were Lough Inch, the Coolagh Lakes and Ballindooley Lough. As described above for aquatic habitats, sub-littoral vegetation was examined by snorkelling.

Varnished hook-moss

The Varnished hook-moss survey was carried out by Dr Rory Hodd from the 2 to the 7 September 2014.

Potential sites for survey were selected in consultation with ecologists carrying out habitat mapping within the scheme study area. Potential sites were identified as those where fen occurred, and where brown moss species (i.e. a suite of moss species indicative of, and generally restricted to, fen habitats) had been noted. Sites where fen transitions into bog, or where transition mire or intermediate fen had been noted, were prioritised as they had the most potentially suitable habitat for the species.

Nine potential sites were surveyed for the presence of Varnished hook-moss (**Figure 8.2.1**). The nearest known site for Varnished hook-moss, at Gortachalla Lough, north of Moycullen, was also visited in order to establish the species' habitat preferences in this specific area. Each site was extensively searched for areas where conditions were suitable for the growth of this species, and areas where plant species with similar requirements were found. Any areas which were deemed potentially suitable were thoroughly searched and the moss flora of these areas was examined in detail.

Other Species

Records were kept of the locations of any other rare or protected plant encountered during the course of the habitat surveys, with a particular focus on Flora (Protection) Order, 2015 plant species, where there were existing or historic records.

1.3 Mammals (excluding bats)

Protected species – Otter and Badger

2014 River Corrib Otter Survey

The Otter survey was carried out by Scott Cawley Ltd. staff from the 15 April to the 7 May 2014.

The survey included Otter Habitat (as defined as being a 10m width of bankside each side of the river in the Threat Response Plan: Otter (2009-2011) (NPWS, 2009) within the boundary of the Lough Corrib cSAC between Lough Corrib (Coolanillaun/Tonacurragh) to the Salmon Weir in Galway City. The Otter survey study area, as it relates to the proposed road development, is shown on **Figures 8.3.1** to **8.3.14** (the full extent of that survey is shown on Figure 4.3.17 of the **Route Selection Report**). The status and activity of any Otter holts was recorded along with any evidence of activity, including paths, tracks, feeding signs, sprainting sites or couches (Otter resting places).

2015/2016 Otter and Badger Survey

The mammal survey was carried out by Scott Cawley Ltd. staff and Dr Chris Peppiatt over three survey periods: 30 April to 5 June 2015, from the 28 October to 8 November 2015, and from the 25 to 28 October 2016.

A corridor of approximately 500m along the route of the proposed road development was surveyed for Badger and Otter activity as part of the multi-disciplinary walkover survey – as shown on **Figures 8.3.1** to **8.3.14**. The status and activity of any Badger setts or Otter holts was recorded along with any evidence of activity, including paths, tracks, feeding signs, latrines or couches (Otter resting places).

As part of the survey, two infra-red motion-activated camera were installed between the 9 July and the 4 August 2015 (under NPWS Licence No. 024/2015) to monitor a number of small burrows along a stream bank located adjacent to playing fields at National University of Galway (NUIG).

No species specific surveys were undertaken for other protected mammal species for which field signs are less frequent and/or reliable than other larger mammals, such as Pine marten, Irish stoat and Irish hare. Nevertheless, during all surveys attention was paid to search for activity signs such as searching soft muds for tracks, and to look for droppings. Potential presence of these species in suitable habitat was recorded based on the habitat preferences described in Hayden & Harrington (2000).

1.4 Bats

The following sections describe the methodologies employed to carry out the various bat surveys undertaken to inform the various stages of Constraints, Route Selection and EIA (refer also to **Appendices A.8.7**, **A.8.8**, **A.8.9** and **A.8.10** for stand-alone technical reports for discrete elements of surveys e.g. radio-tracking studies). The bat surveys were carried out under the following licences, issued by the NPWS[2]:

- DER/BAT 2014-17 - Derogation licence to disturb bat roosts throughout the State (valid until 31 December 2018)
- DER/BAT 2014-39 - Derogation licence to disturb bat roosts in Galway County and City
- DER/BAT 2015-02 - Derogation licence to disturb bat roosts in Galway County and City
- DER/BAT 2015-03 - Derogation licence to disturb bat roosts throughout the State
- DER/BAT 2015-24 - Derogation licence to disturb Menlo Castle bat roost and bat roosts north of Galway City and from Oranmore to Furbogh to the west and from the coast to Moycullen to the North
- DER/BAT 2016/09 Derogation licence to disturb bat roosts throughout the State
- DER/BAT 2017/06 Derogation licence to disturb bat roosts throughout the State
- C056/2014 - Licence to capture protected wild animals (bats) for educational and scientific purposes throughout the State
- C098/2014 - Licence to capture protected wild animals (bats) for educational and scientific purposes in an area bounded by Oranmore and Claregalway to the east across to Moycullen and Furbogh to the west, Galway
- C009/2014 - Licence to attach a ban, ring, tag or other marking device to a wild animal bat) in an area bounded by Oranmore and Claregalway to the east across to Moycullen and Furbogh to the west, Galway
- 027/2014 - Licence to use an acoustic lure to capture bats in an area bounded by Oranmore and Claregalway to the east across to Moycullen and Furbogh to the west, Galway, including Menlo Castle roost and night/satellite roosts in Galway
- C004/2015 - Licence to attach a ban, ring, tag or other marking device to a wild animal bat) in an area including Menlo Castle, north of Galway City and from Oranmore to Furbogh to the west and from the coast to Moycullen to the north, County Galway
- C033/2015 - Licence to capture protected wild animals (bats) for educational and scientific purposes throughout the State
- C085/2015 - Licence to capture protected wild animals (Lesser horseshoe bats) for educational and scientific purposes in an area including Menlo Castle, north

[2] The individual licences that applied to individual survey elements are listed under the relevant survey sections.

of Galway City and from Oranmore to Furbogh to the west and from the coast to Moycullen top the north, County Galway

1.4.1 Winter hibernation surveys

As part of preliminary investigations to identify potential winter hibernation roosts for bats, particularly Lesser horseshoe bats which hibernate in caves and cellars, desktop data on such features was researched to draw up a short list of likely locations.

A cave database compiled by David Drew (Drew, 2004), formerly of Trinity College (http://www.ubss.org.uk/irishcaves/irishcaves.php), and the Geological Survey of Ireland (GSI) karst features Geographical Information System (GIS) layer were consulted to locate caves within the wider scheme study area. The National Monuments Service database (http://www.archaeology.ie) was consulted to determine if man-made underground sites (souterrains, mines, ice houses) or unoccupied structures, such as caves and manor houses that may have underground structures or large chimneys, were present within the wider scheme study area.

Potential hibernation sites identified from the desktop study were surveyed internally on the following dates; 11 - 14 March 2014, 21 March 2014, 6 February 2015, 24 February 2016, 8 and 11 January 2018. Sites were visited during daytime and inspected for the presence of hibernating bats and evidence of bat presence (e.g. droppings, staining).

In addition, bat detectors were deployed at potential winter hibernation sites (Cooper's Cave, Newry's Cave, Prospect Hill Railway tunnel, and Menlo Castle) to record bat activity both during the mating season (September-October 2014) and the hibernation period (February-March 2015). Surveys were conducted under licence from the NPWS (DER/BAT 2014-17 and DER/BAT 2015-02 and DER/BAT 2016-09) and care was taken not to disturb bats or to affect access to and from these potential roost sites.

1.4.2 Building surveys

In 2014, a list of potential bat roost buildings was compiled following a vehicle-based survey in areas within, and adjacent to, the scheme study area. Buildings regarded to have high potential to support Lesser horseshoe bat roosts were identified as a priority early in the Constraints and Route Selection phase, with structures that offered roosting opportunities to other bat species identified subsequently. The physical characteristics (construction material, roofing material, estimated age etc.) and GPS locations were recorded and a photograph of each building was taken. The building inspections were undertaken between July and October 2014.

In 2015, 2016 and 2017, buildings within or immediately adjacent to the proposed road development, and specific buildings within 1 km of the proposed road development, that were identified as being of high potential for roosting bats (as guided by Collins, 2016) (i.e. buildings with an obvious, or high, likelihood to support roosting bats, their size, shelter, protection, conditions and surrounding

habitat) were also surveyed. Daytime building inspections and dusk/dawn surveys were conducted in August and September 2015, July and August 2016 and May-June 2017.

The locations of all buildings surveyed are shown on **Figure 8.17.1**.

The daytime building inspections involved a full examination of the internal and external areas of the structures to search for the presence of bats and identify potential roost sites. Bat activity is usually detected by the following signs:

- Bat droppings (these will accumulate under an established roost or under access points)
- Insect remains (under feeding perches)
- Oil (from fur) and urine stains
- Scratch marks
- Bat corpses

Surveyors filled out a standardised roost survey form and these were compiled into a Potential Bat Roost (PBR) building database.

In some situations, where a building had a high potential as a Lesser horseshoe bat roost but no physical evidence was found, a frequency division ultrasound detector (for example an Anabat SD1, Wildlife Acoustic Song Meter 2 or SMZC, or similar) was left in-situ for several nights.

Any bat droppings that were found were placed in 1.5ml eppendorf tubes with silica and sent to Waterford Institute of Technology for genetic analysis to identify the bat species.

The roost surveys were carried out under licence from the NPWS (DER/BAT 2014-39, DER/BAT 2015-03, DER/BAT 2016-09, DER/BAT 2016-28 and DER/BAT 2017-06).

For bat activity surveys conducted in 2015, bat activity around buildings was monitored using a hand-held bat detector (Pettersson 240x, Wildlife Acoustics EM3, or similar) to determine if bats were exiting/entering buildings. Dusk activity surveys were conducted for up to two hours after sunset, while pre-dawn surveys were generally conducted from 2hrs before sunrise. For buildings inside, and within 1km of, the proposed road development at least one internal survey and dusk or dawn survey was conducted. Where internal access was not possible, up to three activity surveys were conducted on a building, subject to accessibility.

Two additional counts of Lesser horseshoe bats at Menlo Castle, Cooper's Cave and the roost at Aughnacurra (PBR178) were undertaken in August 2018: the first count on the 22 August 2018 and the second count over the 27/28 August 2018.

1.4.3 Surveys of bats using Eborhall House and Ballymaglancy Cave cSAC

Eborhall and Ballymaglancy Cave, located to the north of Lough Corrib, are both important roost sites for breeding and hibernating Lesser horseshoe bats respectively. Eborhall House is the "qualifying" roost for the Lough Corrib SAC whilst the nearby Ballymaglancy Cave is a cSAC in its own right (No. 000474) and is thought to provide hibernation roosts for the bats from the Ebor Hall and Stables site.

As part of the assessment of the potential movement of this bat species across the landscape, it was deemed important to determine if any of the ringed bats[3] that were roosting near the scheme study area were also using these roosts, even though they are located a considerable distance to the north (more than 30km).

Surveys were undertaken at Eborhall House and Ballymaglancy Cave to determine the presence of Lesser horseshoe bats that were ringed at roosts within the scheme study area were undertaken under licence DER/BAT 2015-03, DER/BAT 2016-09, DER/BAT 2016-28 and DER/BAT 2017-06) on 21 October 2015, 23 August 2016 and 14 July 2017. Surveys in 2015 were undertaken by Paul Scott (Scott Cawley Ltd) with Mr John Higgins (NPWS Local Conservation Ranger) and in 2016 by Dr Daniel Buckley and in 2017 by Paul Scott. Daytime visual surveys were undertaken to count and identify any marked bats. Only the October 2015 surveys included Ballymaglancy Cave. No ringed bats from the scheme study area were recorded during these visits.

1.4.4 Tree Surveys

Trees within, or immediately adjacent to, the proposed road development (see **Figure 8.16.1** to **8.16.14**) were assessed for their potential as bat roosts as part of multidisciplinary surveys carried out from April to June 2015 and in October/November 2015. The suitability of each tree to support roosting bats was classified using the categories outlined in *Bat Surveys: Good Practice Guidelines* (Hundt, 2012). Whilst these guidelines have been superseded by Collins (2016) the overall approach and valuation criteria are still valid:

- Category 1*: Trees with multiple, highly suitable features capable of supporting larger roosts
- Category 1: Trees with definite bat potential, supporting fewer suitable features than Category 1* trees, or with potential for use by single bats
- Category 2: Trees with 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 which may have limited potential to support bats
- Category 3: Trees with no potential to support bats

Trees assigned a category of 1*, 1 or 2 were re-inspected from 10 to 25 September 2015. Trees with crevices accessible by ladder were surveyed using an endoscope

[3] See **Section 8.3.8** of **Chapter 8**, **Biodiversity** for details on bats that were ringed.

to determine if bats were roosting in the trees, if there was evidence of bats or simply if the potential roost feature offered good conditions for roosting.

Internal inspection of trees was carried out under licence from the NPWS (DER/BAT 2015-03).

1.4.5 Vehicle transect surveys

Vehicle transect surveys took place in June and July 2014. Three transect routes were designed within the scheme study area; an eastern transect (east of the River Corrib), a western transect (west of the River Corrib) and an urban transect (roads within Galway City). The locations of the vehicle transect routes are shown on **Figures 8.4.1** to **8.4.2**. The survey methodology was designed with reference to that used by the All-Ireland Car-based Bat Monitoring Scheme (Roche et al., 2012). The only deviation from that survey methodology related to the use of a GPS unit to georeference the call records, removing the requirement to survey a section and stop to record location references on a map.

Prior to the first survey, surveyors mapped out their driving route during the day, identifying potential hazards. Roads that were unsafe (carrying large volumes of traffic) were excluded from the survey. Surveys were conducted on nights with potential for high levels of bat flight activity (i.e. warm, dry, calm conditions).

Surveying commenced 45 minutes after sunset with roads being driven at approximately 25km/h. Bat activity was recorded using EM3 bat detectors (Wildlife Acoustics) with a GPS unit (Garmin) attached to record the location of bat calls and to plot the transect route. Detectors were mounted on the passenger window of the survey vehicle. Detectors were set to record continuously, saving call files in the compressed WAC format. Each transect was surveyed twice (eastern and western transects on the 17 and 18 June 2014; the urban transects on the 26 June and 1 July 2014). For the second night of surveying, the transect start and end points were reversed.

Bat calls were analysed using the Kaleidoscope auto-identification software (Wildlife Acoustics) and were all manually verified to ensure the software identified calls correctly.

1.4.6 Walked transect surveys

Walked transect surveys took place in June and July 2014. Twenty-one survey sites were selected and a transect route was designed within this to encompass a representative sample of the habitats within the scheme study area. These areas are shown on **Figures 8.4.1** to **8.4.2**.

Prior to the detector survey commencing, the survey sites were walked during the day to plot a route and identify any health and safety issues. Surveys were conducted on nights with potential for high levels of bat flight activity (i.e. warm, dry, calm conditions).

Surveying commenced 45 minutes after sunset. Bat activity was recorded using EM3 bat detectors (Wildlife Acoustics) with a GPS unit (Garmin) attached to record the location of bat calls and to plot the transect route. Detectors were set to record

continuously, saving call files in the compressed WAC format. Each transect was walked once. In addition, an Anabat SD1 or an SM2 detector was placed overnight in suitable bat habitat along the transect routes.

Bat calls recorded using EM3 detectors were analysed using the Kaleidoscope auto-identification software (Wildlife Acoustics) and were all manually verified to ensure the software identified calls correctly. Bat calls recorded on the Anabat detectors were analysed using the software AnalookW (Titley Scientific).

1.4.7 Static detector activity surveys

In 2014, as part of the Constraints and Route Selection studies, static detector surveys of bat activity in selected locations within the scheme study area were conducted from the 12 August to the 2 November 2014. Twenty-four sites for static detector deployment were selected across the scheme study area to survey the bat species present at different locations, as well as to collect comparative data on species richness and general levels of bat activity. The locations of the static detectors are shown on **Figures 8.4.1**, **8.4.2** and **8.22.1**. These locations were selected to cover a range of habitat types and to cover locations that might be crossed by potential route options. The static detectors used were SM2 or SM2+ bat detectors (Wildlife Acoustics). Detectors were set to record in WAC format from half-an-hour before dusk to half-an-hour after dawn set to automatically trigger in response to potential bat calls.

Static monitoring using SM3BAT bat detectors (Wildlife Acoustics) was also conducted at three underground sites in the scheme study area (Cooper's Cave, Newry's Cave and Prospect Hill Railway Tunnel) in the autumn period from the 29 September to the 31 October 2014 and in winter from 4 February to 26 March 2015, in order to determine their use during the autumn mating and winter hibernation periods. An additional bat detector (Wildlife Acoustics SMZC) was placed in the chimney flue in Menlo Castle in winter, underneath the known maternity roost, to determine if bats were present there during the hibernation period. Whilst Lesser horseshoe bats are generally inactive in winter, they do wake up to move around the roost space, and to feed and drink water, and can be detected doing so by the installed equipment. Licences specifically permitting these winter surveys, under certain conditions to protect the roosts and bats, were acquired from the NPWS (DER/BAT 2014-39 and DER BAT 2015-02).

In order to collect long-term data on the bat species flying in specific locations along the route of the proposed road development) in 2015, 42 locations were monitored from the 7 July to the 23 September 2015 using a range of static detectors: seven SM2, one SM3 and one SMZC detector – for locations see **Figures 8.4.1** to **8.4.2**. Detectors were left to record at each location for a five-night survey period and this was repeated twice providing three survey periods. The static detectors were deployed at locations where the corridor of the proposed road development intersected linear features or woodland edges in the proximity of known bat roosts, or in areas where bats had previously been recorded. The siting of detectors also targeted areas where less-common species were known to occur

such as the Lesser horseshoe bat and also for recording the "quieter"[4] Brown long-eared bat and *Myotis* bat species.

Of the 42 locations, 19 were subject to further long-term static detector surveys (10 September to 9 October 2015) to determine if bats were flying near linear features and woodland severed by the proposed road development (see **Figures 8.4.1** to **8.4.2** for locations). Whilst bat flight paths are not restricted to always following linear features, these were regarded to be landscape features that could be severed by the proposed road development. The locations were chosen based on the results of the long-term static detector monitoring carried out earlier in the year, as outlined above. Locations that had suggested very high bat activity and those with records of less common and quieter species were prioritised; e.g. Lesser horseshoe bats, Brown long-eared bat and *Myotis* bats. For these "crossing point surveys", an SM2 with two microphones was deployed for three consecutive nights at each location. One microphone (fixed to the SM2 unit) was placed on one side of the proposed road development, a second was placed on the opposite side of the proposed road development and connected to the same SM2 unit by a 50m cable. Analysis of bat calls and their temporal relationship were then used to support the identification of bats likely to have crossed the proposed road development – i.e. a bat call recorded at one microphone, followed by a call from the same species within a certain recording interval (between 8 and 30 seconds), was a "potential crossing". The choice of time period was based on a variety of sources of data which quotes bat flight speeds of "small species" of 3-8m/s (18-29km/h), Pipistrelle species 4.4m/s, Lesser horseshoe bats 3.5m/s and Natterer's bats 4.5m/s (Baagøe, 1987 and Jones and Rydell, 1994). This method also varies in effectiveness for different species and for different flight characteristics as fast commuting bats with loud echolocation calls (e.g. Leisler's bats) would be detected almost simultaneously by both microphones. Quieter bats (echolocation calls only detected at close range) which may have more weaving flight patterns, such as Lesser horseshoe bats when foraging, could take much longer to pass between the two detector microphones.

In order to ground-truth the results of the crossing point surveys, manual surveys were also conducted on one night when the static detectors were recording. Surveyors recorded bat flight activity at each location, over a period of 2 hours after sunset, from a vantage point using a hand-held bat detector (Batbox Duet) and recorded the time bats were recorded on the detector and/or visually along with the direction of bat flight. Surveys concluded when bats could no longer be seen.

Bat calls were analysed using the Kaleidoscope auto-identification software (Wildlife Acoustics) and were all manually verified to ensure the software identified calls correctly.

In order to record and assess bat activity within the lands proposed for habitat enhancement at Menlough, four SM2BAT+ detectors placed along hedgerows from 28 July - 11 August 2017, and again from 2 – 15 May 2018.

[4] Presence/absence of Brown long-eared bats and some *Myotis* species of bats can be problematic in manual, roving surveys as their echolocation calls have limited volume and range. Longer-term monitoring increases the chances of encountering them.

1.4.8 Radio-tracking studies

Radio-tracking of bats allows accurate recording of where bats are flying from their roosts, where they feed and other roost sites. It is an intensive method of data collection but provides very useful and reliable data for impact assessment purposes. Radio-tracking work undertaken as part of the collection of baseline data for the purposes of impact assessment was undertaken over four sessions, over two seasons in 2014 and 2015:

- Session 1: 30 July - 7 August 2014 and was led by Greena Ecological Consultancy Ltd., with the aim of radio-tracking Lesser horseshoe bats and (to a lesser extent) vespertilionid bats in order to identify the location and extent of foraging areas and the location of day/night/transitional roosts in the scheme study area
- Session 2: 19 - 29 August 2014 and was led by Geckoella Environmental Consultants Ltd. with the aim of locating vespertilionid bat roosts within the scheme study area
- Session 3: 2 - 9 September 2014 and was led by Greena Ecological Consultancy Ltd., with the aim of identifying and mapping vespertilionid and rhinolophid bat movements to mating sites or winter roosts
- Session 4: 16 - 23 May 2015 and was led by Greena Ecological Consultancy Ltd., with the aim of determining movements of the Lesser horseshoe bats in Menlo Castle during the spring period and to locate day roosts for this species in the western part of the scheme study area

Lesser horseshoe bats were captured at two sites in the wider scheme study area during sessions 1 and 3: Menlo Castle and Cooper's Cave. Bats were captured using mist nets and harp traps as they emerged or arrived at roosts after sunset. Vespertilionid bats were captured at six sites (Bearna Woods, Cooper's Cave, Menlo Woods, Merlin Woods, NUIG, and the NUIG Recreational Facilities) using mist nets, harp traps and an acoustic lure (Sussex Autobat) that attracts bats by emitting artificial foraging and social calls (Hill and Greenaway, 2005).

Several licences were issued by the NPWS to permit capture of bats using the traps and use of the acoustic lure and the fitting of the radio transmitters - Refs: C098/2014, C009/2014, 027/2014, C004/2015, C033/2015, C085/2015, DER/BAT 2015-24.

Captured bats were identified to species level and weighed to determine if they were suitable for tagging with radio transmitters. Radio transmitters (Biotrack and Holohil) were glued between the fur-clipped shoulder blades of the bats using latex adhesive and usually detached from the tagged bat within two weeks of being attached. Priority was given to tagging female Lesser horseshoe bats, *Myotis* bats and Common pipistrelles as at that time little was known about where these species were flying, feeding and roosting.

Bats were tracked using Australis 26K and Sika UHF radio receivers with Yaggi rigid aerials. Omni-directional antennas were used to search for bats by vehicle. Both receivers were able to automatically scan through different frequencies, which made it possible to search for a number of tagged bats at any one time. For sessions

1 and 3, bats were tracked at night while they were foraging to determine home ranges, core foraging areas and identify night roosts; bats were also located using the telemetry signal during the day to identify roosts. For session 2, bats were only tracked during the day to locate roosts. For sessions 1 and 3, foraging and commuting bats were observed from fixed (often elevated) points where suitable radio reception was available, such as at elevated or other suitable vantage points. Where possible, surveyors made close approaches to bats to ascertain the exact foraging area and behaviour, or to attempt pursuit if the bat was moving away. Accurate bearings of bat locations were simultaneously taken, by two or more surveyors, from hand held sighting Silva Expedition 54 compasses. These bearings were then used to calculate a location, using the Locate software. GPS units (Garmin) were used to increase the speed and accuracy of the surveyors recording their locations. Over survey nights, surveyors built up a picture of bat commuting routes and of bat foraging areas. Foraging areas were estimated using minimum convex polygons (MCP) and multi-lateral polygons (MLP) generated from the outermost locations radio-tracked bats were recorded. A MCP is defined as an animal's home range size, with the shape, and position represented by joining the outermost fixes (Mohr, 1947). A MLP is defined as the minimal area between all confirmed points of an animal's occurrence during a radio-tracking session.

1.4.9 Marking studies

In order to provide long-term data on bat movements that may be recaptured or rediscovered in other roosts (such as hibernation roosts), several bats that were caught as part of the radio-tracking surveys, over both seasons, were fitted with special anodised aluminium rings, each with a unique serial number. The rings were fitted over the forearm of the bat by experienced bat workers under licence from the NPWS (Licence No. C009/2014 and C004/2015). All Lesser horseshoe bats that were fitted with radio transmitters were also marked with rings so that, if captured again within the same survey session, they would not be re-fitted with transmitters. Bats other than Lesser horseshoe bats were also ringed, in an effort to locate mating or winter hibernation sites if these bats were subsequently recaptured in the mating season.

As stated previously, surveys of roosts in winter 2014 and 2015 included looking for Lesser horseshoe bats that were fitted with rings. In order to identify if ringed bats from the scheme study area were interacting with roosts further north – and in particular the roost at Eborhall (the Qualifying Interest roost for the Lesser horseshoe bats in Lough Corrib cSAC) – internal surveys were conducted on the 21 October 2015, 23 August 2016 and 14 July 2017 at Eborhall (and Ballymaglancy Cave on 21 October 2015), which are located more than 30km from Menlo Castle on the northern shores of Lough Corrib. Locating ringed bats at sites like these would provide valuable data as to the relationship between winter roost sites and the location where the bat was originally caught and tagged.

1.4.10 Collection of data on Lesser Horseshoe bat population and distribution

An analysis of the NPWS's Lesser horseshoe bat roost database was conducted to estimate the importance of the maternity colony at Menlo Castle for the Lesser horseshoe bat population at a local, regional and national level. The most recent counts and distribution of all summer roosts in counties Galway, Mayo, Clare and Limerick, which make up the northern sub-population of this species in Ireland according to Dool (2016), were used to determine the proportion that the Menlo Castle roost contributes to the summer population in these counties and therefore its strategic importance for the sub-population at a regional level.

Previous records for Lesser horseshoe bats within the scheme study area were sourced from the Bat Conservation Ireland database and the NPWS's Lesser horseshoe bat database. Mr Conor Kelleher, Mr Brian Keely, Dr Kate McAney, Dr Catriona Carlin (Galway Bat Group) and local NPWS conservation ranger Rebecca Teesdale were also consulted to collate any additional summer and winter roost records that were not in the above databases.

This initial desktop assessment was supplemented by data collected during subsequent field surveys.

1.5 Invertebrates

1.5.1 White-clawed crayfish

The White-clawed crayfish survey was carried out by Scott Cawley Ltd. and Julian Reynolds, under licence from the NPWS, from the 23 August 2014 to the 6 September 2014.

The watercourses surveyed are shown on **Figure 8.5.1**. Depending on the size of the waterbody, it was either surveyed using sweep-netting with hand nets (following Reynolds *et al*. 2010) or trapped using crayfish traps of appropriate mesh size. Where trapping was undertaken, traps were checked for crayfish and baited each morning and were left out over two or three nights.

1.5.2 Freshwater pearl mussel

The Freshwater pearl mussel *Margaritifera margaritifera* survey was carried out by Dr Evelyn Moorkens and Dr Ian Killeen, under licenses from the NPWS, from the 11 to the 24 August 2014.

The level of survey undertaken was determined in consideration of the potential for the presence of the Freshwater pearl mussel from a review of the following maps: OSI Discovery Series mapping, and the Geological Survey of Ireland's (GSI) Bedrock Geological Map of Ireland. Suitable habitat potential was considered to include areas of acid rock with sufficient gradient to have the potential for good flow in the river channel, including riffle habitat.

The main channel of the River Corrib and the area east of the River Corrib were discounted through not having the appropriate underlying geology to support the

Freshwater pearl mussel. The watercourses west of the River Corrib which were surveyed as part of the Constraints Study for the proposed road development are shown on **Figure 8.5.1** – see also the full report in **Appendix A.8.11**.

In each stream a rapid assessment was undertaken of river stretches identified from the desktop assessment, following the current standard methods for Freshwater pearl mussel survey (Anon., 2004). As the streams were small, the survey was carried out by wading in an upstream direction using a bathyscope according to published Stage 1 survey techniques (Anon., 2004).

1.5.3 Other Annex II molluscan species

The molluscan survey work was carried out by Dr Evelyn Moorkens and Dr Ian Killeen, under licenses from the NPWS, from the 11 to the 24 August 2014.

This element of the survey work included the following four Annex II molluscan species (surveys for the Freshwater pearl mussel were carried out separately, as described under the relevant section above):

- *Vertigo geyeri* (Geyer's whorl snail)
- *Vertigo angustior* (Narrow-mouthed whorl snail)
- *Vertigo moulinsiana* (Desmoulin's whorl snail)
- *Geomalacus maculosus* (the Kerry slug)

The molluscan survey sites were chosen based on a review of habitats within the scheme study area from recent aerial photography in combination with the results of habitat mapping surveys carried out within Lough Corrib cSAC, the Ecological Sites, and the wider scheme study area (as described above under *Habitats*), to locate habitat types with potential to support Annex II molluscan species. The survey sites are shown on **Figure 8.5.1** – see also the full report in **Appendix A.8.12**.

The habitat requirements for each of the four species concerned are described in detail in *Monitoring and Condition Assessment of Populations of Vertigo geyeri, Vertigo angustior and Vertigo moulinsiana in Ireland* (Moorkens & Killeen, 2011) and in *Database of association with habitat and environmental variables for non-shelled slugs and bivalves of Britain and Ireland* (Moorkens & Killeen, 2009).

Overall, initial surveys and the aerial photography review indicated that there were four main areas of potential habitat for *Vertigo* snail species:

- Areas of reed swamp, wet grassland and fen along the River Corrib corridor
- Coolagh Lakes area
- Ballindooley Lough area
- Turlough features east of the River Corrib

No potential suitable habitat was recorded for the Kerry slug within the scheme study area.

At each survey site a wide area was investigated and the main habitats with the potential to support *Vertigo* species were sampled. Habitats were sampled by hand, (i.e. examination of litter, stems and the underside of timber). Suitable habitat vegetation was sampled by banging leaves onto a white tray, and by the removal of amalgamated litter samples from areas of best potential for *Vertigo* species.

Approximately 2-3 litres of litter (e.g. dead/decomposing vegetation) were taken from each sampling site, air dried in the laboratory, and then sieved through two mesh sizes (3mm and 0.5mm). The contents of each sieve was examined for snails. An Olympus 40X binocular microscope was used to examine the smaller species.

1.5.4 Marsh fritillary

2013 Survey

The field work was conducted in two stages. An initial vehicle based survey was carried out with reference to OSI aerial photographs and a number of areas with suitable habitat were recorded. Areas which appeared on the photographs to have a similar appearance to these locations were then selected as survey sites. A total of 57 survey locations were identified. The locations of these sites are presented in **Appendix A.8.14**.

Field maps were prepared for each of the survey locations identified. At each of the sites the occurrence of sufficient amounts of the food plant of the Marsh fritillary, Devil's-bit scabious *Succisa pratensis*, were mapped by annotating the field maps and taking a series of waypoints on handheld GPS units or handheld computers (Trimble Nomads). At sites with suitable habitat, notes were made on:

- Habitat type
- Management (grazing intensity and stock type)
- Sward height
- Cover of *S. pratensis*
- Cover of scrub

Where suitable habitat was recorded, a search for Marsh fritillary larval webs was conducted. This comprised a meandering walk, covering as much of the suitable habitat as possible, targeting areas most likely to support webs e.g. south-facing slopes, dense patches of *S. pratensis*, structured vegetation patches and sheltered locations. When larval webs were encountered assessments were carried out according to the Marsh fritillary Larval Web Survey/Monitoring sheet prepared by the National Biodiversity Data Centre (NBDC) and NPWS (http://butterflies.biodiversityireland.ie/rare-species/marshfritillary/larval-web-form/). The locations of larval webs were recorded on the Trimble Nomads.

All field work was completed by the 28 September 2013, within the recommended survey period for Marsh fritillary larval webs (National Roads Authority, 2009).

2014 Survey

Large scale larval web and habitat suitability surveys for Marsh fritillary were carried out by Woodrow Environmental Consultants Ltd. between the 15 September and 10 October 2014 (see **Appendix A.8.13** for full report), with the vast majority of the work completed by 26 September 2014.

The selection of areas for survey within the scheme study area was informed by:

- Desktop records for the species
- Results from Marsh fritillary surveys of the area undertaken in 2013 (Barron et al., 2013) – see **Appendix A.8.14**
- Results of the large scale habitat surveys across the scheme study area which yielded useful information on potential suitability of habitat based on the presence of the species' food plant Devil's-bit scabious *Succisa pratensis*
- A review of orthophotography within those habitat polygons known to support Devil's-bit scabious - for example, where areas were clearly improved they were discounted as being unsuitable areas for priority survey included those close to the existing known population, or areas holding habitat similar in character to known suitable habitat polygons

Based on this information, large areas within the scheme study area which were either known or considered likely to support Marsh fritillary, were selected for survey as indicated on **Figures 8.6.1** and **8.6.2**.

Habitat condition and larval web surveys followed approaches adopted by NPWS in 2010 with amendments agreed following the 2011 National Marsh Fritillary report (Woodrow *et al*., 2012).

Larval Web Survey

Larval web surveys were undertaken during targeted walks of each site relying on the experience of the surveyors to identify potential areas of search while in the field. Experience has shown that, given highly experienced surveyors, this can be a very effective and reliable survey method where the intention is to identify the presence of colonies rather than undertaking a full population survey.

The method for larval web surveys relied on the high level of experience of the survey team and was undertaken as follows:

- Site surveys were undertaken with two or more surveyors. Each surveyor was responsible for undertaking habitat condition surveys and larval web surveys
- Larval web surveyors walked a zig-zag route through the most appropriate habitat, concentrating on the most likely features and aspects for larval webs
- Where a larval web was found, surveyors undertook a short more intensive zig-zag search of the neighbouring area to ascertain whether it was a significant colony
- After three or four larval webs were recorded, or if no more were located immediately, the surveyors continued to cover the remainder of the site in a zig-

zag pattern, until all the habitat survey was completed and then moved on to the next site

- Handheld GPS units were used to record 12 figure grid references for each larval web
- Habitat condition was recorded at all web locations

Habitat Condition Survey

Habitat condition parameters were recorded only at sites where larval webs were recorded. While habitat condition assessments are particularly useful in Marsh fritillary monitoring programmes and habitat management assessments, since they allow for analysis of the selection of different sites (or sub-sites) by Marsh fritillaries based on different criteria, such assessments were not central to this study which aimed to identify any *potentially suitable* habitat. The extensive experience of the survey team allowed this to be done for all sites, based on identification of areas of dense and/or extensive Devil's-bit scabious within a reasonably open sward.

Habitat condition assessments involved the collection of data on the following criteria:

- Vegetation height recorded by the average band in which the sample fell into (A = <12cm, B = 12-25cm, C = 25--50cm, and D = >50cm)
- Devil's bit Scabious abundance (A = 1-2 plants /m2, B = 3-9 plants /m2, C=10+ plants /m2, and D = no plants)
- Presence of habitat structure - tussocks/dominant tussock-forming species present
- Presence of low invading scrub (<25cm tall and >10% cover)
- Evidence of stock grazing (poaching, dung etc.)

Survey Limitations

Safe access to the whole of one area (at the western end of the Western Distributor Road) was not obtained due to blocking watercourses. In this instance, where access was not feasible, the surrounding area was surveyed for potentially suitable habitat from vantage points using binoculars. Much of the area comprised fairly improved pasture, scrub, woodland and wetland and so would have held very little potential for the species. No flowering Devil's-bit scabious was observed. This area is not directly impacted by the proposed road development and this limitation does not affect the impact assessment of the proposed road development on the local March fritillary population.

2015 and 2016 Surveys

The 2015 Marsh fritillary butterfly survey was carried out by Woodrow Environmental Consultants Ltd. on the 8, 9 and 15 September 2015. The 2016 survey was carried out by Woodrow Environmental Consultants Ltd. on the 14, 15 and 26 September 2016.

Surveys were undertaken for potentially suitable Marsh fritillary habitat, and larval webs, in targeted areas within and adjacent to the proposed road development – for survey locations see **Figures 8.6.1** and **8.6.2**. Areas were initially surveyed in 2013 (Barron *et al.*, 2013) and again in 2014 (Woodrow Sustainable Solutions Ltd., 2015). These initial surveys identified habitat suitability for Marsh fritillary butterflies, within areas where the Marsh fritillary food plant (*Succisa pratensis*) had been recorded during botanical surveys, and also Marsh fritillary larval web locations to ascertain the status of the species locally.

The general approach to the work was to undertake intensive larval web surveys within known suitable habitat within the proposed development boundary, in addition to 'rapid' larval web surveys over areas in proximity to these areas. The latter surveys were to provide a wider context for the surveys within the proposed development boundary and an understanding of the wider metapopulation. This is useful in order to inform the baseline for any future population monitoring, inform on the potential impact of removal of suitable habitat areas from the metapopulation network, and also to inform on the potential likelihood of future use of areas within the proposed development boundary prior to construction.

In addition, habitat condition points were gathered at regular locations in order to ascertain habitat suitability for Marsh fritillaries within all polygons.

Larval web and habitat condition surveys followed approaches adopted by NPWS in 2010 with amendments agreed following the 2011 National Marsh Fritillary report (Woodrow, *et a*l. 2012).

Larval web field surveys

Larval web population surveys were undertaken using two approaches. Firstly, intensive surveys were undertaken on all suitable habitat falling within the proposed development boundary. Secondly, 'rapid' assessment surveys were then undertaken on suitable habitat in the surrounding locality. In some instances, this was immediately adjacent to the proposed road development, in others it included surveys up to c.500m from the proposed development boundary (where such areas occurred in significant clusters of suitable habitat).

Intensive larval web surveys were undertaken as follows:

- After an initial walkover of the site to ascertain potentially suitable habitat, a survey boundary edge was established and marked with bamboo canes
- Fieldworkers formed a line, with each fieldworker no more than 2m from the next, and walked an initial transect along the length of the survey area, inside the boundary line, marking the inside of the transect with marker canes
- Transects were repeated, each inside the previous, until the entire survey area had been surveyed
- Hand-held GPS units were used to record 12 figure grid references for each web. Bamboo canes were used to mark webs and routes taken and the track logged on a GPS unit in order to ensure that there was no double-counting. Webs were noted as active, inactive or parasitized as appropriate

'Rapid' larval web surveys were undertaken during targeted walks of each site, relying on the experience of the surveyors to identify potential search areas while in the field. Experience has shown that, given highly experienced surveyors, this can be a very effective and reliable survey method where the intention is to identify the presence of colonies, rather than undertaking a full population survey. The method for 'rapid' larval web surveys was as follows:

- Site surveys were undertaken with two surveyors. Each surveyor was responsible for undertaking habitat condition surveys and larval web surveys
- Larval web surveyors walked a zig-zag route through the most appropriate habitat, concentrating on the most likely features and aspects for larval webs (based on experience)
- Where a larval web was found, surveyors undertook a short more intensive zig-zag search of the neighbouring area to ascertain whether it was a significant colony
- After three or four larval webs were recorded, or if no more were located immediately, the surveyors continued to cover the remainder of the site in a zig-zag until all the habitat survey was completed and then moved on to the next site
- Hand-held GPS units were used to record 12 figure grid references for each larval web

Habitat condition was recorded at all recorded larval web locations.

Habitat condition surveys

Habitat condition surveys followed approaches adopted by NPWS in 2010 with amendments agreed following the 2011 National Marsh Fritillary report (Woodrow, *et al*. 2012).

Habitat condition assessments involved the collection of data as per the habitat condition criteria described above under the 2014 survey methodology (with an intention to take a minimum of five survey points per site for small sites and five survey points per hectare for larger sites).

1.6 Birds

1.6.1 Breeding birds

Red grouse

The Red grouse survey was carried out by Dr Chris Peppiatt from 18 June 2014 to the 9 August 2014 after the methodology outlined in Murray *et al.*, (2013).

The Red grouse survey sites were chosen based on a review of recent aerial photography of the scheme study area to identify areas of potentially suitable habitat (i.e. areas of blanket bog and heath). Within each of the survey sites, transects spaced 100m apart were walked such that the surveyor came within 50m of all parts of the survey site. The location of any flushed birds, or evidence of Red

grouse such as droppings, was recorded and mapped. The survey sites are shown on Figure 4.3.21 of the **Route Selection Report**.

Barn owl

Barn Owl Survey and Monitoring 2014

The Barn owl survey was carried out by BirdWatch Ireland from 26 June 2014 to 18 July 2014.

A desktop study, in combination with field assessment, was conducted on the 26 June 2014 to determine the extent of the scheme study area potentially suitable for Barn owls. This initial assessment identified an area of c.30km^2 within Galway City and surrounds as largely unsuitable for nesting Barn owls, which was based on knowledge of nest site selection and requirements in Ireland. Although Barn owls may use urban areas for foraging, nesting within built up areas is unusual (Copland & Lusby, 2012). In addition, survey work is less effective due to access to buildings and, for these reasons, this area was excluded from further survey work. Therefore, the overall scheme study area, considered as potentially suitable and which was the focus for further survey work, comprised an area of c.195km^2. A map of the Barn owl study area is shown in the Barn owl survey report in **Appendix A.8.15** (see Figure 2.1 of that report).

Prior to beginning the fieldwork, all relevant information on existing and previously active Barn owl sites and sightings from within the Barn owl survey area were extracted from relevant BirdWatch Ireland databases; including the Barn owl registered site and sightings database and the recent Breeding Birds Atlas (2007 – 2011) database (refer to Balmer *et al*., 2013). All data was collated and the details included on suitable large-scale Ordnance Survey maps.

A detailed survey sheet for use in the field was drafted to take account of the following aspects for each site surveyed; date, county, grid reference, site type, site name, suitability rating (0 – 3), status, nesting opportunities, signs, and whether a roost watch was required and/or carried out. Additional information was recorded relating to the suitability and presence of other raptors, corvids, or other species of note.

All roads within the survey boundaries were systematically traversed by vehicle and the suitability of all buildings and quarries within the Barn owl study area was assessed. Sites that were considered to be potentially suitable were comprehensively searched for signs of the presence of Barn owls. All sites were categorised on a scale of 0 – 3 based on potential nesting and roosting opportunities for Barn owls: 0, for unsuitable; 1, representing potentially suitable sites for roosting but unlikely for nesting; 2, being suitable roosting or nesting sites; and 3, representing sites considered to be very suitable for nesting Barn owl.

At each site, a thorough search was conducted inside and outside of the building, or within a quarry, in order to locate signs indicating the presence of Barn owls (particularly pellets, evidence of whitewash splashings and moulted feathers). Depending on the site characteristics, adjacent buildings and potential perches in the immediate vicinity of the site were also assessed. At certain active Barn owl sites, due to the concealed nature of nest and roost sites (e.g. blocked chimneys,

deep cavities etc.), signs are not always obvious or accessible. Therefore, at the particular sites where this was judged to be an issue, it was necessary to conduct a vantage point watch lasting a minimum of one hour and commencing at dusk (i.e. a 'roost watch') in order to confirm activity. These sites were then recorded as active if calls from an adult or owlets were heard, or if a Barn owl was observed either within the site, or entering/exiting the site. These methods were designed to locate all Barn owl sites in buildings and quarries within the Barn owl study area. All signs and sightings of other raptors encountered during fieldwork were also recorded.

Potential tree sites were not assessed as part of this study[5]. However, information on Barn owl activity was sought whenever landowners were encountered over the course of survey work and on an opportunistic basis during fieldwork. Interviews with landowners have been successfully used to assess Barn owl occupation in previous Barn owl surveys (Toms *et al*., 2001). Landowners were asked a series of standardized questions, shown images of Barn owls, and played vocalizations of the species for identification purposes. An assessment was made as to the reliability of each individual report, based on the account, the observer's description and their relevant level of knowledge. Reports that were considered to be potentially unreliable were discarded. Reliable reports were divided into two categories, "breeding season" which consists of the period March to July and "non-breeding season" which comprises the remainder of the year. Greater importance was afforded to those sightings which originated from within the defined breeding season period as these are likely to represent birds holding territory, as opposed to non-breeding season sightings which could represent dispersing juveniles.

At all active or potentially active sites, or those where it was deemed necessary to conduct a roost watch to accurately determine status, additional nocturnal visits were carried out to confirm activity and breeding status.

Barn Owl Survey and Monitoring 2015 and 2016

The results of the Barn Owl survey in 2014 informed the methods for the 2015 and 2016 surveys. All sites classed as suitable (Category 2 or 3) within the 2014 study area were re-visited between June and August of 2015 and 2016 to determine suitability and occupancy (see **Appendix A.8.15**). The same survey methods were employed as per 2014, whereby each site was visited by day and checked for signs of occupancy by Barn Owls. Where the status of a site could not be accurately determined by a day time inspection, a dusk watch was conducted. At all sites where evidence of Barn Owls was confirmed, dusk watches and/or nocturnal surveys were conducted as necessary to establish breeding activity. As in 2014, all raptor species which were encountered during survey work were also recorded.

Barn Owl Survey 2018

A Barn Owl survey was undertaken at Menlo Castle over the 2018 breeding season to continue the monitoring of the breeding status of the site that took place in 2015 and 2016, The survey was carried out according to best practice methods as defined

[5] Note: all trees within the fence line were assessed as part of the bat surveys (see Tree Survey section above under the bat survey methodologies) and none were deemed to be suitable to support nesting Barn owl

by 'Barn Owl Surveying Standards for National Road Projects' (http://www.tiipublications.ie/library/RE-ENV-07005-01.pdf).

The survey was undertaken from late May to September 2018, during which time four visits were carried out (28 May, 20 June, 15 August and the 9 September 2018) to determine occupancy of Barn Owl via searching for signs to indicate presence (all visits) and dusk watches to confirm activity on the first three visits.

Peregrine falcon Survey 2016

Prior to conducting survey work, available information on the recent use of quarry sites (n = 5) by Peregrine falcon within the survey area was collated through records from survey work for the proposed road development in addition to interviews with National Parks and Wildlife Service (NPWS) and local experts who independently monitor Peregrine falcon populations in County Galway. For the survey area and site locations, refer to Figure 3.1 of the Peregrine falcon survey report in **Appendix A.8.16**.

The survey methods followed best practice survey techniques for Peregrine falcon as defined by Hardey et al. (2009) and were adapted for the specific requirements and time scale of this survey. The survey was carried out between the 12 May 2016 and the 10 June 2016. Before the surveys commenced, it was confirmed through communications with the NPWS that the Roadstone Quarry site was occupied by a breeding pair. A vantage point watch was carried out at the other four quarries with recent records for Peregrine falcon. Watches were initiated between 06:00 to 10:00 in the morning or 18:00 to 19:00 in the evening and were conducted in suitable weather conditions. A vantage point watch was conducted from an appropriate and discrete position either within or outside the quarry to provide the best view of suitable rock faces. Searches were carried out in accessible areas to locate signs indicating use of the site by Peregrine including fresh kills, moulted feathers, and pellets, with particular attention given to suitable perches and areas where white-wash was observed. Sites were confirmed as occupied if a bird or pair were observed or if fresh signs were confirmed, and unoccupied if no evidence of Peregrine was recorded.

For sites which were confirmed to be occupied on the first visit, further visits were conducted between the 15 of May and the 10 of June 2016 to establish breeding activity, nest site location and breeding success as required. All follow up survey visits employed vantage point watches of between one to three hours to record Peregrine falcon activity to determine breeding status, including defensive behaviour, attending or visiting a nest, food passes, prey deliveries and the presence of young. At sites where breeding was confirmed, the location of the nest was recorded where possible.

Breeding sites were confirmed to be successful if fledged young or young which were close to fledging were recorded. Sites were classed as failed if, based on the evidence it was apparent that a pair was present at the site and a breeding attempt had likely taken place but young were not successfully raised to fledging. Failed breeding attempts can be difficult to confirm, and can require monitoring from the early stages of the breeding cycle. As the survey was initiated after the typical courtship and laying stages for Peregrine (Ratcliffe, 1993), the presence and behaviour of birds recorded during the monitoring period, in addition to knowledge

of the breeding status at the site in previous years was used to inform the likelihood that a breeding attempt had taken place.

Peregrine falcon Survey 2018

A Peregrine falcon survey was undertaken at Lackagh Quarry over the 2018 breeding season to follow up on the monitoring of the breeding status of the site that took place in 2016. The survey methods followed best practice survey techniques for Peregrine as defined by Hardey et al. (2009) and were adapted for the specific requirements and time scale of this survey, and based on existing knowledge of use of the site by Peregrine. The survey was initiated on the 30 May 2018 and a vantage point watch was carried out which located nesting activity. Subsequent visits on the 20 June and 5 July 2018 focused on monitoring the confirmed breeding location.

General Breeding Birds

Breeding bird surveys were conducted by Dr. Chris Peppiatt, Gerry Murphy and John Small over three visits in May/June 2015 using a methodology adapted from the Breeding Bird Survey (Gilbert et al., 1998). Lands within, and adjacent to, the proposed development boundary were slowly walked in a manner allowing the surveyor to come within 50m of all habitat features – see **Figures 8.7.1** to **8.7.14** for survey corridor. Birds were identified by sight and song, and general location and activity were recorded using the British Trust for Ornithology (BTO) species and activity codes. The conservation status of the bird species recorded is as per:

- Birds of Conservation Concern in Ireland (BoCCI) lists which classify bird species into three categories: Red List – birds of high conservation concern; Amber List – birds of medium conservation concern; and Green List – birds not considered threatened (Colhoun & Cummins, 2013)
- Bird species listed on Annex I of the EU Birds Directive (2008/144/EC)
- SCI species of SPAs within the ZoI of the proposed road development

Woodcock Survey (Breeding)

Woodcock surveys were conducted by Dr. Chris Peppiatt at two woodland sites (Menlough Woods and Bearna Woods), over three visits from 24 May 2015 to 12 June 2015, in line with the methodology outlined for a breeding season Woodcock survey (Gilbert et. al., 1998). Due to access issues one area was resurveyed in June 2016. Surveys commenced one hour before sunset and continued until one hour after sunset. The woodland area was slowly walked and any roding (display in flight) behaviour was recorded.

1.6.2 Wintering birds

Winter bird field surveys were conducted by Dr. Chris Peppiatt, Gerry Murphy, John Small, Tom Cuffe and Scott Cawley Ltd. staff, once a month during daylight hours from September 2014 to March 2015. Due to the diverse nature of the sites surveyed, surveys were conducted using a combination of methodologies. In general, the approach was a 'look-see' methodology (based on Gilbert *et al.* 1998). The survey sites are shown on **Figure 8.9.1**.

Wetland and Peatland Sites

Where possible, sites were surveyed from vantage points (e.g. Ballindooley Lough and Coolagh Lakes) and any species utilising the area, and their activity, were recorded. Larger sites were surveyed using a hybrid methodology of thorough walks through the site with point counts and/or vantage points undertaken along the route of the proposed road development, where possible. The sites covered included:

- River Corrib
- Terryland Stream
- Ballindooley Lough
- Coolagh Lakes
- Moycullen Bogs NHA at Ballagh and Tonabrocky
- Moycullen Bog pNHA at Tonabrocky
- Cappagh Road Peatland
- Lough Inch north-eastern peatland
- Lough Inch southern peatland
- Lough Inch south western peatland

Hen harrier Winter Roost Surveys

Hen harrier Roost Surveys were undertaken at Ballindooley Lough and the Coolagh Lakes. This involved vantage point surveys of the area from 1.5 hours before sunset to 0.5 hours after sunset to record any Hen harriers in the area.

Quarries, Agricultural Areas, and Amenity Areas

Three quarries were surveyed using a hybrid methodology of walks and/or vehicle-based transects through the site with point counts and/or vantage points undertaken along the transect.

Agricultural and amenity areas were surveyed using a combination of vehicle-based surveys and roadside views where possible, with some areas requiring a walk-through to determine usage by wintering birds.

1.7 Amphibians

The amphibian survey was carried out by Scott Cawley Ltd. staff in April and May 2015 with the survey of an additional feature by Dr Chris Peppiatt in June 2016 at Kentfield.

All suitable watercourses, drainage ditches and ponds located within the survey area (see **Figures 8.10.1** to **8.10.8**) were surveyed for the presence of amphibians, in accordance with methodology described in the National Roads Authority's guidelines (National Roads Authority, 2009). An initial assessment of the suitability of surface water features was carried out during the multi-disciplinary walkover in April and May 2015. Suitable features were then subsequently surveyed on two

occasions from 6 May 2015 to 4 June 2015, using a combination of torchlight inspections and manual egg searches (under licence from the NPWS: licence number C010/2015). These surveys were augmented by searches of suitable features over the course of other ecological surveys carried out along the route of the proposed road development.

1.8 Reptiles

Lizard surveys were undertaken by Scott Cawley Ltd. staff in late September/early October 2015. Surveys were undertaken in accordance with the methodologies described in the TII[6] and Highways Agency guidance documents (National Roads Authority, 2008a; and, Highways Agency, 2005). The survey sites were selected to cover a representative range of suitable habitat types for the species along the route of the proposed road development. Ten survey sites were selected, which were located entirely within, partially within, or in close proximity to the proposed development boundary – see **Figures 8.10.1** to **8.10.8**. The outer boundary of each survey site was defined by a square hectare (100m x100m area) and within each site, 10 artificial refugia (roofing felt tiles, each *c.* 0.5m^2 in size) were placed in suitable habitat most likely to be used by basking reptiles. The location of each tile was recorded using a 12 figure GPS co-ordinates. Each tile was also given a unique reference number to aid in recording the survey results. Each survey site was visited a total of five times and involved the surveyor checking each tile for the presence of Lizard at a distance and then close-up. These surveys were augmented by searches of suitable habitat features over the course of other ecological surveys carried out along the route of the proposed road development.

1.9 Fish

All of the surveys described below were carried out by Triturus Environmental Services Ltd. in September 2015. The main waterbodies surveyed are listed in **Table 2** below, with the locations of all surveyed watercourses and survey sites shown on **Figure 8.11.1** - see also the full report in **Appendix A.8.17**. All surveys were undertaken from the 22 – 30 September 2015, during the optimal survey period for the survey type/species involved.

Table 2: Waterbodies surveyed as part of the fisheries assessment

Watercourse type	EPA Code	Hydrometric Area
Sruthán na Líbeirtí (Liberty Stream)	31F01	31
Trusky Stream	31B02	31
Bearna Stream (forms tributary with 'An Sruthán Dubh at Ballard)	31B01	31
Knocknacarragh	31K16	31
Terryland Stream	30T01	30

[6] The Minister for Transport, Tourism and Sport has signed the order for the merger of the National Roads Authority (NRA) with the Railway Procurement Agency (RPA) to establish a single new entity called Transport Infrastructure Ireland (TII). The National Roads Authority is known as Transport Infrastructure Ireland (TII) since 1 August 2015.

Watercourse type	EPA Code	Hydrometric Area
Merlin Stream	No EPA code	29
Coolagh Lakes & river tributary	No EPA code	30
Ballindooley Lough	No EPA code	30

All equipment and Personal Protective Equipment (PPE) used was disinfected with Virkon® prior to and post-survey completion, and best practice precautions were employed to prevent the potential spread of invasive species and water-borne pathogens, according to standard Inland Fisheries Ireland (IFI) biosecurity protocols (available at http://www.fisheriesireland.ie/fisheries-research-1/73-biosecurity-protocol-for-field-survey-work-1).

Electro-fishing Survey

An electro-fishing survey of the existing fish stocks within each watercourse was undertaken between the 22 of September and 30 September 2015 under licence from IFI. The surveys were undertaken along sections of watercourses crossed by the proposed road development or, where the channel was seasonal or inaccessible, at the closest location downstream. The survey sections were 50m lengths and sealed off with stop nets, effectively acting as fish barriers for the depletion survey.

The lower conductivity waters to the west of the River Corrib (i.e. Liberty, Trusky & Bearna Streams) were fished between 250-300 volts for salmonids and at 100 volts for lamprey. In the more alkaline watercourses to the east of the River Corrib electro-fishing was conducted at 225 volts for salmonids and at 100 volts for lamprey. Where no suitable upstream habitat was available, as was the case at two locations, the high conductivity transitional riverine reaches were surveyed using a lower voltage of 75-100 volts: adjoining estuaries in the lower Trusky Knocknacarragh Streams). Other settings – i.e. frequency, duty cycle etc. – are discussed in the detailed methodology text in **Appendix A.8.17**.

Depletion electro-fishing of each site was conducted by two operators in an upstream direction using a single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output). In order to minimise potential damage and undue stress to lamprey species and Atlantic salmon, electro-fishing settings were modified to target specific species at the site (see detailed methodology text in **Appendix A.8.17**). Larval lamprey species, for example, were specifically targeted in areas of low/reduced flow and with a higher proportion of soft sediment. However, this habitat was recorded as very localised or entirely absent in many watercourses with the exception of the Terryland River.

Typically, salmonids require a higher frequency (and also voltage) than lamprey species in order to sufficiently stun them for capture. Unless amended, these settings can result in the inadvertent electro-narcosis of buried ammocoetes, resulting in failure to emerge and recording of absence, as well as damage to the fish (Thompson *et al*. 2010). Therefore, soft sediment areas were identified and targeted first, following stop netting.

Multiple-pass depletion electro-fishing methodology was employed and followed those outlined by Carle & Strub (1978) and Lockwood & Schneider (2000). The

equations used to calculate the population estimates are provided in **Appendix A.8.17**.

Fyke Netting Survey

Boat based fyke netting surveys were undertaken at Ballindooley Lough and Coolagh Lakes. In advance of setting the nets a high resolution transducer was used to locate fish markings and establish a depth profile of the lake basins. This facilitated the positioning of the fyke nets near shelf drop offs and helped establish distributional patterns of fish. Five 1.5m diameter (D shaped) fyke nets, with multi panel mesh, were placed in the margins of the lakes in the littoral zones (windward bank) and in shallow bay areas overnight, and retrieved within 24 hours. The fish captured were measured by two personnel and length frequency graphs and species composition graphs were constructed. All fish were processed quickly and returned alive to the lakes.

Aquatic Macro-invertebrate Survey (Q-Sampling)

Macro-invertebrate samples were collected at the watercourses crossed by the proposed road development between the 22 and 30 September 2015, in advance of the fisheries surveys. Samples were collected at the nearest location containing riffle/glide habitat downstream of proposed crossings. The samples were collected by 'kick' sampling for approximately 2.5 minutes in the faster flowing areas (riffles) of the river using a standard hand net (250mm width, mesh size 500µm). The samples were taken moving across the riffle zone and sampling also involved washing large rocks from the riffle zone, to ensure a full representation of the species composition. Collected samples were elutriated, and fixed in 70% ethanol prior to identification.

The macro-invertebrates were later identified using a Nikon SMZ 1000 stereo microscope and Freshwater Biological Association invertebrate keys. Invertebrate taxa were identified to species level where possible and grouped based on the EPA categories from pollution intolerant to very pollution tolerant on a scale from A to E (see Appendix I of Toner *et al*., 2005).

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A.8.1 Part 2 Ecology Field Survey Methodologies 2019

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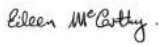
		Signature	Andrew Speer		
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1. Introduction

This Appendix has been prepared to document the methodology of the ecological habitat surveys undertaken between June and August 2019 as part of the 2019 RFI Response.Items 3a and 3b of the RFI required the provision of additional vegetation samples to support and aid the verification of the baseline habitat classifications andmapping presented in the 2018 EIAR and 2018 NIS.

Item 3a of the RFI states:

Provide details of vegetation samples (Relevé data) in each location where the development boundary overlaps with the Lough Corrib cSAC (as shown on Plates 2.3 to 2.6 of the NIS) with up to five samples for each habitat type at eachlocation where space permits. Grid reference and photographs are to be provided for each.

Item 3b of the RFI states:

Provide additional vegetation samples (Relevé data) to support the habitat mapping in other areas within the development boundary, with sufficient samples per habitat type, for empirical verification of the habitat mapping. Gridreference and photographs are to be provided for each.

2. Methodology

The 2019 habitat surveys broadly followed the methodologies set out in the 2018 EIAR and 2018 NIS but **were focused on habitat areas within the proposed development boundary for the proposed N6 GCRR only** and adapted to respond specifically to request for further information from An Bord Pleanála.

2.1 Item 3a – habitat areas within Lough CorribcSAC

Additional relevés[1] were recorded in all habitat areas where the proposed development boundary overlaps with Lough Corrib cSAC, with up to five samples for each habitat type taken at each location where space permitted. Grid reference and photographs were recorded for each relevé and are included in digital format in Annex 1 of the Appendix A.8.19 of the updated EIAR.

Where the area of the overlap was too small to fulfil the area requirement for takinga relevé for that habitat type, a relevé was taken from outside of the overlap to include the actual overlap area and be within the same habitat type where possible,whilst also taking due cognisance of the potential for edge habitats.

[1] Relevés are small vegetation sampling plots used to record the plant species present and their relative abundance within the sampling plot, as a representative sample of a larger habitat area. Relevés are generally a standard size for a given habitat type, but this is also dependant on the subsequent use or analysis required of the data being collected. For example, a sampling plot of 2mx 2m is standard for most habitat types for habitat classification or long-term vegetation monitoring,with larger 10m x 10m (or sometimes 20m x 20m) plots used for woodland classification or monitoring.

2.2 Item 3b – all other habitat areas within the proposed development boundary

This element of the habitat survey involved a walkover of the area within the proposed development boundary and outside of Lough Corrib SAC, to verify and photograph habitats[2], with relevés taken as outlined below. Visual checks were undertaken of habitats to verify any changes to habitat classifications and a photo record was taken as a reference dataset to support the habitat classifications.

In addition to the visual checks, relevé samples were taken from a representative number of habitat areas for each habitat type as outlined in Table 1 below. The percentage of polygon to be sampled for each habitat type varied depending on thefollowing factors:

- The ecological value of the habitat type
- The number of habitat areas which exist whereby sufficient and representative relevé sampling was undertaken for habitats with a proportionally larger number of habitat areas (e.g. dry calcareous and neutral grassland GS1 habitat areas)
- It was considered adequate for habitats of a very low ecological value to carry out a lower sampling percentage (e.g. approx. 18% of amenity grassland GA2 habitat areas were sampled)
- The potential for variation within a habitat type whereby habitats with a potentially higher degree of variation within a given habitat area were sampled at a higher percentage to ensure the variation is captured (e.g. there can be large variation in vegetation composition within grassland habitats and therefore a higher percentage of sampling may be warranted)
- The ecological value and potential for habitat areas to correspond to Annex I habitat types whereby certain habitats with a higher ecological value and a potentially high affinity to Annex I habitat types were sampled at a relatively higher sampling percentage (e.g. dry calcareous and neutral grassland GS1)

Where habitat areas were sampled the number of relevés recorded within each habitat area was decided in the field by the surveyor in consideration of:

- the size of the habitat area (in some areas it was not possible to fit in more thana single relevé)
- the degree of variation within the habitat polygon (i.e. more relevés were recorded where there was a higher degree of variation within a given habitat area)
- the complexity and ecological value of the habitat type. Habitats of a high ecological value and with a higher affinity to Annex I habitat types may require more than a single relevé in order to verify and support the habitat classification

New relevés were not taken in habitat areas where a relevé had been recorded previously (between 2014 and 2018), and the existing habitat information from that relevé accurately represented the habitat area, and the habitat classification had not changed in the interim.

Table 1 Relevé samples taken from a representative number of habitat areas

Habitat Type		Sample Size	
Fossitt Code	**Annex I Code**	**% of Habitat Areas**	**No. of Relevés**
BC4	N/A	66	2
ED2	N/A	Relevé taken where habitat has changed	
ED3	N/A	100	32
ER1	N/A	Not sampled (not suitable for relevés)	

[2] The habitat areas surveyed are those included in the GIS dataset N6GCRR_2019HabitatMap_Polygons.shp included in Annex 3 to the Appendix A.3.1 to the RFI Response.

Habitat Type		Sample Size	
ER2	*8240	100	6
FL5	N/A	Not sampled (not suitable for relevés)	
FL6	*3180	Not sampled – relevé recorded in 2014	
FL8	N/A	Not sampled (not suitable for relevés)	
FS1	N/A	Not sampled (could not be safely accessed)	
FW1	N/A	Not sampled (not suitable for relevés)	
FW2	N/A	Not sampled (not suitable for relevés)	
FW4	N/A	100	5
GA1	N/A	23	49
GA2	N/A	18	12
GM1	N/A	100	3
GS1	*6210/6210	97	121
GS2	N/A	41	18
GS3	N/A	86	18
GS4	6410	69	76
HD1	N/A	46	28
HH1	4030	96	41
HH3	4010	100	19
PB3	*7130	100	2
PF1	N/A	100	1
PF2	N/A	100	16
Residential	N/A	Not sampled (not suitable for relevés)	
WD1	N/A	70	19
WD2	N/A	Not sampled (not suitable for relevés)	
WD4	N/A	100	1
WD5	N/A	Not sampled (not suitable for relevés)	
WL1	N/A	Not sampled (not suitable for relevés)	
WL2	N/A	Not sampled (not suitable for relevés)	
WN2	*8240	85	34
WN6	*91E0	100	3
WS1	*8240	50	102

Habitat Type		Sample Size
WS3	N/A	Not sampled

Relevé Recording

Relevés were recorded on a handheld computer using a prepared form in TurbovegSD.The relevé size was 2m x 2m for all habitats except Limestone pavement and scrub habitats (which were sampled using a 5m x 5m relevé) and woodland habitats (which were sampled using a 10m x 10m relevé).

A photographic record of the relevé(s) and the associated habitat area was taken; with a minimum of one photo. The grid reference of each relevé was also recorded and used to plot the locations of each relevé in a GIS database. This data is included in Annex 1 to Appendix A.8.19 of the updated EIAR.

Plant Nomenclature and Habitat Classification

Plant nomenclature follows that of the National Vegetation Database[3]. The general habitat classifications are as set out in *A Guide to Habitats in Ireland*[4] and for AnnexI habitats, the *Interpretation manual of European Union Habitats EUR28*[5] was used with reference to the corresponding National and Regional habitat survey reports, as applicable:

- *Turloughs over 10 ha: vegetation survey and evaluation* (Goodwillie, R., 1992)
- *Turlough Hydrology, Ecology and Conservation* (Waldren, S. 2015, Ed.)
- *Summary of findings from the Survey of Potential Turloughs 2015* (O'Neill, F.H. & Martin, J.R., 2015)
- *The Irish semi-natural grasslands survey 2007-2012. Irish Wildlife Manuals*, No. 78 (O'Neill et al., 2013)
- *The monitoring and assessment of three EU Habitats Directive Annex I grassland habitats*. Irish Wildlife Manuals, No. 102 (Martin, J.R., O'Neill, F.H. & Daly, O.H., 2018)
- *Results of monitoring survey of old sessile oak woods and alluvial forests*. Irish Wildlife Manuals, No. 71 (O'Neill, F.H. & Barron, S.J., 2013)
- *National survey of limestone pavement and associated habitats in Ireland*. Irish Wildlife Manuals, No. 73 (Wilson, S. and Fernández, F., 2013)
- *Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland*. Version 2.0. Irish Wildlife Manuals, No.79 (Perrin et al., 2014)

[3] Weekes, L.C. & FitzPatrick, Ú. (2010) *The National Vegetation Database: Guidelines and Standards for the Collection and Storage of Vegetation Data in Ireland. Version 1.0.* Irish WildlifeManuals, No. 49. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.

[4] Fossitt, J.A. (2000) *A Guide to Habitats in Ireland*. Heritage Council, Kilkenny.

[5] CEC. (Commission of the European Communities) (2013) *Interpretation manual of European Union Habitats EUR28*. European Commission, DG Environment.

A.8.1 Part 3 Ecology Field Survey Methodologies 2022 to 2024

ARUP

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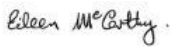
		Signature			
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Contents

1. Introduction

This Appendix presents the field survey methodologies for the following ecological surveys undertaken in 2022 to 2024 to validate the previous surveys undertaken for the Project and inform the updated EIAR and updated NIS:

- Habitats and Flora (including rare and protected flora species and invasive alien plant species)
- Terrestrial Mammals (excluding bats)
- Bats
- Birds (including general breeding and wintering birds, and specialist surveys of Barn Owl, Peregrin Falcon, Red Grouse, Woodcock, and Hen Harrier)
- Reptiles
- Amphibians
- Aquatic surveys (including fisheries assessment, eDNA analysis, biological water quality, lake macro-invertebrates, and aquatic vegetation)
- Invertebrates (White-clawed crayfish and Marsh fritillary butterfly)

2. Methodology

2.1 Habitats and Flora Surveys

2.1.1 Habitat Survey

A habitat survey was undertaken of all lands within the Assessment Boundary, plus a 100m buffer, during August to September 2023 by Dr John Conaghan, Eamonn Delaney (Delichon Ecology) and Scott Cawley Ltd. to verify that habitat baseline data collected to date between 2014 and 2019.

Indicator species and species abundances using percentage cover were recorded via target notes. Where any habitat was found to have changed between 2019 and 2023, habitat types were re-classified, using the *Guide to Habitats in Ireland*[1] for consistency with previous surveys. The location of target notes was determined by surveyors' professional judgement, with target notes acting as a representative sample of the habitat type. In some instances habitats comprise a broad continuum of vegetation types, and in these instances multiple target notes were recorded.

Where changes to habitats was noted since 2019, the habitat's revised extent was mapped onto an aerial photograph, with GPS points taken where a habitat's extent could not be clearly identified

[1] Fossitt, J.A. (2000) *A Guide to Habitats in Ireland*. Heritage Council, Kilkenny.

from the aerial photograph. Vascular plant nomenclature follows that of the New Flora of the British Isles Fourth Edition (Stace 2019).

Any newly identified Annex I habitat types were classified after the *Interpretation manual of European Union Habitats EUR28* (CEC 2013) with reference to the corresponding national habitat survey reports and NPWS wildlife manuals, as applicable. The nomenclature for Annex I habitats follows that of the *Interpretation manual of European Union Habitats EUR28* with abbreviated names after those used in The Status of EU Protected Habitats and Species in Ireland (NPWS, 2019a, 2019b and 2019c).

It is important to note that Annex I grassland habitats were defined with reference to both the *Interpretation Manual of European Union Habitats EUR28* and the *Irish Semi-Natural Grassland Survey 2007-2012*. Appendix 1 of the *Irish Semi-Natural Grassland Survey 2007-2012* contains the assessment criteria for the five Annex I grasslands surveyed during the Irish Semi- Natural Grassland Survey (ISGS). The assessment criteria listed in Appendix 1 was used to assess the structure and functions of the Calcareous grassland [*6210] habitats and *Molinia* meadows [*6410]. In addition to this, they were also used as a guide, where it was immediately clear when considering if a grassland community represented the Annex I habitats. In the scenario that a grassland community broadly corresponded to these criteria but did not match them exactly, as grassland habitats generally exist on a gradient between clearly not Annex I and definitely Annex I, the expert judgement of a suitably qualified and experienced botanist was applied, with reference to the *Interpretation Manual of European Union Habitats EUR28* and the *Irish Semi- Natural Grassland Survey 2007-2012*, to make the decision as to whether the grassland community corresponded to the Annex I habitat as defined by the assessment criteria, but with unfavourable structure and functions or if the grassland community was non-Annex or corresponded to another Annex I habitat.

The wooded variant of the priority Annex I habitat Limestone pavement [*8240] was recorded in some woodland areas. It should be noted that there are no guidelines or definitions for how Annex I habitat Limestone pavement [*8240] should be distinguished from non-Annex woodland with some limestone boulders or rocks in it. For the purposes of the Project best expert judgement was used, applying a very broad and precautionary definition of what may be classified as wooded limestone pavement [*8240] Annex I habitat type. Criteria were developed by BEC Consultants based on available definitions and published literature, and that were judged to be appropriate and applicable in the field, based on the unique Irish context of woodland limestone pavement.

For the purposes of the Project, wooded limestone pavement [*8240] were those areas having a closed canopy of trees at least 3m tall with at least 50% of the surface (at polygon scale) comprising bedrock at the surface (the bedrock was normally covered by mosses) and retaining some evidence of limestone pavement structure; that is, evidence of clints, grikes or other features confirming that the rock was more likely to be pavement structure instead of random boulders or collections of rock. Also, in the wooded limestone [*8240] pavement habitats encountered, soil was generally present but was thin (< 2cm), though could be deeper in places, for example, in old grykes, due to a build-up of humus. Rocks were sometimes completely covered by bryophytes such as *Eurhynchium striatum*, *Neckera crispa* and *Thamnobryum alopecurum*, but soil was typically lacking underneath the moss growth. These areas often occurred in mosaic with non-Annex I WN2 woodland, and differed from these woodlands by virtue of soil depth, as well as areas of exposed limestone pavement and boulders.

In cases where it was difficult to differentiate between wooded limestone pavement [*8240] and non-Annex woodland — for example, areas with a high proportion of scattered boulder and rock and collapsed stone walls, which added to rock cover but with deeper soils or lacking evidence of pavement structure — expert surveyor judgement was applied using all of the agreed criteria.

This determined whether a polygon would be mapped as either [*8240], or in the case where small elements of the polygon included [*8240], mapped as a mosaic of [*8240] along with the other relevant habitat types present within the mosaic.

Finally, it should be noted that a conservative approach was followed and many of the polygons classified as [*8240] wooded limestone pavement were very marginal and were on the cusp of what may or may not be considered [*8240.] It should also be noted that the majority of the polygons mapped as wooded limestone pavement [*8240] received the lowest Annex quality rating as they are considered to be poor examples of limestone pavement.

The survey dates are provided in Table 8.2 of the updated EIAR. The Ecological Habitat survey locations are shown in Figure 8.1.1 and Figure 8.1.2.

2.1.2 Rare and Protected Flora Species

Records were kept of the locations of any other rare or protected plant encountered during the course of the habitat surveys, with a particular focus on *Flora (Protection) Order, 2022* plant species, where there were existing or historic records.

The survey dates are provided in Table 8.2 of the updated EIAR. The Rare and Protected Species locations are shown in Figure 8.2.1

2.1.3 Lackagh Quarry petrifying spring survey

Dr Joanne Denyer was commissioned by Scott Cawley Ltd. in 2023 to undertake a survey and assessment of calcareous seepages at Lackagh Quarry, Co. Galway. A survey was undertaken by Dr Rory Hodd in 2018 to inform the 2018 EIAR (See Appendix A.8.21).

The aim of the 2023 survey was to map all calcareous seepages within the quarry, assess if they correspond to the Annex I priority habitat Petrifying springs [*7220] and note any changes from the baseline survey.

The site was walked over in early July 2023 by Dr Joanne Denyer. Each calcareous seepage area recorded in the 2018 baseline was relocated and assessed. Additional seepages were also recorded.

For each seepage the presence of tufa, positive indicator species for Petrifying springs [*7220] (Denyer, Eakin, & Gill, 2023; Lyons & Kelly, 2016) and water flow were recorded. Where a seepage corresponded to the Annex I priority habitat Petrifying springs [*7220], a detailed monitoring plot was undertaken following the methodology of Denyer, Eakin & Gill (2023) and Lyons & Kelly (2016). Note that not all seepages were accessible in full due to the steep quarry face and loose rock present.

Vascular plant nomenclature follows that of the *New Flora of the British Isles* (Stace, 2019). The bryophyte nomenclature adopted by Blockeel *et al*. (2021) was used.

The survey dates are provided in Table 8.2 of the updated EIAR. Petrifying springs [*7220] locations are shown in Figure 8.22.8.

2.1.4 Non-native invasive plant species

Records were kept of the locations of any non-native invasive plant species encountered during the course of the habitat surveys, with a particular focus on non-native invasive species listed on the Third Schedule of the *European Communities (Birds and Natural Habitats) Regulations 2011* (as amended), where there were existing or historic records.

The survey dates are provided in Table 8.2 of the updated EIAR. The survey area locations are shown in Figure 8.1.1 and Figure 8.1.2.

2.1.5 Habitat Survey Limitations and Divergence from Standards

A proportion of the survey area for habitats was inaccessible due to access being denied to surveyors by landowner/interested parties. Where lands could not be accessed, verification of habitat type was conducted from the closest accessible land parcel with the aid of binoculars. Where inaccessible land parcels remained outside of the field of vision of surveyors from adjacent land parcels, the classification from the period 2014 – 2019 was accepted as current. This does not impose limitations on the ability to complete a robust assessment, as in the absence of interventions such as land clearance (which is generally easily identified even from outside of a land parcel), habitat succession tends to be gradual.

2.2 Fauna Surveys

2.2.1 Terrestrial Mammals (excluding bats)

A terrestrial fauna survey (excluding bats) was undertaken in October 2023 and November 2023 by Scott Cawley Ltd.

The Study Area covered the lands within a 150m buffer of the Assessment Boundary along the entirety of the Project.

The presence/absence of terrestrial fauna species were surveyed through the detection of field signs such as tracks, markings, feeding signs, and droppings, as well as by direct observation.

The habitats on site were assessed for signs of usage by protected/red-listed fauna species, and their potential to support these species. Surveys to check for the presence of badger setts and otter holts within the Study Area, and to record any evidence of use, were also undertaken. Previously recorded mammal breeding and resting places recorded during the 2015 surveys were re-visited and data were updated accordingly.

Additionally, the presence of otter (*Lutra lutra*) was determined during the aquatic surveys, through the recording of otter signs within 150m upstream and downstream of each sampling point. Notes on the age and location of signs (ITM coordinates) were made, in addition to the quantity and visible constituents of spraint (i.e. remains of fish, crustaceans, molluscs etc.).

The status and activity of any Badger setts was recorded along with any evidence of activity, including paths, tracks, feeding signs, and latrines. As were any Otter holts, couches, slides, tracks, and feeding signs.

No species-specific surveys were undertaken for other protected mammal species for which field signs are less frequent and/or reliable than other larger mammals, such as Pine marten, Irish stoat and Irish hare. Nevertheless, during all surveys attention was paid to search for activity signs such as searching soft muds for tracks, and to look for droppings. Potential presence of these species in suitable habitat was recorded based on the habitat preferences described in Hayden & Harrington (2000).

Survey dates are provided in Table 8.2 of the updated EIAR. Survey areas are shown in Figures 8.4.1 – 8.4.15

2.2.1.1 Survey Limitations and Divergence from Standards – Mammals

There were several limitations to this survey. Heavy rain occurred on several of the survey days. Adverse weather conditions can affect mammal surveys where signs such as tracks, scat and trails are useful indicators of present species. Tracks and prints can be washed away in the rain

and deep puddles, and flooded areas made finding tracks difficult in areas. Scat can be degraded by heavy rain making identification difficult. Notwithstanding this, given the extensive data collected for the Project between 2014 and 2018, and since landscape change was relatively limited across the Study Area, adverse weather conditions did not impose any significant limitations on the ability to assess impacts or mitigate for mammals.

Small discreet individual land parcels across the Study Area were not accessed due to limitations with landowner permission. Where possible these land parcels were viewed from adjacent land holdings and from public roadways. Overall this is not considered a significant limitation given the small discreet areas involved across the extent of the Project.

2.2.2 Bats

The following section describe the methodologies employed for bat surveys undertaken in 2023.

The survey conducted in 2023 was a focussed area within the 2014 – 2018 survey area, in that roosts located within the Assessment Boundary for the Project and its immediate vicinity were resurveyed..

The 2023 bat activity data does not supersede the 2018 data but adds to it, in its function to verify the baseline predictions that underpin the impact assessment. The following appendices include stand-alone technical reports for discrete elements of surveys (e.g. radio-tracking studies):

- Appendix 8.7 Galway Bat Radio-tracking Project - Bat Radio-tracking surveys. Radio-tracking studies of Lesser horseshoe and vesper bat species, August and September 2014 (Rush & Billington, 2014)
- Appendix 8.8: Galway City Transport Project - Bat Acoustic Surveys: Summer-Autumn 2014 (Geckoella Ltd., 2015a)
- Appendix 8.9: N6 Galway City Transport Project - Bat Radio-tracking and Roost Surveys 19 to 29 August 2014 (Geckoella Ltd., 2015b)
- Appendix 8.10: Galway bat radio-tracking project. Radio tracking studies of Lesser horseshoe bat species, May 2015 (Rush & Billington, 2015)

A summary of all field surveys undertaken in 2023, is provided below.

The methodologies employed are based on the approaches documented in *Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edition)* (Collins, 2016). The methodologies documented in the guidelines are evidence based and are complementary to the *Bat Mitigation Guidelines for Ireland – V2* (Marnell, *et al*., 2022). The methodologies employed for surveys in 2023 are generally a continuation of the methodologies employed for the collection of the baseline for the Assessment Boundary between 2014 and 2017. Where divergences have occurred, these divergences are noted and explained in the subsections below.

Three survey methodologies have not been repeated in 2023, based on the professional judgement of the authors of this report and on consultation with the NPWS on 3 March 2023.:

- Vehicle transect surveys conducted to inform the baseline in 2014 were not repeated in 2023. The walked transects along the Project in 2023, supported by automated detector deployments, provides a more robust survey methodology to inform the bat derogation licence application and the updated EIAR.

- The crossing point element of the automated/static bat detector surveys undertaken in 2015, did not greatly influence or support the final design of the bat mitigation strategy and therefore has not been repeated.
- Radiotracking surveys conducted in 2014 and 2015 have not been repeated in 2023 given the comprehensive data already collected between 2014 and 2018 and concerns on the part of the NPWS relating to the potential impacts of the surveys on bats relative to the unlikely change in data. It was agreed that the completion of a revised marking study of the local lesser horseshoe bat population in combination with the completion of a landscape-scale assessment of changes to bat foraging and commuting habitats could be used to infer whether lesser horseshoe bat landscape use has changed since 2014 and 2015.

2.2.2.1 Survey Dates and NPWS Licences

A summary of all field surveys undertaken in 2023 is provided in Table 1 below. Bat surveys were conducted across a single calendar year, 2023, covering the seasons winter, spring, summer and autumn. Where different surveys relating to a particular ecological receptor (e.g. habitats) were undertaken over several survey seasons or covered different geographic locations along the route of the Project, the surveys are described/presented in chronological order.

Table 1: Bat Surveys and Survey Data in 2023

Survey	Survey Date(s)	Surveyor(s)
Bat Surveys		
Marking surveys of lesser horseshoe bats	May and August 2023	Greena Ecological Consultancy – fitting rings on lesser horseshoe bats under licence from the NPWS Scott Cawley Ltd. - follow-up inspections of known and potential lesser horseshoe bat roosts to identify and count bats with and without rings
Winter hibernation and roost inspection surveys	February to March 2023	Scott Cawley Ltd.
Building / tree roost inspection surveys	May to September 2023	Scott Cawley Ltd.
Ground-level tree assessment and inspection of tree PRFs	April 2023 and August 2023	Scott Cawley Ltd.
External/Internal Building inspections	May to September 2023	Scott Cawley Ltd. Ove Arup & Partners Ltd. Caroline Shiel Consulting Ecologist Barbara McInerney Consulting Ecologist
Roost Counts at Menlo Castle	May to September 2023	Scott Cawley Ltd.
Roost presence/likely absence surveys	May to September 2023	Scott Cawley Ltd. Ove Arup & Partners Ltd. Caroline Shiel Consulting Ecologist Barbara McInerney Consulting Ecologist
Bat Activity Surveys		
Walked transect activity surveys	April to September 2023	Scott Cawley Ltd.
Automated/static bat detector surveys	April to September 2023	Scott Cawley Ltd.

The bat surveys were carried out under licence DER/BAT 2023-02[2] and 21/2023[3], issued by the NPWS[4].

[2] Granted under Regulation 54 of the European Communities (Birds and Natural Habitats) Regulations 2011

[3] Granted under Section 9 and 23 (6) (b) of the Wildlife Active 1976 to 2018

[4] The individual licences that applied to individual survey elements are listed under the relevant survey sections.

2.2.2.2 Building surveys

2.2.2.2.1 Roost Inspection Surveys

The scope of building/structure inspection surveys extended to all buildings located within or immediately adjacent to the Assessment Boundary. Buildings within the Assessment Boundary are likely to be relevant to the bat derogation licence application to facilitate the construction of the Project, whilst any roosts that occur in buildings in the immediate vicinity could theoretically be impacted by the Project.

One-hundred and sixty-five buildings were identified within this zone of influence, with building/structure inspection completed on 129 of the 165 buildings in 2023. A further six buildings were inspected internally or externally in 2023. Access was denied for building/structure inspection by the occupants of 30 of the 165 buildings in 2023. As such, 135 of 165 were subject to surveys in 2023.

Buildings/structure inspections in 2023 were completed by qualified and experienced ecologists from Scott Cawley Ltd., Arup, and independent ecologists Barbara McInerney and Caroline Shiel. All surveyors conducting roost inspection surveys are licensed by the NPWS to do so. In this instance, surveys were completed under licences DER/BAT 2023-02[5] and 21/2023[6].

The full list of buildings identified for survey, and those buildings which were appraised and/or inspected for roosting bats in 2023 are illustrated on Figure 18.27.1.

The daytime building/structure appraisal and inspection involved a full examination (where accessible) of the internal and external areas of the structures to identify actual or potential bat roosts and access points and to locate any evidence of bats, as per the methodology followed in the 2014 – 2018 surveys (refer to Appendix A.8.1 Part 1).

Where safely accessible voids, crevices or cracks in the buildings were examined using torches or endoscopes. Any bat droppings that were found were placed in 1.5ml eppendorf tubes with silica and sent for genetic analysis to identify the bat species. Of the 135 buildings surveyed in 2023, access was granted and/or possible to the internal parts of 78 of those buildings.

Following completion of building/structure inspections in 2023, the 135 buildings surveyed were assigned to suitability categories ranging between 'Negligible' and 'High' as per the categories documented in Table 4.1 of *Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd Edition)* (Collins, 2016).

In those cases where access was denied in 2023, the previous confirmed roost status determined from buildings inspections and emergence/re-entry surveys conducted between 2014 – 2018 has been retained (refer to Appendix A.8.1 Part 1), taking a conservative approach.

The suitability of a building for roosting bats took account of the presence of potential roost features (PRFs), and surrounding landscape characteristics (e.g. whether the building was located adjacent to/connected to areas suitable for foraging bats).

2.2.2.2.2 Dusk emergence surveys

Dusk emergence surveys were undertaken to establish if roosting bats are present or likely to be absent from buildings within the Assessment Boundary and its immediate vicinity and, if roosting bats are present, to characterise the roost type and importance. Bat activity was

[5] Granted under Regulation 54 of the European Communities (Birds and Natural Habitats) Regulations 2011

[6] Granted under Section 9 and 23 (6) (b) of the Wildlife Active 1976 to 2018

recorded using Elekon BatLogger M2 devices which record full spectrum bat echolocation calls (as .wav files).

Surveys commenced at 15 minutes before sunset and continued for up to two hours. The number of dusk emergence surveys was dependant on several factors, but principally the suitability category assigned to the building on foot of completion of building/structure inspections as documented above.

Emergence surveys were conducted at 100 of the 165 no. buildings across the Study Area by ecologists from Scott Cawley Ltd., Arup and Independent Ecologists Caroline Shiel and Barbara McInerney.

Access for surveys was denied by the owners of 30 buildings, and surveys could not be conducted from outside the site boundary of these properties.

Thirty-two buildings that were subject to initial building/structure inspection survey were determined by surveyors, using their professional judgement, to be:

- Of negligible suitability for roosting bats and therefore no further survey is required (24 buildings)
- Of such low suitability for roosting bats that bats are very unlikely to use the buildings as a roost, and therefore no further surveys are required (eight buildings)

For the three remaining buildings, surveys were not completed in 2023 for other reasons; however, as noted above, taking a conservative approach, the roost status from the previous surveys was taken for these roosts.

Dusk emergence surveys were undertaken during the appropriate time of year to detect maternity and day roosts (e.g. between May and September, inclusive).

Weather conditions were considered as part of survey design, however the location of the Project on the Atlantic seaboard means that weather conditions are more changeable than in the eastern part of the country. In general surveys proceeded during periods of light to moderate rainfall.

The locations of buildings surveyed for dusk emergence survey in 2023 are illustrated in Figure 8.27.1.

2.2.2.3 Surveys of bats using Eborhall House and Ballymaglancy Cave, Cong SAC

Eborhall House and Ballymaglancy Cave, located to the north of Lough Corrib, are both important roost sites for breeding and hibernating Lesser horseshoe bats respectively. Eborhall House is the "qualifying" roost for the Lough Corrib SAC whilst the nearby Ballymaglancy Cave is a SAC in its own right (No. 000474) and is thought to provide hibernation roosts for the bats from Eborhall House.

As part of the assessment of the potential movement of this bat species across the landscape, it was deemed important to determine if any of the ringed bats[7] that were roosting near the Study Area were also using these "qualifying" roosts, even though they are located a considerable distance to the north (more than 30km).

[7] See Section 3 of Appendix C of the Bat Derogation Licence Application 2025 which is in Appendix A.8.25 Part 2 of the updated EIAR.

Surveys were undertaken at Eborhall House and Ballymaglancy Cave to determine the presence of Lesser horseshoe bats that were ringed at roosts within the Study Area were undertaken under licence DER/BAT 2023-02[8] and 21/2023[9].

Eborhall House (4 Summer inspections, 2 Winter Inspections) was surveyed on 7 July 2023, 27 July 2023, 10 August 2023, 7 September 2023, 14 November 2023, and 13 December 2023, as part of the known summer/winter roosts located north of Loch Corrib. Other known roosts associated with Eborhall House were inspected, on the same dates. These are Ballymaglancy Cave (Summer/Winter), Kelly's Cave (Winter), Bunnadober Mill (Summer, Maternity Roost).

Surveys were undertaken by Scott Cawley Ltd. Ecologists Daniel Connell MCIEEM, Síofra Quigley MCIEEM, Kristie Watkin Bourne and Cathal O'Brien six times (four Summer inspections, two Winter inspections). Daytime visual surveys were undertaken to count and identify any marked bats. No ringed bats from the Scheme Study Area were recorded during these visits.

2.2.2.4 Surveys of bats using Ross Castle Lake and Woods SAC and Cloonnabinnia Cave

Surveys were undertaken at Ross Castle to determine the presence of Lesser horseshoe bats that were ringed at roosts within the Study Area were undertaken under licence DER/BAT 2023-02[10] and 21/2023[11].

Ross Castle (4 Summer inspections, 2 Winter Inspections) was surveyed on 6 July 2023, 26 July 2023, 10 August 2023, 6 September 2023, 13 November 2023, and 12 December 2023.

As part of the Ross Castle inspections, known summer/winter roosts located south/east of Loch Corrib and associated with Ross Castle were inspected, on the same dates. These are Cloonnabinnia Cave (Summer/Winter). Cloonnabinnia Hotel is a known Lesser Horseshoe roost; however, the building is in a derelict state, unsafe to enter, and permission to access the grounds was denied by the owners.

The surveys were undertaken by Scott Cawley Ltd. Ecologists Daniel Connell MCIEEM, Síofra Quigley MCIEEM, Kristie Watkin Bourne and Cathal O'Brien 6 times (4 Summer inspections, 2 Winter inspections). Daytime visual surveys were undertaken to count and identify any marked bats. No ringed bats from the Study Area were recorded during these visits.

2.2.2.5 Tree Surveys

An initial desktop review was conducted to identify and target trees for further assessment. The desktop review included appraisal of trees identified as *potential bat roosts* over the period 2014 – 2018, combined with a review of orthophotography on Google Street maps and Google Street View. Twenty-three tree groups were identified across the Scheme Study Area for ground-level tree appraisal.

Ground-level tree appraisal surveys were conducted Scott Cawley Ltd. ecologists between 11 and 14 April 2023 and on 29 August 2023.

[8] Granted under Regulation 54 of the European Communities (Birds and Natural Habitats) Regulations 2011

[9] Granted under Section 9 and 23 (6) (b) of the Wildlife Active 1976 to 2018

[10] Granted under Regulation 54 of the European Communities (Birds and Natural Habitats) Regulations 2011

[11] Granted under Section 9 and 23 (6) (b) of the Wildlife Active 1976 to 2018

Additionally, a single tree with a potential roost feature was inspected by Síofra Quigley MCIEEM of Scott Cawley Ltd. on 22 February 2023 concurrent with completion of winter hibernation surveys.

The ground-level tree appraisal consisted of identification and recording of features which could potentially be used by roosting bats (potential roost features or PRFs).

In trees PRFs typically arise from disease, decay or other physical damage to a tree, or arise from the natural growth form of the tree (association PRFs).

PRFs have been categorised and described as per Bat Roosts in Trees: A Guide to Identification and Assessment for Tree-Care and Ecology Professionals.

Where safely accessible from ground level, PRFs were inspected using a torch and mirror / a handheld endoscope device (RIGID CA 350x or similar). Any signs of roosting bats were recorded. Surveyors are licenced to enter and survey bat roosts and are trained and experienced in the inspection of trees for roosting bats.

Tree Survey dates are detailed in Table 1. See Figures 8.25.1 to 8.25.15 for survey locations.

2.2.2.6 Walked transect surveys

The approach to walked transect surveys is based on the methodologies contained in *Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd Edition)* (Collins, 2016).

It diverges from the guidelines with respect to survey effort in that each transect has been completed three times (once per season) across the period of peak bat activity, rather than once/ twice per month as advocated by Collins (2016) for moderate or high suitability landscapes for foraging and commuting bats. The landscape in Galway ranged between low to high suitability for foraging and roosting bats, depending on location.

Bats are strongly associated with woodland and riparian habitats in Ireland (Roche *et al*., 2014). It is Scott Cawley's professional opinion that this reduced survey effort does not impose any limitations on the ability to complete an impact assessment of the Project for the following reasons:

- Walked transect surveys are complemented by the deployment of a suite of automated detectors across the Assessment Boundary. These automated detectors record bat data over a period of a number of days, and therefore offer a longer-term view of bat activity which cannot be captured from walked transects, which represent a shorter snapshot in time.
- While additional walked transect surveys would generate additional data, the additional effort expended is not likely to be commensurate to the value of the data generated, e.g. any additional data generated is not likely to provide any additional insights into how bats are using the landscape.

The Project was divided into 15 distinct areas for the completion of 15 no. separate walked transect routes. Walked transect surveys took place across three separate survey seasons between April and September 2023. Inclusive:

- Spring/early-season surveys were conducted between April and May 2023
- Summer/mid-season surveys were conducted between June and July 2023
- Autumn/late-season surveys were conducted between August and September 2023

Prior to the detector survey commencing, the transect routes were walked during the day to plot a route and identify any health and safety issues. Surveying commenced 30 minutes after sunset.

Transects were walked at a constant speed and bat activity was recorded using BatLogger M devices which record full spectrum bat echolocation calls (as .wav files) and the GPS location of the recording. Detectors were set to record continuously, and each transect was walked once per survey. The starting point/direction of each transect was varied across the seasons to capture variability in bat activity at different periods after dusk. Qualitative observations of bat activity were also recorded, as appropriate — i.e. number of bats, flight direction, flight height, behaviour (e.g. commuting or foraging) where this was detectable.

Bat calls were analysed using Elekon BatExplorer software (Version 2.2.6), with data review, validation and verification conducted by Jared Bennett, Shane Brien, and Colm Clarke MCIEEM of Scott Cawley Ltd.. Recordings were initially assigned to a suggested species using the software's in-built auto-identification function[12].

Calls of all bat species were verified using the professional judgement of the reviewer, with reference to published literature on bat call identification including *Bat Calls of Britain and Europe: A Guide to Species Identification* (Russ, 2021) and *Social Calls of the Bats of Britain and Ireland* (Middleton *et al*., 2022). Where the auto-identification system correctly identified a recording to the relevant species/category, the call was marked as 'verified' by the reviewer. Calls that were misidentified by the auto-identification system were re-classified/reassigned to another relevant category/species by the reviewer.

The 2023 walked transect extents are illustrated on Figures 8.6.1 and 8.6.2 and survey dates are included in Table 1.

2.2.2.7 Automated detector activity surveys

Automated/static bat detectors Wildlife Acoustics Song Meter Mini Bat Ultrasonic Recorders were deployed three times across the Project between April and August 2023, with the purpose of sampling bat data early in the season, mid-season and late season.

- The following detectors malfunctioned and were redeployed: L19 (Autumn) L23 (spring)
- The following detectors malfunctioned and were not redeployed: L18 (spring) L44 (Summer)

It should be noted that these malfunctions do not pose any limitations on the overall dataset collated for the project and/or the ability to complete the impact assessment, as for each location (as for all 50 locations across the survey area) automated detectors were deployed a further two times within the same survey year, at the same position. Additionally, walked transects for bat activity were conducted both through and throughout these particular areas during spring, summer, and autumn periods, co-ordinated with the time of the automated detector deployments. Combined with the historical data obtained, this approach ensured that a comprehensive and representative dataset was obtained for subsequent analysis.

Fifty locations for automated detector deployment were selected across the Project to cover a range of habitat types likely to be of importance to bats and pick up variability in bat activity over time. The locations of automated detectors were selected to complement the walked transects described above.

[12] The BatExplorer calculates species suggestions according to the selected species library (UK Bats EN – Elekon) and the averaged call parameters of a recording. These species suggestions are assigned a plausibility (%) and a ranking, with the highest ranked species suggestion assigned by the software to the recording

Each automated detector was deployed for a minimum of five consecutive nights and set to record from 30 minutes before sunset to 30 minutes after sunrise. All automated/static bat detectors were deployed with the same settings, namely:

- Date, time and GPS Location were set for each deployment to facilitate solar calculation of sunrise and sunset by the device
- Gain = 12 dB
- Sample rate = 256 kHz
- Minimum duration = 1.5 ms
- Maximum duration = none
- Minimum trigger frequency = 15 kHz
- Trigger level = 12 dB
- Recording mode = WAV

The locations automated/static bat detectors were deployed in 2023 are illustrated on Figure 8.36.1 and deployment dates for each location are provided in Appendix A.8.25.

Bat calls were analysed using Elekon BatExplorer software (Version 2.2.6), with data review, validation and verification conducted by Jared Bennett, Shane Brien ACIEEM, and Colm Clarke MCIEEM of Scott Cawley Ltd.. All are trained and qualified ecologists with experience in bat data analysis.

Recordings were initially assigned to a suggested species using the software's in-built auto-identification function[13]. As the performance of auto-identification systems for bats is dependent on the training data used to train it, and as bat calls often vary by habitat, the performance of auto-identification systems can vary (Collins, 2023).

In particular auto-identification systems can return a high error rate for less common bat species. For this reason, it is necessary to validate and then verify bat calls that have been through auto-identification.

Post-classification validation comprised a review of a subset equating to a minimum of 10% of calls assigned to the following categories by BatExplorer:

- Noise
- Common pipistrelle bat *Pipistrellus pipistrellus*
- Soprano pipistrelle bat *P. pygmaeus*

Calls of all other species were verified by using the professional judgement of the reviewer, with reference to the literature on bat call identification including *Bat Calls of Britain and Europe: A Guide to Species Identification* (Russ & Bat Conservation Trust, 2012) and *Social Calls of the Bats of Britain and Ireland* (Middleton *et al*., 2022).

Where the auto-identification system correctly identified a recording to the relevant species/category, the call was marked as 'verified' by the reviewer. Calls that were misidentified

[13] The BatExplorer calculates species suggestions according to the selected species library (UK Bats EN – Elekon) and the averaged call parameters of a recording. These species suggestions are assigned a plausibility (%) and a ranking, with the highest ranked species suggestion assigned by the software to the recording

by the auto-identification system were re-classified/reassigned to another relevant category/species by the reviewer.

Following verification, an error rate of false positive classifications was calculated for Noise, Common pipistrelle bat and Soprano pipistrelle bat recordings using the following formula:

$$\frac{SUM\ (VERIFIED\ RECORDINGS)}{SUM\ (AUTO{-}CLASSIFIED\ RECORDINGS)} - 1$$

All calls assigned to bat species other than those listed above were manually reviewed and verified or reassigned by the reviewers.

The need for verification of all other species arises from the increased risk of classification errors for those species when relying upon auto-identification only (Collins, 2023). This is related to the relatively small number of calls generated from these species.

2.2.2.8 Marking studies

Lesser horseshoe bats roosting sites at Aughnacurra (PBR178), Coopers Cave (PBR112), and Menlo Castle (PBR06) were visited to capture bats by hand, using static hand net, mist net, cone trap and harp between 8 – 10 May 2023 and again on 22 August 2023 by Geoff Billington MCIEEM, Stephen Davison and Alison Johnston MCIEEM of Greena Ecology Ltd and Simon Brain of Amenity Tree Care Ltd. under licences from the NPWS. For full details, refer to Appendix A.8.25 Part 1 and Appendix A.8.25 Part 2.

Surveys were led and directed by Geoff Billington who has over 25 years of experience in bat survey including advanced licence bat survey techniques. A subset of Lesser horseshoe bats from these roosts was captured and marked with anodised aluminium rings stamped with a unique alphanumeric serial number.

The rings were fitted over the forearm of the bats by the surveyors, the sex of the bat was noted and bats were then released by hand. Fitting of rings was restricted to lesser horseshoe bats. Any other bat species that were captured accidentally were immediately released.

Following the fitting of rings to lesser horseshoe bats, roost inspection surveys were conducted under licence[14] [15] by Scott Cawley Ltd. six times (four Summer inspections, two Winter inspections) at the known lesser horseshoe roost sites listed in Table 2 below to count lesser horseshoe bats and to record any ringed individuals at these roosts, including the serial number on the ring (See Appendix C of the Bat Derogation Licence 2025 Application (which is in Appendix A.8.25 of the updated EIAR).

The use of these invasive survey techniques was undertaken to evidence, support and verify the hypothesis that the Lesser horseshoe bat population local to Menlo do not form part of nor support the qualifying interest lesser horseshoe bat populations of any nearby SAC sites, including the Lough Corrib SAC qualifying interest roost at Ebor Hall House.

This type of information gathering is not possible from alternative less-invasive observational/bat activity surveys (for Ringing locations in 2023, See Figure 8.26.1).

[14] European Communities (Birds and Natural Habitats) Regulations, 2011 (S.I. No 477 of 2011) Regulation 54 derogation licence reference DER/Bat 2023 – 02 for roost disturbance of all bat species and all roost types.

[15] Wildlife Acts 1976 to 2018 - Sections 9 and 23 (6) (b) reference 21/2023 to photograph / film wild animals (all bat species).

Table 2: Known Roosts of Lesser Horseshoe Bats in the Vicinity of the Proposed Project that were visited as prat of the Marking Surveys

Ref. No.	Roost Name	Note	SAC roost	Inspection 1	Inspection 2	Inspection 3	Inspection 4	Inspection 5	Inspection 6
N/A	Ross Castle	Summer Roost (NPWS)	Ross Lake and Woods SAC [001312]	6 July 2023	26 July 2023	10 August 2023	6 September 2023	13 November 2023	12 December 2023
N/A	Cloonabinnia Hotel	Derelict and unsafe – Access denied by new owner (NPWS)		N/A	N/A	N/A	N/A	N/A	N/A
PBR160	Cloonabinnia Cave	Winter Roost (NPWS)		6 July 2023	26 July 2023	10 August 2023	6 September 2023	13 November 2023	12 December 2023
N/A	Eborhall House	Summer Roost (NPWS)	Lough Corrib SAC [000297]	7 July 2023	27 July 2023	10 August 2023	7 September 2023	14 November 2023	13 December 2023
N/A	Ballymaglancy Cave	Winter Roost (NPWS)		7 July 2023	27 July 2023	10 August 2023	7 September 2023	14 November 2023	13 December 2023
N/A	Kelly's Cave	Winter Roost (OPW)		N/A	N/A	N/A	7 September 2023	14 November 2023	13 December 2023
N/A	Bunnadober Mill	Summer Roost (OPW/NPWS)		N/A	N/A	N/A	7 September 2023	14 November 2023	13 December 2023
PBR06	Menlo Castle	Summer Roost & Winter Roost (NPWS)	Roosts not within any European site, and populations not known to form part	9 March 2023	29 March 2023	13 June 2023	11 July 2023	15 August 2023	N/A
PBR50	Ballybrit Castle	Not a known LHB roost		23 February 2023	9 March 2023	N/A	N/A	N/A	N/A

Ref. No.	Roost Name	Note	SAC roost	Inspection 1	Inspection 2	Inspection 3	Inspection 4	Inspection 5	Inspection 6
PBR12	Cooper's Cave	Summer Roost & Winter Roost (NPWS)	of any SAC populations	22 February 2023	9 March 2023	14 June 2023	12 July 2023	16 August 2023	-
PBR136	Newry's Cave	Roost		22 February 2023	-	-	-	-	-
PBR114	Dangan Ice House, University of Galway Campus	Not a known LHB roost		22 February 2023	8 March 2023	-	-	-	-
PBR113	Souterrain in the townland of Lydican	Not a known LHB roost		23 February 2023	8 March 2023	-	-	-	-

2.2.2.9 Landscape change analysis – Lesser Horseshoe Bat

A landscape scale analysis has been undertaken, as requested by the NPWS at a consultation meeting on the 3 March 2023 to determine whether there have been any landscape scale changes since the original 2014 – 2018 bat surveys (refer to Appendix A.8.1) that might influence the movement, foraging behaviour or roosting behaviour of lesser horseshoe bats within the Study Area.

The analysis focused on identifying material changes to habitat extents and distribution to evaluate whether, as a result of any changes, bats are likely to be using the local landscape in a different way to that recorded and predicted as part of the baseline survey data collected between 2014 and 2018 and used to inform the impact assessment and development of the mitigation strategy and monitoring plan set out in the updated EIAR.

For the purposes of this assessment, a material change is one that will or has the potential to affect how bats move, forage and roost within the territory of the Lesser horseshoe bat population centred around the maternity roost at Menlo Castle. Examples of such changes might be the loss of linear habitat features such as stone walls, hedgerows or treelines, the loss of woodland habitat areas, habitat loss due to increased urbanisation, or land use zoning changes that might result in loss of 'green' space in the near future.

In 2018, the core area used by the Menlo Castle Lesser horseshoe bat population extended from the N59 Moycullen Road to the west to the N83 Tuam Road to the east, and from Menlough Village and the shores of Lough Corrib to the north to the Coolagh Lakes and Jordan's Island area to the south (see Figure 8.29.1 for the 2014 – 2018 Lesser horseshoe bat survey results).

The following datasets were reviewed to identify any material landscape scale habitat changes that have occurred since 2019 (i.e. until 2023, 2019 was the most recent date of habitat review and verification work undertaken in relation to the Project which included all lands within the Assessment Boundary):

- 2018 habitat map for the Project
- 2019 habitat map for the Project
- 2023 habitat map for the Project
- Google Earth orthophotography[16]
- Bing maps[17]
- Google maps[18]
- The National Landcover Map 2018[19]
- Galway City Development Plan 2017-2023 land use zoning map
- Galway City Development Plan 2023 – 2029 land use zoning map

[16] Image dates range from 20 June 2022 to 9 August 2023

[17] Image date 25 May 2023

[18] Image date 05 April 2017

[19] Developed using imagery from the OSi aerial photography campaign of 2018 formed the main data source alongside satellite imagery from the European Space Agency (ESA) Sentinel 2 programme and OSi's PRIME 2 vector spatial database

- Variation 2(a) to the Galway County Development Plan 2015 – 2021, Bearna Plan, Land Use Zoning Map for Bearna, July 2018
- Galway County Development Plan 2015 – 2021 land use zoning map
- Galway County Development Plan 2022 – 2028 land use zoning map
- Galway County Development Plan 2022 – 2028, Galway Metropolitan Area, Briarhill, Land Use Zoning Map

Ad-hoc observations on land use change recorded over the course of other ecological survey work carried out in 2023 were also factored into the analysis, where relevant.

Across the Study Area, but particularly within the core area used by the Menlo Castle Lesser horseshoe bat population, there are relatively few material changes to the habitat baseline information.

Most of the material changes recorded across the Study Area are associated with expanding residential, commercial or industrial development, with the remainder related to vegetation clearance and extensions to existing development such as car parks or graveyards. The subset of those areas that lie within the core area used by the Menlo Castle Lesser horseshoe bat population similarly comprise of small-scale development expansion and vegetation clearance.

The scale and extent of individual change areas are relatively small, they are widely dispersed within the core area used by the Menlo Castle Lesser horseshoe bat population, and few are within or immediately adjacent to the Project. There are also no significant changes to land use zonings in the core area used by the Menlo Castle Lesser horseshoe bat population from 2019 onwards. Therefore, landscape scale land use change is not predicted to have influenced how the Menlo Castle Lesser horseshoe bat population move, forage or roost within the Study Area.

Any changes to bat usage of the Study Area arising from the 2023 bat surveys are discussed in Appendix A.8.25 Part 2 of the updated EIAR.

2.2.2.10 Survey Limitations and Divergence from Standards – Bat Surveys

Access was denied for building/structure inspection and dusk emergence surveys by the occupants of 30 of the 165 buildings. To overcome this limitation, where access was denied in 2023, the previous confirmed roost status determined from buildings inspections and emergence/re-entry surveys conducted between 2014 – 2018 has been retained (refer to Appendix A.8.1 Part 1), taking a conservative approach.

With respect to assessment of trees for the identification of PRFs, As noted in *Bat mitigation guidelines for Ireland v2* (Marnell *et al.*, 2022), 'it is extremely difficult to survey trees and be certain that any bat roosts have been detected'. This has been accounted for in developing the mitigation strategy (as submitted to NPWS to inform the derogation licence for the Project, refer to Appendix A.8.25 of the updated EIAR) whereby all trees with potential to support roosting bats will be subject to pre-felling checks, including emergence, to ensure the protection of any bats that may be present at that time.

Divergences from survey standards for walked transect surveys for bats are discussed under the relevant heading above and are not repeated here. The level of surveying conducted allowed a detailed picture of the species assemblage present in the Study Area and informed the constraints studies, the design of the Project and the preparation of the updated EIAR.

Notwithstanding the inability to access certain lands and building in 2023, sufficient data was gathered to support the assessment of impacts on bats, in accordance with the relevant guidelines.

2.2.3 Breeding Birds

General breeding bird surveys were undertaken within a 50m buffer of the Assessment Boundary, between 25 – 28 April, 25 and 26 May, 30 May – 01 June and 27 – 29 June 2023 by Scott Cawley Ltd., using a methodology adapted from the Bird Monitoring Methods - *A Manual of Techniques for Key UK Species* (Gilbert, Gibbons & Evans, 1998).

The Breeding Birds Survey Area covered the lands across the full extent of the Assessment Boundary with an additional 50m buffer, shown in Figures 8.10.1-8.10.15. Lands within the Survey Area were slowly walked between dawn and 12 (noon) in a manner allowing the surveyor to come within 50m of all habitat features. Birds were identified by sight and song, and general location and activity were recorded using the British Trust for Ornithology (BTO) species and activity codes.

The survey dates are provided in Table 8.2 of the updated EIAR. The Survey Area locations are shown in Figures 8.10.1-8.10.15.

2.2.3.1 Survey Limitations and Divergence from Standards – Breeding Birds

Access was denied by landowners to a small number of land parcels. These areas of no survey access generally related to residential areas and smaller sections of semi-natural habitats, particularly between Aughnacurra and the River Corrib and in the Upper Dangan area. Notwithstanding this issue, the data generated was sufficient to inform the baseline of the Project and there are no limitations imposed on the ability to complete an impact assessment and mitigation strategy for breeding birds. All surveying was conducted in optimal weather conditions, with no rain or high winds. The surveys lasted for the full 75 minutes, as stipulated by the methodology followed (BTO/Heward *et al*., 2015). All sites surveyed featured habitats conducive to breeding birds.

2.2.4 Wintering Birds

General wintering bird surveys were undertaken, once per month, between December 2022 and March 2023 and between September 2023 and March 2024 by Scott Cawley Ltd. using a methodology based on the Bird Monitoring Methods - *A Manual of Techniques for Key UK Species* (Gilbert, Gibbons & Evans, 1998).

The Survey Area covered the lands within a 300m buffer along the entire length of the footprint of the Assessment Boundary, as shown in Figure 8.13.1. Lands were initially surveyed visually using binoculars/scope from a vantage point(s) at the edge of the Survey Areas followed by a walkover of the area to identify birds which may not be visible from a distance (e.g. waders) or cryptic species such as snipe, and evidence of usage by wildfowl such as swans or geese (e.g. droppings).

Birds were identified by sight and general location and activity were recorded using the British Trust for Ornithology (BTO) species and activity codes.

The survey dates are provided in Table 8.2 of the updated EIAR. The Survey Area are shown in Figure 8.13.1.

2.2.4.1 Survey Limitations and Divergence from Standards – Wintering Birds

There were several limitations to these surveys. Weather conditions over the winter period were interchangeable with some periods of heavy rainfall, limiting visibility on some occasions. Surveyors overcame this limitation by walking the fields previously surveyed via vantage point to ensure full coverage of all areas.

Small discreet individual land parcels across the Study Area were not accessed due to landowners / interested parties refusing access. Where possible these land parcels were viewed from adjacent land holdings and from public roadways. Overall this is not considered a significant limitation given the small discreet areas involved across the extent of the Project.

2.2.5 Barn Owl Surveys

Field surveys were conducted between the 07 May and 03 December 2023 to confirm Barn Owl occupancy and breeding status at all accessible sites identified as potentially suitable. The survey methodology employed followed the methods as defined by the *Survey and Mitigation Standards for Barn Owls to inform the Planning, Construction and Operation of National Road Projects* (TII, 2021).

All sites which were accessible received a day-time inspection to determine suitability for breeding Barn owl based on nesting opportunities available and to search for signs (*e.g.* Barn Owl pellets, whitewash, moulted feathers) to indicate the presence of Barn Owls. For sites at which a day-time inspection could not effectively determine the presence of Barn Owls, a nocturnal survey was conducted to confirm Barn Owl occupancy. All information on Barn Owl sightings and reports were collated to identify potential areas where tree nesting Barn Owls may occur within the Survey Area. At all sites or areas where evidence of Barn Owls was confirmed, a nocturnal survey was carried out to determine the breeding status of the site.

The Survey Area for the Barn owl incorporated the Assessment Boundary and a 5km buffer. This zone of influence was informed by the 'Survey and Mitigation Standards for Barn Owls to inform the Planning, Construction and Operation of National Road Projects' which requires assessment of the potential impacts to Barn Owl within a 5km radius of the preferred route option(s) (TII, 2021).

The extent of the zone of influence for Barn Owl surveys and for assessing the impacts to Barn Owls is based on the home range ecology of the species to incorporate all nest sites which may be potentially impacted by the development of a National Road Project (within 5km from the route) (Lusby *et al.,* 2021).

Information on the presence and distribution of Barn Owl within the zone of influence (henceforth Survey Areas) was collated from available sources, including published sources, a survey of Barn Owls in County Galway (Lusby *et al.,* 2022), survey reports (Lusby *et al.,* 2021, 2021a, 2022), The National Biodiversity Data Centre, through consultation with BirdWatch Ireland and collating reports of the species in the relevant area.

The results and associated data derived through the survey of Barn Owls within the Study Area between 2014 and 2016 for the 2018 EIAR (Refer to Appendix A.8.15 of the updated EIAR) was also interrogated to identify sites where the presence of Barn Owl was confirmed during this survey and to identify sites which were considered to be suitable for the species in the area surrounding the Project at the time of the 2014 – 2016 surveys.

To identify all structures potentially suitable for breeding Barn Owl within the defined survey area, aerial imagery was assessed in addition to visually assessing buildings within the Survey Areas which were possible to view from public access roads in May 2023. This assessment was carried out to identify sites which could be used by breeding Barn Owl to inform the field surveys.

The location details of all sites determined to be potentially suitable for Barn Owl were recorded. The landowners of these sites were identified, where possible, to request permissions to access these sites to undertake a thorough investigation of the site, which included an inspection of the suitability of the site for Barn Owl, a search for signs to indicate Barn Owl presence and/or a nocturnal survey. At sites where it was not possible to identify the relevant

landowners using these approaches, nocturnal surveys were conducted from public roads, where this was deemed to be a reliable method of establishing Barn Owl occupancy.

Where access to sites was not possible (landowner could not be identified/contacted or permission to access was not granted), the suitability of these sites for Barn Owl could not be effectively determined; this was recorded as such.

A map of the Barn owl Survey Areas and full details of the report are available in the Barn owl survey report in Appendix A.8.15 – Part 3 (see Figure 1 of that report) of the updated EIAR.

2.2.5.1 Survey Limitations and Divergence from Standards – Barn Owls

Access was denied by landowners to eight of the 58 sites identified as potentially suitable for Barn Owl. All of these inaccessible sites were over 1km of the Project and therefore at reduced risk of indirect impact from the Project. Notwithstanding the inability to access issues at a subset of suitable sites, the data collected in 2023 in combination with the existing data from 2014 – 2016 is sufficient to inform the impact assessment and mitigation strategy of the Project.

2.2.6 Peregrin Falcon Surveys

Field surveys were conducted between 14 April and 26 June 2023 to confirm Peregrine occupancy and breeding status at all accessible sites identified.

The objective of the survey was to determine the breeding status (i.e. if a breeding pair was present and a breeding attempt occurred) and the nest site location to inform potential impacts and mitigation requirements where relevant and necessary. An inspection was carried out of the site to identify signs (e.g. prey remains, whitewash, pellets, etc.) to indicate the presence of Peregrine, followed by vantage point watch/es where necessary to confirm occupancy and breeding status at the particular site.

Information on the presence and distribution of Peregrine within the zone of influence (henceforth the defined Survey Areas) was collated from various sources. The primary sources were the results and associated data derived through the survey of Peregrine Falcon within the Study Area undertaken between 2014 – 2016 to inform the 2018 EIAR (Refer to Appendix A.8.16 of the updated EIAR) and information from consultation with the NPWS in relation to the annual monitoring programme of Peregrine breeding sites in County Galway, which includes all known breeding sites in the defined survey area (Irene O'Brien, pers comm). Other sources of information were also interrogated to collate information on other sites which may not be included in the aforementioned above sources, which included published sources and The National Biodiversity Data Centre.

To inform field surveys, all built-structures, quarries and rocky outcrops which may be suitable for breeding Peregrine were identified within the defined survey area. This included identification of all sites where Peregrine are known to have nested in the last ten years (2014 – 2023) within the defined Survey Areas. This assessment was carried out to identify all sites which could be used by breeding Peregrine to inform the field surveys. The landowners of these sites were identified, where possible, to request permissions to access these sites to undertake a thorough investigation of the site, which included an inspection of the suitability of the site for Peregrine, a search for signs to indicate presence of Peregrine and/or undertake vantage point watches to determine occupancy and breeding status. To avoid duplication of survey effort and unnecessary risk of disturbance to breeding Peregrine, information on occupancy and breeding status of Peregrine at traditional sites was provided by the NPWS for selected quarry sites generated through their annual monitoring programme; these sites were not visited as part of this survey and communication was maintained with NPWS throughout the 2023 breeding season to ensure standardisation of data received. Where access to sites was not possible (landowner could

not be identified/contacted or permission to access was not granted), the suitability of these sites to Peregrine could not be effectively determined; this was recorded as such.

A map of the Peregrine Falcon Survey Areas and full details of the report are available in the Barn owl survey report in Appendix A.8.16 – Part 3 (see Figure 2 of that report) of the updated EIAR.

2.2.6.1 Survey Limitations and Divergence from Standards – Peregrine Falcon

There were no limitations arising from accessibility or other factors which affect the ability to assess and mitigate effects on Peregrine Falcon arising from the Project.

2.2.7 Red Grouse Surveys

Red grouse surveys were undertaken between 02 and 03 March, 15 and 16 March, and 28 and 29 March 2023 by Scott Cawley Ltd.

Species-specific methodologies for red grouse are not available in *Bird Monitoring Methods - A Manual of Techniques for Key UK Species* and *Irish Wildlife Manual, No. 50*. Therefore a methodology adapted from Scottish Natural Heritage (SNH) guidelines (Scottish Natural Heritage, 2017), *Bird Monitoring Methods - A Manual of Techniques for Key UK Species* and *Irish Wildlife Manual, No. 50: The status of Red Grouse in Ireland* (Cummins *et al*., 2010) was applied taking into account the effects of land use, habitat, and habitat quality on their distribution.

The Survey Areas comprised of suitable habitat (heath and bog habitats, and their mosaics, mapped during 2014 surveys for the Project and surveyed for Red grouse in 2014) within a 500m buffer from the Assessment Boundary based on the SNH guidance (Scottish Natural Heritage, 2017). Suitable habitats within the Survey Areas were slowly walked in a manner allowing the surveyor to come within 50m of all habitat features at dawn, where feasible.

Where it was not possible to access areas, vantage points were used to listen out for calling males, and habitats scanned for individual birds for a 15-minute period. Calling males, sightings of individual birds and droppings were recorded and mapped.

The survey dates are provided in Table 8.2 of the updated EIAR.

2.2.7.1 Survey Limitations and Divergence from Standards – Red Grouse

The red grouse survey methodologies were adapted from *Bird Monitoring Methods - A Manual of Techniques for Key UK Species* which states that the surveys to count males should commence one hour prior to sunrise. After the first red grouse survey visit, the starting time of the surveys was amended to sunrise, as a risk assessment conducted by surveyors determined the high risk of injury from falling (including falling into bog pools) from walking on bog and heath in the dark could not be satisfactorily mitigated without affecting survey results (e.g. from additional light spill from a torch).

A later start time in this instance does not compromise the assessment of the presence of Red grouse within the Study Area, considering the majority of the survey area was assessed to be sub-optimal. Considering this, adjusted start time is not considered to be a limitation and sufficient survey data was gathered to fully inform the assessment of impacts on Red grouse.

2.2.8 Woodcock

Woodcock surveys were conducted by Scott Cawley Ltd. using survey methodologies based on BTO Guidelines, which themselves follow methodologies as prescribed in *Current status and recent trend of the Eurasian Woodcock* Scolopax rusticola *as a breeding bird in Britain* (Heward *et al*., 2015).

The Survey area concentrated on discrete, potentially suitable habitats overlapping the Assessment Boundary and 300m buffer. Counts of roding males provide an index of the number of individual male Woodcock within an area. The 2023 survey involved counts of roding males made during the spring and early summer, at fixed preselected points within or adjacent to those woodland areas surveyed in 2015 and 2016, and any additional habitats defined as suitable within the Assessment Boundary, determined from desk studies conducted prior to fieldwork commencing.

These sites included Menlough Woods and the surrounding wooded environs (extending from the River Corrib to Cappagh Road), Cappanabornia (N83), Lower and Upper Dangan, Ardaun (N6) and Bearna Woods), over three visits from 29 May 2023 to 28 June 2023.

Three dusk survey visits were made, at least one week apart, at each site in areas of suitable breeding habitat (i.e. forestry/woodland). Each survey began 15 minutes before sunset and continued for 60 minutes after sunset. In total, each survey lasted 75 minutes, with all aural and/or visual detections of Woodcock recorded.

Count points were positioned as close to the specific woodland habitat(s) under observation, ideally at least 100m from any given woodland edge, and where possible utilising a vantage position that allowed for both maximum coverage of the sky line above the target canopy and those of any adjacent and/or proximal woodland sites included in the survey.

Evenings that were wet or windy were avoided. While woodcock do fly in light rain, higher winds can impact the woodcock breeding flight behaviour. Each flypast is recorded as a separate event (timed to the nearest minute), even if they occur in quick succession. Sometimes more than one Woodcock may fly by together; in these cases the number of individuals in the flypast is recorded.

If no woodcock are detected after two evening visits there is no need to make further visits (Heward *et al*., 2015).

Habitat is likely to have a strong influence upon whether or not a site is occupied by woodcock in the breeding season, and may also help explain why any changes in distribution or abundance may have occurred.

Therefore, basic habitat details were recorded during the surveys, to help characterise the surrounding woodland (within 200m of the count point) and assess its suitability; including woodland type, dominant ground vegetation, and other non-woodland habitats.

The survey dates are provided in Table 8.2 of the updated EIAR. The survey area locations are shown in Figures 8.7.1 to 8.7.15.

2.2.9 Hen Harrier

Separate wintering Hen harrier roosting surveys were carried out between December 2022 and March 2023 and between September 2023 and March 2024 at two locations: Ballindooley Lough and surrounds in the eastern extent of the Project, and the Coolagh Lakes and surrounds in the centre of the Project.

These surveys were carried out by Scott Cawley Ltd., with the survey methodology focused on vantage point surveys of the areas to determine presence/absence of roosting hen harrier at these locations.

Small discreet individual land parcels within the scheme were not accessed due to limitations with landowner permission. Where possible these land parcels were viewed from adjacent land holdings and from public roadways.

The survey dates are provided in Table 8.2 of the updated EIAR.

2.2.10 Reptiles

The survey to record the presence/absence of Common lizard *Zootoca vivipara* was undertaken between 21 – 25 August 2023 and again between 12 – 14 September 2023 by Scott Cawley Ltd. following the methodology described in the *Herpetofauna Workers' Manual* (Gent & Gibson 2003) and in the TII and Highways Agency guidance documents (Highways Agency, 2005; National Roads Authority, 2008a).

Twelve survey sites were selected to cover a representative range of suitable habitat types for the species across the Project, and were located entirely within, partially within, or in close proximity to the Assessment Boundary.

Eight of the survey sites were surveyed as part of the 2015 Common lizard surveys, with an additional four selected in 2023 determined from desk studies conducted prior to fieldwork commencing to identify areas of suitable lizard habitat.

The outer boundary of each survey site was defined by a square hectare (100m x 100m area) and within each site, 10 artificial cover objects (ACOs) (roofing felt tiles or corrugated onduline tiles, each c. 0.5m^2 in size) were placed in suitable habitat most likely to be used by basking reptiles.

The location of each tile was recorded using 12 figure GPS co-ordinates. Each tile was also given a unique reference number to aid in recording the survey results. Each survey site was visited a total of five times during the warmest part of the day and involved the surveyor checking each tile for the presence of lizard at a distance, then close-up and underneath. These surveys were augmented by searches of suitable habitat features over the course of other ecological surveys carried out across the Project.

Only eight of the ten 2015 lizard survey sites were repeated as two of those survey sites could no longer be accessed due to limitations with owner access. To ensure the survey covered sufficient and representative Common lizard habitat across the Study Area, four additional sites were added in the 2023 survey bringing the total number of survey sites to 12.

The survey dates are provided in Table 8.2 of the updated EIAR. The survey area locations are shown in Figures 8.14.1 to 8.14.8.

2.2.10.1 Survey Limitations and Divergence from Standards – Reptiles

Limiting factors for the Common lizard survey were poor weather conditions and restricted land access due to refused access by landowners. Two of the survey days for sites 7 – 13 were cold and wet (13 and 15 September) and, therefore, unsuitable for surveying. To ensure these sites were surveyed during suitable weather conditions, additional survey days were undertaken a from 25 – 27 September.

Only seven of the eleven 2015 lizard survey sites were repeated, as four of those survey sites could no longer be accessible due to refused access by landowners.

To ensure the survey covered sufficient and representative common lizard habitat across the assessment boundary, six additional sites were added in the 2023 survey bringing the total number of survey sites to thirteen.

2.2.11 Amphibian Surveys

An assessment was undertaken of the suitability of surface water features, such as watercourses, drainage ditches and ponds, for amphibian species (Common frog *Rana temporaria* and Smooth newt *Lissotriton vulgaris*) within and immediately adjacent to the Project.

The amphibian habitat suitability assessment was carried out in conjunction with the Terrestrial Mammal surveys. Where potential habitat was present, surveys were undertaken using methodology adapted from *National Roads Authority (NRA) Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes* (National Roads Authority, 2009), and *Northern Ireland Environment Agency (NIEA) Newt Surveys NIEA Specific Requirements* (Northern Ireland Environmental Agency, 2017).

Suitable habitats within the Assessment Boundary were surveyed once during daytime hours, with this daytime survey including visual checks, hand-searching and sweep-netting of suitable habitat features. Follow-up dusk torching surveys were carried out at all features deemed to be suitable to support smooth newt.

Smooth newt surveys were undertaken on the 26 – 28 April, 17, 18, and 29 – 31 May and 01, 06, and 07 June 2023 by Scott Cawley Ltd. using a methodology adapted from National Roads Authority (NRA*) Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes* (NRA, 2008), and *Northern Ireland Environment Agency (NIEA) Newt Surveys NIEA Specific Requirements* (Northern Ireland Environmental Agency, 2017).

The Survey Areas comprised of suitable habitat (ponds, pools and slow flowing ditches) identified across the Assessment Boundary during the wintering bird and previous habitat surveys. This included a resurvey of suitable habitat for Smooth newt originally surveyed in 2015, where these were still accessible and present. Suitable habitats within the Survey Areas were surveyed once during daytime hours, with this daytime survey including visual checks, hand-searching and sweep-netting of suitable habitat features. Follow-up dusk torching surveys were carried out at all features suitable to support Smooth newts.

The survey dates are provided in Table 8.2 of the updated EIAR. The survey area locations are shown in Figures 8.14.1 to 8.14.8.

2.2.11.1 Survey Limitations and Divergence from Standards – Amphibian and Amphibian Habitat Surveys

Individual land parcels across the Study Area were not accessed due to limitations with landowner permission to access lands. This resulted in two (2) of the previously surveyed areas to not be reevaluated in 2023.

This was not considered a significant limitation given the prevalence of the Smooth newt and Common frog across Ireland and the small number of locations which could not be resurveyed representing a small proportion of the total suitable habitat resource for these species, with a number of additional areas surveyed in 2023.

2.2.12 Aquatic Surveys

Triturus Environmental Ltd. were commissioned by Scott Cawley Ltd. to conduct baseline aquatic surveys. Aquatic surveys were undertaken in August and September 2023.

Undertaken on a catchment-wide scale, the surveys provide a 2023 baseline assessment of the aquatic ecology, including fisheries and biological water quality, as well as protected species and habitats in the vicinity of the Project, inclusive of proposed watercourse crossings.

All freshwater watercourses which could be affected directly or indirectly by the Project and associated infrastructure (e.g. bridges) were considered as part of the current assessment.

This included riverine watercourses crossed by and in the vicinity of the Project. A number of lakes (5) adjoining the Project were also surveyed. Thus, a total of 31 sites were selected for detailed aquatic assessment.

The courses and nomenclature for the watercourses surveyed followed Environmental Protection Agency (EPA) mapping.

Riverine survey sites were present on the River Corrib (EPA code: 30C02), Knocknacarragh Stream (31K16), Tonabrocky Stream (31T13), Bearna Stream (31B01), Oddacres Stream (31O05), Loughinch Stream (31L26), Cloghscoltia Stream (31C36), Trusky Stream (31B02), Freeport Stream (31F04), Forramoyle West Stream (31F01), Newvillage Stream (31N03) and several unnamed streams. A total of five. lakes were also surveyed, namely Ballindooley Lough and unnamed adjacent pond, Coolagh Lough (upper), Coolagh Lough (lower) and an unnamed lake at Menlo.

The aquatic survey sites were located in the Carrowmoneash (Oranmore)_SC_010, Corrib_SC_010 and Knock[Furbo]_SC_010 river sub-catchments within hydrometric areas 30 (Corrib) and 31 (Galway Bay North).

Aquatic surveys of the riverine watercourses within the vicinity of the Project were conducted on 29, 30 and 31 August 2023. Lake survey sites were undertaken on 01, 07 and 08 September 2023.

Survey effort focused on both instream and riparian habitats at each aquatic sampling location. Surveys at each of these sites included a fisheries assessment (electro-fishing and or fisheries habitat appraisal), White-clawed crayfish survey, macrophyte and aquatic bryophyte survey and (where suitable) biological water quality sampling (Q-sampling) or macro-invertebrate sweep sampling.

Environmental eDNA was also collected to support these surveys by helping detect cryptic species in addition to profiling fish assemblages at the lake sites using metabarcoding.

This holistic approach informed the overall aquatic ecological evaluation of each site in context of the Project and ensured that any habitats and species of high conservation value would be detected to best inform mitigation.

In addition to the ecological characteristics of the site, a broad aquatic and riparian habitat assessment was conducted utilising elements of the methodology given in the Environment Agency's *River Habitat Survey in Britain and Ireland Field Survey Guidance Manual 2003* (EA, 2003) and the Irish Heritage Council's *A Guide to Habitats in Ireland* (Fossitt, 2000). This broad characterisation helped define the watercourses' conformity or departure from naturalness. All sites were assessed in terms of:

- Physical watercourse/waterbody characteristics (i.e. width, depth, channel form) including associated evidence of historical drainage
- Substrate type and relative condition, listing substrate fractions in order of dominance (i.e. bedrock, boulder, cobble, gravel, sand, silt etc.)
- Flow type at riverine sites by proportion of riffle, glide and pool in the sampling area
- An appraisal of the macrophyte and aquatic bryophyte community at each site
- Riparian vegetation composition and bordering land use practices

The survey dates are provided in Table 8.2 of the updated EIAR. The survey area locations for all the Aquatic surveys are shown in Figure 8.16.1.

2.2.12.1 Fisheries assessment (electro-fishing)

A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish sites on watercourses in the vicinity of the Project in August and September 2023 following notification to Inland Fisheries Ireland, under the conditions of a Department of the Environment, Climate and Communications (DECC) licence. The survey was undertaken in accordance with best practice (CEN, 2003; CFB, 2008) and Section 14 licencing requirements.

Furthermore, a fisheries habitat appraisal of the aquatic survey sites, inclusive of five lake sites was undertaken to establish their importance for salmonid, Lamprey, European eel (*Anguilla anguilla*) and other fish species. The baseline assessment also considered the quality of spawning, nursery and holding habitat for salmonids and Lamprey within the vicinity of the survey sites.

The fisheries appraisal for the lakes was accompanied by eDNA lake metabarcoding to profile the fish stocks.

2.2.12.2 eDNA analysis

To validate site surveys and to detect potentially cryptically-low populations of high conservation value species within the Study Area, composite water samples were collected from lake sites L1, L2, L3, L4 and L5 and analysed for White-clawed crayfish, Crayfish plague (*Aphanomyces astaci*), European eel and Smooth newt (*Lissotriton vulgaris*) environmental DNA (eDNA).

Given the paucity of fisheries data, composite eDNA metabarcoding[20] samples were also collected from Ballindooley Lough (L1), Coolagh Lough (upper) (L2) and Coolagh Lough (lower) (L3) to provide a complete list of all fish species present at each site. This metabarcoding approach utilises fish environmental DNA to establish the full spectrum of fish species present that can be missed by other sampling methods.

In accordance with best practice, a composite (4000ml) water sample was collected by walking the entire perimeter of each lake site, thus maximising the geographic spread at the site and increasing the chance of detecting target species' DNA. The composite sample was then filtered and fixed (preserved) on site using a sterile proprietary eDNA sampling kit, with the filter volume recorded for each site (1000ml).

The fixed sample was stored, in the dark, at room temperature and sent to the laboratory for analysis within 48 hours of collection. DNA from each filter was extracted in the lab using a commercial DNA extraction kit with a protocol modified to increase DNA yields.

DNA was purified to remove inhibitors using a commercial purification kit. Purified DNAs were amplified with polymerase chain reaction (PCR) for a hypervariable region of the 12S rRNA gene to target fish within each sample. A total of n = 12 PCR replicates were analysed for each lake site.

[20] Metabarcoding entails using high throughput sequencing (HTS) to determine the sequence information from a pool of genetic material, which can then be linked to a DNA barcode database, hence the name metabarcoding (Deiner *et al*., 2017). In contrast to eDNA sampling (maximum of 4 specified species per sample), metabarcoding analyses entire taxonomic groups (e.g. fish) and provides a complete list of all species detected within a sample

2.2.12.3 Biological water quality (Q-sampling)

The 27 no. riverine survey sites were assessed for biological water quality through Q-sampling in August to September 2023. All samples were taken with a standard kick sampling hand net (250mm width, 500µm mesh size) from areas of riffle/glide utilising a 2-minute kick sample, as per Environmental Protection Authority (EPA) methodology (Feeley *et al*., 2020). Large cobble was also washed at each site for 1-minute (where present) to collect attached macro-invertebrates (as per Feeley *et al*., 2020).

Samples were elutriated and fixed in 70% ethanol for subsequent laboratory identification to species level. Samples were converted to Q-ratings as per Toner *et al*. (2005) and assigned to WFD status classes. Any rare invertebrate species were identified from the NPWS Red List publications for beetles (Foster *et al*., 2009), mayflies (Kelly-Quinn & Regan, 2012), stoneflies (Feeley *et al*., 2020) and other relevant taxa (i.e. Byrne *et al*., 2009; Nelson *et al*., 2011). Macrophytes and aquatic bryophytes

Surveys of the macrophyte and aquatic bryophyte community were conducted by instream wading at each of the survey sites, with specimens collected (by hand or via grapnel) for on-site identification.

An assessment of the aquatic vegetation community helped to identify any rare macrophyte species listed under the Flora (Protection) Order, 2022 and or Irish Red list for vascular plants (Wyse-Jackson *et al*., 2016) or habitats corresponding to the Annex I habitats, e.g. Floating river vegetation [3260].

2.2.12.4 Lake macro-invertebrate communities

The 5 no. lake sites were sampled for macro-invertebrates via sweep netting in September 2023. A standard pond net (250mm width, mesh size 500µm) was used to sweep macrophytes and submerged vegetation to capture macro-invertebrates. The net was also moved along the lake bed to collect epibenthic and epiphytic invertebrates from the substratum (as per Cheal *et al*., 1993). A 3-minute sampling period was employed.

To ensure appropriate habitat coverage, the sampling period was also divided amongst the range of meso-habitats present at the survey sites to get a representative sample for sub-habitats.

2.2.12.5 Aquatic vegetation surveys

The Aquatic Vegetation survey was undertaken by Nick Stewart and Bob Ludgate on 28 – 30 August 2023. A small inflatable boat was used to access along the river, launched from Menlo Pier. The boat survey extended from the meeting of the River Corrib and Friars Cut, around 500m upstream of Menlo, down to the Quincentenary Bridge, including the channel on the eastern side of Jordan's Island.

The vegetation was examined by grapnelling at regular along the course of the river, looking for areas of vegetation and recording the species present and their abundance on a three-point scale. As much of the channel was found to be unvegetated because of depth, this meant that attention was mostly concentrated along the margins and around islands.

Downstream of the Quincentenary Bridge, the river was examined on foot from publicly accessible points, ai from the edge and wading where feasible. Downstream of the Salmon Weir the river splits into several channels, including the Eglington Canal and all of these were examined from the Weir to the first bridges downstream.

However, the main channel, downstream of the Salmon Weir, was inaccessible due to high containing walls and it was only possible to view this visually from above.

The survey dates are provided in Table 8.2 of the updated EIAR. The survey area locations are shown in Figure 8.16.1.

2.2.12.6 Survey Limitations and Divergence from Standards – Aquatic Baseline and Fisheries asset of the survey area

The River Corrib was not surveyed during catchment wide surveys carried out during 2020 as part of the National Research Survey Programme that informs WFD assessment (Gordon *et al*., 2021), and thus limited data exists for the river between Lough Corrib and the Galway Weir based on recent fisheries survey data.

2.2.13 Invertebrates

2.2.13.1 White-clawed crayfish survey

White-clawed crayfish *Austropotamobius pallipes* surveys were undertaken at the aquatic survey sites in August – September 2023 under a National Parks and Wildlife (NPWS) open national licence (no. C24/2023), to capture and release crayfish to their site of capture. As per Inland Fisheries Ireland aquatic biosecurity recommendations, the crayfish sampling started at the uppermost site(s) of the catchment/sub-catchments in the survey area to minimise the risk of transfer invasive propagules (including crayfish plague) in an upstream direction.

Hand-searching of instream refugia and sweep netting was undertaken according to Reynolds *et al*. (2010). An appraisal of white-clawed crayfish habitat at each site was conducted based on physical habitat attributes, water chemistry and incidental records in mustelid spraint.

Additionally, a desktop review of crayfish records within the wider survey area was completed.

The survey dates are provided in Table 8.2 of the updated EIAR. The survey area locations are shown in Figure 8.81.1

2.2.13.2 Marsh Fritillary

Two hundred and fifty-six polygons were initially investigated to identify suitable marsh fritillary habitat in 2014 by Woodrow Sustainable Solutions (refer to Appendix A.8.13 of the updated EIAR). These surveys identified 105 suitable marsh fritillary habitat polygons, with an area of c.80.6 ha. The minimum polygon size was set to 0.2 ha. Sites smaller than this size, while they may host Marsh Fritillary in years when populations are large, are likely to be too small to host a self-sustaining population of the species.

A total of 180 polygons were investigated in 2023 within the Assessment Boundary, within the vicinity, the wider localities of the Galway metropolitan area and bordering the Galway County/City Councils' respective boundaries. The size of the survey area in 2023 was c.194.3 ha. The polygons identified for investigation based on the results generated by Woodrow Sustainable Solutions in 2014 (refer to Appendix A.8.13 of the updated EIAR) and by BEC Consultants in 2013 (refer to Appendix A.8.14 of the updated EIAR).

Marsh fritillary surveys were conducted over two phases: the first to record habitat suitability; the second, to undertake habitat condition assessments and locate larval webs.

The aim of the habitat suitability survey (conducted between 14 – 31 August 2023) was to determine the extent of suitable habitat within or adjacent to the Assessment Boundary. The area of suitable habitat mapped for the species across the Study Area in 2014 totalled approximately 110ha, spread over 139 distinct habitat patches—the densest clusters of which were concentrated around the bog/heath/scrub/wet grassland habitat mosaics at Na Foraí Maola, Lough Inch, An

Chloch Scoilte, Ballard, Na hAille, Cappagh and Tonabrocky. Of the suitable habitat patches in these areas, larval webs were recorded in 39 (in total covering an area of c.60ha).

Other factors assessed which influence habitat suitability included: the presence or absence of tussocks, sward height and percentage cover of other flora species including *Molinia caerulea* which, when present with *S. pratensis*, is often where marsh fritillary occur.

An assessment of the abundance of *S. pratensis* and *M. caerulea*, measured as percentage cover, was conducted within areas of suitable habitat along pre-determined zig-zag transects. Areas of $1m^2$ quadrats separated by an approximate distance of 10 to 20 paces were searched along the zig-zag transects to determine their suitability for supporting larval webs.

Following the identification of suitable habitat areas, a second phase of surveys was undertaken between 04 – 20 September 2023 to classify habitat condition and to determine the presence/absence of larval webs using the methodology outlined in the *Marsh Fritillary Monitoring Scheme*[21]. Habitat condition was determined alongside the larval web surveys. Some important aspects of habitat conditions included: evidence of grazing by livestock, slope, and exposure. Additionally, if seen, the presence of adult butterflies in flight was recorded.

Surveys comprised searching for larval webs (typically found beneath the leaves of *S. pratensis*). The search was carried out in $1m^2$ quadrats which were surveyed at approximate intervals of 20m along a pre-determined zig-zag transect within the suitable habitat. As part of the larval web surveys, the vegetation height was split into three categories (1: 5 – 12cm, 2: 12 – 25cm and 3: >25cm), signs of disturbance by livestock were also recorded.

The abundance of devil's-bit scabious was described under the following categories:

- Frequent
- Widespread
- Patchy (locally abundant)
- Patchy sparse
- Rare
- Surveyors conducted presence/absence searches for larval webs within the $1m^2$ quadrats.

Where larval webs were present, the number of webs was recorded and whether webs were active or inactive was noted. Larval web's locations were recorded. Inactive webs where present (i.e. from the previous year) were also noted. Table 3 outlines the details of when Phase 1 and Phase 2 were conduct, Table 4 outlines the comparison of areas from the previous survey and the 2023 surveys.

[21] https://biodiversityireland.ie/app/uploads/2021/11/Marsh-Fritillary-Habitat-Condition-Form.pdf (NBDC, 2021a), https://biodiversityireland.ie/app/uploads/2021/11/Marsh-Fritillary-Larval-Survey-Form.pdf (NBDC, 2021b)

Table 3: Ecological surveys and survey dates

Survey	Survey Date(s)	Surveyor(s)
Phase 1 survey (habitat suitability)	14 to 31 August 2023	Scott Cawley Ltd. (Siofra Quigley, Alison Bourke, Jared Bennett and Tim Redmond)
Phase 2 survey (larval web search)	04 to 20 September 2023	Scott Cawley Ltd. (Siofra Quigley, Jared Bennett, Sorcha Shanley, Aoife Fogarty, Cian O'Flaherty and Jamie Dempsey)

Table 4: Marsh fritillary details

Category	Published 2019 (polygon areas)	2023 results (polygon areas)
Total survey area	936 ha (196)	194.32 ha (180)
Suitable habitat (excluding Phase 2)	80.6 ha (105)	52.38 ha (43)
Suitable habitat (Phase 2 only)	-	50.5 ha (39)
Total potentially suitable habitat	-	75.02 ha (44)
Inaccessible	1.2 ha (3)	14.71 ha (11)
Denied access	10.5 ha (1)	39.06 ha (47)
Not suitable	-	13.05 ha (35)

2.2.13.3 Survey Limitations and Divergence from Standards – Marsh fritillary

Surveys to inform the 2018 EIAR were undertaken over two seasons between 2013 and 2014. Marsh fritillary populations are dynamic, with populations varying between years and with suitable sites (e.g. habitat containing their food plant *Succisa pratensis*) undergoing cyclical colonisation and extinction events. Completion of surveys across two seasons provided an insight into the cyclical nature of populations at some sites which was not replicated in 2023 as surveys in 2023 were conducted across a single season. Nonetheless, the 2023 surveys in this instance have been used to supplement, verify and support the information gathered in 2013 and 2014 and the absence of surveys from a second season does not impose any limitations on the ability to assess and mitigate for any impacts on Marsh Fritillary.

Other variables that may have influenced the outcomes of surveys in 2023 were:

- Variable weather conditions, comprising a dry June and abnormally wet July and August, which may have impacted survival of adult and larval Marsh fritillary.
- A fire which is known to have occurred in June 2023, and is likely to have affected Marsh fritillary populations at Tornabrocky. This site previously harboured large numbers of larval webs during surveys in 2014.
- Access was refused to a large proportion of proposed survey locations, with a smaller proportion of proposed survey locations inaccessible due to dense scrub encroachment. This limitation has been overcome by the adoption of results from the 2013 and 2014 surveys for the purposes of assessment of sites where access was refused by landowners.

2.3 References

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